ENVIRONMENTAL PROTECTION AGENCY - GHANA

NATIONAL IMPLEMENTATION PLAN OF THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS

(2018 REVISED EDITION)

ACCRA, JUNE 2019

ACKNOWLEDGEMENTS

The successful preparation of the updating/revision of Ghana's first National Implementation Plan (NIP) for the Stockholm Convention on Persistent Organic Pollutants (POPs) is another success story of a multi-stakeholder collaboration for the sound management of chemicals and wastes in Ghana. The hard work, cooperation and support by all national stakeholder institutions and individuals deserve recognition and appreciation.

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John A. Pwamang
Ag. Executive Director,
Accra, June 2019

FOREWORD

Persistent Organic Pollutants (POPs) are among emerging global chemicals management concerns which demand urgent concerted action by governments, industry, civil society and the international community to reduce their negative impacts on human health and the environment.

This project was coordinated by the Environmental Protection Agency in the framework of the Global Environment Facility Expedited Enabling Activity "Review and Update of the National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants (POPs) in Ghana (UNEP Contract Number: PCA/2014/003/Ghana P1-33 GFL-000464)". The Global Environment Facility (GEF) funded the preparation of the Review and Updated NIP with the United Nations Environment Programme (UN Environment) acting as the GEF Implementing Agency.

Mr. Daniel S. Amlalo, the Executive Director of the Environmental Protection Agency served as the National Project Coordinator, whilst Dr. Sam Adu-Kumi, Ag. Director of the Chemicals Control and Management Centre (the Project Coordinating Unit) of the Environmental Protection Agency served as the National Project Coordinator.

Ghana's National Implementation Plan (NIP) elaborates the current POPs situation and details the commitments and ongoing activities for the control and management of POPs. The focus of the NIP is in line with the National Environmental Action Plan, and the Ghana Government's Coordinated Programme of Economic and Social Development Policies 2017-2024 among others. The implementation of the NIP constitute an important step towards meeting the commitments of the World Summit on Sustainable Development whose goal is to ensure that, by 2020, chemicals are produced and used in ways that minimize their significant adverse effects on human health and the environment. The NIP ultimately seeks to contribute to the achievement of the United Nations 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs).

The necessity in promoting synergies among related Multilateral Environmental Agreements (MEAs) notably the Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal, the Rotterdam Convention on Prior Informed Consent (PIC) Procedure for Certain Chemicals and Pesticides in International Trade, among others is highlighted in the NIP.

Recognizing that the environment is the common heritage for present and future generations, the Government of Ghana will endeavour to support the implementation of the measures, actions and activities outlined in the NIP to reduce and ultimately eliminate POPs and other toxic substances from Ghana. All the POP- pesticides covered by the Stockholm Convention have long been prohibited from use in Ghana. The challenges for the country therefore pertain mainly to PCBs, Brominated Flame Retardants, Per- and Polyfluoroalkyl Substances (PFAS), unintentionally produced POPs (dioxins and furans amongst others) from uncontrolled combustion processes and the management of sites contaminated by POPs and other toxic substances. The Action Plans of the updated NIP outlines priority areas that require attention for Ghana to realize the objective of the Stockholm Convention of protecting human health and the environment from the harmful impacts of POPs. The areas include the following:

- Information, education and communication strategy to create awareness on POPs;
- Improvement in policy and legal framework;
- Institutional strengthening and capacity building;
- Development of appropriate and environmentally sound technologies, cleaner production and promotion of Best Available Techniques (BAT) and Best Environmental Practices (BEP); and
- Development of infrastructure and technical capabilities for analyzing POPs in biota and various environmental media.

It is envisaged that the updated National Implementation Plan will be serve as a living document to reflect future decisions made by the Government of Ghana and by the Conference of the Parties such as amendments to the Convention or its annexes, including the addition of chemicals to Annexes A, B or C.

I wish to thank all national stakeholders and our global development partners whose immense contributions made the preparation of the current edition of the NIP possible. This Plan is certainly one of the most important elements towards Ghana's full compliance with the Stockholm Convention on POPs, and it significantly represents Ghana's contribution to the protection of the global environment.

Professor Kwabena Frimpong Boateng
Minister Of Environment, Science, Technology and Innovation
June, 2019

ABBREVIATIONS AND ACRONYMS

AG	Attorney General
AGI	Association of Ghana Industries
AMCEN	African Ministerial Conference on Environment
ATL	Akosombo Textiles Limited
AU	African Union
BAT	Best Available Technique
BCF	Bioconcentration Factor
BECE	Basic Education Certificate Examinations
BEP	Best Environmental Practice
BOST	Bulk Oil Storage and Transport
CAS	Chemical Abstract Service
CBO	Community Based Organisation
CCMC	Chemicals Control and Management Centre
CEG	Criteria Expert Group
CEPS	Customs Excise and Preventive Service
CIEN	Chemical Information Exchange Network
COP	Conference of Parties
COCOBOD	Ghana Cocoa Board
CRIG	Cocoa Research Institute of Ghana
CSIR	Council for Scientific and Industrial Research
DA	District Assembly
DANIDA	Danish International Development Agency
DDD/ DDE	Metabolites of Dichlorodiphenyltrichloroethane
DDT	Dichlorodiphenyltrichloroethane
DEMC	District Environmental Management Committees
DVLA	Driver and Vehicle Licensing Authority
EAP	Environmental Action Plan
EC	Emulsifiable Concentrate
ECG	Electricity Company of Ghana
ECOG	Evergreen Club of Ghana
ECOLAB	Ecological Laboratory of University of Ghana
ECOWAS	Economic Community of West African States
EIA	Environmental Impact Assessment
ELISA	Enzyme Linked Immunosorbent Assay
EPA	Environmental Protection Agency
EPC	Environmental Protection Council
EPR	Extended Producer Responsibility
ESM	Environmentally Sound Management
FAO	Food and Agriculture Organisation of the United Nations
FCUBE	Free Compulsory Universal Basic Education
FDB	Food and Drugs Board
FOE	Friends of the Earth - Ghana
GAEC	Ghana Atomic Energy Commission
GBC	Ghana Broadcasting Corporation
GDP	Gross Domestic Product
GEF	Global Environment Facility
GES	Ghana Education Service
GHAFF	Ghana National Association of Farmers and Fishermen
GHANED	Ghana Environmental Database
GHS	Ghana Health Service
GHS	
GIZ	
GNFS	Global Harmonised System for Labelling and Classification
German	Technical Cooperation
GNFS	Ghana National Fire Service
GNPC	Ghana National Petroleum Corporation

GRATIS	Ghana Regional Appropriate Technology Information Service
GSB	Ghana Standards Board
GTV	Ghana Television
GWCL	Ghana Water Company Limited
HBCD	Hexabromocyclododecane
HCB	Hexachlorobenzene
HCBD	Hexachlorobutadiene
IARC	International Agency for Research on Cancer
IFCS	Intergovernmental Forum on Chemical Safety
IIR	Institute of Industrial Research
INC	International Negotiating Committee
IOMC	Inter-Organisation Programme for the Sound Management of Chemicals
ISD	Information Services Department
I-TEQ	International Toxicity Equivalence
KAPB	Knowledge, Attitudes, Practices and Behaviour
KATH	Komfo Anokye Teaching Hospital
KNUST	Kwame Nkrumah University of Science and Technology
Kow	Octanol/Water Partition Coefficient
LC50	Lethal Concentration 50
LD50	Lethal Dose 50
LI	Legislative Instrument
LPG	Liquefied Petroleum Gas
MCT	Ministry of Communication and Technology
MDAs	Ministries, Departments and Agencies
MEA	Multilateral Environmental Agreement
MOPSD-PSI	Ministry of Private Sector Development and President's Special Initiative
MOI	Ministry of Information
MLGRD	Ministry of Local Government and Rural Development
MOFA	Ministry of Food and Agriculture
MOTI	Ministry of Trade and Industry
MP	Member of Parliament
MSDS	Material Safety Data Sheet
MSTQA	Metrology, Standards, Testing and Quality Assurance
MWRWH	Ministry of Sanitation and Water Resources
NBSSI	National Board for Small Scale Industries
NCT	National Coordinating Team
NEPAD	New Partnership for Africa's Development
NGO	Non Governmental Organisation
NIP	National Implementation Plan
NLCD	National Liberation Council Decree
NMIMR	Noguchi Memorial Institute for Medical Research
NOEC	No Observable Effect Concentration
NRCD	National Redemption Council Decree
PBDEs	Polybrominated diphenyl ethers
PCBs	Polychlorinated biphenyls
PCDDs	Polychlorinated dibenzo-p-dioxins
PCDFs	Polychlorinated dibenzofurans
PCN	Polychlorinated Naphthalenes
PCP	Pentachlorophenol
PFAS	Per- and polyfluorinated alkylated substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PIC	Prior Informed Consent
PNDCL	Provisional National Defence Council Law
POPs	Persistent Organic Pollutants
POPROC	Persistent Organic Pollutants Review Committee
PPM	Parts Per Million
PPP	Polluter Pays Principle
PPRSD	Plant Protection and Regulatory Services Directorate

PRTR	Pollution Release Transfer Register
PSCE	Parliamentary Select Committee on the Environment
PSI	President's Special Initiative
SAICM	Strategic Approach of International Chemical Management
SES	Safe and Environmentally Sound
TCDD	Tetrachlorodibenzo-p-dioxin
TDI	Tolerable Daily Intake
TEQ	Toxicity Equivalents
TOR	Tema Oil Refinery
UG	University of Ghana
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organisation
UNITAR	United Nations Institute for Training and Research
USA	United States of America
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
VALCO	Volta Aluminium Company
VRA	Volta River Authority
WHO	World Health Organisation
WRI	Water Research Institute

Pieces of possible PCB-containing capacitors found at the Achimota power station in Accra

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EXECUTIVE SUMMARY

Introduction

Persistent Organic Pollutants (POPs) are highly toxic substances released into the environment through human activity. They cause an array of adverse effects, notably, diseases and birth defects among humans and animals.

Aware that POPs pose major and increasing threat to human health and the environment, in May 1995, the Governing Council of the United Nations Environment Programme (UNEP) requested in its decision 18/32 that an international assessment process be undertaken of an initial list of 12 POPs (the so-called "dirty dozen"). These are: aldrin, chlordane, DDT, dieldrin, endrin, hexachlorobenzene (HCB), heptachlor, mirex, toxaphene, dioxins (PCDD), furans (PCDF) and polychlorinated biphenyls (PCBs).
An Inter-Governmental Negotiating Committee (INC), mandated to prepare an international legally binding instrument for implementing international action, started its work in June 1998 in Montreal, Canada, and concluded same in Johannesburg, South Africa, in December 2000. The INC also established an expert group to develop criteria and a procedure for identifying additional POPs as candidates for future international action as well as a number of immediate actions to address POPs.

The Stockholm Convention on Persistent Organic Pollutants (POPs) was adopted and opened for signature at a Conference of Plenipotentiaries held from 22 to 23 May 2001 in Stockholm, Sweden. Ninety-two (92) States and the European Community signed the Convention at a ceremony in Stockholm on 23 May 2001. The Stockholm Convention entered into force on 17 May 2004, 90 days after the submission of the fiftieth instrument of ratification. Ghana signed the Convention on 23 May 2001 in Stockholm, Sweden, and ratified it on 30 May 2003. The Convention entered into force for Ghana on 17 May 2004.

The first Conference of the Parties (COP1) of the Stockholm Convention in 2005 adopted the initial list of twelve POPs classified as Annex A (Elimination), Annex B (Restriction) and Annex C (Unintentional Production). Since its fourth meeting in 2009, the COP has decided to amend Annexes A, B and C to the Convention. As at the end of COP8 held in 2017, there were 28 chemicals listed as Annexes A, B or C of the Convention. The following are the new 16 chemicals added the Convention:

- Alpha hexachlorocyclohexane
- Beta hexachlorocyclohexane
- Chlordecone
- Hexabromobiphenyl
- Hexabromocyclododecane
- Hexabromodiphenyl ether and heptabromodiphenyl ether (commercial octabromodiphenyl ether)
- Hexachlorobutadiene
- Lindane
- Pentachlorobenzene
- Pentachlorophenol and its salts and esters
- Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF)
- Polychlorinated naphthalenes
- Technical endosulfan and its related isomers
- Tetrabromodiphenyl ether and pentabromodiphenyl ether (commercial pentabromodiphenyl ether)
- Decabromodiphenyl ether (Commercial mixture, c- DecaBDE)
- Short-chain chlorinated paraffins (SCCPs)

Objective of the Stockholm Convention

The objective of the Stockholm Convention is to protect human health and the environment from persistent organic pollutants. This is consistent with the precautionary approach set forth in Principle 15 of the Rio Declaration on Environment and Development.

Preparation of National Implementation Plans

Article 7 of the Convention requires Parties to prepare National Implementation Plans (NIPs). A National Implementation Plan is a formal planning document, which defines a country's commitments, current situation and actions it plans to undertake in the fields of POPs management. Elements of Article 7 include the following:

- Transmission of implementation plan to the Conference of the Parties within two years of the date on which the Convention enters into force.
- Review and update, as appropriate, implementation plans on periodic basis as specified by a decision of the Conference of the Parties.
- Cooperating directly or through global, regional and sub-regional organizations, and consultation with national stakeholders, including women's groups and groups involved in health of children, in order to facilitate the development, implementation and updating of their plans.

- Establishing the means to integrate national implementation plans for persistent organic pollutants in their sustainable development strategies where appropriate.

Ghana prepared its first NIP in 2007. The addition of a number of chemicals to Annexes A, B or C of the Convention, following the initial list of twelve POPs adopted by the first Conference of the Parties (COP1) in 2005, necessitated the need for Parties to review and update their NIPs in accordance with decision SC-1/12.

The current revision of the NIP includes all 23 chemicals listed in Annexes A, B or C of the Stockholm Convention as of COP-6.

Ghana's Commitment to Implement the National Implementation Plan of the Stockholm Convention on POPs

Sound Management of Chemicals and Hazardous Waste in Ghana and the 2030 Agenda for Sustainable Development

Ghana, through the Environmental Protection Agency, has been playing a lead role in promoting sound management of chemicals and hazardous wastes (including POPs) for industrial, agricultural, public health and consumer uses, in order to avoid damage to human health, the ecosystems, and the environment in general. Ghana has also signed on to the 2030 Agenda for Sustainable Development and has initiated the process to incorporate the 17 Sustainable Development Goals (SDGs) into its Medium Term Development Plan.

Sound management of chemicals and wastes is central to achieving the three dimensions of sustainable development (namely social, economic, and environment) and consequently the SDGs, aimed at addressing poverty, food security. Securing human rights particularly for women, children and vulnerable populations, as well as linkages to climate change and protection of biodiversity could also be realised through sound management of chemicals.

The SDGs have many links to chemicals and waste management with SDG specifically devoted to the subject under the theme: Sustainable Consumption and Production. Sound management of chemicals and waste also has impacts on SDG 3 (Good Health and Well-being) and SDG 6 (Clean Water and Sanitation). Goal 12 aims to achieve, by 2020, the environmentally sound management of chemicals and all wastes throughout their life-cycle and significantly reduce their release to air, water and soil. Goal 3 on the other hand, seeks to reduce substantially, by 2030, the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.

At the country level, several national stakeholders contribute to a wide range of activities aimed at promoting the life-cycle approach to the sound management of chemicals and hazardous waste.

Ghana prepared a national profile for the sound management of chemicals in 1997. The profile provided a comprehensive assessment of the national chemicals management infrastructure relating to the legal, institutional, administrative and technical aspects, along with an understanding of the nature and extent of chemicals availability and use. A national action programme for an integrated chemicals management in Ghana, was also initiated in 1997.

Relevant International Commitments and Obligations

Ghana supports international efforts towards the sound management of chemicals and hazardous wastes and participated fully during the negotiations of all the existing chemicals-related multilateral environmental agreements (MEAs) and frameworks. The conventions provide international legal frameworks for the sound management of chemicals throughout their life-cycle and include the following:

- The Minamata Convention on Mercury (2013);
- The Strategic Approach to International Chemicals Management (SAICM) (2006);
- The Stockholm Convention on Persistent Organic Pollutants (POPs) (2001);
- The Rotterdam Convention on Prior Informed Consent (PIC) Procedure of certain Pesticides and Chemicals in International Trade (1998);
- The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989);
- Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa (1994);
- FAO International Code of Conduct for the Distribution and Use of Pesticides (as amended in 2003);
- ILO Convention on the Safety of Chemicals at the Workplace (1990);
- The UN Convention on Substances that Deplete the Ozone Layer (Vienna Convention) (1985);
- Montreal Protocol on Substances that Deplete the

Ozone Layer (1987);

- London Amendment of the Montreal Protocol on Substances that Deplete the Ozone Layer (1990);
- UN Chemicals Weapons Convention (1993);
- The provisions of the Rio Declaration on Environment and Development and Agenda 21 (1992).

Apart from the Bamako Convention all the above Conventions and Frameworks have been ratified and steps are being taken to domesticate and implement them at the country level.

Assessment of the POPs Issues in Ghana

Comprehensive inventories have been carried out to ascertain the status of POPs in Ghana in order to facilitate early and continuous actions on the implementation of the Convention. The inventories, which covered all 23 chemicals, listed in Annexes A, B or C of the Convention as of COP-6 revealed the following:

Assessment of Institutional, Policy and Regulatory Framework for the Sound Management of POPs

As required by its Policy Statement on the Environment, the Government of Ghana is expected to "take appropriate measures, irrespective of the existing levels of environmental pollution and extent of degradation, to control pollution and the importation and use of potentially toxic chemicals". This expectation from government has necessitated the need for a more comprehensive policy on toxic substances (including POPs) for the country.

Act 490 provides a regulatory framework for the sound management of potentially bioaccumulative and toxic substances, which include POPs in Ghana. This framework is however inadequate and incapable of dealing with the specific requirements of the Convention.

In 2013 a comprehensive national policy on POPs was approved and adopted by Cabinet, which aims at the life-cycle management and control of POPs and also for identification, decontamination, and remediation; and restricts of POPs contaminated lands, in line with Ghana's obligation under the Stockholm Convention on POPs. The policy proposes the development of a new legal legal framework or the amendment of an existing legal regime to give effect to Ghana's obligations under the Convention. The policy in effect seeks the domestication in a national legal framework, of Ghana's obligations under the Convention.

Considering the scope of Act 490 regulations could be adopted under section 26 to ban and phase-out the importation, sale, transfer and use of POPs. Among the provisions to be covered under the regulations are the following: scope, definitions, annual reports; requirements for handling, storage, labelling, treatment and disposal, spill prevention and clean ups, storage facility closure, insurance and surety bonds. The policy also prescribes that separate technical guidelines should be developed to facilitate the effective implementation of the regulations once adopted.

Besides the national policy on POPs, a more a more comprehensive policy and regulatory framework that covers all chemicals in Ghana must be developed. Such framework is envisaged to be developed under the five-year strategic action plan (2018-2022) on sound management of chemicals and hazardous wastes towards the achievement of the 2020 goals of the Strategic Approach to International Chemicals Management (SAICM) & and the 2030 Sustainable Development Goals (SDGs).

Multi-Sectoral and Multi-stakeholder collaboration

A framework exists for multi-sectoral and multi-stakeholder collaboration in the control and management of chemicals in the country. It is made up of representatives of Ministries, Departments and Agencies (MDAs) such as the Plant Protection and Regulatory Services Directorate (PPRSD) of the Ministry of Food and Agriculture, Ghana Standards Authority, Ghana Atomic Energy Commission, Customs Division of the Ghana Revenue Authority, Ministry of Health/Ghana Health Service, Food and Drugs Authority, Narcotic Control Board, NGOs, the universities and research institutions, who participate in committee meetings aimed at sound management of chemicals and hazardous wastes in the country. The Agency plays a coordinating role.

Chemical Legislation on POPs and Gaps Analysis

There are several chemicals-related legislation in Ghana but there is lack of coordination among the regulatory bodies responsible for their operation. Although these laws are not specific to POPs, they have some relevance to the POPs listed in the Convention, and provide a framework for the management of other chemicals and pesticides including POPs. Many of these laws however, do not adequately address the dangers posed to humans and the environment by the chemicals under the Convention. Where they may be relevant, the institutions that deal with them do not have the resources to monitor or research into their disposal as required by the Convention. The existing chemicals-related laws are listed in the main text.

Pesticides

Part 11 of Act 490 on Pesticides Control and Management, is the regulatory framework for the control and management of all pesticides in Ghana. This law addresses the registration of all pesticides prior to their use in Ghana, including POPs pesticides. The law also recognizes the need for the safe handling and use of pesticides and reflects this through provisions for licensing of persons or entities engaged in all pesticide use activity such as retailing, commercial pest control, importation, manufacture, formulation, distribution, use and transportation of pesticides. Issues regarding safeguards to pesticide use such as the use of personal protective equipment have been provided in the law with stated penalties for non-compliance. additionally, the law also has provisions for the listing or registration of pesticides as banned pesticides.

Presently, all the listed POP pesticides have been banned under Act 490 for all uses and listed in the register of pesticides. In view of the fact that none of the POPs pesticides are being used in Ghana, the country does not require specific exemptions/acceptable purposes for further usage of POPs pesticides.

PCBs and other POPs Wastes

Significant progress has been made toward strengthening the legal framework with regards to PCBs and other hazardous substances. The Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917) and the Hazardous, Electronics and other Wastes (Classification), Control and Management Regulations, 2016 (LI 2250) comprehensively deal with all hazardous wastes, including POPs wastes, under the Convention as well as those covered under the Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal. Act 917, which deals with importation, exportation, transportation and notification procedures, empowers the Agency to ensure that PCBs and other POPs-related wastes are regulated.

An LI specific to PCBs would be required to comprehensively address PCB=related issues. Technical and environmental guidelines for implementing a PCBs regulatory framework, have been developed. An administrative system for PCB-related enforcement and inspection activities has been also been developed and is in operation. Ghana Revenue Authority (Customs Division) and the Agency currently conduct industrial and import inspection for PCBs and PCB-containing equipment. The Ghana Revenue Authority (Customs Division) has also been provided with an L–2000 PCB Analyser for use at points of entry to prevent PCBs inflow.

Polybrominated diphenyl ethers (PBDEs)

Plastics in electronic products are a major use area of polybrominated diphenyl ethers (PBDEs). C-OctaBDE was used as additive brominated flame retardant (BFR) mainly in ABS plastic in cathode ray tube (CRT) casings and other plastics in electronics. Currently, there is no known legislation on the importation of used computers and TVs in the country and there is also no import duty paid on computers and accessories. There is however a specific regulation, LI 1932, 2008 on Energy Efficiency with relevance to EEE and WEEE. LI 1932 prohibits the manufacture, importation, sale or distribution of incandescent filament lamp, used refrigerators, used refrigerator-freezers, used freezers and used air-conditioners as well as the sale and distribution of used refrigerators, freezers and air-conditioners. This law is however silent on the importation of used computers and TVs. This is in line with the policy decision by the government to ensure that such EEE are made accessible to Ghanaians to help improve the computer literacy rate. Therefore, importers only pay Value Added Tax (VAT) and other levies. An importer who is able to prove (by letter from the Ministry of Finance) that the computers and accessories are meant for donation or charity, is even exempted from paying VAT. This has led to an alarming influx of EEE (and WEEE) into the country, most of which are second-hand equipment. The policy direction on ICT and demands of the current information and digital age, are major drivers for the high per capita EEE import and use, as well as e-waste generation in Ghana.

No regulation or management policy for PBDEs currently exists in Ghana. Large amounts of plastics containing PBDEs are still in use and are indiscriminately disposed of at the end of their lives, creating outdoor reservoirs for the future dispersal of PBDEs into the environment. A concerted action is needed not only to regulate the importation and use of POP-PBDEs containing articles into Ghana, but also to find ways to effectively manage waste electrical and electronic products and end of life vehicles that contain PBDEs. Comprehensive regulations are needed covering the life-cycle management of e-waste, end of life vehicles and construction waste. Besides LI 2250, 2016, there is no regulatory framework addressing end of life vehicles and their management.

Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride (PFOS/PFOSF)

There is no specific legal regime for PFOS. Section 10 of Act 490 establishes a Hazardous Chemicals Committee to advice the Agency on the regulation and management of hazardous chemicals and to perform any other function

relating to chemicals. The Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917) also provides for the control, management and disposal of hazardous wastes among other things. A regulatory framework for PFOS and related substances need to be developed for the effective implementation of the NIP.
The capacity and practical experiences in PFOS/PFOSF management in Ghana is limited. There are no Apart from the lack of specialized laws that control and manage PFOS/PFOSF in Ghana (except for partial coverage under Act 490 and Act 917, the capacity and practical experience in PFOS and PFOSF management in Ghana are very limited.
The Agency collaborates with, Customs Division of GRA and the Ghana National Fire Service on issues of importation, monitoring and application of PFOS and PFOSF. Procedures and other capacities for PFOS and PFOSF waste including empty containers, are lacking.

Institutional Gaps

In addition to the numerous uncoordinated pieces of legislation and regulations, there are also a number of institutions whose activities impinge on POPs management, regulation and enforcement. Each of these institutions has either/or a combination of usage, management or regulatory functions. Their functions are often uncoordinated, with some institutions experiencing conflicts in the execution of duties leading to duplication of efforts and waste of resources. Public awareness of the requirements of the existing laws is low and this affects the level of compliance.

Assessment of POPs Pesticides (Annex A, Part I Chemicals)

Pesticides have been used extensively in Ghana since pre and post-independence times, mainly for agriculture, public health, vector control, animal health and other household pest control purposes. Available data suggest that the use of pesticides have increased over the years mainly due to the high cost of labour and the relatively easy access, reduction in drudgery and cheaper cost of pesticides. Government subsidy and other promotional interventions to boost agricultural production, which is the mainstay of the Ghana economy, have also contributed immensely to the rise in pesticides use. Organochlorines, and organophosphates were the predominant group of pesticides in use in the past. Later developments led to the gradual phasing out of the organochlorines with an increase in the use of organophosphates and also the introduction of the carbamates and pyrethroids and the biopesticides. As the use of pesticides increased, the negative impact on human health and the environment became widely reported including cases of some fatalities. In addition, some studies have also confirmed the presence of organochlorines the use of which had ceased many years earlier but which still persist in the environment. This attests to the persistent nature of POP pesticides.

There has not been any previous and current production of POP pesticides in Ghana and the country does not envisage any possibility of producing POP pesticides in the future.

There is only one company in Ghana, Wynca Sunshine Agric Products that is permitted to undertake the formulation of technical grade Glyphosate, imported from China. Almost all the pesticides used in the country are imported and there has been a general increase in quantities imported over the past few years, especially herbicides. Importation (past and present) has mainly been in the form of formulated products, which are meant for agriculture and public health purposes.

Official importation of all POPs pesticides (including the initial nine (9) POPs pesticides of the “dirty-dozen”, as well as endosulfan and lindane) listed under the Convention, have been banned or ceased since 1985. Currently there are no records of importation of new POPs pesticides into Ghana.

Assessment of Polychlorinated Biphenyls (Annex A, Part II Chemicals) and Polychlorinated Biphenyls-Containing Equipment

Available information indicates that there has never been any production of PCBs in Ghana. All PCBs in Ghana were the result of the importation of PCB-containing equipment (mainly transformers and capacitors).

Significant quantities of PCB-containing transformers and capacitors were identified according to the the preliminary inventory carried out in 2003 during the development of the first NIP. The investigations confirmed that some 2-3 % of the transformers sampled, contained pure PCBs and a further 13 % were PCB contaminated to a level higher than the threshold set in the Stockholm Convention. The update of the first NIP provided an opportunity to re-assess the situation in relation to management of PCBs.

PCB applications by location include, electric utilities (including distribution networks), industrial facilities, residential and commercial buildings. In Ghana, the main potential PCB-containing applications at the target locations, were found to be transformers and capacitors (closed applications). Available information indicated

that the Electricity Company of Ghana (ECG) officially ceased importing PCB-containing transformers and capacitors for use in Ghana, in 1972. Statistics on national imports and the nature of such imports (including quantity and type) were however not available to allow the estimation of potential volumes of such uses.

ECG as well as the Volta River Authority (VRA) and their clients (individual customers and industry) are the major users of PCB-containing equipment in Ghana. The main potential PCB-containing applications at the target locations, were found to be transformers and capacitors (closed applications). Plasticizers constitute the largest source (open applications) of PCB releases in Ghana. Other open applications may include certain paints, fire retardants and lubricants.

The preliminary inventory carried out in 2003 revealed that there were about 455 pre-1972 possible PCB containing transformers (11kV and 33kV) found countrywide. One hundred and forty-seven (147) pieces of possible PCB-containing capacitors were found at the Achimota and Tema power stations. Though there was an administrative directive by the Electricity Company of Ghana Limited (ECG) to ban the importation of PCBs and PCB-containing equipment into Ghana in 1972, there was the possibility that the post–1972 transformers may also contain significant amounts of PCBs as a result of, for example, retrofilling with possible PCB contaminated mineral oils.

Nine thousand, nine hundred and seventy-two (9,972) pieces of transformers and capacitors out of the estimated 12,000 or 83.1% were inventoried as at June 2013. A small but significant number of equipment in the northern part of the country was yet to be assessed.

The density test was preliminarily employed in the field to identify pure transformer oil contaminated with PCBs. In the major screening the L–2000 PCB Analyser was used to determine the levels of concentration of each sample.

Significant capacity building activities for key stakeholders namely, government enforcement agencies, PCB holders such as electricity companies and the private sector, have been undertaken through a series of workshops. Customs Officers were successfully trained and are currently utilising the adopted PCB guidelines & agreement on implementations and procedures for targeted identification and procedures at customs entry points. PCB holders have been trained in the safe handling of PCBs and PCB containing equipment, including their temporary storage and transportation. PCB holders have also received technical support for the development of phase-out and disposal management plans. The major holders of transformers (i.e. Volta River Authority, GRIDCo and Electricity Company Ghana) have developed and implemented systems for prevention of reintroduction of PCBs, detection and management potential PCB-containing electrical equipment. For detection, all key stakeholders have been provided with a Chlorinated Organic analyser (L-2000). The Ghana Atomic Energy Commission has trained all technicians and relevant staff handling electrical equipment on the use of the Analyser.

Assessment of Polybrominated Diphenyl Ethers (POP-PBDEs) (Annex A, Part IV and Part V Chemicals) and Hexabromobiphenyl (HBB) (Annex A, Part 1 chemicals) and Hexabromocyclododecane (HBCD)

An inventory on POP-PBDEs was carried out in 2016. The inventory covered the major articles that can be impacted with POP-PBDEs, namely the electrical and electronic equipment (EEE) and related waste (WEEE), the transport sector and to some extent furniture. It focuses mainly on identifying the relevant use categories and life cycle stages of these sectors. Other use categories of POP-PBDE such as insulation materials for buildings were not addressed in this inventory since they were considered of less relevance in and required monitoring for a useful assessment. Also HBB was not specifically addressed since the major use was in the 1970s with a relatively small volume. Furthermore, since the applications were in the same use sectors as POP-PBDEs (e.g. plastic of electronics, PUR foams in transport) the possible remaining HBB in products is expected to be managed together with the POP-PBDE material flows.

Data from Ghana Revenue Authority (Customs Division) on the import of TVs and PCs/Laptops (both new and used), was obtained for the period 2006 to 2014. The records indicate that for the 9-year period, a total of 8,802,892 units (220,072 tonnes) of TVs and PCs/Laptops were imported.

Despite difficulties in obtaining data on new and used EEE, as statistical data does not distinguish between these two categories of products, the studies in Ghana, revealed that in 2009, around 70 % of all imports were used EEE. 30 % of the used EEE imported was determined to be non-functioning (hence should have been defined as e-waste): half of this amount was repaired locally and sold to consumers and the other half was un-repairable. It is unclear how much of the remaining used imported EEE functioned for a reasonable time after it was sold. Almost all of the collected material reaches the informal recycling sector.

The data of imported new and second hand EEE (tonnes 2006-2014) and the corresponding POP-PBDEs are documented. A sharp increase in the amount of import of used PCs/Laptops and TV sets were discovered between 2011 and 2013, with corresponding increase in POP-PBDEs. Furthermore, the value for imports in 2008 was low and did not fit into the trend with high imports in 2011 and 2013. The explanation given from the data source, showed a possibility of mix-up in data handling. However, import of TV sets decreased considerably in 2013 and 2014 (probably due to enforcement of a law on import of WEEE into Ghana).

The amount of EEE entering the waste stream (WEEE) is important for planning the waste and resource management of this critical material flow within a country. The amount of POP-PBDE that entered the waste stream (for the year 2009), was derived from the Ghana e-Waste Country Assessment, 2011 which shows the order of magnitude, which might be similar today. In total, 810,400 tonnes of category 3 WEEE with 7.5% CRT monitors (60,780 tonnes including 18,233 tonnes CRT plastic); and 872,000 tonnes of WEEE in category 4 with 42.5% CRT TVs (370,600 tonnes including 111,172 tonnes CRT plastic), were entering the end-of-life stream and needed to be managed as waste. Therefore, the total estimated amount of POP-PBDE content, were 46 tonnes for CRT monitors and 97 tonnes for CRT TVs.

The import of used cars, buses, trucks and other transport, represents a major and ongoing source of POP-PBDEs, particularly for low and middle-income countries like Ghana, and therefore needed to be quantified. Based on available data from the Driver and Vehicle Licensing Authority (DVLA), the total amount of PUR foam alone in imported second hand vehicles that needed to be managed in an environmentally sound manner from this period, was estimated at 3804 tonnes for the period 2010-2014.

The total estimated amount of c-PentaBDE (tetraBDE, pentaBDE, hexaBDE and heptaBDE) in imported vehicles for the period 2010-2014, was estimated to be 3.3 tonnes, out of which 2.6 tonnes were in cars/trucks and 0.7 tonnes in buses, contained in the 3804 tonnes of PUR foam. This shows that POP-PBDEs listed in 2009 under the Stockholm Convention are imported within used vehicle. It was noted that DecaBDE was still used in vehicles and is present in vehicles produced after 2004.

Vehicles in use represent a major stock of POP-PBDEs and are important for the future planning of waste management of the transport sector. The inventory of POP-PBDEs is directly relevant to the implementation of the Stockholm Convention. The estimated amount of c-PentaBDE (tetraBDE, pentaBDE, hexaBDE and heptaBDE) in imported vehicles in use and stockpiled for the period 2000-2009, was found to be 32.64 tonnes in the 154,833 tonnes of PUR foam. It was also estimated that 37,600 vehicles out of which approximately 95 % have been produced before 2005, were potentially impacted by POP-PBDEs.

Additionally, vehicles may reach end-of-life due to accidents. Statistics from the Ministry of Roads and Transport indicated that there were 6,384 crashes involving 9,914 vehicles between January and June, 2015 and hence approximately 19,828 for the whole inventory year of 2015. Considering that 50% of these vehicles have also reached end-of-life, the total amount of end-of-life vehicles was approximately 45600 vehicles. The total amount of PUR foam in vehicles entering the end-of-life category in 2015 that needed to be managed in an environmentally sound manner, was estimated at 750 tonnes. The total polymers in these vehicles were estimated to be 6840 to 9120 tonnes, based on total polymer content of 150 to 200 kg per vehicle. The estimated amount of c-PentaBDE (tetraBDE, pentaBDE, hexaBDE and heptaBDE) in these impacted end-of-life vehicles in 2015, was estimated at approximately 1.5 tonnes.

The overall use of c-PentaBDE in PUR foam in furniture is estimated to represent approximately 60 % of total production but actual levels are closely linked to the flammability standards in a country. Ghana has no specific flammability standards for furniture/mattresses and it is therefore considered to have low levels of POP-PBDEs in furniture and mattresses. However, there has been a tremendous importation of furniture from China into the country for over a decade but is uncertain whether China has specific flammability standards (such as the United States and United Kingdom).

The data collected from Ghana Export Promotion Authority under the Ministry of Trade and Industry on furniture, was therefore not used for the estimation of POP-PBDEs because no flammability standard exists for these articles in Ghana and it was therefore assumed that PBDEs were not used in furniture. These and other products need to be checked for bromine using sliding spark or handheld XRF equipment. Analysis of samples that tested positive, could then determine the c-PentaBDE content (or reveal other BFRs present).

There is no record on POP-PBDEs-containing furniture and mattresses in Ghana, thus an inventory of the amount of historically deposited POP-PBDEs-containing

furniture, mattresses, rebond and related material, was difficult to prepare in order to assess the environmental risks that may arise from wastes in landfills.

A preliminary assessment of HBCD in the construction and textile sector, did not lead to quantifiable results. For the insulation foams, it could not be clarified if polystyrene used in Ghana contained HBCD or not. There is no monitoring capacity to assess if polystyrene used in construction contained HBCD. Also for textiles, it could not be clarified if e.g. uniforms of fire fighters and army or curtains used in public places contained HBCD due to the lack of labelling of these textiles. Also for such an assessment monitoring capacity would be needed. For the transport sector most likely some of the textiles or polymers are treated with HBCD (or DecaBDE) as revealed by a study in Japan.

Currently it is not known what flame retardants are used in Ghana (e.g. in the textile industry, polymer production or construction). Also it is not known what alternative flame retardants are imported in products such as polymers or textiles. It is suspected that DecaBDE (which was listed in Stockholm Convention at its 8th COP meeting in 2017 with a range of exemptions) is partly used or is dpresent in these articles and processes. There is an urgent need to assess what alternatives are used and what alternatives are imported in articles to Ghana.

The most effective alternative would be to find non-halogenated substitutes for POP-PBDEs. Currently, decabromodiphenyl ethane, with several positive environmental attributes and economic viability, has been deemed as a suitable substitute for decaBDEs. Non-halogenated flame-retardants such as phosphorus or mineral based compounds, have also been gaining attention in recent years.

Further assessment is needed and might be done within the context of the sustainable chemistry approach.

Assessment of DDT (Annex B, Part I chemicals)

DDT had been used extensively in Ghana in the past for both agriculture and public health purposes. The Ministry of Food and Agriculture, the Ghana Cocoa Board and the Ministry of Health, were the major importers of DDT prior to its ban. DDT was officially used in agriculture as the main insecticide against cocoa capsids and for malaria and filariasis control programmes by the Ghana Cocoa Board and Ministry of Health respectively. There is general paucity of data on DDT import and application in Ghana. There is also no information on export of any kind.

Information obtained from the Ministry of Health shows that in the late 1950s and the early 1960s, DDT was used for indoor residual treatment and malaria control in Ho, in the Volta Region. However, there are no available figures on quantities imported or used for that activity. Information obtained from the Cocoa Research Institute of Ghana (CRIG) at Tafo, indicates that, DDT was introduced in Ghana (then Gold Coast) after the Second World War for use on cocoa farms. In 1944-1945, 2.5% DDT formulation was recommended for use against capsids on cocoa since this formulation made excellent emulsion.

Other DDT formulations that were used at the time were: (a) 10% DDT dusting powder- against mealy bugs and ants and (b) 25% DDT fog applied with smoke generators – against capsids and mealy bugs. Apart from the "Square Mile" area at CRIG (Tafo), DDT was also used extensively at Akwadum and Adonkwanta areas in Eastern Region. In the early 1950s DDT was replaced with Gamma-BHC (Lindane) and used extensively on cocoa in Ghana.

Information gathered from the Ghana Statistical Service as part of the initial NIP, indicated that there had been some unofficial importation of DDT into the country in the recent past. The current inventory review did not register any DDT stocks in the country. There was a high level of awareness among the users that DDT is banned and hence illegal to possess in Ghana.

Assessment of PFOS, its salts, PFOSF and related substances (Annex B, Part I chemicals)

Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF) are fully fluorinated compounds. They are commonly used as salts or incorporated into larger polymers. Perfluorooctane sulfonyl fluoride (PFOSF) is used as an intermediate to produce different PFOS related substances (approximately 165 substances).

PFOS and related substances have been used in different industrial and consumer applications and products since 1950s. The perfluorinated carbon chain has both hydrophobic and lipophobic properties. They can repel grease, dirt as well as water. These unique properties make them valuable for various industrial and consumer applications as surface-active substances.

PFOS/PFOSF are present in aqueous film forming foams (AFFFs) that are used to extinguish flammable hydrocarbon liquid fires by rapidly discharging oxygen from fire environment.

There is no production of PFOS/PFOSF and related substances in Ghana. All products and articles, which may contain PFOS/PFOSF and related substances in Ghana, enter the country through importation. As Ghana is a signatory to the Stockholm Convention, official importation of PFOS and related substances is prohibited since there are currently no exemptions listed. However, PFOS might be imported to the country unrecognized in products.

Information on industries producing products which potentially use PFOS including producers of cleaners and surfactants, paper production, paint production, plastic industry or furniture industry, indicated that none of these industries in Ghana was manufacturing products or articles containing PFOS or its related substances.

Other industries suspected to possibly use products containing PFOS and related substances which were assessed included: fire-fighting foam dealers, fire-fighting foam users, the mining sector, the oil and gas industry, metal plating, photography, food packaging. The main users were those, which use fire-fighting foam. For other industries, the use of PFOS could not be confirmed. However, these companies might use other per- and polyfluorinated alkylated substances (PFAS), which are currently not listed (but candidate chemicals) under the Stockholm Convention.

In the PFOS/PFOSF inventory, the main stocks and use were found to be fire-fighting foam from government fire-fighters and other companies. For some of the companies PFOS in fire-fighting foam could be confirmed. For some of the AFFF, it was not clear if they contained PFOS or other PFAS. A detailed inventory (Tier III inventory) is required.

The quantity of suspected specific fire-fighting foam used per year for fire-fighting and the sites where they were used, was gathered from the stakeholders identified, namely Ghana Fire Service, Bulk oil Storage and Transportation Company, Tema Oil Refinery as well as Ghana Ports and Harbour Authority.

In the areas of training exercise, the total quantity of PFOS used was 26833 kg fire-fighting foam containing between 134 kg and 402.5 kg of PFOS.

According to the inventory, the total amount used in actual fire events for the past 20 years was 118,588 kg for fire-fighting which contained an estimated amount of 593 kg to 1,779 kg PFOS and related substances. Since it could not be confirmed if all these foams contained PFOS (also other PFAS might have been released within this amount and for the time period), this can be seen as an upper estimate for PFOS for the identified fire events since the 1990s. Again, PFOS foams have been used since the 1970s, and therefore, the total release of PFOS, via fire-fighting foams, was considerably higher compared to this compilation of the last 20 years.

Assessment of Releases from Unintentional Production of Annex C Chemicals (PCDDs/PCDFs, HCB, PCBs, PeCB)

Polychlorinated dibenzo-*p*-dioxins (PCDDs)/polychlorinated dibenzofurans (PCDFs) together with polychlorinated biphenyls (PCBs), polychlorinated naphthalenes (PCNs), hexachlorobenzene (HCB), pentachlorobenzene (PeCB), and hexachlorobutadiene (HCBD) are listed in Annex C of the Stockholm Convention as unintentionally produced POPs (UPOPs).

As proposed by the UNEP toolkit ("Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs, January 2013"), the inventory focused on PCDD/PCDF since for the sources present in Ghana, the PCDD/PCDF, are indicative for other UPOPs and the reduction of PCDD/PCDF will also address and reduce other UPOPs.

The main sources groups/categories of PCDP/PCDFs present in Ghana have been identified for the inventory year (2015). The emissions of PCDP/PCDF to air, water, land, products and residues for ten source groups, were documented. The inventory estimates were based on industry and statistical data available in Ghana and using the emission factors from UNEP toolkit 2013 (http://toolkit.pops.int/).

Waste incineration, ferrous and non-ferrous metal production, power generation and heating, are the main sources of PCDD/PCDF in Ghana. For these sources also, the most reliable data are available.

A total of 1,929g TEQ of PCDD/PCDF was emitted from known sources compared to 668.2 g TEQ of PCDD/PCDF in the baseline inventory year 2002 (recalculated using the 2013 toolkit). This shows an increase in PCDD/PCDF emissions levels by more than 100%. This could however, to a large extent be attributed to the more comprehensive inventory and availability of data for the 2015 inventory year compared to data collected in 2002. Additionally, some production volumes e.g. for the metal industries, have increased.

The largest source of emissions of PCDD/PCDF to air, according to the inventory, was from the waste incineration sector, which emitted a total of 1081g TEQ/a with major emission to air (1,055 g TEQ/a), corresponding to 56% of the total emissions.

The second largest source were open waste burning of dumpsites. The releases from open waste burning for 2015, was estimated at 487.8 g TEQ/a. The largest share was from open burning on landfills. Waste generated in the country is collected for disposal at designated dumpsites and landfill sites. Open burning of waste occurs at official dumpsites and these may either be accidental, as in most cases or authorized. In all cases, information on quantities of the materials burnt, is very difficult to obtain. Since dumpsite fires are frequent, it is estimated that in over a year, 25% of the waste (around 1,186,250 tonnes) on landfills and dumpsites, is burning or smouldering. This resulted in a total estimated release of 367.8 g TEQ (355.9 g to air and 11.9 g to residues).

Biomass burning was the major source of 2002 inventory. With the change in emission factory the estimated releases have decreased. Furthermore, forest fires are better controlled and have reduced from 24,300,000 tonnes to 8,100,000 tonnes with an estimated release of 9.3 g TEQ/year. Agricultural burning and savannah and grassland fires, have not changed compared to the baseline inventory and are estimated at 9.3 g TEQ/year.

Another relevant source was the heat and power generation sector (178.6 g TEQ/a; 13 % of the total emissions). Major emitter was household heating and cooking with contaminated wood or biomass fired stoves (102.3 g TEQ/a) and stoves with virgin wood (10.1 g TEQ/a) and charcoal fired stoves (2.7 g TEQ/a). Biomass fired power plants with mixed input had an estimated release of 63.5 g TEQ/a.

Another high release (90 g TEQ/a) was estimated for cable smouldering and e-waste burning which is of high concern due to the direct exposure of people at the open burning sites. Other releases from the metal production stem from iron and steel industry (3.7 g TEQ/a) and from lead production (1.6 g TEQ/a).

For chemicals and consumer goods, the major releases were estimated for 2,4-D and derivatives use with 30.4 g TEQ/year. For textile production the release estimate was 1.0 g TEQ/year.

There were some accidental fires with associated releases. Based on data from the Ghana National Fire Service of accidental fires in houses and vehicles for 2015, a release of 2.3 g TEQ from fires in buildings and 0.2 g TEQ from vehicle fires. A number of accidental fires occur in many parts of the country unreported. Therefore, the release from this source is underestimated. Also the releases from bio-mass burning could not be estimated for 2015 due to a lack of data.

Regarding release vectors into compartments, the largest of the emission vector of PCDDs/PCDFs from the various sources, was air (1783 g TEQ/a; 92.4%) followed by residue (75.6 g TEQ/a; 3.9%). However, since PCDD/PCDF are quickly adsorbed by particles and then deposited, the major amount of PCDD/PCDF is finally adsorbed on soil and land.

Information on the state of knowledge on POP stockpiles, contaminated sites and wastes, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites

Preliminary Assessment of Stockpiles of POPs Pesticides, POPs Contaminated Sites and Wastes

Clean Farms Ghana Project

The Clean Farms Ghana Project was initiated to identify obsolete pesticides in the country for safeguarding and final disposal. According the 2011 project report, inventory process registered about 70 MT of obsolete pesticides and an estimated 6 MT of used empty pesticide containers. The identified obsolete stocks comprised POP pesticides, namely endosulfan. The details of the quantities of endosulfan, which were, collected during the Clean Farms Project, is indicated in text.

Pesticide stockpile management with PCB GEF project

The Capacity Building for the Elimination of PCBs in Ghana project, identified by the Clean Farms Ghana Project, was managed and exported disposed of in an environmentally sound manner under the Ghana Project on Capacity Building for the Elimination of PCBs. in Ghana collected. An estimated 110.2MT of obsolete pesticides containing POP pesticides were safely disposed of at the end of the project.

FAO assessment project

There still remain some quantities of obsolete pesticides that have been safeguarded and stored in the temporary storage site in Pokuase, near Accra. Further assessment of

remaining POPs stockpiles is currently conducted within the FAO project. The stockpiles will be collected and shipped for destruction in an environmentally sound manner. There are plans underway to dispose of the remaining obsolete pesticides under the FAO assistance project.

POPs pesticide contaminated sites

Pesticide contaminated sites may arise from locations where pesticides have been stored, buried, formulated, repackaged, accidental spills and warehouse fires. There are a number of small storage units belonging to pesticide retail outlets that as a result of improper management, have leakages and spills that may have led to the contamination of these sites. Some of the contaminated sites identified during the various inventories conducted include, (i) the temporary storage site at Pokuase (TSS); (ii) Crop Services Directorate (CSD) warehouse of Ministry of Food and Agriculture; (iii) warehouses of the Ghana Cotton Company Limited (GCCL), in Tamale. Other sites may include two pesticide warehouses in Kumasi with unspecified quantities of pesticides, which were recently destroyed by fire (iv), and a number of cocoa input warehouses located within the Cocoa growing areas of Ghana.

It was also clear from the inventory that little or no information exist to accurately identify locations where pesticides may have been used and stored in the past. There has not been any investigation done to verify these sites as well as ascertain the level of contamination. A typical example was the findings made during the preliminary inventory under the first NIP that in the early 1970's some quantities of pesticide containers, some of which may be from POPs pesticides, were buried within the premises of the Plant Protection and Regulatory Services Directorate (PPRSD) at Pokuase in the Ga District of the Greater Accra Region as well as at the Tono and Vea Irrigation sites in the Upper East Region. There has not been any effort to locate the exact site for verification and possible remediation.

The current inventory has also brought to light, the fact that, there are a number of warehouses belonging to the Cocoa Input Company, the Ghana COCOBOD, some importers and retail outlets, current and abandoned plantation farms such as the Ejura farms in the Ashanti region, and many others, where pesticide products had been stored and used, even at present and these areas are either contaminated or may be contaminated. A comprehensive investigation may be required to ascertain what kind of contamination exists as well as the levels in all these sites. Additionally, the manner in which responses to the questionnaire were given and the high number of non-respondents, may be attributed to the inadequacy in the level of knowledge of POP pesticides among the respondents.

There are measures in place under FAO assistance project for Ghana to remediate the immediate sites or locations where the stockpiles of obsolete pesticides were stored in Pokuase. There are no remediation measures in place for the remaining contaminated sites identified during the current inventory and mentioned in the report. Consequently, data on releases are not available.

PCBs Stockpiles, Wastes and Contaminated Sites

The Ghana PCB project identified the major stockpiles and their proper handling and management as well as safe disposal of the PCB containing waste streams so as to reduce the releases of these POPs in Ghana and regionally. PCB-containing wastes were found at ECG main sub-station H and the VRA materials stores at Tema. These are primary stations where broken down transformers from all over the country are stored. Obsolete capacitors in the basement of the Achimota Sub-station H were safely moved to a temporary storage site (ECG Training School in Tema) and stored in maritime containers. These comprised 65 pieces of 33 kVA capacitors of 78 kg each and 51 pieces of 11kVA capacitors of 75 kg each giving total of 8,895 kg and 6 tonnes of PCB oils.

A technically sound central storage site was constructed and operated in Accra-Tema area:

- Two (2) forty-footer containers were installed at the main temporary storage site (ECG Training School) in Tema to receive obsolete capacitors from Achimota and Tema;
- Ten (10) pieces of PCB-contaminated transformers that weree out of service and belonging to NEDCO-VRA were transported from Wa and Tamale to the temporary storage site in Tema;
- Twenty-three (23) drums of PCB-contaminated oil that was drained from transformers in service at the Golden Star Wassa Mine, were also transported to the temporary storage site in Tema;
- In total about 40 metric tonnes of PCB wastes are in the temporary storage site in Tema.

The site has since been decommissioned following the PCBs waste disposal. Vehicles used during the transportation of the PCBs waste were in compliance with national and international standards for transportation of dangerous goods, ensuring appropriateness of vehicles used for transport of the PCBs. All PCBs waste, totalling 53 tonnes consisting of

capacitors (pure PCBs), PCBs oils and PCBs contaminated solid waste, were packed and transported out of the country for final disposal in an ESM. The composition was segregated as follows: 9 Mt capacitors (with pure PCBs), 28 Mt of PCBs contaminated oils, 16 Mt of PCBs contaminated solid wastes.

POP-PBDEs Stockpiles, Wastes and Contaminated Sites

Large volumes of e-waste plastic and polymers from cars, have accumulated at dumpsites and at sites where end of life vehicles and WEEE are managed.

Currently there is no specific storage for polymers from WEEE or end of life vehicles in Ghana. There is also no specific collection point or storage for EEE/WEEE or end-of-life vehicles. All the damaged vehicles are sold as scrap, which can be used as sources for spare parts or to the steel recycling industries. Currently a large part of these polymers are finally burned in the open, dumped or otherwise thrown away into the wider environment around road sides or car repair shops and partly end up in the sea contributing to marine pollution.

Also, street vendors collect large quantities of the end-of-life vehicles and domestic electric appliances. Most of those are sold as scrap, which can be used as sources for spare parts, and those that cannot be reused are dismantled manually, and then treated in unqualified workshops, backyards or in unregistered small factories, where the recovery processes are crude and primitive.

Open burning of unwanted scrap and wastes, is a common practice in Ghana. The Stockholm Convention BAT/BEP guidance and the PBDE BAT/BEP guidance, warn about the contents of shredder residues, which are dioxin precursors and may result in the formation of PCDD/F or other dioxin-like compounds when burnt. As a result of these crude operations and associated leakage, evaporation, runoff, and leaching into the environment, many toxic chemicals, such as PBDEs and polybrominated dibenzo-p-dioxins/furans (PBDD/Fs), which are often unwanted and unavoidable by-products of human activities, can enter the environment. In addition, dumping of PBDE containing materials and equipment, also results in additional contamination of dumping sites.

Landfill/dump fires are frequent ae frequent occurrences on Ghanaian dumpsites and this results in the release of PBDE, PCDD/F and PBDD/F. The first monitoring programme of PCDD/F; PBDD/F and other dioxin-like compounds was carried out under a Ghana-Japanese cooperation arragement. Uncontrolled small scale backyard electronic waste recycling, contributes to significant emissions of PBDEs.

This highlights the urgent need for some stringent regulations to control small-scale backyard e-waste recycling operations. Alternative policy approaches are also urgently needed. Such approaches should aim to integrate informal collection with formal recycling: collection and refurbishment or reuse can be handled informally but equipment could then be passed to the formal sector for proper dismantling, recycling and final disposal.

Currently a national policy on plastic waste management is underway. Within this policy also waste plastic from WEEE and EoL vehicles will need to be covered. As a first immediate action the open burning of these plastic and other polymers should be stopped. All polymers should be managed in an environmentally sound manner. The PBDE containing materials should be managed within the collection and management of WEEE and end-of-life vehicles. The ESM of these plastic fractions should be integrated in the overall management of polymers in Ghana.

PFOS, its salts and PFOSF Stockpiles, Wastes and Contaminated sites

Stockpiles of possibly/likely PFOS/PFOSF-containing foams held by different stakeholders have been compiled within the inventory development as of 2016. The inventory indicated that the Tema Oil Refinery and Bulk Oil Storage and Transportation Company involved in petroleum operations have large quantititiesy of stockpiles of PFOS and related substance based foams. The Tema Oil Refinery also commits more of their stock into training activities. The Ghana National Fire Service headquarters handles the purchase of all relevant consumables for the National Fire Service and supply them to the various stations across the country. The Ghana National Fire Service Training School also handles all the training needs of its subsidiaries and substations.

The Tema Oil Refinery and Bulk Oil Storage and Transportation Company are the largest users possibly/likely PFOS/PFOSF-containing foams and this may result from large frequency of incidents and support they lend to other sectors of the state whenever there is a fire outbreak. Annual consumption varies among user categories with figures ranging from 39.33 – 36,000 litres. This is partly related to frequency of incidents and training needs.

For some of the foams confirmation is needed to ascertain whether the foams contain PFOS or other PFAS. Also PFAS containing foams need to be managed when used in firefighting for protection of ground-/surface water and soils.

Stockpiles of likely/possibly PFOS/PFOSF-based firefighting foams and indicated that a total of 63, 014.2 litres or 64, 274.48 kg of PFOS/PFOSF were in the country in 2016. Out of this amount 321.37 kg low net PFOS/PFOSF and 964.12 kg of high net PFOS/PFOSF were released.

Waste generated from application of firefighting foam, expired products and spills, are not scientifically managed in an environmental sound manner at the national level. The waste that is deposited in an area after firefighting, is not treated. The waste storage is in the open area under direct sunlight, therefore the waste at the fire scene is absorbed by the soil, ending in the atmosphere or washed by water that empties into the drains and may finally enter a natural water body.

In the current inventory, no other stockpiles from industrial sectors, articles or insecticides were identified.

Contaminated consumer articles and products like carpets, textiles or paper could also not be addressed in this first PFOS inventory. There are large volumes of synthetic carpets, textiles and furniture in use, which might have been treated with PFOS. Since the major use of PFOS for surface treatment was before 2002, a share of these articles and products have reached their end-of-life and have been disposed of in landfills and dumpsites. Paper products treated with PFOS have alsolargely ended in dumpsites.

PFOS were substituted mainly by other PFAS after 2000. These chemicals are also highly persistent or have persistent degradation products. Therefore PFAS are an emerging policy issue under SAICM and also need to be addressed and managed in Ghana.

PFOS, its salts and PFOSF, have high chemical stability and low volatility. These properties make them persistent in the environment. As a result, they can be found in soil and groundwater as contaminants after decades of use. Waste is not segregated in Ghana and is managed as bulk waste hence different products and articles containing PFOS/PFOSF may enter the waste stream after the end of their useful life. Companies using firefighting foams indicated that their waste is disposed of in the drainage system which finally ends up in sewage water or sludge.

Areas suspected to be contaminated with PFOS/PFOSF and its related salts include, the training and equipment testing sites where fire drills are held, stockpiles storage areas where accidental spill or leakage may occur and fire scenes where large volumes of firefighting foams were used, as well as dumpsites across the country. In the area of training exercise, the total quantity of PFOS used was calculated to 26833.14 kg and this contained between 134.17 kg Low net PFOS/PFOSF and 402.50 kg High net PFOS and related substances.

According to the inventory, the total amount used in actual fire events for the past 20 years was 118,588.15 kg, which contained between 592.94 kg (low estimate) and 1178.82 kg (high) estimate PFOS.

The sites where these foams have been used can be considered contaminated with PFOS-based foams after These are the training and equipment testing sites where fire drills are held, stockpiles storage areas where accidental spill or leakage may occur and fire scenes where large volumes of firefighting foams were used, as well as dumpsites across the country.

Initial screening of rivers and drinking water has been initiated by a study, which revealed that substantial levels of PFOS/PFOSF have been detected in river and drinking water in Ghana.

The study reported contamination of tap water, Pra and Kakum Rivers in the Central Region with PFCs (PFOA, PFOS, PFHxA, PFDA and PFPeA). The mean concentrations of ∑PFCs in the Kakum and Pra Rivers were 280.80 and 397.63 ng/L, while tap water (supplied from the treatment of water from those rivers) contained concentrations of 196.57 and 200.29 ng/L. The risk quotient (RQ) attributed to drinking of tap water was estimated at 1.01 and 1.74 for PFOA and PFOS, respectively. For a country that does not produce these compounds, the risk quotient (RQ) raises concern particularly about contamination from such emerging pollutants in local water sources.

Unintentional POPs Contaminated Sites

A range of potentially UPOPs contaminated site types have been discovered during the inventory development. These sites have however not been assessed for contamination level. The following site types are present in Ghana and need further assessment during NIP implementation.

Application sites of PCDD/PCDF containing pesticides and chemicals

PCP was most probably previously used in Ghana for treatment of wood and leather. The current inventory has found 2,4-Dichlorophenoxy acetic acid (2,4-D), an organochlorine herbicide which is extensively used as defoliant to control water hycinth. However, since the beginning of the last decade, its use has rapidly extended to the control of broad leaf plant in different plantation.

Timber manufacture and treatment sites

Woods that are locally produced for electricity poles or construction might have been treated with PCP leading to associated contamination of these wood treatment sites.

Textile and leather factories

Textile factories and leather tanneries have no specific waste management systems. Sites where wastes from tanneries and textile industry have been disposed of or released, might therefore be contaminated with PCDD/PCDF.

Sites were PCB were used, stored and disposed

The following locations are potentially PCB and PCDF contaminated sites:

- The areas where PCBs are currently stored;
- Areas where PCBs have been stored in the past;
- Areas within companies which do or have done maintenance of transformers;
- Sites where PCB transformers have been used and have experienced leakages;
- Sites where fires involving transformers or condensers have occurred.

Waste incinerator

Releases from waste incinerators in Ghana are high. The areas impacted by releases from these incinerators can become contaminated over time. Also areas where ashes from these incinerators are disposed of or spread, can be considered contaminated.

Metal industries and copper/e-waste smouldering

The releases from copper cable and e-waste burning sites, are high and result in the generation of contaminated sites. Open burning activities of e-waste takes place in Agbogbloshie and smaller sites in Ghana with associated soil pollution and are therefore contaminated.

Fire Accidents

Areas where major fire accidents took place in the past, might be contaminated including the sites where two pesticide warehouses housing an unspecified quantities of pesticides, were destroyed by fire in Kumasi.

Dredging of sediments; contaminated flood plain

Currently there is no information about dredging of sediments in Ghana. Since dams have been constructed for a hydropower plant, sludge could be considered to have been generated through dredging. Also contaminated sludge might be produced from harbours. The extent of these activities, the contamination levels and the fate of this sludge, needs to be assessed during the NIP implementation,

Dumps of wastes/residues

The following areas are dumpsites and landfill sites where wastes have been disposed of:

Sites where ashes from incinerators are disposed of;

Sites where ashes from metal industry are disposed of;

Sites where sludges from textile industry and leather tanneries are disposed of or where tanneries and textile industries released or release their effluents. Most of the large industrial facilities, like tanneries, and textiles dispose of their wastewater either in rivers or open land;

Sites where waste is and have been burned in the open for extended time.

Kaolin or Ball Clay Sites

High concentrations of mainly PCDD were found in mined ball clay from the some African countries, USA and Germany. However, only a part of the Kaolinite is impacted by PCDD. Ghana has clay/kaolin resources and also industrially use the kaolinite. At present no estimation can be made if the Kaolinite in Ghana is impacted by PCDD. This is an important assessment since some woman eat clays in particular during pregnancy and it has been found in some African countries with contaminated clay that this had an impact on elevated PCDD levels in human milk.

Existing programmes for monitoring releases and environmental and human health impacts, including findings

Article 11 of the Stockholm Convention places an obligation on countries to undertake appropriate research on POPs. Studies in this area are however sparse in Ghana. Currently, there is no comprehensive system for monitoring POPs releases in Ghana though the potential sources of POPs have been determined. However, there are on-going studies that provide some estimate of the impact of releases on the population. There is therefore the need for a comprehensive analyses to be conducted to obtain an overall picture of the state of the environment

and human health with regards to POPs releases.

Declaration and Reporting of Priority Pollutant Releases

The EPA has a system in place that requires industrial establishments and other potential sources of pollutants to monitor and report on releases of criteria pollutants. However, these do not specifically address releases of POPs into the environment due to inadequate laboratory infrastructure and analytical capability in the country.

Current Monitoring Activities on POPs

The Agency has in place environmental quality monitoring programmes. The monitoring programmes include the following:

- Monitoring and establishment of the status and trends of air and water quality;
- Compliance monitoring in selected areas and undertakings to establish trends in environmental quality; and
- Quarterly monitoring of effluent quality of industries.

The air quality programme is aimed at collecting and collating baseline vehicular exhaust emissions data for the development of vehicular exhaust emission standards and regulations. The programme forms part of the overall goal of improving urban and roadside air quality under the World Bank Clean Air Initiative for Sub-Saharan African cities. It is envisaged that the programme will be extended in future to measure emissions resulting from Annexes A and C chemicals (PCBs, HCBs and PCDDs/PCDFs), when the requisite capacity is developed. The Agency is also collaborating with other stakeholders to monitor emissions from vehicles.

In collaboration with the Ghana Atomic Energy Commission, the Agency has conducted limited air, water and human milk monitoring studies on all Stockholm Convention POPs since 2007. These constitute part of the GEF funded project undertaken in collaboration with the Stockholm Convention Global Monitoring Plan, and the MONET project activities undertaken in collaboration with the Research Centre for Toxic Compounds in the Environment (RECETOX) of the Czech Republic.

The Council for Scientific and Industrial Research-Water Research Institute (CSIR-WRI) has also conducted limited studies on PCBs, dioxins and furans. However, there is currently no programme for regular monitoring of the POPs.

Monitoring POPs pesticides in the Ghanaian Environment

There is no established system in place to monitor POP pesticides in food, environmental media and in humans as well as the health impact of POP pesticide use. The following are the some of the current monitoring or research activities carried out by some institutions and researchers, as they relate to POPs:

- Pesticide residues in fish from the Densu River Basin in Ghana;
- Pesticide residues in water and sediment from the Densu River Basin in Ghana.

Other Monitoring Activities on POPs

Other research and monitoring activities carried out on POPs in Ghana include the following:

- Epidemiological Studies to examine the extent of pesticide associated symptoms in farmers;
- Assessment of the knowledge, attitudes, and peoples' perception concerning the use of pesticides by farmers;
- Human exposure studies on POPs (PCBs, PBDEs and HBCDs) in Ghana using breast milk;
- Toxicological analysis of human organs and fluids, foods and drinks;
- Monitoring of the pesticide (organochlorine, organophosphorus and synthetic pyrethroids) residue levels in fruits and vegetables; and
- Estimation of dietary intake of pesticides from fruit and vegetables.

The study highlighted the need for further monitoring of these contaminants in Ghana using matrices like fish, food and dust to determine the source(s) of exposure and evaluate possible long-term impacts on human health, especially infants. Many POPs, especially brominated flame retardants (BFRs) are endocrine disrupting chemicals (EDCs), and could have dire consequences on human health.

Challenges to research

The assessment brought revealed the capability of the scientific, research, and regulatory institutions to undertake monitoring and toxicological studies. It was observed that there was limited human resource capacity in the form of multidisciplinary teams such as toxicologists, epidemiologists, occupational health and public health specialists. Funding is however required to facilitate the conduct of toxicological studies and other monitoring studies on POPs in Ghana.

Preliminary Assessment of the Extent of Exposure of the Human Population (Especially Vulnerable Groups) and the Environment to POPs

Identification of impacted populations or environments, estimated scale and magnitude of threats to public health and environmental quality, and social implications for workers and local communities

Health and Socio-Economic Assessment of Persistent Organic Pollutants in Vulnerable Populations of Ghana

A review of the extent of exposure of the human population and environment in Ghana to POPs was carried out. The inventory covered the extent to which POPs is an issue in Ghana with regard to production, use, emission, to assess human exposure particularly that of vulnerable groups.

Exposure to POPs may cause birth and developmental defects, chronic illnesses, serious health problems including cancers, dysfunctional immune and reproductive systems, greater susceptibility to disease, diminished intelligence and death. Studies have shown that many POPs are endocrine disruption chemicals (EDCs) and humans and animals are exposed to POPs mostly through their diet and occupationally. E-wastes are an important source of environmental contamination from PBDEs and other POPs (PCBs, PCDD/Fs) and a wide range of heavy metals (e.g. lead, cadmium, mercury, antimony) in most developing nations such as Ghana. Soil and sediment can be seriously contaminated by crude e-waste recycling operations, which are common in Ghana.

A survey was carried out to identify the impact of POPs on identified key stakeholders, namely refuse dump operatives and scavengers, e–waste handlers, fishmongers, those who singe animals, health service providers from the Ghana Health Service (GHS) and the Volta River Authority and Electricity Company of Ghana (generators and distributors respectively of electricity in Ghana).

The objectives of the study were to identify: (i) areas of use or production of substances containing POPs among vulnerable groups of workers; and (ii) processes that might predispose vulnerable workers to POPs. Groups of persons interviewed, whose activities make them potential generators of POPs included, e-waste workers, general waste dump and landfill site operators and scavengers, fish mongers, health care workers, users and potential users of POPs containing substances: transformer oils.

The methods used consisted of key informant interviews or focus group discussions with various stakeholders whose income generating activities include the use of substances containing POPs or have the potential to generate unintended POPs. Questions sought to explore the understanding of respondents regarding the nature and risks from POPs that they encounter in their work.

The greatest potential source of POPs in this assessment is likely to be incinerators. This represents a major source of concern since that is the main mode of treatment available in health facilities for the bulk of healthcare waste**.** No chemical containing POPs was however identified among the chemicals being used in the facilities. The majority of the health workers however do not have the requisite education on the potential health effects of the chemicals they use. The following conclusions were drawn by the survey:

(i) Activities identified which are likely to increase the risk of exposure to POPs include burning and incineration operations at landfill sites, management of healthcare waste and e-waste as well as among animal singers using discarded car tyres as fuel for singeing. The potential for exposure of operatives of power companies like the Electricity Company of Ghana also exists;

(ii) for all occupational groups that employ burning in the course of their economic activities, there was a general awareness of exposure to noxious substances in smoke, soot and fumes as is evident from activities of general and e-waste workers, fish mongers, waste incinerators in health facilities. Despite the awareness, they did not know the exact chemicals contained in these emissions or levels of risk to their health and well-being;

(iii) Government agencies that are potential users of POPs in the form of pesticides and transformer oils, are aware of these substances and have done away with them (in the case of pesticides) or are in the process of eliminating their use in equipment. There is a need for monitoring for their presence in the environment;

(iv) Persons whose health is adversely affected as a result of exposure to POPs may lose income resulting in increasing levels of poverty, especially where alternate sources of livelihood are not easily available. Poverty may in turn lead to reduced access to food within communities resulting in poor nutritional status. Social problems like child delinquency, school drop-outs, and indulgence in criminal activities and prostitution to earn an income, and other social vices may increase;

(v) There is however very little evidence on the magnitude of health problems caused by exposure to the POPs. Hence there is the need for research into the manifestations of POPs on human health;

(vi) there must be research into modern and sustainable technologies for healthcare waste management including the use of non-burn techniques such as hydroclaves and their use adopted for hazardous waste streams. In the e-waste sector, informal dumpsites operating in major cities must be abolished or considered for re-designation, and their status changed to formal recycling centres as provided by the Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917).

A number of reviews, evaluations and assessments of POPs sources, regulations on their uses, situational analysis in Ghana of POPs in terms of their lifecycles; their presence in the environment, food, feed and humans; national monitoring capacity and vulnerable groups at risk and those with a potential risk of exposure to POPs; environmentally sensitive areas to POPs emissions, hot spots and contaminated sites have been documented.

It was realized that no institution or organization has been mandated to monitor POPs in the environment, food, feed and humans, though some organizations may deal with some aspect of this, especially in analysis, in the course of their work. No institution also officially monitors the presence of POPs Pesticides, industrial POPs, dioxins and furans.

Potential risk groups are those who may be exposed occupationally and non-occupationally. Occupationally, the risk group include,

- Workers from the small-scale aluminium smelting companies who rely on scrap metals as raw materials for production.
- Casual workers employed to work at waste dump sites.
- Casual workers involved in asphalt mixing during road construction.
- Personnel at the petroleum refinery exposed to leaded fuel and also at the fuel dispensers.
- Fish smokers employing polished timber as fuel wood
- Farmers engaged in agricultural production where the use of pesticides is not regulated.
- Technicians responsible for the servicing and maintenance of PCB-containing transformers and capacitors.

The non-occupational group includes the general public exposed to emissions from open burning of waste, domestic and industrial fires, bush burning and vehicular emissions.

It is estimated that, from these and many other potential risk groups, over half of the population of Ghana may be directly or indirectly exposed to POPs, aggravating the threat of health-related issues and decline in environmental quality. These have both social and health implications for workers and local communities.

Exposures in both cases are either accidental or deliberate. However, these could be prevented to a large extent by the institution of safe systems of work and the use of appropriate personal protective equipment.

The use of personal protection equipment is very limited among agricultural workers. This may either be due to lack of knowledge on its significance or sheer recalcitrance. The same can be said for transportation, storage and disposal of chemicals and their containers after use. Medical surveillance among POPs users need to be researched into. Employers should be sensitized to provide routine medical examinations for their employees. In areas of dioxin and furan releases, vulnerable groups are taking no special precautions. There is therefore an urgent need for sensitization at both the individual and institutional levels if preventive measures are to be effective.

The gaps identified can be bridged by putting in place measures to increase public education and raise awareness. Encouragement of research in grey areas, training of specialists, conducting of studies on health effects of those exposed and the general public. Priority areas that need urgent attention include the following:

- Training of specialists in clinical toxicology to strengthen the management of poisoning cases in the health institutions and poison centres;
- A well-equipped national accredited laboratory, which can analyze and detect samples to the minutest detail possible.

Technical and Infrastructural capacity for POPs Assessment, Measurement, Analysis, Alternatives and Prevention Measures Management, Research and Development

Waste management systems in the country are underdeveloped. There are inadequate sanitary landfills for the proper disposal of waste of all categories. Most categories of waste are collected in a largely uncoordinated manner and deposited at dumpsites and

left to naturally rot or in some cases burnt. The numerous waste dumps scattered all over the country is evident of the level of the magnitude of the problem of poor waste management in Ghana.

In Ghana the infrastructure and capability for the remediation of contaminated sites are underdeveloped. There is therefore the need to build capacities and develop the requisite infrastructure to manage contaminated sites in the country. Relevant national stakeholder institutions have a major role to play in the development of capacity for contaminated sites management, including remediation. The roles that would be played by such institutions within the framework of NIP implementation would include:

- Enhancement of their capabilities for the assessment of POPs contaminated sites and remediation;
- Research on appropriate scientific methods for identification of contaminated sites and guidelines for remediation;
- Provision of information on Best Available Techniques (BAT) and Best Environmental Practices (BEP) for POPs contaminated sites remediation.

Monitoring of POPs in the environment, food, feed and humans is virtually non-existent in the country. A number of institutions, though not concerned primarily with the monitoring of POPs in the environment, have been identified to deal with pesticide analysis in the course of their work.

Currently there are no specific programmes for monitoring the effects of POPs on human health. This is due, among other things, inadequate personnel and facilities required to effectively monitor the effects and assess the impact of POPs on the population. There is therefore the need to train health personnel in particular and other related institutions and equip existing laboratories to carry out proper assessment of POPs on human health on a continuous basis.

A situational analysis conducted on the monitoring, research and development capacity of the various institutions in the country indicated that the chemical effects of POPs on economic, social and health activities are quite well known. However it is difficult to assess the institutional capacity to deal with the problems that may arise in terms of monitoring, research and development of its human and material resources. A number of academic and research institutions in Ghana with the potential to develop and to meet such challenges have been identified. These institutions have similar and basic problems including inadequate facilities, personnel and infrastructure required for effective research and development. There is therefore the need to resource the institutions to enable them undertake local research and development and also contribute to the ongoing Global Monitoring Programme on POPs towards the effectiveness evaluation as required under Article 16 of the Convention.

The EPA has initiated the process of developing a comprehensive chemicals information management system to assist in sound chemicals management including POPs. The information system would be networked with relevant public and private institutions to facilitate the exchange of information on chemicals and to make the systems easily accessible to the general public. This system will serve as the national focal point for the exchange of information and a clearinghouse mechanism for information on POPs as required under Article 9 of the Convention.

A number of human and institutional capacity gaps have been identified. These include:

- Inadequate experts with the requisite qualifications to regulate and manage POPs; and
- Inadequate financial resources to acquire the equipment and logistics (e.g. chemicals and other consumables) necessary to carry out experiments and monitor activities related to POPs.

Assessment of current level of information, awareness, and education among target groups. and existing systems to communicate such information to the various groups

For POPs pesticides, some level of awareness exists especially among the main relevant stakeholder institutions including the Ministry of Food and Agriculture, Pesticide Importers Association, Non-Governmental Organizations, CropLife Ghana and the Ghana Input Dealers Association. There are, however, gaps regarding awareness of POPs pesticides among the end users particularly farmers and those engaged in public health pest control activities, who are unable to distinguish POPs pesticides from other pesticides. There is also evidence of knowledge gap among Customs Officers at the border points regarding the proper identification and regulatory requirement regarding POPs pesticides.

With respect to other POPs categories, the situation is not different for the relevant stakeholders and end users, except for PCBs. There is little awareness for example

among firefighters on PFOS, e-waste recyclers on PBDE, building and construction industry and workers on HBCD. It is the same position among end users. For PCBs, the level of awareness among the main stakeholder institutions has increased as a result of the PCBs Elimination Project in Ghana.

There is the need to increase public awareness among end users and other identified stakeholders on the knowledge of POPs in general and their potential health impacts on human health and the environment.

Continuous and detailed education programmes are being implemented at all levels of society so that every Ghanaian becomes aware of the problem and fully assumes responsibility in safeguarding the environment. In the formal system, Environmental Education has been integrated into the curriculum of schools. In the non-formal system, sustained efforts are being made to promote awareness among policy makers to provide training for resource managers at appropriate levels, and promote greater public awareness and motivation for environmental action.

There are sectors responsible for providing education in all forms throughout the country. Some of the institutions and organizations, which have various means of disseminating environmental and chemicals related information to the public, include the following:

- Non-Governmental Organisations and Community Based Organisations;
- Ghana Education Service;
- Municipal, Metropolitans and District Assemblies;
- Media;
- Religious Organisations or Faith Based Organisations;
- Universities and Research Institutions; and
- Traditional Institutions.

Among the tools techniques and mechanisms, employed to disseminate environmental and chemicals related information by governmental institutions and civil society organisations are:

- Seminars, Workshops and Symposia;
- Durbars;
- Publications;
- Teaching;
- Interviews on Radio/TV;
- Discussion on Radio/TV;
- Advertisements on Radio/TV;
- Presentation of messages on Billboards and posters;
- Jingles;
- Radio/TV drama;
- Focused group meetings;
- Festivals and anniversary celebrations;
- Press Releases;
- Presentation of statements on the floor of Parliament by Members of Parliament (MPs) on chemicals including POPs;
- Religious meetings;
- Essay competition for schools and colleges.
- Songs.

At the national level, government public information policy and practices related to the environment can be found in the 1992 Constitution as well as various laws. The major ones are Act 490, Act 917, LI1652 and LI 2250. There is in existence an education and awareness creation campaign strategy which seeks to develop and implement effective information and communication for the sound management of chemicals in Ghana. This strategy is under revision to address certain issues of national concern.

Ghana is exploring all available technologies and strategies to establish an effective and functional communication system for the smooth exchange of information with other parties to the Convention.

Although Ghana has not been effective in meeting the reporting requirements under the Convention, the country under the Special Programme Trust Fund of UNEP, is strengthening its institutional capacities for an integrated, sustainable sound management of chemicals and waste throughout their lifecycle. This is expected to meet the reporting requirements under the Stockholm Convention.

Priorities Areas of National Concern

The main priority areas of national concern have been identified as follows:

i. Education and awareness creation for all stakeholder groups including the general public;
ii. Monitoring, control and evaluation;
iii. Development of new legislation and harmonization of existing ones;
iv. Updating and refining of inventory including developing inventories of recently listed POP chemicals and identification of contaminated sites;
v. Final elimination of remaining Polychlorinated Biphenyls in Ghana and initiation of action on the management of PCNs and SCCPs in these applications;

vi. Capacity building and implementation of BAT and BEP for source reduction of unintentional and industrial POPs emissions;
vii. Strengthening the institutional capacity in terms of legal and technical infrastructure as well as human resource development including training of Customs Officers and Environmental Inspectors to manage POPs;
viii. Management of stockpiles and wastes of POPs;
ix. Information Exchange and Networking;
x. Identification and management of contaminated sites including containment and possibly remediation;
xi. Further research into the extent of exposure of the population to POPs and development of capacity for risk and socio-economic assessments; and
xii. Development of sustainable chemistry and sustainable production policies;
xiii. Continuing the search for safer alternatives and related substitution.

Stockholm Convention Implementation Principles and Strategy

The overall objective of sound management of POPs in Ghana, is firstly to strengthen the national capacity and capability to deliver a comprehensive assessment of the threats posed by POPs and other hazardous chemicals to human health and the environment. It also seeks to reduce and ultimately eliminate POPs from the environment as envisaged under the Stockholm Convention on POPs. This is in line with the attainment of the 2020 overall orientation goals of SAICM and the 2030 Sustainable Development Agenda.

Sustainable chemistry, as an innovative approach, will be pursued to serve as a vehicle towards the implementation of the Stockholm Convention, the sound management of chemicals beyond the 2020 SAICM goals as well as hazardous wastes in general, towards the achievement of sustainable consumption and production (SDG 12) and chemical related SDGs.

Principles of Implementation

The NIP will form an integral part of the national integrated chemicals management programme and the implementation strategy would be based on the following principles:

Public and Stakeholder Participation

A coordinated approach will be adopted, with co-operation among all relevant stakeholders at all levels and all sectors. Responsibilities related to chemicals management as well as those involved in activities that influence chemical safety, including the private sector, industry, labour and public interest groups will be assigned. Women and children's groups in particular, will be empowered and encouraged to actively participate in the implementation of the NIP.

Transparency in Information Sharing and Exchange

Data and Information will be collected and where necessary generated, especially those specific to the national or local situation and made available to the general public. National chemical databases will provide information on the amounts of chemicals imported, formulated and traded in the past and present. Clinical, epidemiological, and environmental data are needed to support decision-making as well as assess and manage risks under local conditions.

Adherence to Polluter Pays Principle

Adequate legal, institutional, administrative and technical infrastructure will be pursued. This will help enforce regulatory provisions of the Convention including adherence to "the polluter pays principle".

Integration with Overall Environmental Management and Sustainable Development Policies

Implementation of the NIP is expected to contribute to the promotion of sound management of chemicals (including POPs) for industrial, agricultural, public health and consumer purposes, in order to avoid damage to human health, ecosystems, and the environment in general. This will ensure the attainment of the sustainable development goals contained in the Ghana Environmental Action Plan.

Adherence to and Use of Technologies and Applications of International Standards

The risk of POPs to human health and the environment will be assessed using internationally recognised criteria, standards and limits to the extent possible. Risk management based on sound principles and use of Best Available Techniques and Best Environmental Practices (BAT/BEP) will be applied.

Commitments Regarding Public Awareness and Education

Efforts will be made to train and sensitise identified groups and the general public on POPs issues. An informed population is recognised as vital in achieving public co-operation and confidence in POPs management.

Adherence to International Requirements

Decisions concerning manufacture, formulation, import and use of individual and candidate POPs, will be reassessed periodically on a scheduled basis, and in response to the availability of significant new information so as to meet international requirement including those of the EU. Research into alternative chemicals to POPs will be vigorously pursued.

Activities, Strategies and Action Plans

The national profile for chemicals management will be updated to include issues on the Stockholm Convention on POPs. Activities, strategies and action plans have been prepared to implement the country's obligations under the Stockholm Convention. Specific targets, milestones and performance indicators have been outlined to allow progress of implementation to be reviewed and monitored.

Development and Capacity Building Proposals, Priorities and Targets for Implementation

Project proposals prepared as part of the first NIP for the implementation of the strategies and action plans are being reviewed in line with the updated NIP. The overall goal of these projects is to improve the management of risks to human health and the environment from POPs. The main proposals are as follows:

- Strengthening the human and institutional capacity for the management of POPs;
- Development of capacity and capability for the identification, analysis and monitoring of POPs in the environment;
- Capacity building towards the elimination of Annex A Chemicals in Ghana;
- Development and implementation of information and communication system for the management of POPs;
- Investigation and assessment of the nature and severity of health effects experienced by humans as a result of exposure to POPs;
- Environmentally sound management (ESM) and disposal of POPs and remediation of contaminated sites.

Resource Requirements and Funding

An initial assessment of resources and budgetary estimates needed for the successful and effective implementation of the NIP, which were identified in the first NIP, has been reviewed. An initial framework for developing priority projects for the NIP has been outlined. This framework will take into consideration and identify specific human resources, stakeholder contributions and requirements, for possible Global Environment Facility (GEF) incremental cost and funding by development and donor partners. By linking chemicals management to waste management, co-funding can partly come from national budgets dedicated to chemicals and waste management in particular. For the management of POPs contaminated wastes such as e-waste, plastic or automotive shredder residues, extended producer responsibility contributions should contribute to the environmental sound management of related waste fractions.

CHAPTER 1: INTRODUCTION

1.0 Context and Background: Persistent Organic Pollutants, Human Health and the Environment

Over the past 50 years the world has conducted vast, uncontrolled, worldwide chemical experiments involving the oceans, air, soils, plants, animals, and human beings. The "Chemicals Revolution" has indeed contributed greatly to the welfare of human beings. Chemicals have increased crop yields by killing crop pests and have made possible an endless array of useful products. But once released into the environment, some chemicals despite their benefits produce toxic reactions, persist in the environment for years, travel thousands of kilometres from where they were used, and threaten long-term health and ecological consequences that were never anticipated or intended. One class of substances in particular, called Persistent Organic Pollutants (POPs), has aroused international concern. POPs are among the highly toxic pollutants released into the environment through human activity. They cause an array of adverse effects, notably, diseases, birth defects and death, among humans and animals. Specific effects can include cancer, allergies and hypersensitivity, damage to the central and peripheral nervous systems, reproductive disorders, and disruption of the immune system.

POPs act as powerful pesticides (e.g. DDT) and serve a range of industrial purposes (e.g. PCBs). Some POPs are also released as unintended by-products of combustion and industrial processes (e.g. PCDDs and PCDFs). While the risk level varies from POP to POP, by definition all of these chemicals share the following four properties:

- High toxicity: Short term and long term exposures of humans and the environment to POPs lead to detrimental adverse effects as a result of the inherent physical and chemical properties of the chemicals;
- Persistence: These highly stable compounds can last for years or even decades in the environment before breaking down or degrading into less dangerous forms;
- Potential for long-range environmental transport: They circulate globally through the various environmental compartments (air, water, soils, sediments) via a process known as the "*grasshopper effect*";
- Bioaccumulation: POPs concentrate in living organisms; they are readily absorbed in fatty tissue, where concentrations can become magnified by up to 70,000 times the background levels. Fish, predatory birds, mammals, and humans are high up the food chain and so absorb the greatest concentrations.

1.1 The Stockholm Convention on POPs: Historical Perspectives, Adopted Amendments, Objectives and Country Obligations

1.1.1 Historical Perspectives

Aware that POPs pose major and increasing threats to human health and the environment, the Governing Council of the United Nations Environment Programme (UNEP) in May 1995 requested in its decision 18/32 that an international assessment process be undertaken of an initial list of 12 POPs (aldrin, chlordane, DDT, dieldrin, dioxins, endrin, furans, hexachlorobenzene, heptachlor, mirex, PCBs and toxaphene). The Council also requested that the Intergovernmental Forum on Chemical Safety (IFCS) develop recommendations on international action for consideration by the UNEP Governing Council and the World Health Assembly not later than 1997.

Subsequently the IFCS provided recommendations to UNEP that served as a basis for the mandate to begin negotiations of a global POPs Convention. The IFCS recommended that available information was sufficient to demonstrate the need for international action on 12 POPs and that international action, including a global legally binding instrument, is required to reduce the risks to human health and the environment arising from the release of the 12 POPs.

In February 1997, the UNEP Governing Council in its decision 19/13C, invited UNEP to prepare for and convene an International Negotiating Committee (INC), with a mandate to prepare an international legally binding instrument for implementing international action initially beginning with the 12 POPs. The Council further requested that the INC establish an expert group to develop criteria and a procedure for identifying additional POPs as candidates for future international action. The decision also included a number of immediate actions to address POPs.

The first meeting of the INC to develop an international legally binding instrument for implementing international action on certain POPs was held in June 1998 in Montreal, Canada, at which the Criteria Expert Group (CEG) was established. Subsequent meetings of

the INC were held in Nairobi, Kenya, in January 1999, in Geneva, Switzerland, in September 1999, in Bonn, Germany, in March 2000, and in Johannesburg, South Africa, in December 2000 where the negotiations were successfully completed. The CEG completed its mandate in two meetings: the first in Bangkok, Thailand, in October 1998 and the second, in Vienna, Austria, in June 1999. A meeting of 18 countries designated by the INC to deliberate on financial resources and mechanism held in Vevey, Switzerland, in June 2000 helped lay the groundwork for consensus on these issues at the final negotiation session.

The Stockholm Convention on Persistent Organic Pollutants (POPs) was adopted and opened for signature at a Conference of Plenipotentiaries held from 22nd to 23rd May 2001 in Stockholm, Sweden. Ninety-two (92) States and the European Community signed it at a ceremony on 23rd May 2001. The Convention entered into force on 17th May 2004, 90 days after the submission of the fiftieth instrument of ratification. As of August 2018, there were 152 signatories and 182 parties.

Ghana signed the Convention on 23rd May 2001 in Stockholm, Sweden, and ratified it on 30th May 2003.

1.1.2 Amendments to the Convention

Since entry into force on 17 May 2004, the Convention has been amended by the Conference of the Parties, at several meetings, in accordance with Article 21:

(1) At its first meeting held in Punta del Este, Uruguay, from 2 to 6 May 2005, the Conference of the Parties adopted decision SC-1/2, which established the arbitration and conciliation procedures, as required in Article 18 of the Convention, to govern the settlement of disputes between Parties. The procedures are set out in Annex G, which entered into force on 27 March 2007

(2) At its fourth meeting held in Geneva, Switzerland, from 4 to 8 May 2009, the Conference of the Parties adopted amendments to Annexes A, B and C to list 9 (nine) additional chemicals, respectively:

- alpha hexachlorocyclohexane;
- beta hexachlorocyclohexane;
- chlordecone;
- hexabromobiphenyl
- hexabromodiphenyl ether and heptabromodiphenyl ether;
- lindane;
- pentachlorobenzene;
- perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride; and
- tetrabromodiphenyl ether and pentabromodiphenyl ether.

(3) At its fifth meeting held in Geneva, Switzerland, from 25 to 29 April 2011, the Conference of the Parties adopted an amendment to Annex A to the Convention to list the following new POP:

- technical endosulfan and its related isomers.

(4) At its sixth meeting held in Geneva, Switzerland, from 28 April to 10 May 2013, the Conference of the Parties adopted an amendment to Annex A to list the following new POP:

- hexabromocyclododecane (HBCD).

(5) At its seventh meeting held in Geneva, Switzerland, from 4 to 15 May 2015, the Conference of the Parties adopted amendments to Annexes A and C to the Stockholm Convention to list the following new POPs:

- hexachlorobutadiene (Annex A);
- pentachlorophenol and its salts and esters; and
- polychlorinated naphthalenes.

(6) At its eighth meeting held in Geneva, Switzerland, from 24 April to 5 May 2017, the Conference of the Parties adopted amendments to Annexes A and C to list the following new POPs:

- decabromodiphenyl ether (decaBDE);
- short-chain chlorinated paraffins (SCCPs); and
- hexachlorobutadiene (Annex C).

This updated NIP assesses the situation of POPs listed by the Stockholm Convention COP until 2013. However, activities for the recent listed POPs, such as inventory development, are also included in the action plans.

1.1.3 Objective of the Convention

The objective of the Convention is to protect human health and the environment from persistent organic pollutants (Article 1). This is consistent with the precautionary approach set forth in Principle 15 of the Rio Declaration on Environment and Development.

1.1.4 Convention Provisions

There are four main areas of the Convention, namely:

- General Obligations;
- Control Provisions: Intentionally Produced POPs, Unintentionally Produced POPs, Stockpiles and Wastes;
- Procedures for adding new POPs;
- Financial and Technical assistance;

1.1.4.1 General Obligations of Parties under the Convention:

Each Party is obliged to:

- Develop, within two years after entry into force, plans for implementing the obligations of the treaty (Article 7);
- Designate a National Focal Point for exchange of information on production, use and release of POPs and on their alternatives (Article 9);
- Promote and facilitate public awareness and participation, education, research, development and monitoring on all aspects of POPs and their alternatives (Articles 10, 11);
- Report (Article 15) to the Conference of Parties (COP) on:
  - Measures taken to implement the provisions of the Convention and effectiveness of measures taken
  - Quantities of POPs in Annex A, B and C that are traded or released, and list of States involved.

1.1.4.2 Control Provisions

Article 3 of the Convention urges states to take measures to reduce or eliminate releases from the intentional production and use of POPs. It requires states, among others, to prohibit and/or take legal and administrative measures to eliminate the production, use, importation and exportation of chemicals listed in Annex A (aldrin, alpha hexachlorocyclohexane, beta hexachlorocyclohexane, chlordane, chlordecone, dieldrin, endrin, heptachor, hexabromobiphenyl, hexabromodiphenyl ether and heptabromodiphenyl ether, hexachlorobenzene (HCB), lindane, mirex, pentachlorobenzene (PeCB), polychlorinated biphenyls (PCBs), tetrabromodiphenyl ether and pentabromodiphenyl ether, toxaphene, technical endosulfan and its related isomers, hexabromocyclododecane (HBCD), Pentachlorophenol (PCP) and its salts and esters, Polychlorinated naphthalenes (PCNs), and hexachlorobutadiene (HCBD)). States are also required to restrict production and use (for malaria vector control only) of chemicals listed in Annex B (Dichlorodiphenyltrichloroethane (DDT) and Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOS-F)). There are special provisions for PCBs, hexabromodiphenyl ether and heptabromodiphenyl ether, tetrabromodiphenyl ether and pentabromodiphenyl ether, Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOS-F) and DDT.

Article 5 requires Parties to put measures in place to reduce or eliminate releases from unintentional production of some of the banned chemicals listed in Annex C (HCB, PeCB, PCB, Polychlorinated dibenzo-p-dioxins (PCDDs), Polychlorinated dibenzofurans (PCDFs), PCNs and HCBD). This article recommends the use of Best Available Techniques (BAT) and Best Environmental Practices (BEP).

There are provisions for measures to reduce or eliminate releases from stockpiles and wastes (Article 6). The goal is the environmentally sound management (ESM) of stockpiles, wastes, products and articles upon becoming wastes that consist of, contain or are contaminated with POPs listed in Annex A, B or C. This is to be done in close collaboration with the appropriate bodies of the Basel Convention on the Transboundary Movement of Hazardous Wastes and their Disposal.

1.1.4.3 Procedures for Adding New POPs

Annex D of the Stockholm Convention specifies information requirements and screening criteria for listing a chemical in Annexes A, B and/or C of the Convention. These include information on:

- Chemical identity;
- Persistence;
- Bio-accumulation;
- Potential for long-range environmental transport; and
- Adverse effects.

A statement of the reasons for concern including, a comparison of toxicity or ecotoxicity data with detected or predicted levels of a chemical resulting or anticipated from its long range environmental transport, and a short statement indicating the need for global control will be provided by a proposing Party. Additional information to support the review of the proposal referred to in paragraph 6 of Article 8 of the Convention will also be provided by the proposing Party. The secretariat of the Convention shall verify such information submitted by a Party and forward the proposals to a Persistent Organic Pollutants Review Committee (POPRC).

1.1.4.4 Financial and Technical Assistance

The Convention specifies that developing countries and countries with economies in transition will need technical and financial assistance. Regional and Sub-regional Centres were established for capacity building and transfer of technology to assist countries in need.

Developed countries have undertaken activities to provide technical assistance, new and additional financial resources to meet agreed full incremental implementation costs (Article 13).

The Global Environment Facility (GEF) has been designated as the principal entity entrusted with the operations of the financial mechanism on an interim basis (Article 14), and is required to support the execution of capacity building and related activities (e.g. the preparation of NIPs).

1.2 The POPs Chemicals: Definitions and Properties

The Convention addresses the challenges posed by all listed chemicals. The chemicals are classified into three groups, pesticides, industrial compounds, and by-products. They are further classified into 3 broad categories as follows: Annex A chemicals (those for elimination), Annex B chemicals (those for restriction) and Annex C chemicals (unintentionally produced). The present edition of the NIP addresses the following chemicals:

1.2.1 Pesticides

1.2.1.1 Aldrin

Chemical Name: 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo,exo-5,8-dimethanonaphthalene ($C_{12}H_8Cl_6$).
CAS Number: 309-00-2
Properties: Solubility in water: 27 g/L at 25 °C; vapour pressure: 2.3 x 10^{-5} mm Hg at 20°C; log K_{ow}: 5.17-7.4.
Discovery/Uses: It has been manufactured commercially since 1950, and used throughout the world up to the early 1970s to control soil pests such as corn rootworm, wireworms, rice water weevil, and grasshoppers. It has also been used to protect wooden structures from termites.
Persistence/Fate: Readily metabolised to dieldrin by both plants and animals. Biodegradation is expected to be slow and it binds strongly to soil particles, and is resistant to leaching into groundwater. Aldrin was classified as moderately persistent with half-life in soil and surface waters ranging from 20 days to 1.6 years.
Toxicity: Aldrin is toxic to humans; the lethal dose for an adult has been estimated to be about 80 mg/kg-body weight. The acute oral LD_{50} in laboratory animals is in the range of 33 mg/kg body weight for guinea pigs to 320 mg/kg body weight for hamsters. The toxicity of aldrin to aquatic organisms is quite variable, with aquatic insects being the most sensitive group of invertebrates. The 96-h LC_{50} values range from 1-200 g/L for insects, and from 2.2-53 g/L for fish. The maximum residue limits in food recommended by FAO/WHO varies from 0.006 mg/kg milk fat to 0.2 mg/kg meat fat. Water quality criteria between 0.1 to 180 g/L have been published.

1.2.1.2 Alpha-hexachlorocyclohexane (alpha-HCH)

Chemical Name: (1a,2a,3b,4a,5b,6b)-Hexachlorocyclohexane ($C_6H_6Cl_6$)
CAS Number: 319-85-6
Properties: Solubility in water: 2 mg/l at 25 °C; vapour pressure: 4.5x10^{-5} mm Hg at 25 °C; log K_{ow}: 3.8
Properties: Solubility in water: 56 g/L at 25 °C; vapour pressure: 0.98 x 10^{-5} mm Hg at 25 °C; log K_{ow}: 4.58-5.57.

Discovery/Uses: Alpha-HCH by itself is neither intentionally produced nor placed on the market. It is produced as the main constituent of technical HCH which is used as organochlorine insecticide or chemical intermediate to manufacture enriched HCH (lindane). For each ton of lindane produced, around 6-10 tons of the other isomers including alpha- and beta-HCH are created. Large stockpiles of alpha- and beta-HCH are therefore present in the environment

***Persistence/Fate*:** Alpha-HCH is highly persistent in water in colder regions and may bioaccumulate and biomagnify in biota and arctic food webs. Hydrolytic half-lives of alpha-HCH show strong temperature dependence. At 20 °C, pH 8 the DT50 was 0.8 years whereas it increased at lower temperature (5 °C, pH 7.8) to 26 years.

Toxicity: Alpha-HCH is the isomer with the highest neurotoxic potential beside gamma-HCH. Alpha-HCH has been classified as potential carcinogenic to humans (group 2B) by the International Agency for Research on Cancer (IARC) and adversely affects wildlife and human health in contaminated regions.

1.2.1.3 Beta-hexachlorocyclohexane (beta-HCH)

Chemical Name: (1-alpha, 2-beta, 3-alpha, 4-beta, 5-alpha, 6-beta)-Hexachlorocyclohexane ($C_6H_6Cl_6$)
CAS Number: 319-85-7

Properties: Solubility in water: 1.44 mol*m^{-3} at 25 °C; vapour pressure: 0.053 Pa at 25 °C; log K_{ow}: 3.9 25°C.

Discovery/Uses: Although the intentional use of beta-HCH as an insecticide was phased out years ago, this chemical is still produced as unintentional by-product of lindane. For each ton of lindane produced, around 6-10 tons of the other isomers including alpha- and beta-HCH are created.

Persistence/Fate: Beta-HCH is highly persistent in water in colder regions and may bioaccumulate and biomagnify in biota and arctic food webs. It is reported to have half-lives of 100 and 184 days on cropped and uncropped plots respectively from sandy loam soil under subtropical conditions. Beta-HCH is the most prevalent HCH-isomer in human fatty tissue with estimated half-life of 7.2-7.6 years following inhalation exposure in the body.

Toxicity: The concentration range for lethal acute toxic effects is 150 mg/kg to > 16000 mg/kg in mice and 600 mg/kg to > 8000 mg/kg in rats. A long-term study (52 weeks) in rats with 0, 10, 100 and 800 mg/kg beta-HCH in their diet (i.e. 0.5, 5 and 40 mg/kg bw/day) led to liver enlargement and histological changes. The LOAEL was 10 mg/kg diet. Toxicological studies with beta-HCH have demonstrated neurotoxicity and hepatotoxicity. Also, reproductive and immunosuppressive effects and effects on fertility were seen in laboratory animals. Beta-HCH has been classified in group 2B as possibly carcinogenic to humans by the International Agency on Research and Cancer (IARC). Several epidemiological studies indicate that beta-HCH might play a role in human breast cancer.

1.2.1.4 Chlordane

Chemical Name: 1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene ($C_{10}H_6C1_8$).
CAS Number: 57-74-9

Properties: Solubility in water: 56 g/L at 25 °C; vapour pressure: 0.98 x 10^{-5}mm Hg at 25 °C; log K_{ow}: 4.58-5.57.

Discovery/Uses: Chlordane appeared in 1945 and was used primarily as an insecticide for control of cockroaches, ants, termites, and other household pests. Technical grade chlordane is a mixture of at least 120 compounds. Of these, 60-75% are chlordane isomers, the remainder being related to endo-compounds including heptachlor, nonachlor, diels-alder adduct of cyclopentadieneand penta/hexa/octachlorocyclopentadienes.

***Persistence/Fate*:** Chlordane is highly persistent in soils with a half-life of about 4 years. Its persistence and high partition coefficient promotes binding to aquatic sediments and bioconcentration in organisms.

Toxicity: LC_{50} from 0.4 mg/L (pink shrimp) to 90 mg/L (rainbow trout) have been reported for aquatic organisms. The acute toxicity for mammals is moderate with an LD_{50} in rat of 200-590 mg/kg body weight (19.1 mg/kg body weight for oxyclordane). The maximum residue limits for chlordane in food are, according to FAO/WHO between 0.002-mg/kg milk fat and 0.5 mg/kg poultry fat. Water quality criteria of 1.5 to 6 g/L have been published. Chlordane has been classified, as a substance for which there is evidence of endocrine disruption in an intact organism and possible carcinogenicity to humans.

1.2.1.5 Chlordecone

Chemical Name: 1,1a,3,3a,4,5,5,5a,5b,6-decachloro-octahydro-1,3,4-metheno-2Hcyclobuta-[cd]-pentalen-2-one (**$C_{10}Cl_{10}O$**)
CAS Number: 143-50-0

Properties: Solubility in water: 2.7 mg/L (25 °C); vapour pressure: 3.0x10^{-5} - 4.0x10^{-5} Pa (25 °C); log K_{ow}: 4.50- 5.41.
Discovery/Uses: It was first produced in 1951 and introduced commercially in 1958. Chlordecone is a synthetic chlorinated organic compound, which was mainly used as an agricultural pesticide such as fungicide against apple scab and powdery mildew, fly larvicide and control the Colorado potato beetle. It was in some instances used on household products such as ant and roach traps at concentrations of approximately 0.125%.

***Persistence/Fate*:** Chlordecone is an extremely stable compound and is not expected to degrade in the environment to any significant extent. Chlordecone is resistant to aerobic degradation, although some anaerobic biodegradation does occur and that Chlordecone is very persistent in the environment.
Toxicity: Chlordecone is readily absorbed into the body and accumulates following prolonged exposure. The pesticide is both acutely and chronically toxic, producing neurotoxicity, immunotoxicity, reproductive, musculoskeletal and liver toxicity at doses between 1 - 10 mg/kg bw/day in experimental animal studies. Liver cancer was induced in rats at a dose of 1 mg/kg body weight per day and in mice at a dose of 2.6 mg/kg bw/day, and reproductive effects are seen at similar dose levels. The International Agency for Research on Cancer has classified Chlordecone as a possible human carcinogen

1.2.1.6 Dichlorodiphenyltrichloroethane (DDT)

Chemical Name: 1,1,1-Trichloro-2,2-bis-(4-chlorophenyl)-ethane ($C_{14}H_9C1_5$).
CAS Number: 50-29-3.

Properties: Solubility in water: 1.2-5.5 g/L at 25 °C; vapour pressure: 0.2 x 10^{-6} mm Hg at 20 °C; logK_{ow}: 6.19 for *p, p'*-DDT, 5.5 *p, p'*-DDD and 5.7 for *p, p'*-DDE.

Discovery/Use: DDT appeared for use during World War II to control insects that spread diseases like malaria, dengue fever and typhus. Following this, it was widely used on a variety of agricultural crops. The technical product is a mixture of about 85% *p,p'*–DDT and 15% *o,p'*-DDT isomers.

Persistence/Fate: DDT is highly persistent in soils with a half-life of up to 15 years and of 7 days in air. It also exhibits high bioconcentration factors (in the order of 50,000 for fish and 500,000 for bivalves). In the environment, the product is metabolized mainly to DDD and DDE.

Toxicity: the lowest dietary concentration of DDT reported to cause eggshell thinning was 0.6 mg/kg for the black duck. LC_{50} of 1.5mg/L for large mouth bass and 56mg/L for guppy have been reported. The acute toxicity of DDT for mammals is moderate with an LD_{50} in rat of 113-118mg/kg-body weight. DDT has been shown to have an estrogen-like activity and possible carcinogenic activity in humans. The maximum residue levels in food recommended by WHO/FAO range from 0.02 mg/kg milk fat to 5 mg/kg meat fat. Maximum permissible DDT residue levels in drinking water (WHO) is 1.0 g/L.

1.2.1.7 Dieldrin

Chemical Name: 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydroexo-1,4-endo-5-8-dimethanonaphthalene ($C_{12}H_8C1_6O$).

CAS Number: 60-57-1

Properties: Solubility in water: 140 g/L at 20 ^{0}C; vapour pressure: 1.78 x 10^{-7} mm Hg at 20^{0}C, log K_{ow}: 3.69-6.2.

Discovery/Uses: It appeared in 1948 after World War II and used mainly for the control of soil insects such as corn rootworms, wireworms and cat worms.

Persistence/Fate: It is highly persistent in soils, with a half-life of 3-4 years in temperate climates, and bioconcentrates in organisms. The persistence in air has been estimated in 4-40 hrs.

Toxicity: The acute toxicity for fish is high (LC_{50} between 1.1 and 41 mg/L) and moderate for mammals (LD_{50} in mouse and rats ranging from 40 to 70 mg/kg body weight). However, a daily administration of 0.6 mg/kg to rabbits adversely affected the survival rate. Aldrin and dieldrin mainly affect the central nervous system but there is no direct evidence that they caused cancer in humans. The maximum residue limits in food recommended by FAO/WHO varies from 0.006 mg/kg milk fat and 0.2 mg/kg poultry fat. Water quality criteria between 0.1 to 18 g/L have been published.

1.2.1.8 Endrin

Chemical Name: 3,4,5,6,9,9-Hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonaphth[2,3-b]oxirene ($C_{12}H_8C1_6O$).

CAS Number: 72-20-8

Properties: Solubility in water: 220-260 g/L at 25^{o}C; vapour pressure: 2.7 x 10^{-7} mm Hg at 25 ^{o}C; log K_{ow}: 3.21-5.34

Discovery/Uses: It has been used since the 1950s against a wide range of agricultural pests, mostly on cotton but also on rice, sugar cane, maize and other crops. It has also been used as a rodenticide.

Persistence/Fate: Is highly persistent in soils (half-lives of up to 12 years have been reported in some cases). Bioconcentration factors of 14 to 18,000 have been recorded in fish, after continuous exposure.

Toxicity: Endrin is very toxic to fish, aquatic invertebrates and phytoplankton; the LC_{50} values are mostly less than 1g/L. The acute toxicity is high in laboratory animals, with LD_{50} values of 3-43 mg/kg, and a dermal LD_{50} of 5-20 mg/kg in rats. Long-term toxicity in the rat has been studied over two years and a NOEL of 0.05 mg/kg-bw/day was found.

1.2.1.9 Heptachlor

Chemical Name: 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene ($C_{10}H_5C1_7$).

CAS Number: 76-44-8

Properties: Solubility in water: 180 g/L at 25 ^{o}C; vapour pressure: 0.3 x 10^{-5} mm Hg at 20 ^{o}C; log K_{ow}: 4.4-5.5

Production/Uses: Heptachlor is used primarily against soil insects and termites, but also against cotton insects, grasshoppers, and malaria mosquitoes. Heptachlor epoxide is a more stable breakdown product of heptachlor.

Persistence/Fate: Heptachlor is metabolised in soils, plants and animals to heptachlor epoxide, which is more stable in biological systems than heptachlor. Heptachlor epoxide is carcinogenic. The half-life of heptachlor in soil is in temperate regions 0.75-2 years. Its high partition coefficient provides the necessary conditions for bioconcentrating in organisms.

Toxicity: The acute toxicity of heptachlor to mammals is moderate (LD_{50} values between 40 and 119 mg/kg have been published). The toxicity to aquatic organisms is higher and LC_{50} values down to 0.11 g/L have been found for pink shrimp. Limited information is available on the effects in humans and studies are inconclusive regarding heptachlor and cancer. The maximum residue levels recommended by FAO/WHO are between 0.006-mg/kg milk fat and 0.2 mg/kg meat or poultry fat.

1.2.1.10 Hexachlorobenzene (HCB)

Chemical Name: Hexachlorobenzene (C_6Cl_6)

CAS Number: 118-74-1
Properties: Solubility in water: 50 g/L at 20°C; vapour pressure: $1.09x10^{-5}$ mm Hg at 20°C; log K_{ow}: 3.93-6.42
Discovery/Uses: It was first introduced in 1945 as fungicide for seed treatments of grain crops, and used to make fireworks, ammunition, and synthetic rubber. Today it is mainly a by-product in the production of a large number of chlorinated compounds, particularly lower chlorinated benzenes, solvents and several pesticides. HCB is emitted to the atmosphere in flue gases generated by waste incineration facilities and metallurgical industries.
Persistence/Fate: HCB has an estimated half-life in soils of 2.7-5.7 years and of 0.5-4.2 years in air. HCB has a relatively high bioaccumulation potential and long half-life in biota.
Toxicity: Many of the available acute and chronic toxicity studies failed to demonstrate effects at or below the solubility limit, but based on validated long-term studies for fish, crustaceans and algae, a 90-day study on the fresh water fish O. Mykiss revealed the lowest NOEC of 3.7g/L. The acute toxicity of HCB is low with LD_{50} values of 3.5mg/kg for rats. Mild effects of the [rat] liver have been observed at a daily dose of 0.25mg/kg-bw. HCB is known to cause liver disease in humans (porphyria cutanea tarda) and has been classified as a possible carcinogen to humans by IARC.

1.2.1.11 Lindane

Chemical Name: gamma-hexachlorocyclohexane ($C6H6Cl_6$)

CAS Number: 58-89-9

Properties: Solubility in water: 0.0073 g/L at 25 °C; vapour pressure: $4.2x10^{-5}$ mmHg at 20 °C; log K_{ow}: 3.72.

Discovery/Uses: Technical-grade hexachlorocyclohexane is produced as a mixture of isomers (primarily the α, β, γ, δ, and ε isomers) by photochlorination of benzene. Lindane is the common name for the gamma isomer of hexachlorocyclohexane (HCH). The mixture of HCH isomers is subject to fractional crystallization and concentration to produce 99% pure lindane. Lindane has been used as a broad-spectrum insecticide for seed and soil treatment, foliar applications, tree and wood treatment and against ectoparasites in both veterinary and human applications.
Persistence/Fate: Lindane is persistent, bioaccumulates easily in the food chain and bioconcentrates rapidly. Lindane can partition into all environmental media and reported half-lifes in air, water and soil are: 2.3 days, 3-300 days and up to 2 to 3 years, respectively.
Toxicity: Experimental studies on laboratory animals suggest lindane can induce hepatotoxic, immunotoxic, reproductive and developmental disorders. Lindane is highly toxic to aquatic organisms and moderately toxic to birds and mammals following acute exposures. Chronic effects to birds and mammals measured by reproduction studies show adverse effects at low levels such as reductions in egg production, growth and survival parameters in birds, and decreased body weight gain in mammals, with some effects indicative of endocrine disruption.

1.2.1.12 Mirex

Chemical Name: 1,1a,2,2,3,3a,4,5,5a,5b,6-Dodecachloroocta-hydro-1,3,4-methano-1H-cyclobuta [cd]pentalene ($C_{10}C1_{12}$).

CAS Number: 2385-85-5
Properties: Solubility in water: 0.07g/L at 25°C; vapour pressure: $3x10^{-7}$mm Hg at 25°C; log K_{ow}: 5.28.

Discovery/Uses: The use in pesticide formulations started in the mid 1950s largely focused on the control of ants. It is also a fire retardant for plastics, rubber, paint, paper and electrical goods. Technical grade preparations of mirex contain 95.19% mirex and 2.58% chlordecone, the rest being unspecified. Mirex is also used to refer to bait comprising corncob grits, Soya bean oil, and mirex.

Persistence/Fate: Mirex is considered to be one of the most stable and persistent pesticides, with a half-life in soils of up to 10 years. Bioconcentration factors of 2600 and 51400 have been observed in pink shrimp and fathead minnows, respectively. It is capable of undergoing long-range transport due to its relative volatility (VPL = 4.76 Pa; H = 52Pa/m^3/mol).

Toxicity: The acute toxicity of Mirex for mammals is moderate with an LD_{50} in rat of 235mg/kg and dermal toxicity in rabbits of 80mg/kg. Mirex is also toxic to fish and can affect their behaviour (LC_{50} 96hr) from 0.2 to 30mg/L for rainbow trout and bluegill, respectively). Delayed mortality of crustaceans occurred at 1g/L exposure levels. There is evidence of its potential for endocrine disruption and possible carcinogenic risk to humans.

1.2.1.13 Pentachlorophenol (PCP) and its salts and esters

Chemical Name: 2,3,4,5,6-pentachlorophenol (C_6HCl_5O and C_6Cl_5OH)

CAS Number: Various such as Pentachlorophenol: 87-86-5; Sodium pentachlorophenate: 131-52-2 and 27735-64-4 (as monohydrate); Pentachlorophenyl laurate: 3772-94-9; Pentachloroanisole: 1825-21-4

Properties: Solubility in water: 14 mg/L at 25 ºC; vapour pressure: 1.1 x 10^{-4} mm Hg at 25 ºC; log K_{ow}:5.12 and 5.18.
Discovery/Uses: First produced in the 1930s, it is marketed under many trade names. The main contaminants include other polychlorinated phenols, polychlorinated dibenzo-p-dioxins, and polychlorinated dibenzofurans. PCP has been used as herbicide, insecticide, fungicide, algaecide, disinfectant and as an ingredient in antifouling paint. Some applications were in agricultural seeds, leather, wood preservation, cooling tower water, rope and paper mill system.

Persistence/Fate: PCP degradation may occur by photolysis, which is the fastest pathway, as well as by biodegradation. Under typical environmental conditions, half-lives are <4 weeks (water), <20 weeks (sediment) and <10 weeks (soil). However, PCP can persist for many years at contaminated sites where the levels of PCP exceed the toxicity threshold of soil microorganisms or in cold northern climates.

Toxicity: People may be exposed to PCP in occupational settings through the inhalation of contaminated workplace air and dermal contact or with wood products treated with PCP. Short-term exposure to large amounts of PCP can cause harmful effects on the liver, kidneys, blood, lungs, nervous system, immune system, and gastrointestinal tract. Elevated temperature, profuse sweating, uncoordinated movement, muscle twitching, and coma are additional side effects. Contact with PCP can irritate the skin, eyes, and mouth. Long-term exposure to low levels such as those that occur in the workplace can cause damage to the liver, kidneys, blood, and nervous system. Finally exposure to PCP is also associated with carcinogenic, renal, and neurological effects.

1.2.1.14 Technical endosulfan and its related isomers

*Chemical Name:*6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide ($C_9H_6Cl_6O_3S$)

CAS Number: Alpha (α) endosulfan: 959-98-8; beta (β) endosulfan: 33213-65-9; technical endosulfan: 115-29-7; Endosulfan sulfate: 1031-07-8.

Properties: For technical mixed isomers: solubility in water: 0.05-0.99 mg/L at 25 ºC; vapour pressure: 2.27E-5 – 1.3E-3 Pa, at 25 ºC; log K_{ow}: 3.6.

Discovery/Uses: Endosulfan was developed in the early 1950s. Global production of endosulfan was estimated to be 10,000 tonnes annually in 1984. Endosulfan is an insecticide used to control a host of insect on agricultural crops such as sorghum, cereals, corn and cacao. Its application further extends to ornamentals and forest trees, and has been used in the past as an industrial and domestic wood preservative.

Persistence/Fate: Endosulfan and its related transformation products are considered persistent in soil, sediments and air. Reported DT_{50} for aerobic soil degradation under laboratory conditions ranged from 25 to 128 days for the α + β isomers, and from 123 to 391 days for endosulfan sulfate.
Toxicity: Endosulfan is highly toxic for most invertebrates and vertebrates, including humans. A significant toxicity for aquatic organisms has been observed with acute median lethal concentrations (LC_{50}s) for several species at levels below 1µg L^{-1}. Chronic no observed effect concentrations (NOECs) below 0.1 µg L^{-1} have been reported for fish and aquatic invertebrates. In humans, the primary effect of endosulfan, via oral and dermal routes of exposure, is on the central nervous system (CNS). Acute exposure to high doses of endosulfan results in hyperactivity, muscle tremors, ataxia, and convulsions.

1.2.1.15 Toxaphene

Chemical Name: Polychlorinated bornanes and camphenes ($C_{10}H_{10}C1_8$).

CAS Number: 8001-35-2

Properties: Solubility in water: 550 g/L at 20 °C; vapour pressure: 3.3 x 10^{-5} mm Hg at 25 °C; log K_{ow}: 3.23-5.50

Discovery/Uses: Toxaphene has been in use since 1949 as a non-systemic insecticide with some acaricidal activity, primarily on cotton, cereal grains, fruits, nuts and vegetables. It was also used to control livestock ectoparasites such as lice, flies, ticks, manage and scab mites. The technical product is a complex mixture of over 300 congeners, containing 67-69% chlorine by weight.

Persistence/Fate: Toxaphene has a half-life in soil from 100 days up to 12 years. It has been shown to bioconcentrate in aquatic organisms (BCF of 4247 in mosquito fish and 76,000 in brook trout).

Toxicity: Toxaphene is highly toxic in fish, with 96-hour LC_{50} values in the range of 1.8 g/L in rainbow trout to 22 g/L in bluegill. Long-term exposure to 0.5 g/L reduced egg viability to zero. The acute oral toxicity is in the range of 49mg/kg-body weight in dogs to 365 mg/kg in guinea pigs. In long-term studies NOEL in rats was 0.35mg/kg-bw/day, LD_{50} ranging from 60 to 293 mg/kg-bw. For toxaphene exists a strong evidence of the potential for endocrine disruption. Toxaphene is carcinogenic in mice and rats and is of carcinogenic risk to humans, with a cancer potency factor of 1.1 mg/kg/day for oral exposure.

1.2.2 Industrial Chemicals

1.2.2.1 Hexabromobiphenyl

Chemical Name: Hexabromo -1,1'-biphenyl (C12H4Br6)

CAS Number: 36355-01-8

Properties: Solubility in water: 0.011 mg/L at 25 °C; vapour pressure: $6.9x10^{-6}$ Pa at 25 °C; log K_{ow}: 6.39.

Discovery/Uses: Hexabromobiphenyl belongs to a wider group of polybrominated biphenyls (PBBs). The hexabromo congeners exist as 42 possible isomeric forms. In the 1970s, hexabromobiphenyl was used as a fire retardant in acrylonitrile-butadiene-styrene (ABS) thermoplastics for constructing business, machine housings and in industrial and electrical products and in polyurethane foam for auto upholstery.

Persistence/Fate: Hexabromobiphenyl have low or no degradation in water (DT_{50}>2 months), soil and sediment (DT_{50}>6 months) in the laboratory as well as in the field. Hexabromobiphenyl is considered to be highly persistent with estimated half-life of 182 days in air. It therefore has a strong possibility for long-range environmental transport.

Toxicity: Hexabromobiphenyl is a potent inducer of hepatic cytochrome P-450 metabolizing enzymes in the liver. The mechanism of action underlying a number of the toxicological effects of some of these compounds, including induction of metabolising enzymes, immunotoxicity, hepatotoxicity and reproductive toxicity, is considered to be due to interaction with the cellular Ah receptor causing altered gene expression. Owing to its slow metabolism and excretion, hexabromobiphenyl shows mark bioaccumulation in all species. Average half-lives for 2,2',4,4',5,5'-hexabromobiphenyl in humans have been estimated to be between 8 and 12 years. An LD_{50} of 3,910 µg/kg was reported when 3,3',4,4',5,5'- hexabromobiphenyl was injected into eggs of rainbow trout.

1.2.2.2 Hexabromocyclododecane (HBCD)

Chemical Name: Hexabromocyclododecane and 1,2,5,6,9,10 -hexabromocyclododecane ($C_{12}H_{18}Br_6$)

CAS Number: 25637-99-4; 3194-55-6

Properties: Solubility in water: 65.6 µg/l at 20 °C; vapour pressure: $6.3 \cdot 10^{-5}$ Pa (21 °C) ; log K_{ow}: 5.62.

Discovery/Uses: The production of hexabromocyclododecane is a batch-process. Elemental bromine is added to cyclododecatriene at 20 to 70 °C in the presence of a solvent in a closed system. Depending on the manufacturer and the production method used, technical HBCD may consists of 70-95% γ-HBCD and 3-30 % of α- and β-HBCD. HBCD is reported to be produced in the United States of America, Europe, and Asia. HBCD is used a flame retardant additive, providing fire protection during the service life of vehicles, buildings or articles, as well as protection while stored. Globally HBCD are mainly used in expanded and extruded polystyrene foam insulation while the use in textile applications and electric and with limited applications in electric and electronic appliances.

Persistence/Fate: HBCD is not readily biodegradable according to a study undertaken using an estimation model, BIOWIN (v4.10, EPI Suite v4.0) with the expected time of primary degradation in the order of weeks. In soil, half-lives under aerobic and anaerobic conditions were estimated at 63 and 6.9 days, respectively, the degradation half-lives in aerobic sediment were 20 °C to be 113, 68 and 104 days for α-, β- and γ-HBCD, respectively.

Toxicity: Available studies on toxicity to terrestrial mammals demonstrate that HBCD is rapidly absorbed from the rodent gastro-intestinal tract. The highest concentrations are subsequently reached in adipose tissue and muscles, followed by the liver. Of the three diastereoisomers constituting HBCD, the α-form is much more accumulating than the others (the relative bioaccumulation factor was in one study 99:11:1 for α-, ß-, and γ-HBCD, respectively). Owing to its very low water solubility, ecotoxicity testing of HBCD in aqueous media has a low acute toxicity to aquatic organisms. However, long-term ecotoxicity test with *Daphnia magna* and growth inhibition test with *Skeletonema costatum* both concluded that NOEC and EC_{50} values were below the water solubility of the technical mixture of HBCD (66 µg/L).

1.2.2.3 Hexachlorobutadiene

Chemical Name: 1,1,2,3,4,4-hexachlorobuta-1,3-diene (C_4Cl_6, $Cl_2C=CClClC=CCl_2$)
CAS Number: 87-68-3
Properties: Solubility in water: 3.2 mg/L at 25°C; vapour pressure: 20 and 2926 Pa at 20°C and 100°C; Log Kow: 4.78- 4.9.

Discovery/Uses: Hexachlorobutadiene occurs as a by-product during the chlorinolysis of butane derivatives in the production of both carbon tetrachloride and tetrachloroethene. HCBD was used as intermediate in chemical industry or as a product. It was applied as a solvent (for rubber and other polymers); as a "scrubber" to recover chlorine-containing gas or to remove volatile organic components from gas; as hydraulic, heat transfer or transformer fluid; or in gyroscopes. HCBD was also used in the production of aluminium and graphite rods.
Persistence/Fate: HCBD persists in air until it is either degraded photochemically or deposited in water or soil when adsorbed on particulate matter. Predictions and mass-balance calculations based on monitoring data indicate a very long half-life in the atmosphere being greater than 1 year.

Toxicity: Systemic toxicity following exposure via oral, inhalation, and dermal routes. Effects may include fatty liver degeneration, epithelial necrotizing nephritis, central nervous system depression and cyanosis. The USEPA has classified hexachlorobutadiene as a group C Possible Human Carcinogen. HCBD is highly toxic to aquatic organisms. Ecotoxicity data available indicates that acute LC_{50} values ranging from 0.032 mg/L are reported for the marine crustacean *Palaemontes pugio* to 4.5 mg/L for the freshwater fish *Poecillia latiphinna*.

1.2.2.4 Hexabromodiphenyl ether and heptabromodiphenyl ether (commercial octabromodiphenyl ether)

Chemical Name: Diphenyl ether, octabromo derivative (octabromodiphenyl ether, OctaBDE) ($C_{12}H_2Br_8O$)
CAS Number: Various for benzene, 1,1'-oxybis-, hexabromo derivative; hexaBDE: 36483-60-0; heptaBDE: 68928-80-3; octaBDE: 32536-52-0; nonaBDE: 63936-56-1.

Properties: Solubility in water: 0.5 µg/l at 25 °C; vapour pressure: 6.5910^{-6} Pa at 21 °C; log K_{ow}: 6.29.

Discovery/Uses: Commercial Octabromodiphenyl Ether is a technical mixture of different PBDE congeners having an average of 7.2 to 7.7 bromine atoms per molecule of diphenyl ether. The predominant congeners in commercial octaBDE (c-OctaBDE) are those of heptabromodiphenyl ether and octaBDE. Octabromodiphenyl Ether is used in conjunction with antimony trioxide as a flame retardant in the housings of electrical and electronic equipment, mainly in the plastic acrylonitrile butadiene styrene, but also in high impact polystyrene, polybutylene terephthalate and polyamides. Typically 12–15% of the weight of the final product will consist of octaBDE.

Persistence/Fate: Persistent in the environment with predicts half-lives for reaction with atmospheric hydroxyl radicals ranging from 30.4 to 161.0 d for hexa- to nonaBDEs.

Toxicity: The available information on mammals and birds offer relevant information. The lowest reported NOAEL for traditional endpoints is 2-5 mg/kg bw/d. The effects are relevant for the health and the ecological assessments and therefore useful for assessing risks for humans and wildlife. In addition, immuno-toxicological effects and particularly delayed neurotoxic effects observed after a single dose require specific attention. A critical body burden for HexaBDE 153 of 2000 µg/kg lipid has been estimated based on a NOEL of 0.45 mg/kg; it should be noted that HexaBDE 153 concentrations close to these value have been found in several species and geographic sites and total PBDE concentrations frequently exceed this threshold by a large margin.

1.2.2.5 Tetrabromodiphenyl ether and pentabromodiphenyl ether (commercial pentabromodiphenyl ether)

Chemical Name: Pentabromodiphenyl ether (C12H5Br5O)
CAS Number: 2,2', 4,4'- tetrabromodiphenyl ether (BDE-47): 40088-47-9; 2,2',4,4',5-pentabromodiphenyl ether (BDE-99): 32534-81-9.

Properties: Solubility in water: $9.0X10^{-7}$ mg/L at 20 °C; vapour pressure: $3.50X10^{-7}$ mm Hg at 25 °C; log K_{ow}: 6.5 – 7.4.
Discovery/Uses: Commercial pentabromodiphenyl ether (C-PentaBDE) refers to mixtures of bromodiphenyl ether congeners in which the main components are 2,2', 4,4'-tetrabromodiphenyl ether (BDE-47) and 2,2',4,4',5-pentabromodiphenyl ether (BDE-99). The commercial mixtures contain brominated diphenyl ether congeners with three to seven bromines in the molecule, but molecules with four and five bromines predominate. Commercial pentabromodiphenyl ether mixture are used for flame retardant purposes as additives in consumer products.

Persistence/Fate: The compounds are considered to be persistent with estimated half-lives of 150 days for soil, 600 days for aerobic sediment, 150 days for water and a range of 11 to19 days for air.

Toxicity: Toxicological studies following exposure to BDE-99 formulation was reported to induce neurotoxicity, neurobehavioral development, thyroid hormone system and hispatological alterations in the thyroid and liver of aquatic organisms and in mammals.

1.2.2.6 Decabromodiphenyl ether

Chemical Name: 2,3,4,5,6-Pentabromo-1-(2,3,4,5,6-pentabromophenoxy)benzene ($C_{12}Br_{10}O$)

CAS Number: 1163-19-5

Properties: Solubility in water: <0.1 µg/l at 25 °C; vapour pressure: 4.63×10^{-6} Pa at 21°C, log K_{ow}: 6.27-9.97.

Discovery/Uses: Commercially available decabromodiphenyl ether (c-decaBDE) is a polybrominated diphenyl ether (PBDE) formulation consisting of decabromodiphenyl ether (BDE-209), with small amounts of nonabromodiphenyl ether and octabromodiphenyl ether. Commercially available decaBDE consumption peaked in the early 2000's, but c-decaBDE is still extensively used worldwide due to limited regulatory restrictions. Total production of c-decaBDE in the period 1970-2005 was between 1.1-1.25 million tonnes. DecaBDE is used as an additive flame retardant, and has a variety of applications including in plastics/polymers/composites, textiles, adhesives, sealants, coatings and inks. DecaBDE containing plastics are used in housings of computers and TVs, wires and cables, pipes and carpets.

Persistence/Fate: The decaBDE is highly persistent with estimated atmospheric half-life of 94 days, but can exceed 200 days. Studies of photolytic degradation on various solid matrices has revealed half-lifes of 36 and 44 days for BDE-209 adsorbed to montmorillonite or kaolinite, respectively,

Toxicity: Adverse effects to decaBDE are reported for soil organisms, birds, fish, frog, rat, mice and humans. A study of decaBDE in birds found a mortality of up to 98 % in chicken eggs injected with decaBDE. The effects range from changes at biochemical and cellular level to effects, which may have implications at higher-levels of biological organization including survival, growth and reproduction. In both wild organisms and humans early developmental stages appears more vulnerable to decaBDE exposure than adults. In vertebrates, the liver, the thyroid hormone axis and the nerve system appears to be the main targets for decaBDE toxicity.

1.2.2.7 Pentachlorobenzene

Chemical Name: 1,2,3,4,5-Pentachlorobenzene (C_6HCl_5)

CAS Number: 608-93-5

Properties: Solubility in water: varied between 0.135 and 3.46 mg/L at 25 °C; vapour pressure: 0.11 Pa at 20 °C, log K_{ow}:4.88 and 6.12.

Discovery/Uses: PeCB is produced unintentionally during combustion, thermal and industrial processes. It also present as impurities in products such as solvents or pesticides. PeCB was used in PCB products, in dyestuff carriers, as a fungicide, a flame retardant and as a chemical intermediate e.g. previously for the production of quintozene.

Persistence/Fate: PeCB is considered as persistent given the estimated and experimental half lives in atmosphere, soils and water. Estimated half-life of PeCB is 45 to 467 days is reported in air and 187 to 1550 days in soil. The half-life of PeCB in surface water and deep waters ranged from 194 to 1250 days and 776 to 1380 days respectively.

Toxicity: Within the European Union PeCB is classified as a substance which is very toxic to aquatic organisms (LC50 for fish, daphnia or algae ≤ 1 mg/L). LD_{50}s for PeCB (by gavage in peanut oil) are 940 to 1125 mg/kg bw in adult and weanling rats and 1175 and 1370 mg/kg bw in Swiss Webster mice. It is however moderately toxic in humans.

1.2.2.8 Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOS-F)

Chemical Name: Perfluorooctane Sulfonate (PFOS) ($C_8F_{17}SO_3$)
CAS Number: Perfluorooctane sulfonic acid: 1763-23-1 and its salts; perfluorooctane sulfonyl fluoride: 307-35-7.
Properties: Solubility in water: 519 mg/L at 20 ± 0,5 ºC; vapour pressure: $3{,}31 \times 10^{-4}$ Pa, log $K_{ow:}$ Not measurable.

Discovery/Uses: PFOS is both intentionally produced and an unintended degradation product of related anthropogenic chemicals. The current intentional use of PFOS is widespread and includes: electric and electronic parts, firefighting foam, photo imaging, hydraulic fluids and textiles.

Persistence/Fate: PFOS is extremely persistent with little or no hydrolysis, photolysis or biodegradation in the environment media such as sewage sludge, sediment, soils or ground water. A half-life of PFOS was set to be greater than 41 years in water but might be 1000ds of years.

Toxicity: Toxicity studies on animal's shows that PFOS highly toxic to mammals by binding to proteins in the blood and the liver. Results of a study on rhesus monkeys exposed to 4.5 mg/kg bw/day PFOS potassium salt indicates that all monkeys died following the period of exposure. PFOS has shown moderate acute toxicity to fish. The lowest observed LC_{50} (96h) was estimated to be 4.7 mg/l in a study where fathead minnow (*Pimephales promelas*) were exposed to the lithium salt of PFOS.

1.2.2.9 Polychlorinated Biphenyls (PCBs)

Chemical Name: Polychlorinated biphenyls ($C_{12}H_{(10-n)}C1_n$, where n is within the range of 1-10).
CAS Number: Various (e.g. for Aroclor 1242, CAS No.: 53469-21-9; for Aroclor 1254, CAS No.: 11097-69-1).
Properties: Water solubility decreases with increasing chlorination: 0.01 to 0.0001 g/L at 25°C; vapour pressure: 1.6-0.003 x 10^{-6} mm Hg at 20 °C; log K_{ow}: 4.3-8.26.

Discovery/Uses: PCBs were introduced in 1929 and were manufactured in different countries under various trade names (e.g. Aroclor, Clophen, Phenoclor). They are chemically stable and heat resistant, and were used worldwide as transformer and capacitor oils, hydraulic and heat exchange fluids, and lubricating and cutting oils. Theoretically, a total of 209 possible chlorinated biphenyl congeners exist, but only about 130 of these are likely to occur in commercial products.

Persistence/Fate: Most PCB congeners, particularly those lacking adjacent unsubstituted positions on the biphenyl rings (e.g. 2,4,5-, 2,3,5- or 2,3,6-substtuted on both rings) are extremely persistent in the environment. They are estimated to have half-lives ranging from three weeks to two years in air and, with the exception of mono- and di-chlorobiphenyls, more than six years in aerobic soils and sediments. PCBs also have extremely long half-lives in adult fish, for example, an eight-year study of eels found that the half-life of PCB 153 was more than ten years.

Toxicity: LC_{50} for the larval stages of rainbow trout is 0.32 g/L with a NOEL of 0.01 g/L. The acute toxicity of PCBs in mammals is generally low and LD_{50} values in rat of 1 g/kg bw. IARC has concluded that PCBs are carcinogenic to humans (Category 1). They are also classified, as substances for which there are evidence of endocrine disruption in an intact organism.

1.2.2.10 Polychlorinated naphthalenes (PCNs)

Chemical Name: Polychorinated naphthalenes ($C_{10}H_{8-n}Cl_n$)
CAS Number: 70776-03-3

Properties: Solubility in water decrease with the degree of chlorination 0.08-862 µg/L; vapour pressure with increasing chlorination: 1.5 x 10-6 -0.352 Pa 25 °C, log K_{ow}: 4.2-8.50.

Discovery/Uses: Production of PCNs started around 1910 in both Europe and the United States. PCN are unintentionally generated during high-temperature industrial processes in the presence of chlorine. They are made by chemically reacting chlorine with naphthalene and often used for mothproofing. Polychlorinated naphthalenes (PCNs) comprise of 75 possible congeners in eight homologue groups with one to eight chlorine atoms substituted around the planar aromatic naphthalene molecule.These homologue groups are referred to using the prefixes mono- to octa- (e.g. mono-CNs, di-CNs, etc). PCNs make effective insulating coatings for electrical wires. Others have been used as wood preservatives, as rubber and plastic additives, for capacitor dielectrics and in lubricants.

Persistence/Fate: Atmospheric oxidation by hydroxyl radicals is a possible removal pathway for CNs. Calculated atmospheric half-lives of di-CNs to octa-CNs are between 2.7 to 417 days. Studies on predicted no biodegradation for tetra-CNs to octa-CN with estimated half-lives in water being ≥182 days. Time trends investigation of PCN in soil compartment estimated half-lives of 7.4 years for tri-CNs, 13.1 years for tetra-CNs and 35.3 years for penta-CNs indicating sufficient persistence for long-range transport
Toxicity: Toxicity studies of PCNs have shown that similar to other halogenated compounds such as PCBs, PCDD/Fs the toxicity level depends upon the number and the location of the halogen atoms. They have enzyme-inducing properties in humans. They are of high concern for both aquatic and terrestrial organisms as studies have showed that in harbour porpoises, tetra- to hepta-CNs could pass the blood/brain barrier, a mechanism designed to protect the brain from toxins. Chronic toxicity was predicted to increase from 136 to 0.4 µg/L for di- to hepta-CNs for fish and daphnids which suggest harmful effect.

1.2.2.11 Short-chained chlorinated paraffins (SCCPs)

Chemical Name: Short-chained chlorinated paraffins
CAS Number: 85535-84-8

Properties: Solubility in water: 150 to 470 µg/L at 20 °C; vapour pressure: 1.4 x 10^{-5} to 0.066 Pa at 25ºC; log K_{ow}: 4.48 – 8.69.

Discovery/Uses: Major sources of release of SCCPs are likely the formulation and manufacturing of products containing SCCPs, such as polyvinyl chloride (PVC) plastics, and use in metalworking fluids. SCCPs can be used as a plasticizer in rubber, paints, adhesives, flame retardants for plastics as well as an extreme pressure lubricant in metal working fluids. Chlorinated paraffins are produced by chlorination of straight-chained paraffin fractions. The carbon chain length of commercial chlorinated paraffins is usually between 10 and 30 carbon atoms. Short-chained chlorinated paraffins is between C10 and C13.

Persistence/Fate: They are relatively persistent in environment media with atmospheric half-lives ranging from 0.81 to 10.5 days for long range transport to occur and longer than 1 year from dated core sediment studies. Half-lives of 12.8 hours in water have also been reported.

Toxicity: Freshwater and marine invertebrates appear particularly sensitive to SCCPs, with a reported chronic NOEC of 5 µg/L for *Daphnia magna* and a chronic NOEC of 7.3 µg/L for the mysid shrimp. Severe liver histopathology was observed in trout, with LOECs ranging from 0.79 to 5.5 µg/g in whole fish tissue.

1.2.3 Unintended By-Products

1.2.3.1 Polychlorinated dibenzo-p-dioxins (PCDDs) and Polychlorinated dibenzofurans (PCDFs) (Dioxins and Furans).

Chemical Name: PCDDs ($C_{12}H_{(8-n)}C1_nO_2$) and PCDFs ($C_{12}H_{(8-n)}C1_nO$) may contain between 1 and 8 chlorine atoms. Dioxins and furans have 75 and 135 possible positional isomers, respectively.

CAS Number: Various (2,3,7,8-TetraCDD: 1746-01-6; 2,3,7,8-TetraCDF: 51207-31-9)
Properties: Solubility in water: in the range 0.43 – 0.002 ng/L at 25°C; vapour pressure: 2-0.007x10^{-6} mm Hg at 20°C; log K_{ow}: in the range 6.60 – 8.20 for tetra- to octa-substituted congeners.

Discovery/Uses: They are by-products resulting from the production of other chemicals and from the low temperature combustion and incineration processes. They have no known use.

Persistence/Fate: PCDDs/Fs are characterized by their lipophilicity, semi-volatility and resistance to degradation (half life of TCDD in soil of 10-12years) and to long-range transport. They are also known for their ability to bio-concentrate and biomagnify under typical environmental conditions.

Toxicity: The toxicological effects reported refers to the 2,3,7,8-substituted compounds (17 congeners) that are agonist for the aryl hydrogen receptor (AhR). All the 2,3,7,8-substituted PCDDs and PCDFs plus coplanar PCBs (with no chlorine substitution at the ortho positions) show the same type of biological and toxic response. Possible effects include dermal toxicity, immunotoxicity, reproductive effects and teratogenicity, endocrine disruption and carcinogenicity. At the present time, the only persistent effect associated with dioxin exposure in humans is chloracne. The most sensitive groups are fetus and neonatal infants.

Effects on the immune systems in the mouse have been found at doses of 10 ng/kg bw/day, while reproductive effects were seen in rhesus monkeys at 1-2ng/kg/bw/day. Biochemical effects have been seen in rate down to 0.1ng/kg bw/day. In a re-evaluation of the TDI for dioxins, furans (and planer PCB), the WHO decided to recommend a range of 1-4TEQ pg/kg, bw, although more recently the acceptable intake value has been set monthly at 1-70 TEQ pg/kg bw.

1.2.3.2 Unintentional produced PCBs, PCNs, HCB, PeCB, HCBD

PCBs, PCNs, HCB, PeCB and HCBD are also formed unintentionally.

An important obligation of developing country Parties under the Convention is the preparation of a National Implementation Plan (NIP) to protect human health and the environment from POPs under Article 7 (**Box 1**). Article 7 requires Parties to prepare NIPs. A NIP is a formal planning document, which defines a country's commitments, current situation and actions, which it plans to undertake in the fields of POPs management.

Box 1: Article 7 of the Stockholm Convention: Implementation Plans

1. Each Party shall:
   - Develop and endeavour to implement a plan for the implementation of its obligations under this Convention;
   - Transmit its implementation plan to the Conference of the Parties within two years of the date on which this Convention enters into force for it; and
   - Review and update, as appropriate, their implementation plan on periodic basis and in a manner to be specified by a decision of the Conference of the Parties.
2. The Parties shall, where appropriate, cooperate directly or through global, regional and sub-regional organizations, and consult their national stakeholders, including women's groups and groups involved in health of children, in order to facilitate the development, implementation and updating of their implementation plans.
3. The Parties shall endeavour to utilize and, where necessary, establish the means to integrate national implementation plans for persistent organic pollutants in their sustainable development strategies where appropriate.

1.3 Preparation of NIP: Mechanism and Stakeholder Consultation Process.

1.3.1 Purpose and Structure of NIP

An executive summary is provided to give an overview of the major points in the NIP document. This covers the country commitment to implement the NIP, the objectives of the Convention, national priorities and key issues, targets for implementation and resource requirements. The chapter on introduction outlines the purpose and structure of NIP including a summary of the Stockholm Convention, its aims and obligations. A stakeholder consultation process was paramount in the development of the NIP. The introduction also gives a summary of the POPs issue, providing context and background of the listed chemicals, their uses and problems caused by them. The chapter on country baseline provides basic background information relevant to the NIP. It describes the current situation and state of knowledge in the country about POPs and status of institutional and other capacity to address the problem. The section under strategy and action plan elements, of the NIP has two elements – a formal policy statement and the implementation strategy for the NIP. The implementation strategy sets out specific activities, action plans and strategies to achieve Convention obligations and other objectives set in the country. There are a number of annexes to the document, providing detailed background data and information, specific action plans and other relevant information to meet the objectives of the NIP.

1.3.2 General Principles

This document has been prepared taking into account of the following issues, which are considered important to the successful development of the NIP (**Box 2**):**Box 2: General Guiding Principles for NIP Development**

- NIPs should be tailored to meet the needs of the Party, suitable for use by the Party to meet the obligations of the Convention and will be submitted to the Conference of Parties
- The development of a NIP should build on existing work and assessments where they are available and should not "reinvent the wheel".
- NIPs should not be developed in isolation but should take due account of the aims of sustainable development in the sense of socially, economically and environmentally appropriate policies and actions to maximise the overall benefits. They should be linked to related initiatives where possible to ensure maximum efficiency and reduce duplication of effort.
- The Convention places obligations on the Parties for the 12 chemicals. However, a procedure exists for adding further chemicals to the Convention, therefore it is important that the procedure for developing a NIP is able to respond to the listing of new chemicals
- This guide should be used in conjunction with the Convention text and Annexes and does not substitute the

Convention text for a legal interpretation of the text or a point-by-point analysis of the measures required in a particular country.

1.3.3 Summary of NIP Preparatory Phases

In preparing the NIP and its subsequent updates, cognizance is taken of article 7 (2) and (3) above. It is also executed in accordance with the UNEP/World Bank guidance document, which was endorsed by the POPs INC-7 (UNEP/POPs/INC.7/10) in Geneva, July 2003 and revised in December 2003. The five phases of development are as follows:

- Establishment of Coordinating Mechanism and Process Organisation;
- Establishment of POPs Inventories and Assessment of National Infrastructure and Capacity;
- Priority Assessment and Objective Setting;
- Formulation of NIP;
- Endorsement and Submission of NIP.

Each phase of the process had a detailed series of objectives, tasks and actions, which were undertaken, by identified individuals and groups (e.g. Task Teams). The main activities followed by Ghana were to:

- Undertake inventories of sources and emissions of POPs listed in Annexes A and B to the Convention;
- Develop an Action Plan for the reduction of releases of unintentional by-products. Article 5 outlines some of the elements as inventory of current and projected releases, an assessment of enforcement capacity and adequacy of laws and policies to meet the obligations of by-products reduction of the Convention, and strategies to meet these obligations;
- Build capacity to report every five years on progress in phasing out PCBs as described in Annex I part II of the Convention;
- Prepare a preliminary and comprehensive assessments of stockpiles of POPs and waste products contaminated with POPs, and identify management options, including opportunities for disposal;
- Build capacity to report to the Conference of Parties (COP) on total production, import and export, as per Article 15 of the Convention;
- Build capacity to assess the need for continuation of specific exemptions and preparation of their reporting/extension;
- Build capacity to identify sites contaminated with POPs; and
- Support communication, information exchange, and raising awareness through multi-stakeholder participatory processes, as described in Article 9 and 10.

1.3.4 Stakeholder Participation

The POPs issue impacts on many sectors of society and economy including policy-making, law-making, environmental protection, agriculture, public health, industry, private sector, the public and various interest groups. Relevant national stakeholder institutions and groups were identified, sensitized and assigned with responsibilities from the onset of the NIP initial development and updating processes. Initial workshops intended to provide an excellent opportunity for raising awareness at the national level, as well as bringing together all relevant stakeholders in sound chemicals management for an open discussion and effective communication, were organized. To ensure continuity, a multi-stakeholder National Coordinating Team (NCT) for sound management of chemicals which was set up in 1996 to oversee the preparation of UNITAR/IOMC sponsored National Profile on Chemicals Management pilot project (1996/97), as well as the UNITAR/IOMC National Action Programme for Integrated Chemicals Management project in Ghana, (1997-1999) was maintained for the initial and updating NIP processes. These stakeholders served as core members of the Steering Committee of the POPs enabling activities project. The following national stakeholder institutions actively participated in the initial and updated NIP development in Ghana.

- Government Ministries and Agencies:
  - i) Ministry of Environment, Science, Technology and Innovation (MESTI);
  - ii) Environmental Protection Agency (EPA);
  - iii) Ministry of Food Agriculture (MOFA) (Plant Protection and Regulatory Services Directorate, Veterinary Services Department);
  - iv) Ghana Revenue Authority, Customs Division (GRA-CD);
  - v) Ministry of Finance;
  - vi) Ministry of Health (Ghana Health Service, Food and Drugs Authority);
  - vii) Ministry of Trade and Industry;
  - viii) Ghana Standards Authority;
  - ix) Ministry of Employment and Labour Relations (Factories Inspectorate Department);
  - x) Ministry of Transport;
  - xi) Ministry of Education;
  - xii) Ministry of Justice and Attorney General's Department;
  - xiii) Ministry of Local Government and Rural Development;
  - xiv) Ministry of Gender and Social Protection;
  - xv) Ministry of Sanitation and Water Resources (Ghana Water Company Limited);
  - xvi) Ministry of Interior (Ghana Police Service);
  - xvii) Ministry of Defence;
  - xviii) Ministry of Energy;
  - xix) Ministry of Foreign Affairs and Regional Integration;
  - xx) Ministry of Monitoring and Evaluation;
  - xxi) Ministry of Lands and Natural Resources;
  - xxii) Ministry of Special Development Initiative;
  - xxiii) Ministry of Fisheries and Aquaculture

Development;
xxiv) Ministry of Gender, Children and Social Protection;
xxv) Ministry of Railway Development;
xxvi) Ministry of Tourism, Arts and Culture;
xxvii) Ministry of Youth and Sports;
xxviii) Ministry of Regional Re-organisation and Development;
xxix) Ministry of Roads and Highway;
xxx) Ministry of Chieftaincy and Religious Affairs;
xxxi) Ministry of Communications;
xxxii) Ministry of Information;
xxxiii) Ministry of Inner city and Zongo Development;
xxxiv) Electricity Company of Ghana;
xxxv) Volta River Authority.

- Non-Governmental Organizations
  i) Environmental Interest Groups (Green Earth, Friends of the Earth-Ghana, Environment Youth Action Network, Ecological Restorations, Green Club of Ghana);
  ii) Pesticide Industry Associations;
  iii) Industrial Chemicals Associations;
  iv) Trades Union Congress (Petroleum and chemicals workers union);
  v) Public Interest Groups (Ghana Chemical Society);
  vi) Ghana National Association of Farmers and Fishermen;
  vii) Association of Ghana Industries;
  viii) Women and Children Activists.
- Academic and Research Institutions
  i) Council for Scientific and Industrial Research;
  ii) Ghana Atomic Energy Commission;
  iii) University of Ghana (Chemistry Department, Biochemistry Department);
  iv) Kwame Nkrumah University of Science and Technology (Chemistry Department, Electrical Engineering);
  v) University of Cape Coast (Chemistry Department);
  vi) Water Resources Commission;
  vii) Cocoa Research Institute of Ghana;
  viii) Water Research Institute.
- Media (Electronic and Print)
  i) Ghana Broadcasting Corporation;
  ii) Other Public and Private Media.
- Regional Economic Integration Organisation
  i) ECOWAS.
- International organizations
  i) United Nations Industrial Development Organization (UNIDO);
  ii) United Nations Institute for Training and Research (UNITAR);
  iii) United Nations Development Programme (UNDP);
  iv) UN Environment (United Nations Environment Programme (UNEP));
  v) World Bank;
  vi) Food and Agricultural Organization of the United Nations (FAO); and
  vii) World Health Organization (WHO).

CHAPTER 2: COUNTRY BASELINE INFORMATION

2.0 Introduction

This chapter provides basic background information relevant to the NIP. It describes the current situation and state of knowledge in the country about POPs and the status of institutional and other capacities to address the problem.

2.1 Country Profile

2.1.1 Geography and Population

2.1.1.1 Location

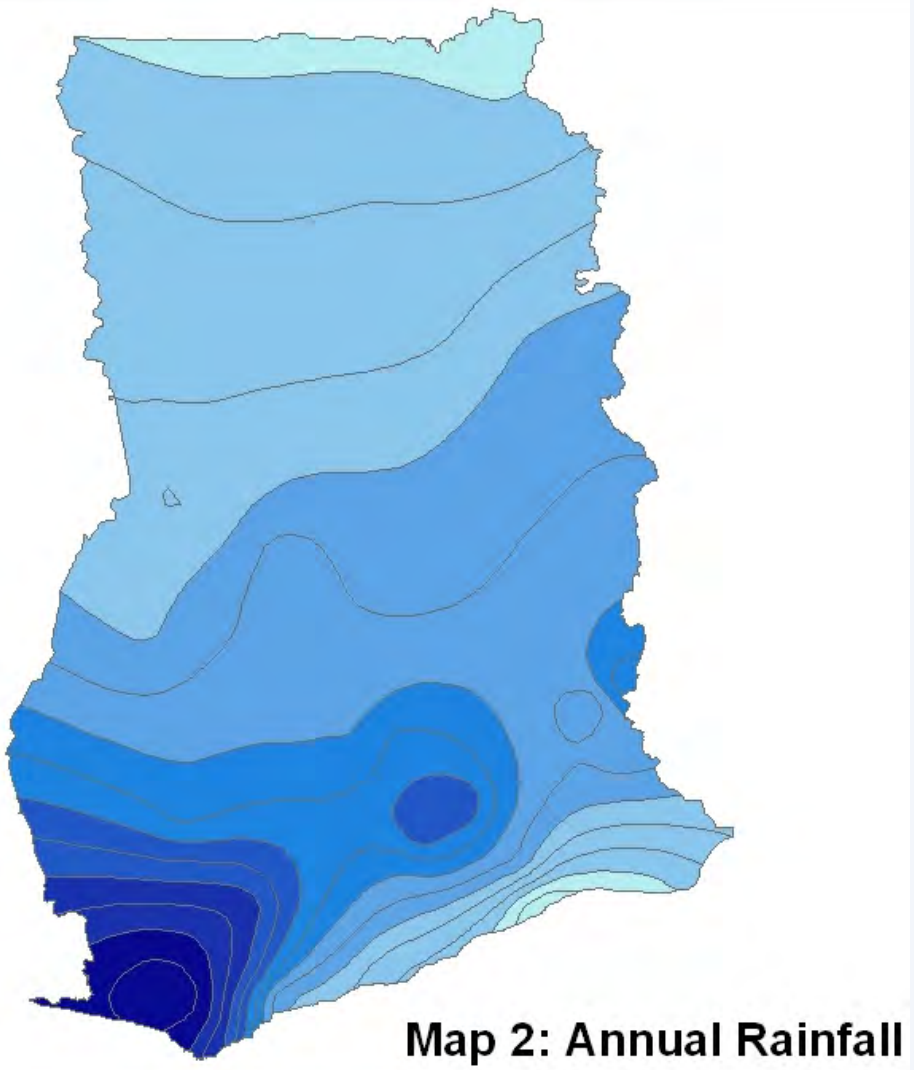
Ghana lies between latitudes 4° 44' and 11° 15' N and longitudes 3° 15' W and 1° 12' E with a land area of 238,539 km^2. It is bounded to the east by the Republic of Togo and to the west by La Cote d'Ivoire. To the north is Burkina Faso and to the south is the Gulf of Guinea (see map 1).

MAP 1: LOCATION MAP OF GHANA

2.1.1.2 Bio-physical Environment

(a) Climate

The Sudan Savannah zone is characterized by a uni-modal rainfall regime lasting 5-6 months and a long dry period of 6 – 7 months in a year. Average annual rainfall, temperature, relative humidity, wind speed, sunshine hours and solar radiation are 885 mm, 28.6°C, 54%, 81 km/day, 7.9 hours and 20.4 MJ/m^2/day respectively. Potential evaporation is 1652 mm per annum and the annual aridity index is 0.60 (see Map 2).



Map 2: Annual Rainfall

The Guinea Savannah experiences a similar rainfall pattern as in the Sudan Savannah zone. Average annual rainfall, temperature, relative humidity, wind speed, sunshine hours and solar radiation are 1033 mm, 28.1°C, 61%, 138 km/day, 7.3 hours and 19.6 MJ/m^2/day respectively. Potential evaporation is 1720 mm per annum and the annual aridity index is 0.60.
The Coastal Savannah zone has bimodal rainfall with an annual average of about 810 mm. Average annual aridity index, temperature, relative humidity, wind speed, sunshine hours and solar radiation are 0.54, 27.1°C, 81%, 251 km/day, 6.5 hours and 18.6 MJ/m^2/day respectively. Annual potential evaporation is about 1504 mm.

The Forest-Savannah Transitional zone is characterized by bimodal rainfall regime with an annual total of 1250 mm and a potential evapotranspiration of about 1430 mm. The annual aridity index is 0.87. Average annual temperature, relative humidity, wind speed, sunshine hours and solar radiation are 26°C, 75%, 133 km/day, 6.2 hours and 18.1 MJ/m^2/day. In all the ecological zones, rainfall is generally accompanied by high intensities and energy loads. The rains are therefore highly erosive.

The High Rainforest has rainfall in excess of 1500 mm a year and mean monthly temperatures are above 20°C.

(b) Vegetation

Ghana is divided into six vegetation zones and corresponds to climate types namely Sudan, Guinea and Coastal Savannah zones, the Forest-Savannah Transitional zone, the Semi-deciduous Forest and the High Rainforest Zones.
The Sudan Savannah covers an estimated area of 1,900 km^2 and consists of short drought and fire resistant deciduous trees interspersed with open savannah grassland. Grass cover is very sparse and in most areas the land is bare and severely eroded.
The Guinea Savannah covers almost the northern two-thirds of the country with an area of 147,900 km^2. The vegetation consists typically of a ground cover of grasses of varying heights interspersed with fire resistant, deciduous, broad-leaved trees at the forest margins. These grade into more open grassland with widely spaced shorter trees towards the north.

The Coastal Savannah covers an estimated area of 4500 km^2. It consists of mainly grassland interspersed with dense thickets often less than 5m high with a few trees. Short and medium grasses are the dominant species.
The Forest-Savannah Transitional Zone (Derived Savannah) covers about 8,300 km^2. Most of the tree species, similar to those in the forest zone, occur in association with tall to medium tall grasses.

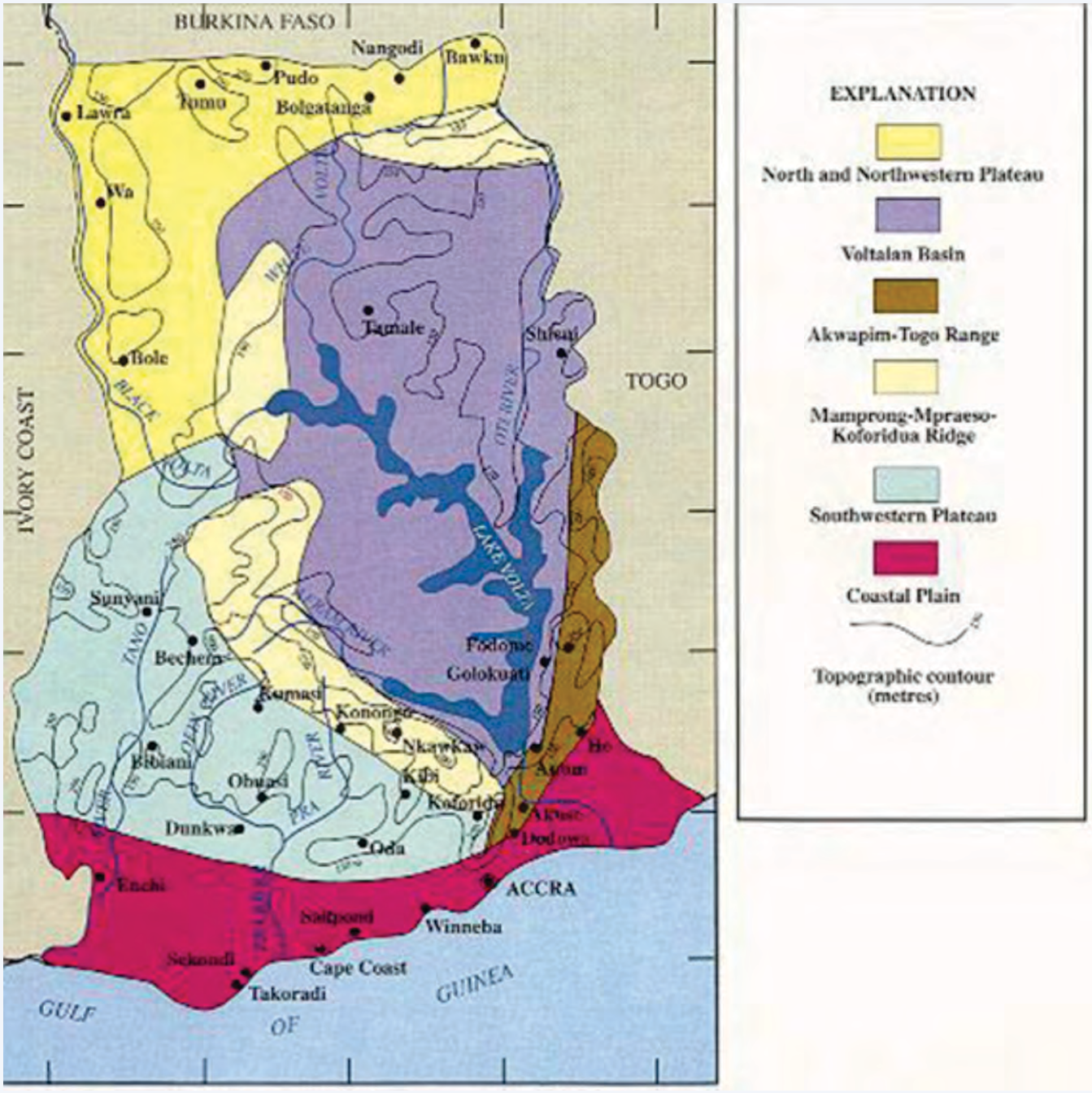
The Semi-Deciduous Forest zone is about 66,300 km^2 in extent and forms about 90% of the total forest zone. The characteristic associations are *Celtic-Triplochiton* and *Antiaris-Chlorophora*. The indicator trees for the former consist of *Celtic milbraedii* and *Triplochiton scleroxylon* whilst the latter is characterized by *Antiaris africana* and C*hlorophora excelsa.* It is within this zone that most food crops, timber extraction and cocoa cultivation takes place. Most of the timber for both local needs and export comes from the zone. As a result of these activities the vegetation outside the forest reserves consists mainly of forest regrowth, thicket, secondary forest and swamp thicket.

The High Rainforest zone covers an area of about 7,500 km^2 and is located in the southwestern corner of the country. The vegetation is generally evergreen although some species common to the semi-deciduous forest may be found. Such species tend to shed their leaves during the dry season. The zone is characterized by the *Cynometra-Lophira-Tarrietia* association with *Cynometra ananta, Lophira alata* and *Tarrietia utilis* as indicator trees (Lane, 1962). The topography is undulating to rolling with numerous fresh water swamps potentially suitable for rice cultivation occupying low-lying valley bottoms. The swamp vegetation consists of raphia palms with shrubs such as *Alchornea cordifolia*, *Caropa procera* and *Macaranga* spp. entangled by various climbers.

MAP 3: MAP OF GHANA SHOWING VEGETATION

(c) Topography

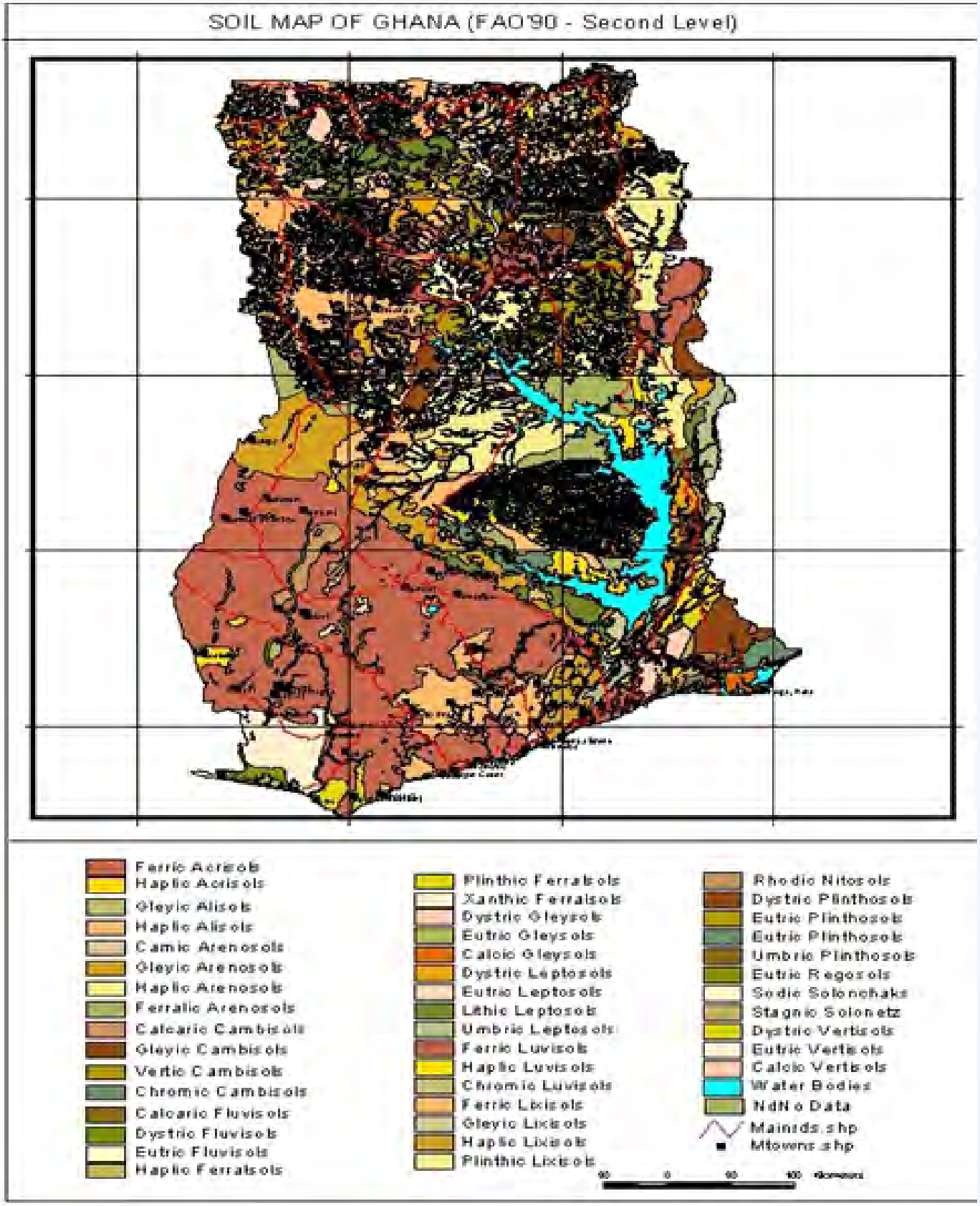
The topography is gently undulating and low in relief with slopes of 3 to 4 percent dominating. Most of the area lies between 153 and 244 meters above sea level. Under the climax vegetation the slopes are stable. However when the vegetation is cleared conditions become unstable and high rates of erosion are inevitable



MAP 4: MAP OF GHANA SHOWING TOPOGRAPHY

(d) Soils

The major soils are Lixisols, Acrisols, Nitisols, Luvisols, Lithosols, Plinthosols, Gleysols and Cambisols. Alluvial soils (Fluvisols) and eroded shallow soils (Leptosols) are found in all the ecological zones. Most of the soils are developed on thoroughly weathered parent materials. Their organic matter content, buffering capacity and cation exchange capacity are low. The soils are consequently of low inherent fertility with nitrogen and phosphorus as the most deficient nutrients. Many of the soils have predominantly light textured surface horizons, heavier textured soils being confined to the valley bottoms and the Accra Plains. In the savanna zones there are extensive areas of iron pan and shallow concretionary and rocky soils, which have low water holding capacities and limited suitability for agriculture.



MAP 5: MAP OF GHANA SHOWING SOIL TYPES

(e) Water Resources

The major sources of water are natural rainfall, rivers, streams, lakes, groundwater and artificially impounded water such as dams, dugouts and reservoirs. Naturally, rainfall is the single source of water that feeds all the other sources. Whenever rainfall is insufficient, recharge of water from the other sources is low.

(f) Human Population

According to the 2010 Population and Housing Census, the country's population was estimated at 24.66 million (Ghana Statistical Service, 2012) and represents an intercensal growth rate of 2.5 per cent as against 2.7 per cent in 2000. Currently the country's population is estimated at 29.6 million (Ghana statistical service 2018). The birth rate is estimated at 32 births per thousand population (2012 estimates) while the death rate is estimated at 7.7 per thousand (2012 estimates). The rate of infant mortality is approximately 40.9 per thousand-live birth while the overall life expectancy is 61.45 years (Ghana Statistical Service, 2012). The current total fertility rate is 4.15 children per woman (Ghana Statistical Service, 2012).

The Ghanaian population is made up of many ethnic groups. According to the 2010 Population and Housing Census, the breakdown of the ethnic composition is as follows: Akans (47.5%), Mole-Dagbon (16.6%), Ewes (13.9%), Ga-Dangme (7.4%), Guma (5.7%), Guan (3.7%), Grusi (2.5%), Mandre-Busanga (1.1) and others (1.6%). There are three main religious groupings in Ghana: Christianity, Islam and the Traditional. The 2010 census estimated Christianity as the dominant religion in Ghana accounting for over two-thirds (71.2%) of the population followed by Islam (17.6%), Traditional religion (5.2%), other 0.8%, and none (5.2%).

2.1.2 Political and Economic Profile

2.1.2.1 Political Profile

Ghana is governed under a republican multi-party constitutional democracy with executive powers vested in the President while legislative powers rests with unicameral legislature of 275 members serving a four-year term at the national level. In addition, the country operates a local government system comprising Regional Coordinating Councils, Metropolitan, Municipal and District Assemblies. The official language is English.

The country has sixteen administrative regions. These are Ahafo, Ashanti, Bono, Bono East, Central, Eastern, Greater Accra, Northern, North East, Oti, Savannah, Upper East, Upper West, Western, Western North, and Volta regions. The country is further divided into 216 districts, which form the basic units of political administration.

Ghana is a member of the following regional organisations: Economic Community of West African States (ECOWAS), African Union (AU) and African Ministerial Conference on Environment (AMCEN).

MAP 6: MAP OF GHANA SHOWING ADMINISTRATIVE REGIONS

2.1.2.2 Economic Profile

Ghana is classified as a developing country with a per capita income of US$ 1328 in 2015 (GSS, 2016) and showed improvement in Human Development Index due to increased access to health care and education. Agriculture and livestock employs 55% of the economically active population. It is predominantly smallholder, traditional and rain-fed, with 85% of the country's 1.8 million farms being smaller than 2 hectares. Only about 12% of Ghana's land is classified as cropped land. Cocoa is the main cash crop and is grown on 40% of the cropped land. It accounts for about 75% of agricultural exports. Other commercially important tree crops are oil palm, coconut, rubber, kola and coffee.

2.1.3 Profiles of Economic Sectors

2.1.3.1 The Agricultural Sector

Agriculture is a vital sector to the Ghanaian economy that accounts for significant share in terms of Gross Domestic Product (GDP), employment, foreign exchange earnings and food production. The sector employs about 45.3% of the country's population. (ISSER, 2015). Until the last decade, the agriculture sector was the major contributor of the country's GDP growth but currently continues to gradually decline over the years. For instance, from the year 2009, agricultural contribution to GDP decreased progressively from 31.8% in 2009 to 29.8% in 2010, 25.3% (2011), 22.9% (2012), 22.4% (2013) to 21.5% in

2014. The trend has been attributable to changes in the various sectors to the economy resulting from the upgrade of the service sector. As a result of initiatives and programmes taken by both government and private sectors, the agricultural sector in Ghana is gradually undergoing transformation from subsistence to mechanised and commercialised agriculture. According to available data for the year 2014, the contribution of the agriculture sector to the overall foreign exchange in the country was 18%, 1% and 3% for cocoa, timber and non-traditional (including yam, cereals, vegetables, fish and others) exports respectively.

The overall growth rate of the agricultural sector in 2014 was estimated as 5.7% with an increase in foreign exchange earnings over the years from 818 to 2,383 million Dollars from 2003 to 2014. While sustainable agricultural production depends primarily on productive soils, the land resources of Ghana, particularly the soil, are being degraded as a result of the interaction of both natural and anthropogenic factors. Meeting the future food needs of Ghana, while reducing poverty and protecting the environment would require halting and reversing soil degradation through restorative measures of soil and water conservation, nutrient and crop management.

2.1.3.2 Livestock and Poultry Population

The savannah areas of Ghana carry most of the livestock population. The Upper West, Upper East and Northern Regions constitute the northern savannah zone. This zone holds 74.4%, 36.4% and 43.4% of the national cattle, sheep and goat stocks respectively. The livestock (cattle, sheep and goats) population density per km^2 in 1996 was 130, 33 and 16 for the Upper East, Upper West and Northern Regions respectively. The Upper East Region has the highest livestock population density. In the whole country, statistics of livestock heads recorded in the year 2014 was 1,657 M (Cattle), 4,335 M (Sheep), 6,044 M (Goat), 682 M (Pigs) and 68,511 M (Poultry).

2.1.3.3 Agro-Industry

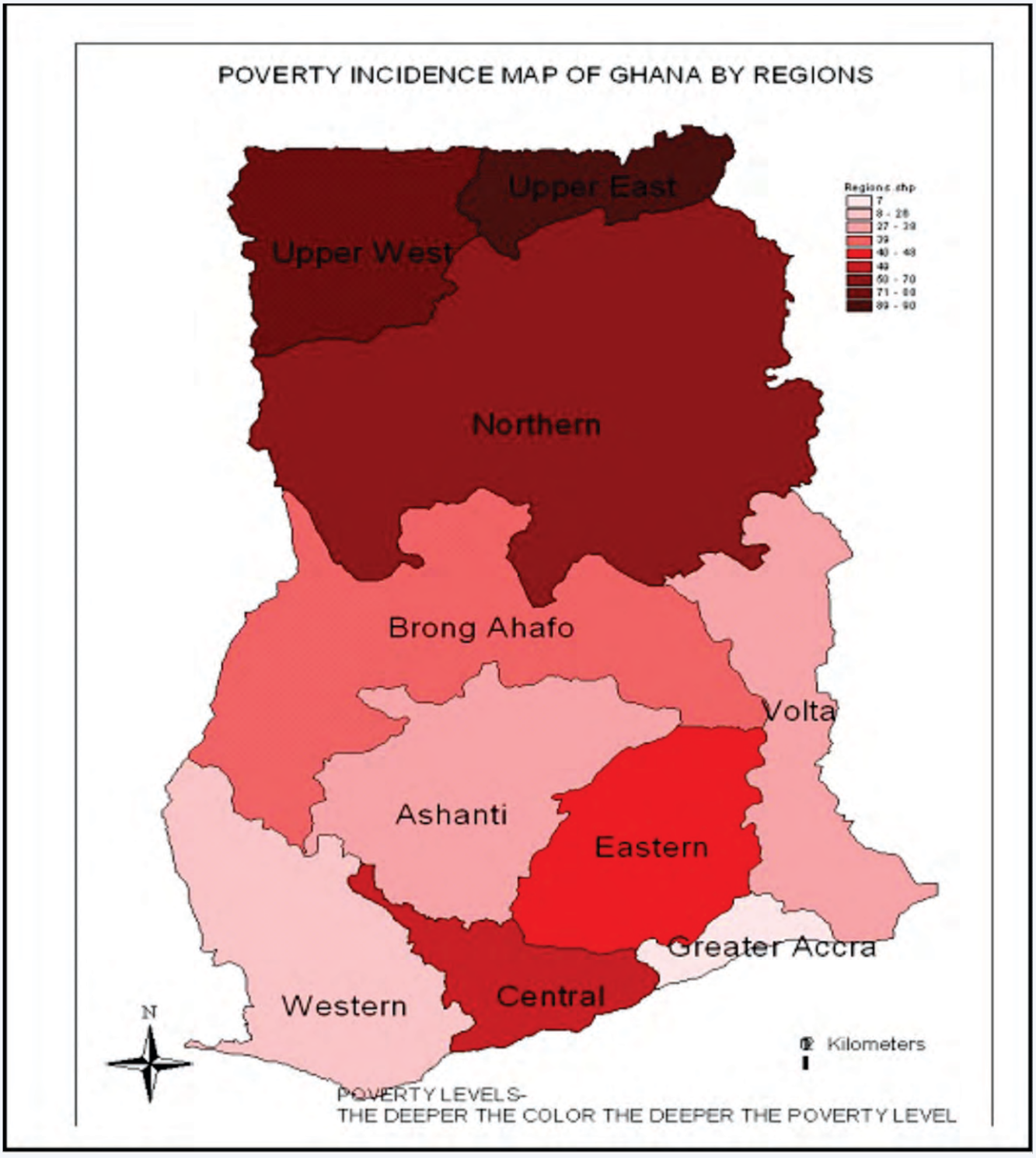
Majority of products for agro-processing are highly perishable. Processing enhances the storage life of the perishables, thus serving as a means of securing food for the lean season as well as supporting household incomes. However, the achievement of these goals is constrained by the inadequate agro-processing facilities, particularly at the community level. The development of the requisite infrastructure for community-based agro-industry would therefore contribute significantly to the attainment of food security and enhancement of the incomes and livelihoods of rural households.

2.1.3.4 Marketing

Agricultural marketing in Ghana is private sector dominated. Most producers depend on a complex chain to take their outputs from the farm gate to the urban consumer. The market position of small holder farmers is very weak, in that they mostly sell in small amounts to itinerant traders, usually soon after harvest and at low prices to meet their cash needs, and/or pay off cash loans. The problems in the development of traditional markets include inadequate marketing infrastructure (e.g. storage and processing facilities) which results in high post-harvest losses, lack of market information which prevents the market from operating in a competitive manner, and lack of transport infrastructure. Solutions to these problems would contribute to improved marketing and distribution of agricultural produce and food security.

2.1.3.5 Alternative Income Generation Activities

The economy of Ghana is basically agro-based. Majority of the rural households depend on land resources for their livelihood. Provision of support for rural communities who engage in non-agricultural and off-farm enterprises could reduce the pressure on the fragile land resources with a consequent reduction in land degradation whilst enhancing the income of rural households.



MAP 7: POVERTY INCIDENCE MAP OF GHANA BY REGIONS

2.1.3.6 Rural Infrastructure Development

Reducing the impacts of POPs and eventual elimination from the environment cannot be achieved without due regard to the general socio-economic environment of the people. For the survival of the populations and to ensure food security, there is the need to provide certain basic infrastructure for water and sanitation, health, education, markets, storage, agro-processing and accessibility (roads). Improvement in rural access roads leads to reduced transport costs, enhanced access to health and market facilities and consequent reduction in post-harvest losses especially for perishable agricultural produce.

Water and sanitation and health infrastructure result in improved health which in turn enables the communities to engage in productive activities, such as farming. Provision of education facilities will equip communities to be better informed and make informed choices. Post-harvest facilities (e.g. storage) afford the producer and the consumer time utility and to even-out supply as against demand. The link between good infrastructure and general economic development is very strong and critical as far as the sound management of chemicals is concerned.

2.1.3.7 Access to Inputs of Production

Withdrawal of government subsidy on agricultural inputs, e.g. seeds, fertilizers, agro-chemicals, etc is one of the contributing factors to low agricultural productivity. As inputs become more expensive, farmers tend to use less than recommended rates or unapproved cheaper inputs at the expense of increased yield and healthy lifestyles. Access to credit for farm activities is often constrained by the high-risk nature of crop production.

Rural cultural systems put a high premium on social activities than on rural agricultural and small-scale rural cottage industries. This has an adverse effect on food security.

Possible interventions among others, to overcome these problems include promotion of access to recommended inputs for production and of block farming schemes, development of supervised input- product marketing credit schemes and establishment of special revolving fund for production, promotion of inventory credit, formation of community co-operatives and credit unions and creation of financial incentives (e.g. review of tax policy to accommodate agricultural subsidies).

2.1.3.8 Agricultural Diversification

Agricultural diversification provides opportunity for farmers to accommodate risks in their enterprise, enhance their incomes and security. The current agricultural production base therefore needs to be expanded to cover non-traditional produce through introduction of small-scale irrigation schemes for dry season farming and vegetable production. Mixed farming needs to be promoted and intensified. Promoting the production of small ruminants and poultry will contribute to the protein needs of households and also enhance income generation for better livelihoods.

2.1.3.9 Food Security

Rain fed agriculture has not been able to sustain year round food production and availability as well as vegetative cover. It has not been successful in fully utilising and harnessing rainfall in agricultural production to generate surpluses for storage for the lean season. Availability of water is therefore central to an effective strategy for ensuring food production.

Provision of water through small irrigation schemes, dugouts, water harvesting, soil and water conservation, promotion of integrated dry land farming systems, development of drought tolerant crops and use of improved crop and livestock husbandry practices will, among other factors, contribute to increased food production and food security.

2.1.3.10 Socio-economic and Cultural Impacts of POPs

Providing adequate supply of food and improving the health of a rapidly increasing human population are two of the current greatest challenges. The annual rate of increase in food production in tropical developing nations, such as Ghana, is less than 1.0%, while in most of these countries; the population is growing at an annual rate of 2.0%. There is thus, a serious gap between food supply and demand.

Pests (including insects, diseases, weeds) compound this problem by destroying agricultural crops in the field and in storage. Pre- and post-harvest losses of agricultural crops are estimated at an average of 35% and are highest in the tropics, particularly Africa.

In the quest to achieve minimum crop losses and maximum control of vector-borne diseases, society incurs great cost in terms of pesticide abuse and misapplication, environmental pollution and the implications for the health of society both in the short and long term. Some of the 'dirty dozen' are employed in industrial and manufacturing processes, while others are also released as by-products or wastes from other processes.

2.1.3.11 The Industrial Chemical Sector

The chemical industry in Ghana has grown steadily since the advent of the structural adjustment programme in the 1980's and 1990's. This has resulted in the increasing amount of the importation of various types of chemicals both for industrial and agricultural purposes.

A variety of chemicals are imported for agriculture, cosmetics, food, plastics, laboratory, petroleum, and a host of other industries. As a result of the problems of waste management (both general and hazardous wastes), pollution of air, water and land are increasingly posing problems.

2.1.3.12 Poverty and the Chemical Industry

Poverty is pervasive in the country. Available figures indicate that in 1999, five out of the ten regions in Ghana have more than 40% of their population living in poverty with the Upper East, Upper West and Northern Regions being the worst affected. In terms of economic activity, poverty is by far highest among food crop subsistence farmers. It is recognized that poverty is a major contributory factor underlying socio-economic cause of misuse and abuse of agricultural and other chemicals. It

often limits the ability of the poor to adopt sustainable measures although they may be aware of the necessity for sound management. Any strategy aimed at eliminating POPs from the environment and its attendant effect on human health should therefore be directed at interventions for poverty reduction. Among suggested interventions, in line with the government's poverty reduction strategy, is increasing per capita agricultural yields as a first step. The objective is to enhance food production and security and rural incomes and livelihoods by increasing crop and livestock production and yield through improved soil and water management practices, crop and livestock husbandry and access to production inputs and possibly including application of POPs.

2.1.4 Environmental Overview

The 2016 State of the Environment (SoE) report for Ghana provides key environmental drivers (such as human population, economics and environment, energy consumption, transport, climate change, waste and recycling, and sanitation) and environmental resources (such as air quality, degraded and contaminates sites, soil condition, sustainable land management, biodiversity, protected areas and conservation, invasive species, freshwater resources, wetlands, coastal ecosystems, and marine ecosystem).

2.1.4.1 Population

There is an increase trend in urban growth with expansion of built environment, loss of agricultural lands, challenges of poor drainage and flooding, and the polycrisis of waste and land management, human mobility, resources and commodity flows, and energy, water and food supplies. In the major cities, housing delivery, has become a major challenge and there is development of slums and informal settlement enclaves with improvised homes, which are characterized by low quality service delivery and poor environmental conditions. It has been estimated that the country would require a total of 2 million dwellings by 2020.

2.1.4.2 Economics and Environment

Gross domestic Product (GDP) growth has slightly increased in recent years partly as a result of poor value addition and use of local content, and in an environment where production technologies are largely inefficient. Further increase in production will be associated with high resource use, which is detrimental to the environment. The excess of import over exports has led to a widening balance of trade deficit and together with high fiscal deficits has partially resulted in debts which are used to finance these deficits; A situation that have impacted on the environment as more natural resources would have to be extracted to finance these debts. Overall, economic indicators have not performed very well and have partially resulted in the slight decrease of the Environmental Performance Index. Reversing the observed trend will require green growth policies that revolves around good governance; formulation of a long-term strategy to guide development; strengthening institutions; human capacity and coordination; better involvement of the private sector; ensuring sustainable consumption and production; improving monitoring, evaluation, finance and research for development.

2.1.4.3 Energy

The energy sector is characterized by huge dominance of petroleum consumption and traditional biomass resources. Electricity, biomass and petroleum consumption has seen increasing trends although kerosene consumption has decreased because of rural electrification programmes that allowed many rural communities that hitherto used kerosene lanterns to be connected to the national electricity grid. Share of renewables (excluding large-scale hydro) was 0.01% of total electricity generation capacity in 2011. However, this share is expected to rise in the foreseeable future. A general rise in emissions from the energy sector has been observed. This has been attributed to the increasing fuel consumption in the growing number of thermal power generation plants, increasing fuel consumption within the transport sector due to increasing vehicle fleets and poor fuel quality and efficiency in the road-transport sub-category as well as rising biomass use in the residential sub-category. Indeed, the energy sector has been the largest source of anthropogenic CO2 emissions and recorded an increase of 340% between 1990 and 2012 (EPA/GEF/UNEP). This underscores the need to diversify the energy sector with a significant proportion of renewable energy to reduce the country's environmental burden of high CO2 emissions.

2.1.4.4 Transport

In the transport sector, except for the railway sub-sector, all the other modes of transport, road, air and water have witnessed improvements in terms of infrastructure and performance operations. The road subsector continues to remain the dominant mode of transport, accounting for 96 % of passenger and cargo traffic. Between 2005 and 2014 the number of newly registered road vehicles has been increasing by an average of 7,511 vehicles per annum. This is however dominated by private vehicles of less than 2000cc indicating the desire of the middle income working class of the population to own their own cars. The trend also indicates the effectiveness of the policy to discourage importation of fuel guzzling engines with relative higher emission capacity. However, a high proportion of newly registered vehicles are used ones imported into the country with the number of over-aged vehicles (over 10 years old in use) showing consistent increases despite penalties imposed on them. Vehicles considered as roadworthy (based on mechanical and electrical tests and not emissions) have also shown average annual increase of 37,759. The total road network of the country is 71,418.9km with the widest category being the feeder roads (59%), followed by trunk roads (21%) and urban (20%). The total land area covered by

feeder roads and trunk roads is 420.86 km2, which represents 0.18% of the total land area of the country. The sea ports at Tema and Takoradi have over the years received physical expansion and improvements in facilities to enable them adequately respond to increasing vessel and cargo traffic. Generally, there is poor used oil disposal practices among majority of the auto repair garages which portends serious environmental and public health problems. There is no legislation on disposal of used vehicle tyres and they are common sight at service centres.

2.1.4.5 Climate Change

Ghana's emissions of Green House Gases (GHG) have increased since 2004. In 2014 Ghana's total GHG emissions, excluding AFOLU sector, were estimated to be 16.51 MtCO2e. Carbon dioxide has increased by 82%, Nitrous oxide by 22% and Methane by 16%. The mean annual temperature has risen by 1.0 °C since 1960. The number of 'hot' days per year has increased by 13.2 %, while the number of 'hot' nights per year has increased by 20 %. 'Cold' days and nights per year have decreased by 3.3 and 5.1 % respectively. In the period 2005 – 2010, the period between start and end of rains varied by as much as 30 % from year to year. Sea Surface temperatures are unstable. Ghana aims to become a full-fledged middle income country by 2020, but climate change is a serious threat to this ambition. It is already affecting economic output, livelihoods and therefore, long-term development prospects, even though Ghana's own contribution to global climate change has been negligible. The reason for Ghana's vulnerability is the reliance on sectors that are sensitive to climate change, such as agriculture, forestry and energy production. Evidence already shows the impact of climate change on our national economy, with clear signs that the coastal zone, agriculture and water resources are all negatively affected, with consequent impacts on poverty, health and women's livelihoods.

2.1.4.6 Waste and Recycling

Waste generation is increasing due to increasing population, urbanization and economic development. Managing waste in Ghana is a challenge. Currently, solid waste generation across the country is estimated at 13,500 tonnes per day. From 2005 to 2015, the volume of municipal solid waste generated daily in Accra increased from 1500 to 2800 tonnes Over 29 % of households in the country dispose of their solid waste indiscriminately and into drains, curbs and open parks, and streams and have become sources of pollution, negatively impacting human health, water and land quality. Between 55% and 75% of solids waste generated daily in the five largest cities in the country - Accra, Kumasi, Sekondi-Takoradi, Tamale, and Tema, is managed by existing systems. The Agbogbloshie dumpsite in Ghana is globally popular for the use of crude methods of e-waste recycling handling and disposal. Between 0.2% and 0.3% of the country's total labour force, (20,300 – 33,600) is engaged in this informal electronic waste refurbishing and management sector.

2.1.4.7 Sanitation

The sanitation sector has made limited progress over the years and unable to meet millennium development goal (MDG) target of 54% as at 2015. Only 15% of the population has improved sanitation. Majority of the population (60%) use shared facilities (public toilets). The common toilet facilities used in Ghana are the water closet (WC), Kumasi ventilated improved pits (KVIP), pit latrines. Whereas the use of bucket/pan latrines has been banned; a very small percentage of the population continue to use these facilities. Wastewater treatment is very limited and only 5% of urban settlements are served with waste water treatment plants. Some pressures impacting the sector include urbanization, inadequate and aging infrastructure, low investment and climate change. Several policies in both the water and sanitation sectors have been formulated and projects implemented to address the pressures.

2.1.4.8 Air Quality

Air pollution has become one of the world's top environmental health risks as high concentrations of particulate matter, chemicals or materials adversely affect human health and the environment, causing serious health and economic impacts. Ghana has achieved significant progress at reducing its ozone depleting substances its HCFC consumption reduction requirements of 35% for 2020 ahead of schedule. Air quality for monitoring data for PM10 in parts of Accra, though not nationally representative, exceed WHO guidelines of 10 µgm-3 and the EPA-Ghana standard of 70 µgm-3, which is a cause of concern. The transport sector contributes the greatest share of emissions, followed by industry and open/indoor burning activities. The relationship between air pollutants and climate change is also gaining increased recognition. Lack of ambient monitoring data hampers the ability to characterize and understand the patterns of PM in urban areas to minimize its impacts. The country has several legislative and regulatory mechanisms to ensure the regulation of air quality, however, efforts are hampered by the inefficiencies due to lack of funds, inadequate data and challenges in sharing information between institutions. Supporting policies and investments are recommended for less polluting and more efficient transport, housing, and industries as well as improved power generation, municipal waste management and agricultural practices for reducing air pollution.

2.1.4.9 Degraded and Contaminated Sites

There are many anthropogenic activities that cause land contamination such as mining activities; petroleum contamination; landfills and dumpsites. Large scale mineral mining companies increased from 12 before 2000 to 33 in 2016. Within this period, a total concession size of 4,478.14 km2 was granted them but only about

28,072.52 Ha were subjected to actual mining activities between 2005 – 2016. Between 2012 – 2016, 1327 licenses and a total concession size of 28,090.79 Ha were granted for small-scale mining. Within the same period, 112 licenses and a concession area of 937.73 acres were granted for sand wining, with 13,889,460 m3 volume of sand mined. As at November 2016, a total of 259 quarry companies have registered with the Ghana EPA and have been granted a total concession size estimated to be 7 770 acres out of which 3004.4 acres have been the area projected to be disturbed. While baseline information on environmental impact of the operations in the oil industry is very much inadequate, a total of 17 bulk storage depots, comprising 90 tanks are located all over the country and these are in good operational conditions. Similarly, there are properly operating 3452 discharge retail outlets all over the country that ensure that there is neither spillage nor leakage occurrence. There are only five engineered landfill sites, and as many 216 dumpsites that are not properly designed, constructed or managed. In all this, the major driver is increase in anthropogenic activities that degrade or contaminate sites compounded by lack of enforcement of legislations, as well as the drive for short term financial gain.

2.1.4.10 Soil Condition

Ghana has a total arable land area of about 13,628,179 ha. Most soils of the arable lands are low in fertility and coarse textured, resulting in poor soil structure and reducing their ability to retain. Dry conditions easily occur within the growing season. The soil condition indicators used in this report are total soil nitrogen, available phosphorus, soil carbon, soil pH and electrical conductivity. The depletion of major soil nutrients is across all the agro-ecological zones with phosphorus and nitrogen being the most depleted nutrients. The important drivers and pressures identified are; increased population, land tenure arrangement, increased food production, and conversion of arable lands to human settlements, climate change and variability among others.

Economic factors, unsustainable land management and policies among others also contribute to soil degradation. From the study, all the major soil quality indicators assessed have decline across the six agro-ecological zones in Ghana over the years due to these pressures. Nutrients are mostly lost through crop harvesting without corresponding replacement through application of inorganic and organic fertilizer. It is therefore necessary to monitor the conditions of the soil in order to identify the pressures and drivers leading to the declining soil condition so as to recommend policy to solving the declining trends. Most of the policies and action plans put in place have not been implemented or enforced. There is a need to intensify soil conservation awareness and enforce soil conservation measures to improve on soil conditions across the country.

2.1.4.11 Sustainable Land Management

The objective of sustainable land management (SLM) is to harmonise the complimentary goals of providing environmental, economic, and social opportunities for the benefit of present and future generations, while maintaining and enhancing the quality of the land (soil, water and air) resource. Sustainable land management is the use of land to meet changing human needs (agriculture, forestry, conservation), while ensuring long-term socioeconomic and ecological functions of the land. Some of the measures used in SLM include initiatives to reduce the impact of sheet, gully and wind erosion, as well as acidification, organic decline, structural decline, and salinization and/or waterlogging of soils. Ghana has very little comprehensive, country wide or historical data sets on the use and extent of Sustainable Land Management approaches.

2.1.4.12 Biodiversity

Ghana is relatively rich in biodiversity, with ca. 5429 plant species, 983 species of butterflies, 377 species of reptiles and amphibians, 794 bird species and 327 species of mammals. The flora includes 119 threatened species, three of which are critically endangered (CR), 20 endangered (EN) and 96 Vulnerable (VU). The Ghanaian fauna includes 56 species of threatened fish, comprising two CR, 18 EN and 36 VU; 11 species of threatened amphibians, comprising 2 CR, 5 EN and 4 VU; 7 species of threatened reptiles, comprising 2 CR and 5 VU; 22 species of threatened birds, comprising 4 CRR, one EN and 17 VU and 20 threatened mammals, comprising 1 CR, 6 EN and 13 VU. The country's biodiversity is under threat from several human-induced pressures, including habitat loss and degradation resulting from farming, urbanization and extractive industries as well as over-exploitation. Other threats include climate change, invasive species and pollution, particularly with regard to aquatic habitats. There are indications that the populations of almost all animal species, including invertebrates such as snails, are on the decline and that rodents are now dominating the species exploited as bushmeat. Ghana has taken commendable steps to safeguard the country's biodiversity through the establishment of protected areas which current stands at ca. 16.5% of the country's total land area; established agencies with responsibility to manage the country's biological resources and has signed on to all the major international treaties that seek to protect biodiversity.

2.1.4.13 Protected Areas and Conservation

Forest conservation in Ghana started in the early 1900s. Since then, relevant institutional and regulatory frameworks have been put in place to ensure that the 8.2 million ha primary forest coverage for the country remained intact. The coming into force of various policies to regulate the management and utilisation of forest and wildlife resources brought into being the creation of protected areas. The purpose for their establishment,

among other things, was to protect habits, conserve biodiversity and regulate timber exploitation to achieve sustainability. Over the years, anthropogenic drivers have fuelled deforestation and forest degradation, with primary forest declining at the rate of 2% per annum. Currently only about 1.7 million hectares of the primary forest, mainly within government gazetted protected areas is left. The overall forest cover has, however, increased in size through plantation development. This has resulted in the expansion of forest cover from 8,627,402 ha in 1990 to 9,294,349 ha in 2015. Despite this gain, the loss of primary forest cover remains an issue of major concern as strategic habitats are being fragmented, remnant forest patches are getting isolated, biodiversity is eroding and ecosystems services that the forest provide are being inhibited. More importantly, pressure is coming to bear on protected areas as there is increasing urge to exploit forest resources from these areas. There is therefore the need for political will and support to enforce existing policies and to strengthen institutional capacity to fully implement rules and regulations governing forest resource management.

2.1.4.14 Invasive Species

The intensity and frequency of the alien invasive species events and its socio-economic and environmental impacts are expected to increase as driving forces and pressures are projected to intensify in Ghana. This could significantly undermine the development agenda of the country that relies significantly on ecosystems services. Status and trends of invasiveness were determined based indicators such as count of individual invasive alien species (IAS) and subspecies in the country, within taxonomic groups and habitats. The geographic distribution or pervasiveness is indicated by the presence of terrestrial IAS in different ecological zones, and presence of aquatic IAS in both natural and man-made water systems. One hundred and two (102) IAS were listed for the entire country: this is far higher than any previous compilation. Forty seven (47) were terrestrial plants of different taxa. Among the important ones were Chromolaena odorata (Acheampong), Striga sp. (Witch weed) and Broussonetia papyrifera (Paper mulberry). Thirteen (13) were aquatic plants, with water hyacinth and Hippo grass being examples of the key ones. Of the 27 animals listed (both terrestrial and aquatic), about 70.0% were insects (Table 3), with majority being agricultural pests. The lower and micro-organisms/pathogens were among disease causative agents of plants, animals and humans. Data quality and accessibility issues existed. Data unavailability, gaps and inconsistencies challenged IAS information generation efforts. The cost of identified IAS includes, disturbances of natural ecosystems and biodiversity, reduced water quality, reduced agricultural productivity, diseases among others.

Globalization and global environmental processes such as international travels, international trade, climate change and associated invasive pathways drive intentional and non-intentional IAS phenomenon in Ghana. Proxy indicators of pressures include deforestation, intensification of land use, expansion of road network, high population densities etc. Efforts made to address IAS issues in Ghana include ratification of international and regional protocols, treaties and conventions, formulation of some sectoral regulations and implementation of some projects. Yet, legislative, policy, regulatory, institutional weaknesses and information issues have hampered progress in managing IAS in a more comprehensive, coordinated and proactive manner. Institutional coordination, capacity building of relevant institutions in data gathering, research and critical management activities must form a core of future efforts to control IAS in Ghana.

2.1.4.15 Freshwater Resources

In Ghana, freshwater availability is a limiting factor to ecosystems and functioning of human activities. Water availability, usage, quality and efficient management require significant attention. Freshwater is affected by several drivers that include population, land use change, pollution from illegal mining, urbanization and industrial development. These drivers continue to impact on fresh water in significant ways that are likely to affect the sustainability of freshwater. The Water Quality Index (WQI) of all Ghanaian waters is in decline. Temperature rise, increase in evaporation and rising demand for freshwater in Ghana means that efforts at sustainable water management must intensify. Investments in the water sector through research (with a focus on datasets) and education that will culminate in reliable projections for demand and quality ought to be pursued.

2.1.4.16 Wetlands

All wetlands in Ghana are under threat from urbanisation and demand for land for housing, industrial development and farming, pollution from domestic, industrial and agricultural waste, as well as over-exploitation of wetland resources. These pressures have led to significant losses in wetland areas, declines in international status of some wetlands and drastic declines in lagoon fisheries in terms of species diversity and productivity. Except for the waterbird monitoring that has been ongoing for the past three decades, there is no systematic data collection that will enable monitoring of trends and changes in the ecological character of Ghanaian wetlands. However, there are several existing institutions whose mandates extend to wetland research and who, with adequate resourcing, could collect the data required to inform management prescriptions for key wetlands in the country.

2.1.4.17 Marine Ecosystems and Resources

Ghana's marine environment is highly productive and supports eighty percent (80%) of the nation's capture fisheries as well as provides a significant source of employment for local fishers. Increasing population and urbanisation, with associated economic activities and

natural oceanic phenomena, has resulted in increased pressure on the environment causing significant concerns such as fisheries depletion, pollution from land based activities and oil/gas activities, habitat degradation, and biodiversity loss.

A number of policy documents such as the Ghana Shared Growth and Development Agenda (GSGDA), the National Climate Change Policy as well as the National Environmental Policy have provided the framework towards addressing these issues. The indicators that have been defined under the 2030 Agenda for Sustainable Development and other national priority themes were used to assess the current state of the marine ecosystem.

2.1.4.18 Coastal Ecosystems

The coastal area contributes immensely to tourism because of the beaches, castles and fortes found here. Thus, issues pertaining to coastal pollution, resilience and sustainable management of coastal ecosystems require considerable focus. A total of nine indicators have been selected to assess where we are currently and identify where we want to get to as a country in relation to effectively managing coastal ecosystems. The status and trends since the 2004 SOE report for most of the coastal ecosystem indicators shows worsening situations with implications on ecosystem functions. Drivers affecting influencing interactions within coastal ecosystems population increase, land use change, pollution and physico-chemical changes, urbanization and industrial development including mining. A growing body of evidence indicates that local air and sea temperatures, wind patterns, ocean current speed and upwelling regimes are all being affected by human mediated climate change. In addition, the anthropogenic activities mentioned earlier act synergistically with climate change to place pressure on coastal ecosystems and their biota.

2.1.4.19 Environmental Policy and Institutional Analysis

The development of environmental policies has not mitigated the damage to the environment due to constraints which make the policies ineffective and negate the realization of policy goals. These constraints include weak compliance and enforcement, conflict of interest, lack of political will and politicization of issues. Additional constraints are lack of capacity to implement policies, absence of coordination and collaboration among institutions and mechanisms, limited resource allocation for implementation, absence of comprehensive monitoring and evaluation system, centralization of policy making, low public awareness and non-involvement of all actors.

2.1.4.20 Gender

Although gender issues were not adequately addressed in the 2004 State of the Environment report, however, since that time, there has been new approaches to issues affecting gender equality in Ghana.

2.1.4.21 Education and Awareness

In building the next generation of environmentalists in Ghana, there should be a greater focus on environmental education and a shift from just information dissemination to a practical approach that engages all stakeholders within the environmental space. Negative attitudes and behaviours place an enormous burden on the environment and these must change if the environmental challenges in Ghana are to be resolved especially in the area of sanitation and general cleanliness. There should also be education and awareness creation embracing all ages and vocations. Social and other forms of media can be employed for this purpose. Environmental laws should be strictly enforced to discourage people from indulging in activities that destroy the environment.

2.2 Institutional, Policy and Regulatory Framework

2.2.1 Environmental Policy, Sustainable Development Policy and General Legislative Framework

The foremost law in Ghana is the Fourth Republican Constitution of 1992, which clearly states the country's commitment to sound environment. Environmental policy formulation and implementation dates back to the colonial period, in 1948 when the first routine explicit environment policy (forest policy) was developed. The first comprehensive environment policy was the National Environment Policy, adopted in 1991, which provided a broad framework for the implementation of the National Environmental Action Plan (NEAP). The NEAP is a set of policy actions, related investments and institutional strengthening activities to make Ghana's development strategy more environmentally sustainable. The areas directly linked to the NEAP are:

- Land management;
- Water management;
- Marine and coastal systems;
- Industrial pollution;
- Mining;
- Hazardous chemicals management; and
- Human settlements.

The ultimate aim of Ghana's environmental policy is to improve the surroundings, living conditions and the quality of life of the entire citizenry, both present and future. The policy, specifically, seeks to:

- Maintain the ecosystems and ecological processes essential for the functioning of the biosphere;
- Ensure sound management of natural resources and the environment; adequately protect humans, animals and plants, their biological communities and habitats against harmful impacts and destructive practices, and preserve biological diversity;
- Guide development in accordance with quality requirements to prevent, reduce, and as far as possible, eliminate pollution and nuisances;

- Integrate environmental considerations in sectoral structural and socio-economic planning at the national, regional, district and grass root levels;
- Seek common solutions to environmental problems in West Africa, Africa and the world at large.

As required by its Policy Statement on the Environment, the Government of Ghana is expected to "take appropriate measures, irrespective of the existing levels of environmental pollution and extent of degradation, to control pollution and the importation and use of potentially toxic chemicals". This expectation from government has necessitated the need for a more comprehensive policy on toxic substances (including POPs) for the country.

The Environmental Protection Agency Act, 1994 (Act 490) provides a regulatory framework for the sound management of pollutants and substances (including POPs) which are hazardous or potentially dangerous to the quality of the environment. The law also prescribes standards and guidelines relating to the pollution of air, water, land and any other forms of environmental pollution including the discharge of waste and the control of toxic substances. This framework is however inadequate in meeting the obligations of the Convention.
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In 2013, a comprehensive national policy on POPs was approved and adopted by Cabinet. It seeks to institute a life-cycle management of POPs. It also provides for the identification, decontamination, remediation and restoration of POPs contaminated lands, in line with Ghana's obligation under the Convention. The policy stipulates that a national legal framework must be developed or an existing regime enhanced to give effect to Ghana's obligations under the Convention.

Among the provisions to be covered under the framework are the following: scope, definitions, annual reports; requirements for handling, storage, labelling, treatment and disposal, spill prevention and clean ups, storage facility closure, insurance and surety bonds. The policy also prescribes that separate technical guidelines be developed to facilitate the effective implementation of the regulations.

Besides the national policy on POPs, there is the need for a comprehensive policy and regulatory framework to deal with all chemicals in Ghana. Such framework is envisaged to be developed under the five-year strategic action plan (2018-2022) on sound management of chemicals and hazardous wastes towards the achievement of the 2020 goals of Strategic Approach to International Chemicals Management (SAICM)and the Sustainable Development Goals (SDGs).

2.2.1.1 Multi-Sectoral and Multi-stakeholder collaboration

There is a framework for multi-sectoral and multi-stakeholder collaboration in the control and management of chemicals in Ghana. The Agency plays a coordinating role and is supported by the following Ministries, Departments and Agencies (MDAs):

- Plant Protection and Regulatory Services Directorate (PPRSD) of the Ministry of Food and Agriculture;
- Ghana Standards Authority;
- Ghana Atomic Energy Commission;
- Customs Division of the Ghana Revenue Authority;
- Ministry of Health/Ghana Health Service;
- Ministry of Justice and Attorney Generals Department;
- Food and Drugs Authority;
- Narcotic Control Board;
- COCOBOD;
- Universities and research institutions;
- Council for Scientific and Industrial Research; and
- NGOs.

These institutions among others participate in committee meetings aimed at sound management of chemicals and hazardous wastes in Ghana.

2.2.2 Roles and Responsibilities of Ministries, Agencies and other Governmental Institutions Involved in POPs Life-cycles (from source to disposal, environmental fate and health monitoring)

In addition to the numerous uncoordinated pieces of legislations, there are also a number of institutions whose activities have a bearing on POPs control and management. The institutions and their functions are presented in Table 1 below.

Table 1: Roles and Responsibilities of Relevant Institutions Related to Chemicals Management

Agency/Organisation/Institution	Roles Relevant to POPs			
	Policy	Monitoring and/or Research	Regulatory and /or Enforcement	Service Provider
Ministry of Environment, Science, Technology & Innovation	■			
Environmental Protection Agency		■	■	
Council for Scientific and Industrial Research		■		■
Land Use and Spatial Planning Authority			■	
Ministry of Lands and Natural Resources	■			
Minerals Commission		■	■	
Ministry of Finance	■			
Ghana Revenue Authority (Customs Division)		■	■	
Ministry of Education	■			
Ministry of Health/Ghana Health Service	■	■	■	
Ministry of Local Government and Rural Development	■	■	■	
Food and Drugs Authority		■	■	
Ministry of Food and Agriculture	■			
Veterinary Services Directorate of MoFA		■	■	
Plant Protection and Regulatory Services Directorate (MoFA)		■	■	
Narcotics Control Board		■	■	
Ministry of Trade and Industry	■			
Ghana Standards Authority		■	■	
Ghana Atomic Energy Commission		■	■	
Ministry of Energy	■			
Energy Commission		■	■	
Ghana National Petroleum Corporation		■	■	
Ministry of Transport	■			
Ministry of Railways	■			
Ghana Ports and Harbours Authority		■	■	
Ghana National Fire Service		■	■	
Ministry of Foreign Affairs and Regional Integration		■	■	
Ministry of Sanitation and Water Resources	■			
Ministry of Works and Housing	■			
Water Resources Commission		■	■	
Ministry of Employment and Labour Relations (Factories Inspectorate Department)		■	■	
Ministry of Gender, Children and Social Protection	■			
Ministry of Justice and Attorney General	■			
Judiciary			■	
Ministry of Interior	■			
Ghana Police Service		■	■	
Ministry of Defence	■			
Ghana Armed Forces			■	
Irrigation Development Authority of Ghana		■		■
Ghana Association of Farmers and Fishermen				■
Cocoa Health Division of Ghana COCOBOD		■	■	■
Cocoa Research Institute of Ghana		■	■	
Pharmacy Council		■	■	
Association of Ghana Industries				■
Electricity Company of Ghana		■		■
Ghana Water Company Limited		■		■
Volta River Authority		■		■
Universities		■	■	■

2.2.3 Relevant International Commitments and Obligations

The Conference of Plenipotentiaries of the Stockholm Convention recognised existing Multilateral Environmental Agreements (MEAs) and programmes related to sound chemicals management. Table 2 provides the list of chemicals-related MEAs and their ratification status for Ghana:

Table 2: Chemicals- Related Multilateral Environmental Agreements (MEAs) and their Ratification Status for Ghana

No	Convention and other MEAs	Year of Ratification
1	Minamata Convention on Mercury (2013)	2017
1	Stockholm Convention on Persistent Organic Pollutants (POPs) (2001)	2003
2	The Rotterdam Convention on Prior Informed Consent (PIC) Procedure of certain Pesticides and Chemicals in International Trade (1998)	2003
3	The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989)	2003
4	Bamako Convention on the Control of Transboundary Movements of Hazardous Wastes (1991)	Not ratified
5	FAO International Code of Conduct for the Distribution and Use of Pesticides (as amended in 2003)	Adopted
7	The UN Convent ion on Substances that Deplete the Ozone Layer (Vienna Convention) (1985)	1989
8	Montreal Protocol on Substances that Deplete the Ozone Layer (1987)	1989
9	London Amendment of the Montreal Protocol on Substances that Deplete the Ozone Layer (1990)	1992
10	UN Convention on Prohibition of the Development Reduction Stockpiling and use of Chemical Weapons and their Destruction (1993)	1997

Ghana participated fully during the negotiations of the above Conventions and has ratified all except the Bamako Convention. Measures are being taken to give effect to our obligations under these Conventions

2.2.4 Description of Existing Legislation addressing POPs (manufactured chemicals and unintentionally produced POPs)

The Constitution

The 1992 Constitution of Ghana provides the broad policy basis for the protection of the environment. The relevant Articles s are as follows:

- Economic Development - Article 36 (9): The State shall take appropriate measures needed to protect and safeguard the national environment for posterity; and shall seek co-operation with other states and bodies for the purposes of protecting the wider international environment for mankind.
- Economic Development - Article 36 (10): The State shall safeguard the health, safety and welfare of all persons in employment, and shall establish the basis for the full deployment of the creative potential of all Ghanaians.
- Duties of a Citizen - Article 41 (k): The exercise and enjoyment of rights and freedoms is inseparable from the performance of duties and obligations, and accordingly, it shall be the duty of every citizen to protect and safeguard the environment.

Policy Statement on Environment

The Policy Statement on the environment requires the State to "take appropriate measures, irrespective of the existing levels of environmental pollution and extent of degradation, to control pollution and the importation and use of potentially toxic chemicals".

The above expectation from the State requires a more comprehensive policy on toxic substances (including POPs) for the country.

2.2.4.1 Existing Chemical Legislation on POPs

There are several chemicals-related legislation in Ghana, which are uncoordinated. Although these laws are not specific to POPs, they have some relevance to the POPs listed in the Convention and provide a framework for the management of other chemicals and pesticides (which includes POPs). Many of these laws however, do not adequately

address the dangers posed to humans and the environment by the chemicals under the Convention. Where the laws are relevant to POPs, the institutions that deal with them do not have the resources to monitor and research into their disposal as required by the Convention. The existing chemicals-related laws are discussed in this section.

2.2.4.1.1 Pesticides

Act 490 (Part II on Pesticides Control and Management) is the regulatory framework for the control and management of all pesticides in Ghana. This law addresses the registration of all pesticides prior to their use, including POP-pesticides . The law also recognizes the need for the safe handling and use of pesticides and as such has provisions for licensing of persons or entities engaged in all pesticide use activity such as retailing, commercial pest control, importation, manufacture, formulation, distribution, use and transportation of pesticides. Issues regarding safeguards for pesticide use such as personal protective equipment, have been provided in the law with stated penalties for non-compliance. In addition, the law also has provisions for the listing or registration of pesticides as banned pesticides.

Presently, all the listed POP-pesticides have been banned under Act 490 for all uses and gazetted in the register of pesticides. In view of the fact that none of the POPs-pesticides are being used in Ghana, the country does not require specific exemptions for further usage of POPs-pesticides.

2.2.4.1.2 PCBs and other POPs Wastes

Significant progress has been made toward strengthening the legal framework with regards to PCBs and other hazardous substances. The Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917) and the Hazardous, Electronics and other Wastes (Classification), Control and Management Regulations, 2016 (LI 2250) provides a comprehensive coverage for all wastes (including POPs wastes) in relation to the Convention as well as the Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal. Act 917, deals with importation, exportation, transportation and notification procedures and empowers the Agency to regulate PCBs and other POPs-related wastes. Technical and environmental guidelines for implementing PCBs regulatory framework have been developed. An administrative system for PCB-related enforcement and inspection has been developed and is being implemented. . The Ghana Revenue Authority (Customs Division) has been provided with an L–2000 PCB analyser for use at points of entry to prevent PCBs importation into Ghana.

2.2.4.1.3 Polybrominated diphenyl ethers (PBDEs)

Plastics in electronic are a major use area of polybrominated diphenyl ethers (PBDEs). C-OctaBDE was used as an additive in brominated flame retardant (BFR) mainly in acrylonitrile butadiene styrene (ABS) plastic in cathode ray tube (CRT) casings and other plastics in electronics. Act 917 and it regulations 2250. provide for the reduction in the use of hazardous materials (including PBDEs) in the manufacture of electrical and electronic equipment. This legislation also comprehensively covers waste electrical and electronic products and end of life vehicles that contain PBDEs.

There is a specific regulation, LI 1932, 2008 on Energy Efficiency with relevance to EEE and WEEE. LI 1932 prohibits the manufacture, importation, sale or distribution of incandescent filament lamp, used refrigerator, used refrigerator-freezer, used freezer and used air-conditioner importation as well as the sale and distribution of used refrigerators, freezers and air-conditioners.

2.2.4.1.4 Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride (PFOS/PFOSF)

The capacity and practical experiences in PFOS/PFOSF management in Ghana is limited. There are no specific laws for the control and management of PFOS/PFOSF in Ghana. However, some provisions under Act 490 and Act 917 is being used to manage PFOS/PFOSF in Ghana. . There is also some collaboration among the Agency, Customs Division of the Ghana Revenue Authority and the Ghana National Fire Service in the importation, monitoring and the use of PFOS/PFOSF applications. Procedures and other capacities for PFOS/PFOSF waste including empty containers are lacking. A comprehensive legal framework needs to be developed for the control and management of the entire per and polyfluoroalkyl substances (PFAS), which include PFOS/PFOSF, in Ghana for the implementation of the Convention.

2.2.4.1.5 Other Chemical-related Legislation

Other chemical- related legislation in operation in Ghana with some relevance to POPs control and management include:

- Public Health Act, 2012 (Act 851) to regulate food, drugs, food supplements, herbal and homeopathic medicines, veterinary medicines, cosmetics, medical devices, household chemical substances, tobacco and tobacco products;
- The Factories, Offices and Shops Act, (Act 328) 1970, which seeks to protect the health and safety of workers from the dangers posed by chemicals to employees in the working environment;
- The Standards Authority Act, 1973 (NRCD 173); which provides for the promulgation of standards for ensuring high quality of goods and for related matters.
- Merchant Shipping (Dangerous Goods) Rules, 1974 (LI 971);
- Ghana Revenue Authority Act, 2009 (Act 791) for

the administration of taxes and to provide for related purposes

- Consolidated Local Governance Act, 2016 (Act 936);
- Export and Import Act, 1995 (Act 503);
- Environmental Assessment Regulations, 1999 (LI 1652).
- The Energy Efficiency (Prohibition of Manufacture, Sale or Importation of Incandescent Filament Lamp, Used Refrigerator, Used Refrigerator-Freezer, Used Freezer and Used Air-Conditioner) Regulations, 2008 (LI 1932)
- A Draft National Occupational Safety and Health Bill which seeks to ensure that measures are instituted for the attainment of optimum health for workers in all occupations in Ghana is awaiting passage.

Table 3 shows the current legal status of each of the listed POPs of the Stockholm Convention in Ghana.

Table 3: Legal status, control action and remaining allowance of POPs in Ghana

Name of Chemical	Current status/control action	Details e.g. reason for control action, remaining allowed uses, etc.
Aldrin	Banned since 1985	Chemical is persistent. Listed as POPs without exemption. Safer alternatives available.
Chlordane	Banned since 1985	Chemical is persistent. Listed as POPs without exemption. Safer alternatives preferred.
Chlordecone	Banned	Chemical is persistent. Listed as POPs without exemption. Safer alternatives preferred.
Dieldrin	Banned since 1985	Chemical is persistent. Listed as POPs without exemption. Safer alternatives preferred.
DDT	Banned since 1985	Chemical is persistent. Other cheaper and safer alternatives such as synthetic pyrethroids for insect control for public health and agriculture are preferred
Decabromodiphenyl ether (commercial mixture, cdecaBDE)	Not banned	Listed in 2017 with exemptions and not yet addressed in this updated NIP.
Heptaclor	Banned since 1985	Chemical is persistent. Safer alternatives preferred.
Hexabromobiphenyl	Not banned	Listed as POPs without exemption. Safer alternatives available.
Hexabromocyclododecane (HBCD)	Not banned	Listed as POPs with exemption.
Hexabromodiphenyl ether and heptabromodiphenyl ether	Not banned	Listed as POPs with specific exemption
Hexachlorobenzene	Banned since 1985	Chemical is persistent. Listed as POPs with exemption Safer alternatives available.
Hexachlorobuadiene	Banned	Listed as POPs with exemption
Alpha hexachlorocyclohexane	Banned	Listed as POPs without exemption
Beta hexachlorocyclohexane	Banned	Listed as POPs without exemption
Lindane	Banned since 2001	Chemical is persistent. Safer alternatives preferred.
Mirex	Banned since 1985	Chemical is persistent. Safer alternatives preferred.
Pentachlorobenzene	Banned since 1985	Listed as POPs without exemption
Pentachlorophenol and its salts and esters	Banned since 2015	Listed in 2015 with exemption and not yet addressed in this updated NIP.

Pentachlorobenzene	Banned since 1985	Listed as POPs without exemption
Pentachlorophenol and its salts and esters	Banned since 2015	Listed in 2015 with exemption and not yet addressed in this updated NIP.
Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride	Not banned yet No exemption granted	Listed as POPs in Annex B with exemptions.
Polychlorinated Biphenyls (PCBs)	Importation is prohibited. Still present in old transformers and capacitors	Use allowed in closed application until 2025. Elimination by 2028.-
Toxaphene	Banned since 1985	Chemical is persistent. Safer alternatives preferred.
Polychlorinated naphthalenes	Not banned	Listed in 2015 in Annex A without exemptions and Annex C. Not yet addressed in this updated NIP.
Short-chain chlorinated paraffins (SCCPs)	Not banned	Listed in 2017 with exemptions and not yet addressed in this updated NIP.

2.2.5 Gaps Analysis

As indicated in the 2016 SoE Report, the development of environmental policies has not curtailed the damage to the environment due to constraints which make the policies ineffective. . The constraints are also true for the sound management of chemicals and wastes including POPs and include:

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- lack of political will and politicization of issues;
- lack of capacity to enforce policies;
- absence of coordination and collaboration among institutions;
- limited resource allocation for implementation policies;
- absence of a comprehensive monitoring and evaluation system;
- conflict of interest of stakeholders;
- mainstreaming of chemicals management into work plans and activities of institutions ;
- low public awareness of harmful effects of POPs on human health and environment; and
- non-involvement of certain relevant actors.

Institutional Gaps:

In addition to the numerous fragmented/uncoordinated pieces of legislation , there are also a number of institutions whose activities have something to do with POPs management, regulation and enforcement. Each of these institutions has one or more functions in the areas of usage, management or regulation. Their functions are often uncoordinated, with some institutions experiencing conflicts in the execution of their duties arising from their respective legal mandates. This situations leads to duplication and wastage. Public awareness of the requirements of the existing laws is low and so is the level compliance.

The 1992 Constitution, the National Environmental Policy and the various national laws that have a bearing on the environment provide the theoretical basis to enable the country control and manage POPs throughout their lifecycle. However, there is an indication that much more needs to be done in the areas of policy review and enforcement. The following gaps have been identified:

- Although Ghana has officially banned the importation and use of all POPs pesticides, safer alternatives, which are now on the market, should be encouraged. There is however limited capacity for registration, licensing, monitoring and analysis to control importation of POPs. There is therefore the need to increase capacity so that existing enforcement measures would be strengthened.
- The Convention requires the prevention of the production and use of new pesticides, which exhibit POPs characteristics. The pesticide registration scheme under Act 490, takes cognisance of the 'persistence criterion' in registering pesticides. There is however inadequate capacity in Ghana to conduct tests to confirm the persistence of various pesticides in Ghana.
- There are no specific regulations to control the likely emissions of unintentional POPs from automobiles in the country and there appears to be no link between the National Environment Policy and the importation of equipment including vehicles into the country. This is a legislative gap that needs to be addressed through the adoption of appropriate regulations.
- The collaboration between the Agency and the Waste Management Departments of the District, Municipal and Metropolitan Assemblies is very weak. As a result, there is uncontrolled release of

dioxins and furans into the environment through incineration of wastes. There is the need to strengthen collaboration between the Agency and MMDAs in Ghana
- It is necessary that future regulations on POPs should be made to cover the control and management polyaromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH) and phenols.

2.2.6 Key Approaches and Procedures for POPs Chemicals and Pesticides Management including Enforcement and Monitoring Requirements

2.2.6.1 Assessment of Capacity and Gaps of Relevant Institutions Involved in Sound Management of Chemicals

The national institutional capacity for the sound management of chemicals including POPs has been assessed. The relevant institutions and their mandates are outlined below:

2.2.6.1.1 Environmental Protection Agency (EPA)

The EPA Act of 1994 (Act 490) established the EPA. It has the mandate to regulate, coordinate and manage the environment. Section 2 of Act 490 spells out the functions of the Agency which include the following:

- To prescribe standards and guidelines relating to the pollution of air, water, land and other forms of environmental pollution including the discharge of toxic wastes and control of toxic substances;
- To promote research, surveys and analyses for the improvement and protection of the environment and the maintenance of sound ecological systems in Ghana;
- To coordinate the activities of such bodies as it considers appropriate for the purposes of controlling the generation, treatment, storage, transportation and disposal of industrial wastes.

In addition to the above functions the Act 490 also establishes a Hazardous Chemicals Committee whose function include monitoring the use hazardous chemicals including POPs by collecting information on their importation, exportation, manufacture, distribution, sale, use and disposal.

Act 490 thus places the Agency in a unique position as a regulator and a manager of the environment. In the discharge of its functions, however, there are some conflicts and overlaps with some institutions that have regulatory roles as far as chemicals management is concerned. There is therefore the need for cooperation between the Agency and such institutions.

The EPA Act, 1994 (Part II: Pesticides Control and Management) mandates the EPA to:

- Register pesticides (sections 28 – 39);
- Restrict and suspend the use of pesticides if necessary (section 37);
- License all categories of pesticide dealers (sections 40 – 45); and
- Enforce Act 490 for the appropriate penalties to be applied (sections 54 – 60).

Act 490, which was passed before the Convention, has a few gaps and requires amendment to make it more comprehensive.

The Agency currently, has limited human resources and logistics to handle any enabling legislation to implement the Convention. The Agency needs to work closely with other institutions and also be strengthened in terms of its human and material resource capacities.

2.2.6.1.2 Ghana Standards Authority (GSA)

The Standards Authority Act, 1973 (NRCD 173);) established the GSA. The GSA may be classified as both a regulator and user, in the assessment of the use and management of POPs in Ghana. The GSA has overall responsibility for quality infrastructure embracing Metrology, Standards, Testing and Quality Assurance (MSTQ). This ensures that goods and services are of acceptable quality for both local and international consumers. It is the standards, testing and quality assurance aspects of the GSA's work that are relevant to the Convention.

The functions of the GSA , requires the Board to provide services that may be relevant to the control and management of POPs. The relevant sections are as follows:

Section 2 (d) empowers GSA to promote standards in public and industrial welfare, health and safety.

Section 3 (2) (b) empowers GSA to promote research in relation to specifications; and to provide for the examination and testing of goods, commodities, processes, and practices, and for those purposes the Authority may establish such laboratories and other facilities as it thinks fit.

The word “goods” according to GSA Act covers all products including POPs.

The activities of the GSA, that may be relevant to the control and management of POPs, are carried out through laboratory examination and testing of goods and provision of quality evaluation reports. An example is the routine analysis of fruits and vegetables for levels of pesticide residues to facilitate export of these products in order to protect public health and safety.

In practice, there is a substantial level of cooperation between the GSA and the Agency. Pursuant to the provisions of Sections 4 and 10 of Act 490, the GSA serves on the Agency's governing Board as well as the Hazardous Chemicals Committee of the Agency. In the circumstances, the GSA contributes directly to the control and management of POPs.

As a user, the GSA uses some of the POPs, including

aldrin, endrin, chlordane, dieldrin, and DDT as Reference Standards for analytical purposes. The GSA does not have direct enforcement powers in the control and management of POPs in Ghana.

2.2.6.1.3 Food and Drugs Authority (FDA)

The Food and Drugs Authority (FDA) formerly the Food and Drugs Board (FDB) was established in August 1997 under the Food and Drugs Law, 1992 (PNDCL 305B). It is the National Regulatory Authority mandated by the public Health Act, 2012 (Act 851) to regulate food, drugs, food supplements, herbal and homeopathic medicines, veterinary medicines, cosmetics, medical devices, household chemical substances, tobacco and tobacco products.

POPs are not specifically referred to in Act 851. The word "household chemical substance" according to Act 851 means a substance or mixture of substances packaged for use in a domestic or office setting as a germicide, an antiseptic, a disinfectant, a pesticide, an insecticide, a rodenticide, a vermicide, or a detergent.

Section 118. (1) of Act 851 stipulates that a person shall not manufacture, prepare, import, export, distribute, sell, supply or exhibit for sale a drug, herbal medicinal product, cosmetic, medical device or household chemical substance (and for that matter POPs) unless the article has been registered by the Authority. There is obviously an overlap in the regulatory functions of FDA and the Agency , if considered in terms of Section 118 of Act 851 and Part 2 of EPA Act, 1994 (Act 490). In practice, however, FDA has restricted itself to the registration of chemical substances used in homes such as mosquito coils and aerosol sprays. There is the urgent need to remove the overlap to make the provisions of the two laws unequivocal. There is some level of coordination between FDA and the Agency.

2.2.6.1.4 Ghana Revenue Authority (Customs Division)

The Ghana Revenue Authority (GRA) was established under Act 791 for the administration of taxes and to provide for related purposes in Ghana.

The Customs Division (CD) of the Authority is responsible for collection of Import Duty, Import VAT, Export Duty, Petroleum Tax, Import Excise and other taxes. It also ensures the protection of revenue by preventing smuggling of goods including chemicals. This is done by physically patrolling the borders and other strategic points, examining of goods, and searching of premises, as well as documents relating to the goods. . The CD is part of the country's security network. In addition to these functions, CD performs agency duties on behalf of other government organizations and Ministries by seeing to the enforcement of laws on import and export restrictions and prohibitions.. The Customs Division of the Ghana Revenue Service may thus be classified as a regulator in the control and management of POPs in Ghana.
EPA Act, 1994 (Act 490) specifies the role of Customs in the enforcement of the provisions of the Act.

The CD currently performs duties on behalf of the Agency by examining documents and Agency certificates/permits to ensure that they cover the particular importation such as chemicals, plastic granules, meat products and agro-chemicals. Records of chemical import returns are submitted by the CD to the Agency on a quarterly basis.

There is a high level of co-operation between the CD and the Agency. Officers of the CD serve on various technical committees of the Agency including the Hazardous Chemicals Committee, the Pesticides Technical Committee, the National Committee on Ozone Depleting Substances (NACODs) as well as participating in the implementation of other projects undertaken by the Agency.

2.2.6.1.5 Plant Protection and Regulatory Services Directorate of the Ministry of Food and Agriculture

The Plant Protection and Regulatory Services Directorate (PPRSD) of the Ministry of Food and Agriculture (MOFA) was established in 1965 by an Act of Parliament: Prevention and Control of Pests and Diseases of Plants Act, 1965 (Act 307) which was replaced by "Plants and Fertilizer Act, 2010 (Act 803). The PPRSD is the national institution with the mandate and capacity to organize, regulate (under the Plant Protection Regulations, 2012 (L.I. 2193)), implement and coordinate the plant protection services needed for the country in support of sustainable growth and development of agriculture. The national plant protection policy of 1992, seeks to establish an Integrated Pest Management, IPM system. The PPRSD also has a mandate to inspect or regulate specific agricultural products and also monitor the quality of agricultural inputs , and is involved in the enforcement of appropriate use of agricultural chemicals. The Agency under section 15 of Act 490 appoints PPRSD staff as pesticide inspectors to assist in the enforcement of Part II of Act 490.

2.2.6.1.6 Ghana Cocoa Board

The Ghana Cocoa Board (COCOBOD) of the Ministry of Food and Agriculture is in charge of cocoa buying and marketing in the country. Section 4 of the Cocoa Industry Regulation Decree 1968 (NLCD 278) for example, gives power to inspectors of COCOBOD to require any person in possession of or transporting or offering for sale any cocoa, to submit same for inspection. Other provisions in the decree concern checking the quality of cocoa beans before export.

COCOBOD approves recommendations by the Cocoa Research Institute of Ghana (CRIG), Cocoa Health and Extension Division (CHED) and Quality Control

Company Limited (QCCL) on test of pesticides for Cocoa.
The Board and its subsidiaries, provide regular training for farmers (users) and monitors risks associated with the use of pesticides.

2.2.6.1.7 Oil and Gas Sector

The upstream oil and gas industry consumes large amounts of chemicals for both drilling and production operations. Lubricants and chemicals are kept on board drilling rigs and production vessels for maintenance activities. Large amounts of fire retardants are also stored on board the vessels, which are sometimes used for training and drills. The potential for use or release of POPs in upstream petroleum operations is therefore real. Another potential source of POPs could be emissions resulting from flaring activities during the drilling phase where well-testing is conducted, as well as during production, when associated gas is flared in large quantities.

2.2.6.1.8 The Energy Sector

The Ministry of Energy and the National Petroleum Authority regulate the institutions involved in crude oil processing, distribution and use. The activities of the Tema Oil Refinery (TOR) and Bulk Oil Storage and Transport (BOST) are potential sources of release of unintentionally produced POPs.

2.2.6.1.9 Electricity Company of Ghana (ECG)

The Electricity Company of Ghana (ECG) is the only electricity distribution company operating in the southern sector of Ghana. It operates in six regions and therefore holds many transformers and other oil based switchgears. Most pre-1972 transformers and capacitors imported into the country by the ECG, contained PCBs some of which are in operation in Ghana.

The ECG officially banned the importation of PCB-containing equipment as far back as 1972. The ECG has worked extensively with the Agency, as part of the PCB Elimination Project in Ghana, to identify and remove PCBs-containing equipment.. Such identified equipment were decommissioned and disposed of as part of the PCB project. Currently, ECG has no pure PCB capacitors or transformer insulation oil. However, there are few PCB contaminated oil-based transformers and switchgears due to cross contamination from the use of oil filtering machines used to recondition insulation oil. The concentration levels of PCBs in the oils are however not more than 50 ppm.

ECG has the capacity to identify and test the levels of PCBs in transformers and switchgears using L2000 Analyser. The company therefore has the capacity to monitor PCBs in their system. However, unavailability of PCB testing reagents, is hindering the success of the monitoring programme.

Nonetheless, the company has the capacity to handle these oils in an environmentally sound manner.
ECG is a major and a committed stakeholder to the implementation of the Convention on POPs in Ghana.

2.2.6.1.10 Volta River Authority (VRA) and GRIDCo

As a generator and supplier of the country's electrical energy, the VRA and GRIDCo respectively are major custodians of transformers and capacitors. They have a major role in the management of PCBs and should therefore develop a continuous programme for their human and institutional capacity to do that. Like the ECG the VRA and the GRIDCo have been supplied with L2000 PCB analysers to identify and test PCB levels in dielectric fluids.

2.2.6.1.11 National Poisons Information Centre

A Poisons Information Centre set up under the Ghana Health Service of the Ministry of Health, partially fulfils the requirement of Article 10 of the Convention for the establishment of information centres by countries to provide information on chemicals including POPs and their alternatives to ensure public access to such information. It has the following key functions:

- Assist health professionals in the diagnosis and management of poisonings from chemicals (including POPs), toxins, venoms and drugs;
- Provide information to health professionals on the toxic effects of poisoning agents;
- Provide information to the general public on prevention and first aid management of acute poisoning;
- Educate the general public on the damaging effects of chemicals on the environment;
- Provide toxicological surveillance through data collection on chemical incidents, exposures and poisonings; and
- Organise training on poisoning prevention and management for health workers and other relevant stakeholders including Pesticide Inspectors of PPRSD.

2.2.6.1.12 Office of the Attorney-General and Ministry of Justice

The Ministry of Justice and Attorney-General's Department is essentially a professional and service ministry providing professional legal services to all MDAs, MMDAs, other Agencies of the State requiring such services and public as a whole. The ministry revises, reforms and replaces laws (including laws on POPs management and control) for the realisation of the policy objectives with regards to National and social growth. The ministry also is responsible for domestication of international as well a international agreements including the convention.

2.2.6.1.13 Non-Governmental Organisations (NGOs)

NGOs carry out advocacy, raise awareness and build capacity through workshops, conferences, durbars, symposia, seminars etc. in communities and among end users of POPs and other chemicals.

2.2.6.1.14 Water Resource Commission

The Water Resources Commission (WRC) was established by Act 522 of 1996 as the apex body responsible for water resources management in Ghana. This institution has the mandate to regulate and manage the utilization of water resources and also to coordinate relevant government policies in relation to water resources by combining its core competencies through effective participation, monitoring and awareness creation for socio-economic development of Ghana. Their core functions are to;

- Propose integrated water resources management plans to guide the utilization, conservation, development and improvement of water resources;
- Initiate, control and co-ordinate activities connected with the development and utilization of water resources;
- Grant water rights;
- Collect, collate, store and disseminate data or information on water resources;
- Engage water sector agencies to undertake scientific investigations, experiments or research into water resources;
- Monitor and evaluate programmes for the operation and maintenance of water resources;
- Advise the Government on any matter likely to have adverse effect on the water resources:
- Advise pollution control agencies in Ghana on matters concerning the management and control of pollution of water resources; and
- Perform such other functions as are incidental to the foregoing

2.2.6.1.15 Council for Scientific and Industrial Research (CSIR)

The CSIR was established by the NLC decree 293 of October 10, 1986 amended by NLCD 329 of 1969 and re-establishment in its present form by CSIR Act 521 on November, 1996. The Council was established to organise and coordinate scientific activities in Ghana. It is mandated to perform the following functions:

- To pursue the implementation of government policies on scientific research and development;
- To advise the sector minister on scientific and technological advances likely to be of importance to national development;
- To encourage coordinated employment of scientific research for the management, utilisation and conservation of the natural resources of Ghana in the interest of development;
- To encourage in the national interest scientific and industrial research of importance for development of agriculture, health, medicine, environment technology and other services sectors and to this end to encourage close linkages with productive sectors of the economy;
- To coordinate all aspect of scientific research in the country and to ensure that the council, the research institutes of the council and other organisation engaged in research in Ghana, coordinate and cooperate in their research efforts;
- To exercise control over the research institutes and projects of the institutes administered by the council in order to ensure that research being carried out (including issues on POPs) by the institute directly benefits identified sectors of the economy and is within the national priorities.

2.2.6.1.16 Land Use and Spatial Planning Authority (LUSPA)

- The Land Use and Spatial Planning Authority (LUSPA) was established by the Land Use And Spatial Planning Act, 2016 (Act 925) under the National Development Planning Commission Act, 1994 (Act 479) and the National Development Planning (System) Act, 1994 (Act 480); to perform the spatial, land use and human settlements planning functions of the national development planning system. Act 925 seeks to revise and consolidate the laws on land use and spatial planning, provide for sustainable development of land and human settlements through a decentralized planning system, ensure judicious use of land in order to improve quality of life, promote health and safety in respect of human settlements and to regulate national, regional, district and local spatial planning, and generally to provide for spatial aspects of socio economic development and for related matters. The functions of the LUSPA are to :
- Prepare and provide for the technical human settlements planning component as may be required by the National Development Planning Commission for inclusion in the national development plans or infrastructure plan prepared by the Commission pursuant to Acts 479 and 480;
- Prescribe the format and content of the spatial development framework, structure plans and local plans;
- Provide directions, guidelines and manuals for spatial planning;
- Develop the capacities of the district assemblies and other institutions for effective performance of their spatial planning and human settlement

management functions; and

- Ensure that the exploitative use of natural resources for agriculture, mining, industry and other related activities do not adversely impact on human settlements.

2.2.6.1.17 Ghana Atomic Energy Commission (GAEC)

GAEC was established by an Act of Parliament, Act 204 of 1963, as the sole Agency in Ghana responsible for all matters relating to peaceful uses of atomic energy. Act 204 was amended in 1993 by the PNDC Law 308 mainly to enable it to create other institutes under the Commission. This amendment resulted in the creation of other institutes in addition to the National Nuclear Research Institute (NNRI) formerly Kwame Nkrumah Nuclear Research Institute (KNNRI). The founding Act 204 of 1963 has been superseded by Act 588 of 2000 to make provision for the GAEC to undertake commercialization of its research and development results. As far as POPs management is concerned, the GAEC has set up organic research team which under the Nuclear Chemistry and Organic Research Centre which focuses mainly on research, monitoring and analysis of POPs in the environment as well as training and capacity building.

2.2.7 Current Sound Management of Chemicals and Wastes Programmes in Ghana

Ghana, through the erstwhile Environmental Protection Council (EPC), initiated a chemical importation monitoring programme in 1985. Under the programme, it was mandatory for all importers of all types of chemicals to obtain clearance permits from the Council before taking delivery of their consignments at the ports.

Currently the Chemicals Control and Management Centre (CCMC) is the division of the Agency that implements the sound management of chemicals and wastes programmes in Ghana. It was established in 1996. The primary objective of the CCMC is the protection of human health and the environment from the potential harmful effects of chemicals and wastes by ensuring the co-existence of the general population with chemical substances through the maximization of the benefits of these chemicals whilst minimizing their adverse health and environmental impacts. CCMC derives its mandate from the following laws:

- Section 10 Part 1 of Act 490 (Hazardous Chemicals Committee);
- Part 11 of Act 490 which provides for the control and management of pesticides in Ghana;
- Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917); and
- Hazardous, Electronic and other Wastes (Classification), Control and Management Regulations, 2016 (LI 2250).

CCMC regulates the importation of industrial and consumer chemicals and pesticides in Ghana through the authorized ports of entry including Tema, Takoradi, Aflao and Elubo borders. All categories of chemicals that are scientifically evaluated to be relatively safe, are permitted to be imported into the country. Specifically, chemicals that are regulated in Ghana include: Pesticides (synthetic and bio-pesticides); industrial and consumer chemicals; plastic raw materials (granules); and others (ozone depleting substances; precursors, etc.).

The CCMC serves as the focal point for all chemicals-related MEAs to which Ghana is a party such as the Stockholm Convention on POPs.

CCMC also supervises the disposal of obsolete chemicals in an environmentally sound manner (ESM).

2.2.7.1 Industrial and Consumer Chemicals Management

In the absence a legislative instrument (L.I.), industrial and consumer chemicals are currently regulated through an administrative arrangement by means of chemical clearance permits. It is mandatory for applicants to submit the Material Safety Data Sheets (MSDS) of every chemical they intend to import to the CCMC. These applications are then screened, based on the information provided in the MSDS and other information obtained from secondary sources. Industrial and consumer chemicals, which have been listed on the Narcotics Control Board's red list or the EPA red list, due to their abuse in Ghana, are severely restricted. Samples of granular industrial raw materials such as fertilizers, polypropylene, high density polyethylene, are sent to the laboratory (e.g. the material science laboratory of Ghana Standards Authority) for chemical analysis, to determine if they are genuine as indicated, before permits are issued for their clearance.

Industrial chemicals are varied and include acids, dyes, solvents, adhesives, plastics, laboratory chemicals, paints, as well as chemicals used in cleaning products, cosmetics and toiletries. Industrial chemicals exclude medicines, pesticides, radioactive substances, and food additives. Consumer chemicals on the other hand, are chemicals or chemical products used for domestic purposes, or in any non-industrial process. Chemicals (particularly POPs) known to be carcinogenic, mutagenic, teratogenic, or which show extreme toxicity under conditions of use, are not allowed into the country.

2.2.7.2 Pesticides Management

Part 11 of Act 490 on Pesticides Control and Management (formerly, Pesticides Control and Management Act, 1996 (Act 528)) regulates the control and management of pesticides, including persistent organic pollutants, in Ghana. According to Section 28 (1) of Act 490, no person shall import, export, manufacture, distribute, advertise or use any pesticides in Ghana unless the pesticide has been

registered by the Agency A in accordance with the Act. The Pesticides Department of the CCMC undertakes the registration and licensing of pesticides dealers (commercial pest control operators, pesticides storage facilities or warehousing, importer/distributors, – retail transporters, formulators, manufacturers, aerial dispersal operators as well as license for repackaging and advertising).

2.2.7.3 Hazardous Chemicals Management

The Environmental Protection Agency Act, 1994 (Act 490) provides for the establishment of a multi-stakeholder Hazardous Chemicals Committee. According to Section 10, paragraph 3 of the Act, the functions of the Hazardous Chemicals Committee are to:

- Monitor the use of hazardous chemicals by collecting information on the importation, exportation, manufacture, distribution, sale, use and disposal of such chemicals.
- Advise the Board and the Executive Director on the regulation and management of hazardous chemicals; and to
- Perform such other functions relating to such chemicals as the Board or the Executive Director may determine.

The CCMC collects information on all chemicals (industrial chemicals and pesticides) imported into the country. The processing of applications for importation of chemicals are supported by documents such as the Material Safety Data Sheets or Technical Dossiers, which provide technical information on the chemicals. The documents may also suggest disposal options of such chemicals as well as information on their toxicity.

2.2.7.4 Hazardous Waste Management

The disposal of obsolete or unwanted hazardous chemicals or wastes, poses a great challenge for regulatory authorities in Ghana. The disposal of municipal and some types of chemical wastes, are essentially carried out at landfill sites, which are not engineered. Incinerators for the disposal of some hazardous wastes, are not available in Ghana. The improper disposal of chemical wastes into the environment, may also result in long-term exposure of the population to pollutants that cause adverse health effects.

The Act 917 and its regulations LI 2250 are expected to help in streamlining the management of all hazardous waste streams, including POPs in Ghana. The purpose of the hazardous waste legislation are among others to;

- regulate the trans boundary movement of hazardous waste;
- regulate the classification, control and management of waste;
- establish a mechanism and procedure for the listing of waste management activities that do not require a waste management permit;
- prescribe requirements for the establishment of take-back systems;
- prescribe requirements and timeframes for the management of wastes listed in the first schedule
- prescribe general duties of waste generators, waste transporters and waste managers; and
- prescribe requirements for the disposal of wastes.

2.2.7.5 Chemical Information Exchange Network (CIEN)

Information management is very vital in the sound management of chemicals and wastes. Developing countries including Ghana, however lack modern information and communication technologies. In view of this challenge, the chemicals and health branch of the United Nations Environment Programme (UNEP) and the United States Environmental Protection Agency (USEPA) undertook a two-year project in 2003 that provided computers and training on accessing chemical information using the internet. The project was re-launched in 2009.

The project catalysed the establishment of chemicals databases by the Agency and other key national institutions as the basis for an information exchange network among the main agencies involved in chemicals management. Some of the key institutions involved in the project are GRA –CD , the PPRSD of MoFA, and the GSA.

The CIEN programme needs to be reactivated to support the implementation of chemical related MEAs such as the Stockholm Convention on POPs in Ghana.

2.2.7.6 Public Education and Awareness

The CCMC periodically organises training workshops and seminars for stakeholders on the control and management of chemicals. The PPRSD also organises training programmes for pesticides dealers. The Ghana National Association of Farmers and Fishermen (GNAFF) is usually represented in these training workshops. Agricultural Extension Officers who are in direct contact with farmers, train them on the correct way to apply pesticides and fertilizers and the need to wear protective clothing when applying pesticides among others. The training of farmers focuses on FAO guidelines on the distribution and use of pesticides. The Pesticides and Fertilizer Regulatory Division of the PPRSD, has also prepared manuals on pesticides management, which are available to farmers and the general public..

2.2.8 Assessment of the Monitoring, Research and Development Capacity in Ghana

Provision of relevant data and information, is critical for risk assessment and management of POPs. The following institutions among others in Ghana have the

potential to develop and provide the necessary data and information for POPs management:

- University of Ghana, Legon;
- University of Cape Coast, Cape Coast;
- Kwame Nkrumah University of Science and Technology, Kumasi;
- University of Development Studies, Tamale;
- University of Education, Winneba;
- Institutes of the Council for Scientific and Industrial Research (CSIR): Water Research Institute, Food Research Institute, Crops Research Institute and Soil Research Institute;
- Environmental Protection Agency;
- Ghana Atomic Energy Commission; and the
- Private Universities

2.2.8.1 Identified Monitoring Gaps

PCBs and other unintentionally produced POPs (UPOPs) are generated as a result of anthropogenic activities. They are also found in some industrial products such as paints, dielectric oils, hydraulic fluids and plastics. For example, dioxins and furans, which are generated as a result of indiscriminate bush and waste dump burning, are difficult to monitor. Although there are some initiatives for the monitoring of POPs (intentional and unintentional produced) in Ghana, deliberate effort to establish a sustainable national POPs monitoring programme, is long overdue. This also calls for the intensification of public awareness and greater cooperation among the relevant institutions.

2.3 Assessment of the POPs Issue in Ghana

2.3.1 Assessment of POPs pesticides (Annex A, Part I chemicals): historical, current, and projected future production, use, import, and export; existing policy and regulatory framework; summary of available monitoring data (environment, food, humans) and health impacts

2.3.1.1 General considerations

Pesticides have been used extensively in Ghana since pre and post-independence times, mainly for agriculture, public health, vector control, animal health and other household pest control purposes. Available data suggest that the use of pesticides have increased over the years mainly due to the high cost of labour and the relatively easy access, reduction in drudgery and cheaper cost of pesticides. Government subsidy and other promotional interventions to boost agriculture production, which is the mainstay of the Ghana economy, have also contributed immensely to the rise in pesticides use. Organochlorines, and organophosphates were the predominant group of pesticides in use in the past. Later developments led to the gradual phasing out of the organochlorines with an increase in the use of organophosphates and also the introduction of carbamates, pyrethroids, and biopesticides. As a result of increase in pesticides usagee, the negative impact on human health and the environment has been widely reported, with some fatalities. In addition, studies have confirmed the presence of organochlorines whose use has been stopped many years ago but is still persisting in the environment. This attests to the persistent nature of POPpesticides.

2.3.1.2 Production of POP-pesticides in Ghana

There has not been any previous and current production of POP- pesticides in Ghana and the country does not envisage any possibility of producing POP-pesticides in future in the light of the provisions of the Convention.
There is only one company in Ghana, Wynca Sunshine Agric Products that is permitted to undertake the formulation of the technical grade of Glyphosate, imported from China.

2.3.1.3 Import of POP-pesticides

Almost all the pesticides used in the country are imported. There has been a general increase in quantities imported over the past few years, especially with regards to herbicides. Importation (past and present) has mainly been in the form of formulated products for agriculture and public health purposes.

Official importation of all POP-pesticides (including the initial nine (9) POP-pesticides of the "dirty-dozen", as well as endosulfan and lindane) listed under the Conventions have been banned.. Currently there are no records of importation of new POP-pesticides into Ghana.

Table 4: Pesticides Import Data

Year	Insecticides		Herbicides		Fungicides		Plant growth regulators	
	Mt	Lit	Mt	Lit	Mt	Lit	Mt	Lit
2009	60,430	3,388.275	998.147	8,981.102	325,932	947,656	-	-
2010	40,666	3,028,724	323,580	13,161,585	242,926	697,913	7,096	5,061
2011	832,807	4,772,537	854,338	30,272,177	595,878	52,010	66,420	6,190
2012	543	4,206,393	991,236	14,578,588	1,759	1,852,275	26,585	-
2013	1,539	6,137,965	4,723	36,869,578	4,599	637,564	-	33,000
2014	6,513	7,647,599	7,889	27,741,792	1,167	481,330	0.02	-
2015	3,695	8,045,662	294,009	22,209,018	1328	219,884	13	-

(Source: Environmental Protection Agency (EPA) Annual reports)

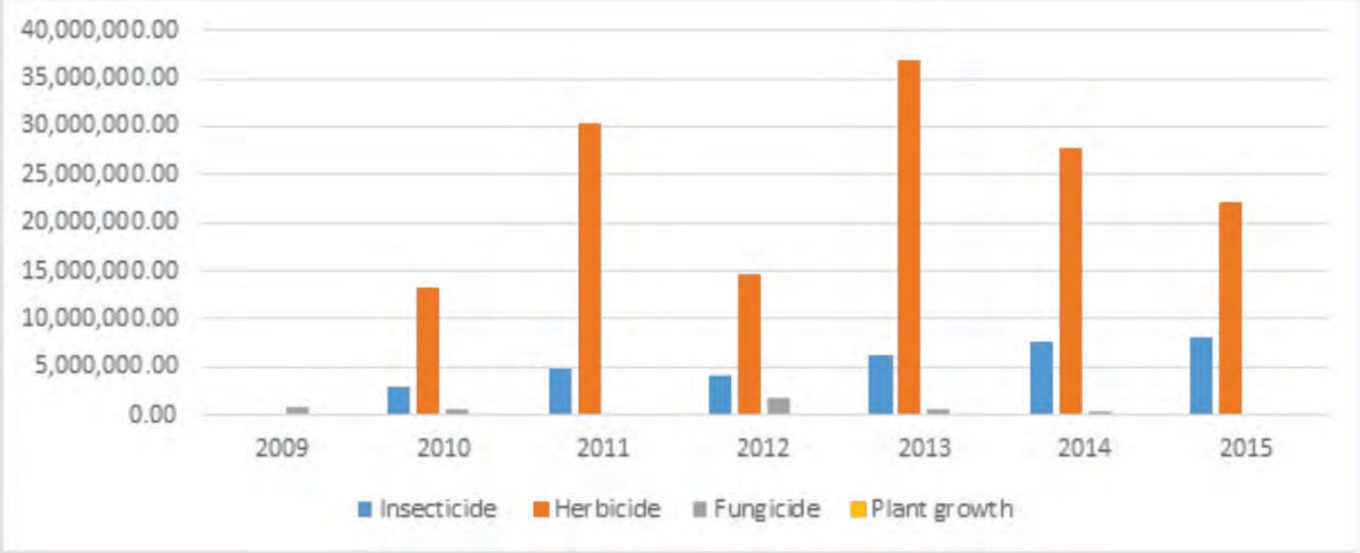

Figure 1: Pesticides Import Data 2009 to 2015 (in litres)

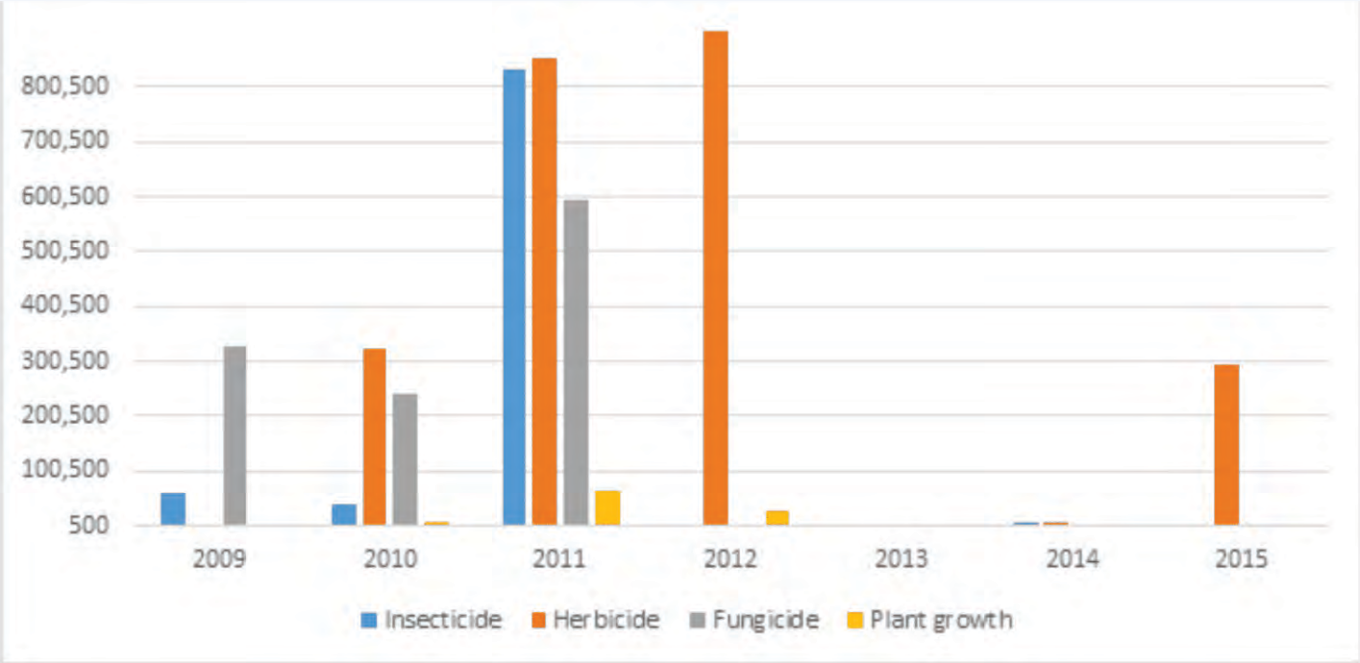

Figure 2: Pesticide import data from 2009 to 2015 (in tonnes)

2.3.1.4 Export of POP-pesticides

There are no records of exportation of POP-pesticides from Ghana to any country. However, unofficial exports of registered pesticides to neighbouring countries within the West Africa Sub-region have been widely reported. In view of the fact that these are unofficial transactions, official records are unavailable.

However, all the remaining quantities of POP-pesticide stockpiles in the country were exported in 2016 for ESM as part of the PCB Elimination project in Ghana.

2.3.1.5 Uses of POP-pesticides

There is no current official use of any POP-pesticides in Ghana. Endosulfan, the last of the POP-pesticides remaining in Ghana in terms of use was commercially registered, sold and used for the control of pest in cotton. It was extensively used by the Ghana Cotton Company on its cotton plantations in the Northern part of Ghana. Its use was severely restricted in the late 2000s with no further importation allowed until its official ban in 2015.

Table 5 below summarizes previous uses of some POP-pesticides in Ghana.

Table 5: Previous Uses of POP-Pesticides in Ghana

No.	Name	Use
1	Chlordane	For termite control
2	DDT	Used widely in public health programmes for mosquito control
3	Aldrin	Insecticide against soil pests, primarily termites, on cotton and maize and for grain storage. Also used on cocoa
4	Dieldrin	Insecticide used on fruit, soil pests and on seed crops, including maize and cotton. Also used on cocoa
5	Endrin	Rodenticide and insecticide used in cotton, rice and maize
6	Heptachlor	Insecticide used against soil insects, especially termites, also used against mosquitoes.
7	Mirex	Insecticide used on ants and termites, also used as a fire retardant
8	Toxaphene	Insecticide used against ticks and mites.
9	Hexachlorobenzene	Fungicide
10	Chlordecone,	No record of use
11	Alpha hexachlorocyclohexane	No record of use
12	Beta hexachlorocyclohexane	No record of use
13	Lindane	Used against insect pest on cocoa
14	Pentachlorobenzene	No record of use
15	Technical endosulfan and its related isomers	Used against insect pest on cotton
16	PFOS – Sulfluramide	Never registered and no record of use in Ghana

2.3.1.6 Legal, Institutional, Regulatory and Enforcement Systems for POP-Pesticides

Act 490 is the regulatory framework for the control and management of all pesticides in Ghana. This law addresses the registration of all pesticides prior to their use in Ghana, including POP-pesticides. The law also recognizes the need for the safe handling and use of pesticides and as such has provisions for licensing of persons or entities engaged in all pesticide use activities such as retailing, commercial pest control, importation, exportation, manufacture, formulation, distribution, use and transportation of pesticides in Ghana. There are provisions in the law with specific penalties against non-compliance to safeguards in pesticide usage such as the use of personal protective equipment.

In addition, the law also has provisions for the listing or registration of pesticides as "banned pesticides" (see Table 3, section 2.2.4.1.5). In this regard, the current known POP-pesticides as listed as banned under Act 490 and gazetted accordingly.

2.3.1.7 Need for specific exemptions/acceptable purposes

There is no need for specific exemptions for use of POPs-pesticide in Ghana because all listed POP-pesticide have been banned under Act 490 for all uses. .

2.3.2 Assessment of PCBs (Annex A, Part II chemicals)

2.3.2.1 General considerations

Significant quantities of PCB-containing equipment (transformers and capacitors) were identified according to investigations conducted during the development of the first National Implementation Plan (NIP) in 2003. The investigations confirmed that about 2-3 % of the total number of transformers sampled contained dielectric fluid of pure PCBs and a further 13 % of transformers contained mineral oils contaminated with PCBs to a level higher than the threshold set in the Convention. The current update of the first NIP provided an opportunity for re-assessing the situation in relation to PCBs management.

2.3.2.2 Production of PCBs

Available information indicates that there has never been any production of PCBs in Ghana. All PCBs in Ghana have entered by the importation of PCB containing equipment.

2.3.2.3 Import of PCBs and PCB Contaminated Equipment

All PCB-containing equipment in Ghana were imported. PCBs applications by location include, electric utilities (including distribution networks), industrial facilities, residential and commercial buildings, etc. In Ghana, the main potential PCB-containing applications at the target locations were found to be transformers and capacitors (closed applications). Available information indicates that the ECG officially ceased importing PCB-containing transformers and capacitors for use in Ghana in 1972. Statistics on national imports and the nature of such imports (including quantity and type) are not available to allow the estimation of potential volumes of such uses.

2.3.2.4 Current Uses of PCBs

The Electricity Company of Ghana (ECG) as well as the Volta River Authority (VRA) and their clients (individual customers and industry) are the major users of PCB-containing equipment in Ghana. Transformers and capacitors (closed applications), and Plasticizers (open applications) constitute the largest source of PCB releases in Ghana. Other open applications may include certain paints, fire retardants and lubricants.

The density test was employed in the field to identify pure PCBs and transformer oils contaminated with PCBs during the preliminarily investigations. In the major screening exercise, however, the L–2000 PCB Analyser was used to determine the levels of concentration of PCBs in each sample collected.

Nine thousand, nine hundred and seventy-two (9,972) pieces of transformers and capacitors representing 83.1 % of the estimated 12,000 were inventoried as at June 2013. A small but significant number of equipment in the northern part of the country are yet to be assessed.

The preliminary inventory carried out in 2003 revealed that there are about 455 pre-1972 possible PCB containing transformers (11 kV and 33 kV) found country-wide. One hundred and forty-seven (147) pieces of possible PCB-containing capacitors were found at the Achimota and Tema power stations. Though there was an administrative directive by the Electricity Company of Ghana (ECG) to ban the importation of PCBs and PCB-containing equipment into Ghana in 1972, there is the possibility some the post–1972 transformers may also contain significant amounts of PCBs as a result of, for example, retrofilling with possible PCB contaminated mineral oils.

The PCBs Elimination project in Ghana succeeded in helping to identify the stockpiles and proper handling and management as well as safe disposal of the PCB containing waste streams so as to reduce the releases of these POPs in Ghana and the region for the matter.

2.3.2.5 Legal, Institutional, Regulatory and Enforcement Systems for PCBs Management

2.3.2.5.1 Strengthening the Legal framework

Significant progress has been made toward strengthening the legal framework with regards to PCBs and other hazardous substances. The Hazardous and Electronic Waste Control and Management Act, 2016, (Act, 917) was enacted in 2016 and seeks to regulate the management of hazardous wastes in Ghana. It deals with importation, exportation, transportation and notification procedures and empowers the Agency to ensure that PCB-related wastes, are duly managed and regulated.

Technical and environmental guidelines for implementing PCBs regulation, have been developed.

2.3.2.5.2 Strengthening Administrative and Technical Framework for Sound Management of PCBs

As part of the PCBs Elimination in Ghana project, an administrative system for PCBs related enforcement & inspection activities, was developed and implemented after the inventory compilation. Capacities have been built at the institutional level for key stakeholders, government enforcement agencies (such as GEAC, ECG, GRIDCo, VRA, GRA and EPA) and PCBs holders (such as electricity companies and the private sector), through series of workshops. The Customs Division of the Ghana Revenue Authority, were trained and provided with an L-2000 Analyser for use at points of entry for import inspection and to prevent PCBs inflow. PCB guidelines and an agreement on implementation and procedures for identification of targeted Customs entry points, were disseminated. PCB holders have been trained in the safe handling of PCBs and PCB-containing equipment, including their temporary storage and transportation. Holders have also received technical support for the development of phase-out and disposal management plans.

The major holders of transformers (i.e. Volta River Authority, GRIDCo and Electricity Company of Ghana) have developed and implemented systems for prevention of reintroduction of PCBs, detection and management of potential PCB-containing electrical equipment. For detection purposes, all key stakeholders have been provided with a Chlorinated Organic analyser (L-2000). Technicians and relevant staff handling electrical equipment have all been trained on the use of the Analyser. VRA, GridCo and ECG have been advised to

develop memoranda of understanding (MoUs) with the Ghana Atomic Energy Commission for detailed training on PCBs sampling and analysis. Key outcomes include but not limited to: (a) mainstreaming of PCBs management into the curriculum of the ECG Training college (b) mainstreaming of PCBs Management as a distinct topic during the Safety, Health and Environmental Weekly Meetings of ECG, VRA and GRIDCo.

As part of activities under the PCBs Elimination in Ghana project, PCBs that are due for elimination as required by the Convention and old stock of transformers and capacitors containing PCBs were identified country-wide. Such stocks will be contained towards their eventual elimination. For the development and implementation of infrastructure for environmentally sound management of PCBs, PCBs training and management has been mainstreamed into the safety, health and environmental departments of most public sector institutions. Public awareness raising has been ongoing and would be sustained. There is a strong inter-dependence and teamwork among key stakeholders.

Sustainability of the sound management of PCBs, is focused on the continuation of PCBs elimination and phase-out beyond the project life in line with the Convention. The result shows that the project has established effective sustainability principles and systems in a number of public sector participating organizations. Examples include the PCBs analytical capacity built at GEAC, provision of L-2000 PCBs Analysers to ECG, GRIDCo, VRA, GRA and EPA as well as mainstreaming of PCBs training and management into the safety, health and environmental departments of stakeholder institutions.

2.3.3 Assessment of POP-PBDEs (Annex A, Part IV and Part V Chemicals) and HBB (Annex A, Part 1 chemicals)

2.3.3.1 General considerations

Brominated flame retardants (BFRs) are organobromine compounds that have an inhibitory effect on combustion chemistry and tend to reduce the flammability of products containing them. They are used in plastics, foams and textile applications, e.g. electronics, clothes and furniture.

Many different BFRs were and are still produced synthetically with varying chemical properties and toxicity. Several groups of BFRs, including hexabromobiphenyl (HBB) and certain congeners/homologues of c-PentaBDE and c-OctaBDE two commercial polybrominated diphenyl ether mixtures (manufactured until 2004) as well as tetraBDE, pentaBDE, hexaBDE and heptaBDE were added to Annex A of the Convention in 2009 whilst commercial DecaBDE was added in 2017. The inclusion these BFRs was due to their toxic properties, persistence and bioaccumulation. While these low volatile pollutants mainly contaminate sites at their point of release, they are also partly transported through air, water and migratory species, across international boundaries and deposited far from their source of release and accumulate in terrestrial and aquatic ecosystems. In the current inventory, PBDEs listed in 2009 were considered and not DecaBDE which was listed in 2017. Since DecaBDE have been used in considerable higher volumes (1.3 million tonnes) compared to c-PentaBDE and c-OctaBDE (100,000 t each) the DecaBDE volumes in the respective PBDE inventories are likely to be considerably higher compared to the POP-PBDEs listed in 2009 for the current inventory.

The inventory covered the major articles that can be impacted with POP-PBDEs, namely the electrical and electronic equipment (EEE) and related waste (WEEE), the transport sector and to some extent furniture. It focused mainly on identifying the relevant use categories and life cycle stages of these sectors.

Other use categories of POP-PBDE, such as insulation materials for buildings etc., were not addressed in this inventory since they are considered of less relevance for Ghana. .

Also HBB was not specifically addressed since the major use was in the 1970s with a relatively small volume. Furthermore the applications of HBB were in the same use sectors as that of POP-PBDEs (e.g. in plastic of electronics, PUR foams in transport, etc.). The possibly remaining HBB in products will be managed together with the POP-PBDE material flows.

The evaluation of available and relevant national data on the selected sectors was conducted by using the tiered approach suggested in the UNEP PBDE Inventory Guidance document[1]. An extrapolation was done with the available data to fill any data gaps.

According to the inventory, POP-PBDEs and POP-PBDE-related articles have never been produced in Ghana. The major challenge is the end-of-life management of the POP-PBDE-containing articles/products and the recycling flows.

Act 917 and its regulations LI2250 compliment the already existing WEEE related policies and legislation including the relevant sections of the 1992 Constitution of the Republic of Ghana [Economic Development - Article 36 (9); Economic Development - Article 36 (10); Duties of a Citizen - Article 41 (k)], Environmental Protection Agency Act, 1994 (Act 490), National Environmental Policy and International and Multilateral Environmental Agreements.

2.3.3.2 POP-PBDEs in EEE and WEEE

2.3.3.2.1 General considerations

PBDEs in plastics constitute a major component of electrical and electronic equipment.. C-OctaBDE was used as an additive in BFR mainly in ABS plastic in cathode ray tube (CRT) casings and other plastics in electronics. The inventory approach recommended by the Convention guidance was used to develop the POP-PBDE inventory.

2.3.3.2.2 POP-PBDEs in imported EEE

Data was obtained from the following sources: (i) GRA-CD import data (ii) Ghana Statistical Service (GSS), and (iii) DVLA

Import data on TVs and PCs/Laptops (new and used) for the current inventory was obtained for the period 2006 to 2014. The records indicate that within the 9-year period, a total of 8,802,892 units (220,072 tonnes) of TVs and PCs/Laptops were imported.

In spite of the difficulty in obtaining segregated data with regards to new and used EEE , studies conducted in 2009 showed seventy percent of all EEE imported were used of which 30% were non-functional, and needed repairs. Half of the non-functional EEE were beyond repairs.

Table 6: GRA-CD import data on new and used TV and PC/Laptop units (2006-2014)

EEE	Category	Year								
		2006	2007	2008	2009	2010	2011	2012	2013	2014
PCs/Laptops	3	187,000	125,000	23,000	151,000	545,169	4,212,830	746,131	1,127,570	944,818
Television sets	4	89,000	153,000	139,000	181,000	34,670	76,082	42,876	18,023	6,723

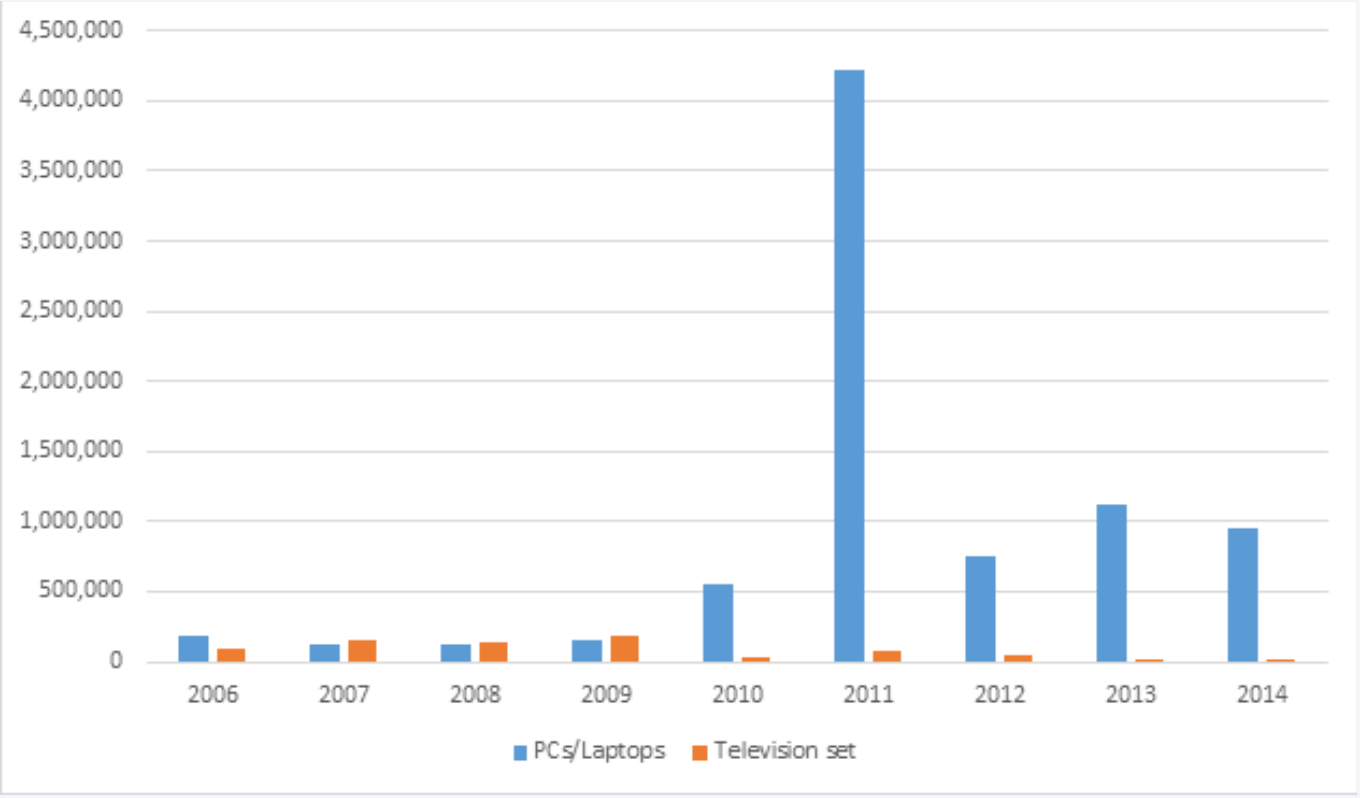

Figure 3: GRA-CD import data on new and used TVs and PCs/Laptops (units, 2006-2014)

The Energy Efficiency (Prohibition of Manufacture, Sale or Importation of Incandescent Filament Lamp, Used Refrigerator, Used Refrigerator-Freezer, Used Freezer and Used Air-Conditioner) Regulations, 2008 (LI 1932) is the specific regulation with relevance to EEE and WEEE. It prohibits the importation as well as the sale and distribution of used refrigerators, freezers and air-conditioners. This law is, however, silent on importation of used computers and TVs. This is in line with the policy decision by the government to ensure that such EEE are made accessible to Ghanaians to help improve the computer literacy rate. Therefore importers only pay Value Added Tax (VAT) and other levies. An importer who is able to prove (by letter from the Ministry of Finance) that the computers and accessories are meant for donation or charity is even exempted from paying VAT. This has led to an alarming in-flux of EEE (and WEEE) into the country, most of which are second-hand equipment. The policy direction on ICT and demands of the current information and digital age are major drivers of high per capita EEE import and use, as well as e-waste generation in Ghana.

The data of imported new and second hand EEE (tonnes 2006-2014) and the corresponding POP-PBDEs are listed in Table 7.

A sharp increase in the amount of import of used PCs/Laptops and TV sets were discovered between 2011 and 2013, with corresponding increase in POP-PBDEs. Furthermore, a value for imports in 2008 was low and did not fit into the trend with high imports in 2011 and 2013. The explanation given from the data source (CEPs) showed a possibility of mix-up in data handling. However, the TV sets import decreased considerably in 2013 and 2014 (probably due to enforcement of a law on import of WEEE into Ghana).

Table 7: EEE (PC/Computers and TVs) import statistics 2006 – 2014 for Ghana (in tonnes) and corresponding total estimated polymer and POP-PBDEs contents (tonnes)

Year	EEE (tonnes)		Polymer content of CRT monitors and TVs*		Total Polymer Content**	c-OctaBDE	Hexa BDE	Hepta BDE
	PC/Computer	TV	PC/Computer	TV				
2006	4,675	2,225	104	284	388	0.36	0.04	0.15
2007	3,125	3,825	69	487	556	0.51	0.06	0.23
2008	575	3,475	13	443	456	0.42	0.05	0.19
2009	3,775	4,525	85	577	662	0.61	0.07	0.26
2010	13,629	867	308	111	419	0.39	0.04	0.15
2011	105,321	1,902	2,381	243	2,624	2.43	0.27	1.01
2012	18,653	1,072	422	137	559	0.52	0.06	0.23
2013	28,189	451	637	58	695	0.64	0.07	0.26
2014	23,620	169	534	22	556	0.52	0.06	0.23

*PC CRT is 7.5 %; and TV CRT is 42.5 % of total EEE imported; **Polymer content is 30 % of CRT monitors and TVs weight

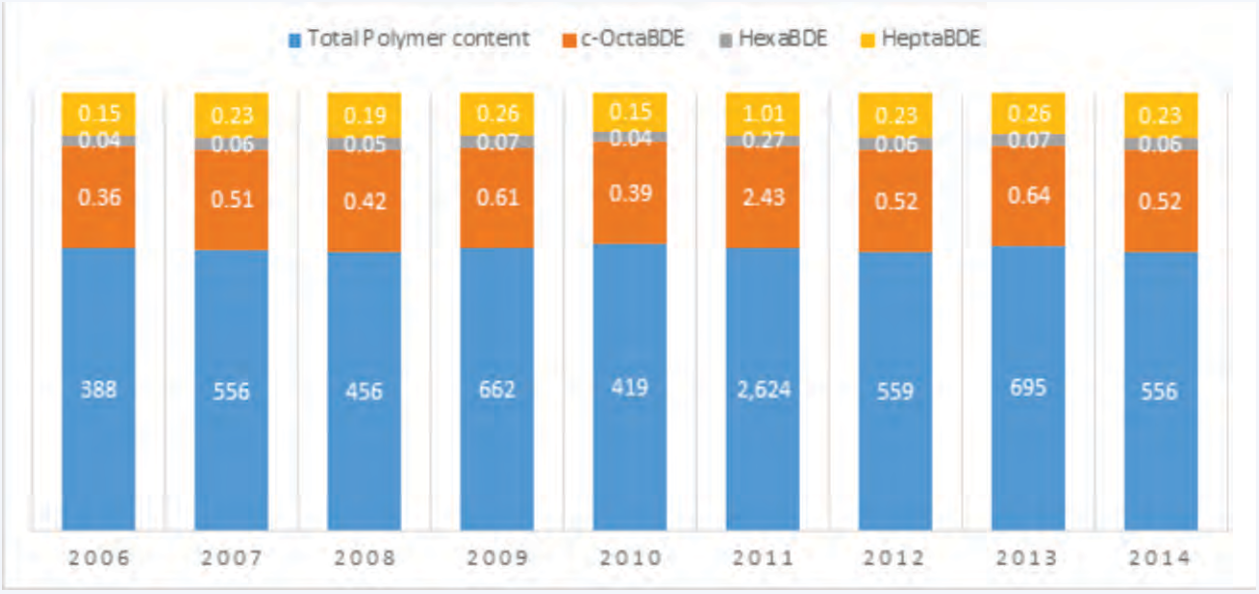

Figure 4: Total polymer content with corresponding BDE

2.3.3.2.3 POP-PBDEs in use/stock EEE

a) Tier 1 approach

Tier 1 inventory approach was applied to the Ghanaian situation, to get a first-hand information on the total amount of POP-PBDEs in the country and the amount of impacted polymers.

Table 8: Total estimated amounts of POP-PBDEs homologues (tonnes) for CRTs in use/stock

POP-PBDEs in CRTs in use/stock in Ghana	c-OctaBDE	hexaBDE	heptaBDE
CRT TV/monitors	4.8 to 14.1	0.53 – 1.6	2.1 – 6.1

b) Tier 2 approach

According to the available EEE/WEEE inventory data, the total amount of used EEE in Ghana in the period 2010 – 2014 was 996,310 tonnes (GRA-CD, 2014). From these, 544,500 tonnes were from EEE category 3 and 451,810 tonnes of EEE category 4. From these amounts, considering the 7.5 % of CRT monitors share from EEE category 3 and the 42 % of CRTs TVs share from EEE category 4, the total amount of respective CRT TVs and monitors was estimated at 40,836 tonnes of CRT monitors and 192,019 tonnes of CRT TVs. The estimated polymer content for the CRT TVs and monitors in use/stock, that needs to be managed in an environmentally sound manner, is 12,251 tonnes for CRT monitors and 57,606 tonnes for CRT TVs. Thus, the total estimated amount of c-OctaBDE content is 31 tonnes for CRT monitors and 50 tonnes for CRT TVs (Table 9) contained in 21000 tonnes of CRT plastic.

The shares of POP-PBDE in c-OctaBDE are 11% hexaBDE (8.9 tonnes) and 43% heptaBDE (35 tonnes) respectively

Table 9: Total estimated amounts of POP-PBDEs homologues (tonnes) for CRTs in use/stock

POP-PBDEs in use/stock in Ghana	c-OctaBDE	hexaBDE(11%)	heptaBDE (43%)
CRT monitors	31	3.4	13.4
CRT TVs	50	5.5	21.6
Total	**81**	**8.9**	**35.0**

2.3.3.2.4 POP-PBDEs in WEEE and Related Plastic Entering the Waste Stream

The amount of becoming WEEE entering the waste stream is important for planning the waste and resource management of this critical material flow within a country. The amount of POP-PBDE which entered the waste stream in 2009 (derived from Ghana e-Waste Country Assessment, 2011) showed trends which might be similar with the current values. In total 810,400 tonnes of category 3 WEEE with 7.5% CRT monitors (60,780 tonnes including 18,233 tonnes CRT plastic); and 872,000 tonnes of WEEE in category 4 with 42.5% CRT TVs (370,600 tonnes including 111,172 tonnes CRT plastic) became WEEE and required waste management.

Therefore, the total amount of POP-PBDE content were estimated to be 46 tonnes for CRT monitors and 97 tonnes for CRT TVs.

2.3.3.3 POP-PBDEs in Transport Sector

2.3.3.3.1 General considerations

The inventory approach recommended by the Stockholm Convention guidance[2] was used to develop the POP-PBDE inventory. Cars and other road vehicles (buses and trucks) constitute the bulk of the transport sector and therefore contribute highest amount of POP-PBDEs to the sector. . POP-PBDEs were produced and used from about 1975 to 2004[3]. Vehicles (including cars, buses and trucks) have been in use in Ghana for a long time, and therefore can be assumed that those with POP-PBDEs may still be in use. Hence, vehicles imported within 2010 to 2014 (and 2000 to 2009) were considered for this POP-PBDEs inventory. . For this study, a 5-step approach of the PBDE inventory guidance developed by the Convention was followed.

Responses from governmental organizations including Ghana Statistical Service, and DVLA, EPA, etc. revealed that, there is no comprehensive inventory of the transport sector in Ghana. Vehicle importation data and the number of

registered vehicles during the period of 2010-2014 and 2000 to 2009 were obtained from GRA-CD and DVLA, respectively.

The fractions of vehicles originating from the European (18 %), Asian (38 %), America (33 %) and other regions (11 %) were estimated[4]. The regional distribution of origin of vehicles is important for the assessment since the Stockholm Convention 2012 POP-PBDE inventory guidance includes different impact factors for regions with high or low usage of POP-PBDEs in vehicles.

2.3.3.3.2 POP-PBDEs in imported vehicles

The import of used cars, buses, trucks and other transport represents a major source of POP-PBDEs, particularly for low and middle-income countries like Ghana, and therefore needed to be quantified.

The Table 10 shows data on the number of cars, minibuses and trucks imported between 2010 and 2014 (DVLA, 2015). 60 % and 75 % of imported cars and trucks/buses respectively from 2010-2014 were estimated to have been produced before 2005.

Table 10: Vehicles import statistics of the inventory years (2010-2014)

Vehicle	2010	2011	2012	2013	2014
Cars	4,884	13,228	10,256	8,868	33,150
Buses	3,925	14,905	6,597	6,165	30,807
Trucks	4,898	11,817	10,070	7,016	17,530
Total	13,707	39,950	26,923	22,049	81,487

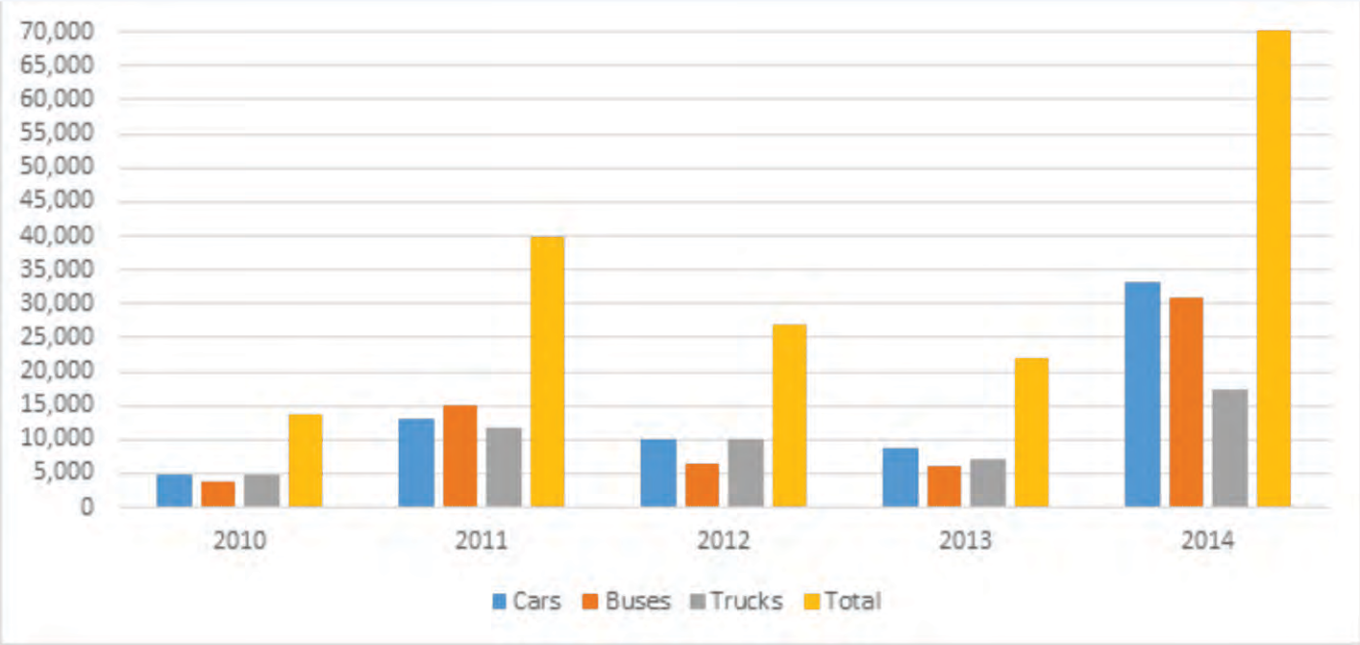

Figure 5: Vehicles import statistics of the inventory years (2010-2014)

Based on the above data, the total amount of PUR foam in imported second hand vehicles that needs to be managed in an environmentally sound manner was estimated to be 3,804 tonnes for the period 2010-2014, as presented in Table 11 below.

Table 11: Estimated amount of PUR foam in imported second hand vehicles (tonnes)

Vehicle	2010	2011	2012	2013	2014
No of Cars/Trucks	9,782	25,045	20,326	15,884	50,680
Total PUR foam (0.016 t/car/truck)	*157*	*401*	*325*	*254*	*811*
No of Buses	3,925	14,905	6,597	6,165	30,807
Total PUR foam (0.032 t/bus)	*126*	*477*	*211*	*101*	*986*
Total PUR foam	238	878	536	355	1797

The total estimated amount of c-PentaBDE (tetraBDE, pentaBDE, hexaBDE and heptaBDE) in impacted imported vehicles for the period 2010-2014 was estimated to be 3.3 tonnes comprising 2.6 tonnes are estimated to be in cars/trucks and 0.7 tonnes in buses. (see Tables 12 and 13 below), . Furthermore DecaBDE is still used in vehicles and is present in vehicles produced after 2004.

Table 12: Total estimated amount of POP-PBDEs in imported cars/trucks for the inventory years 2010-2014

Years	Origin of the total amount of PBDEs (kg) in imported cars/trucks			
	Europe	Asia	USA/North America	Other regions
2010	10	20	174	6
2011	24	51	443	15
2012	19	42	361	12
2013	15	32	279	9
2014	48	100	872	29
Total POP-PBDEs	**Sum of POP-PBDEs: 2,561 kg**			

Table 13: Total estimated amount of POP-PBDEs in imported buses for the inventory year 2010-2014

Years	Origin of the total amount of PBDEs (kg) in imported cars/trucks			
	Europe	Asia	USA/North America	Other regions
2010	10	20	174	6
2011	24	51	443	15
2012	19	42	361	12
2013	15	32	279	9
2014	48	100	872	29
Total POP-PBDEs	**Sum of POP-PBDEs: 2,561 kg**			

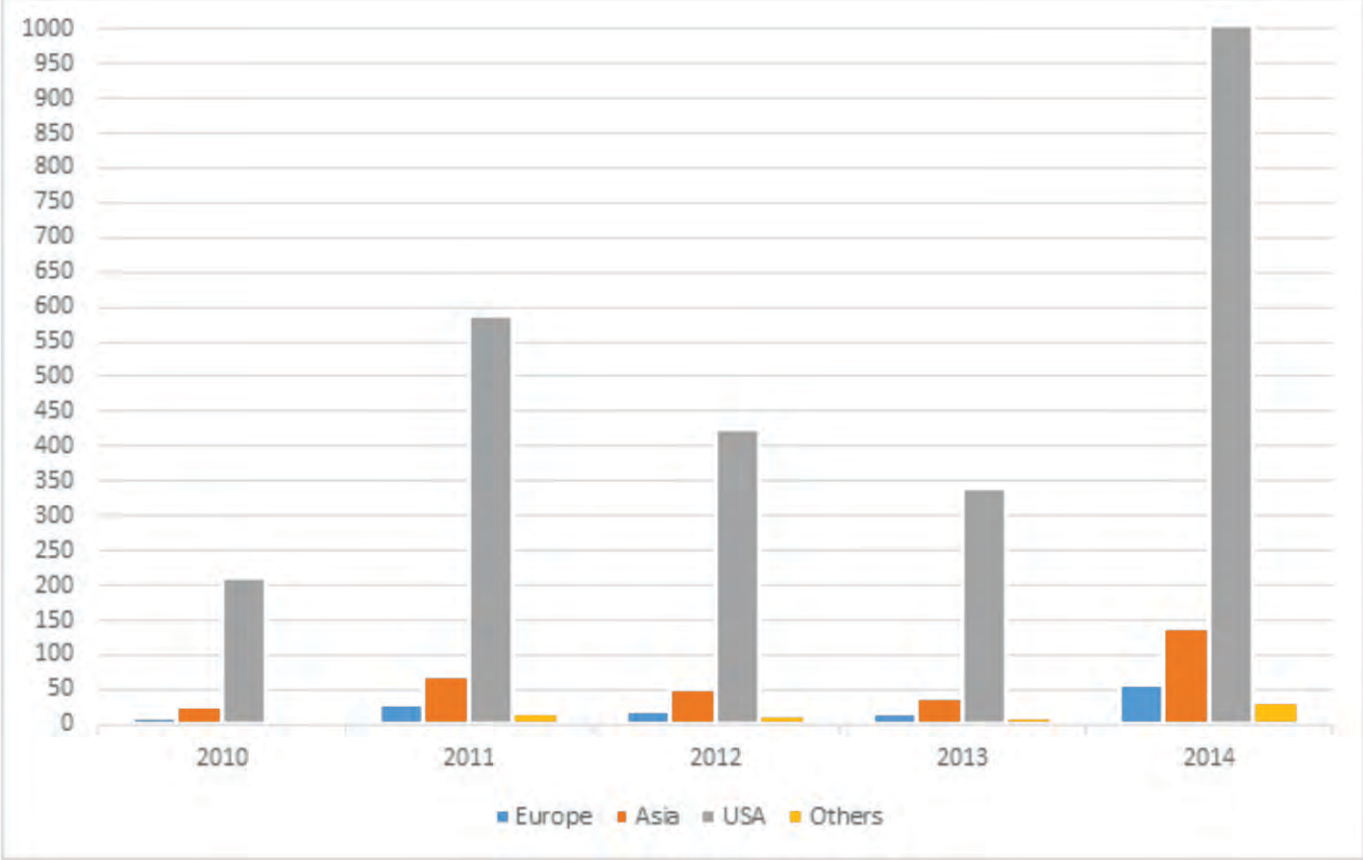

Figure 6: Total estimated POP-PBDEs (kg) in imported vehicles for the years 2010-2014

2.3.3.3.3 POP-PBDEs in registered vehicles in use

For this preliminary inventory, registration of vehicles from 2000 to 2009 was provided by DVLA[5] and the vehicles were considered still in use based on the assumption of 30 years life expectancy of vehicles. Vehicles in use represent a major stock of POP-PBDEs and are important for the future planning of waste management of the transport sector. The inventory of POP-PBDEs is directly relevant to the implementation of the Convention[6]. The data for the registered vehicles in Ghana, which are considered to be in use, are shown in Table 14 below.

Table 14: Number of in use/stockpiled registered vehicles in Ghana (2000-2009)

Registered Vehicles	Years									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cars	357,758	397,446	429,208	450,676	492,361	536,947	588,920	652,778	723,198	789,691
Buses	127,771	141,945	153,288	160,956	175,843	191,761	210,321	233,135	258,285	282,031
Trucks	25,554	28,389	30,657	32,192	35,168	38,353	42,065	46,627	51,657	56,406
Total	**511,083**	**567,780**	**613,153**	**643,823**	**703,372**	**767,067**	**841,314**	**932,540**	**1,033,140**	**1,128,138**

Calculated using 70 % (cars), 25 % (buses) and 5 % trucks

Figure 7: Number of in use/stockpiled registered vehicles in Ghana (2000-2009)

Based on the data from DVLA vehicles statistics, it was possible to obtain the origin of vehicles registered in the country as follows: Asia (38 %), Europe (18 %) and North America (33 %) and the remaining from other regions.

The estimated amount of c-PentaBDE (tetraBDE, pentaBDE, hexaBDE and heptaBDE) in impacted vehicles in use/stockpiled for the period 2000-2009 was found to be 224 tonnes. Out of the 154,833 tonnes of PUR foam, 184 tonnes POP-PBDEs were in cars/trucks whilst 40 tonnes were in buses.

Table 15: Amount of POP-PBDEs in use/stockpiles registered cars/trucks for the period 2000-2009 (kg)

Years	Origin of the total amount of POP-PBDEs (kg) in cars/trucks			
	Europe	Asia	USA/North America	Other regions
Car + truck 2009	1218	2572	22337	745
Busses 2009	146	652	4914	55
Total POP-PBDEs	**Sum of POP-PBDEs in registered vehicles: 32,640 kg**			

Based on the data from DVLA vehicles statistics, it was possible to obtain the origin of vehicles registered in the country as follows: Asia (38 %), Europe (18 %) and North America (33 %) and the remaining from other regions.
The estimated amount of c-PentaBDE (tetraBDE, pentaBDE, hexaBDE and heptaBDE) in impacted vehicles in use/stockpiled for the period 2000-2009 was found to be 224 tonnes. Out of the 154,833 tonnes of PUR foam, 184 tonnes POP-PBDEs were in cars/trucks whilst 40 tonnes were in buses.

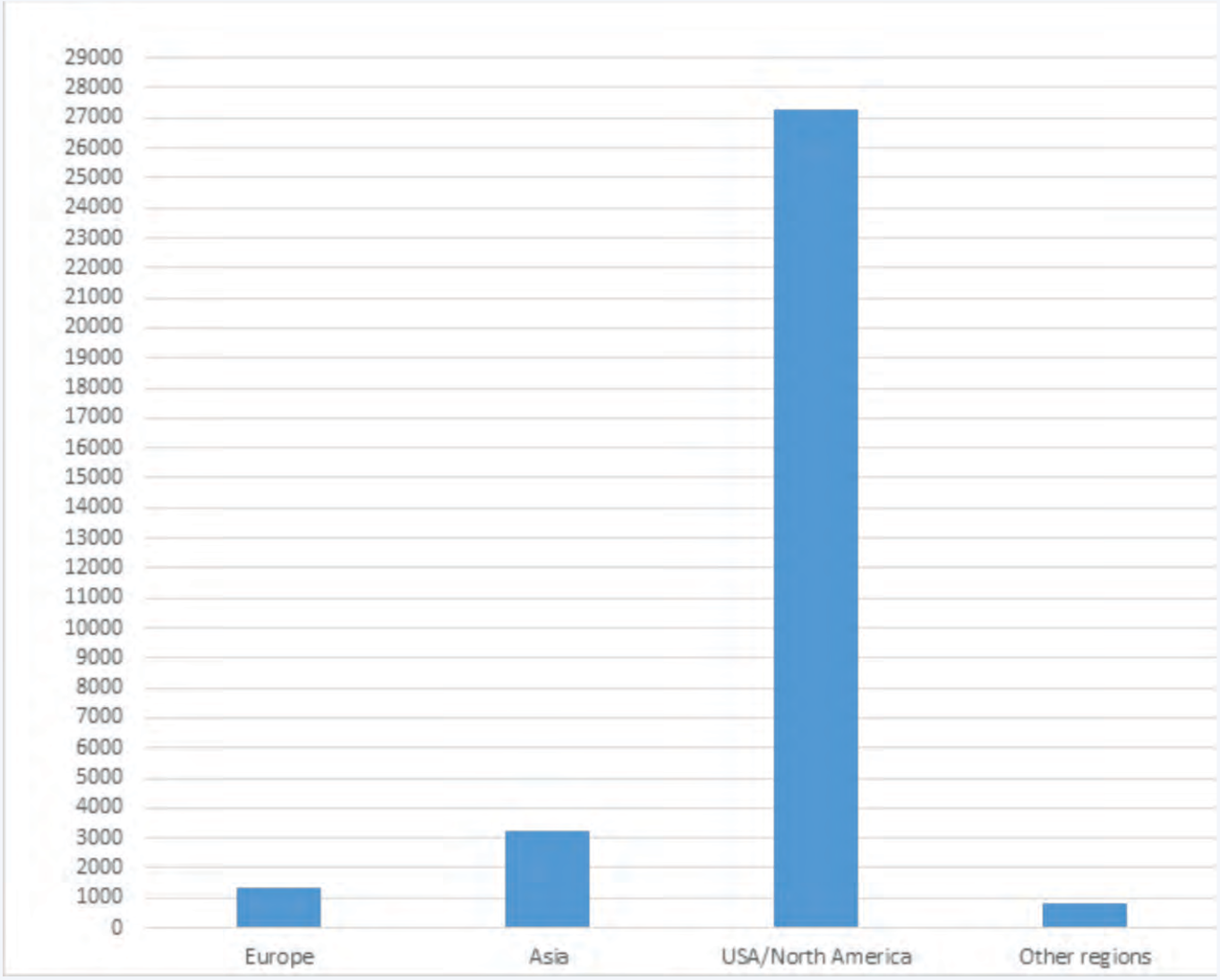

Figure 8: Total POP-PBDEs (kg) in use/stockpile registered vehicles for the period 2000-2009

2.3.3.3.4 POP-PBDEs in end-of-life vehicles (ELVs)

a) Estimation of POP-PBDEs amount for the 2015 inventory year

The estimation of vehicles reaching end-of-life in a specific year is an important consideration for waste/resource management and the related recycling sectors of this material flow.

The estimation of the average life expectancy of vehicles in Ghana was difficult to arrive at, however checks indicate the average age of vehicles in use was estimated to be 30 years. Data on the number of vehicles being scrapped or the number of vehicles whose registration is cancelled was not available from the responsible agencies. Hence, the number of end-of-life vehicles was estimated by the number of total vehicles in use (DVLA, 2015) and their estimated life expectancy of 30 years.

Based on the above information, for this preliminary inventory, it is estimated that out of the 37,600 vehicles which have been produced before 2005, 35,725 of them (approximately 95 %) are potentially impacted by POP-PBDEs.

It is also a known fact that vehicles reach end-of-life due to accidents. Statistics from the Ministry of Roads and Transport indicated that there were 6,384 crashes involving 9,914 vehicles between January and June, 2015 and hence approximately 19,828 for the whole inventory year 2015. Considering that 50% of these vehicles have also reached end-of-life, the total amount of end-of-life vehicles is approximately 45,600. Thus, the total amount of PUR foam in vehicles entering in the end-of-life in 2015 that needs to be managed in an environmentally sound manner was estimated to 750 tonnes. The total polymers in this vehicle are estimated to be 6,840 and 9,120 tonnes based on total polymer content of 150 to 200 kg per vehicle. The estimated amount of c-PentaBDE (tetraBDE, pentaBDE, hexaBDE and heptaBDE) in these impacted end-of-life vehicles in 2015 was estimated to be approximately 1.5 tonnes.

b) Estimation of POP-PBDEs amount for the period 2000-2009

For estimating the total deposited materials from the transport sector and the POP-PBDEs therein the number of vehicles having reached end-of-life over the last 15

years were estimated. Due to the lack of de-registration data, estimates were made for the share of vehicles having entered end-of-life from 2000 to 2015 (mainly from those registered in 2000 - 2009. Those registered between 2010 -2015 were still considered to be in use). The total amount of end-of-life vehicles were estimated to be 140,000 vehicles containing 2240 tonnes of PUR foam and 4.5 tonnes of POP-PBDEs. Total polymer volume in these end-of life-vehicles are estimated from 21,000 to 28,000 tonnes.

2.3.3.3.5 POP-PBDEs in end-of-life vehicles treatment (recycling, open burning, and disposal)

There are some informal unsound e-waste activities going on in Ghana. In their quest to remove precious metals from these damaged vehicles, informal waste recyclers resort to open burning of polyurethane, plastics and cables to retrieve copper and other metals. Some old seats of vehicles that are not badly damaged are re-used. In studies in conducted in Vietnam it was found that sites of open burning of end-of-life vehicles are similarly contaminated with POP-PBDEs (Takahashi et al. 2017)[7].

Due to paucity of data regarding the waste management options that are practiced in Ghana, the recycling quota could not be estimated but was assumed to be below 10%. Taking a simple approach for this preliminary inventory it could be assumed that the polymers from vehicles were recycled and thermally treated in the same proportions as the general municipal solid waste in Ghana. This meant a recycling rate of 5 %, and a share of thermal treatment/open burning of 12 % with the remaining 83% landfilled[8]. Thus a large share of the materials is going to landfills/dumpsites where open burning occurs. A study needs to be conducted generate more concrete data in order to accurately assess the related releases.

2.3.3.3.6 Individual POP-PBDEs homologues in the transport sector

The POP-PBDE homologues listed in the Convention, namely tetraBDE, pentaBDE, hexaBDE and heptaBDE need to be finally considered and not the total amount of c-PentaBDE or c-OctaBDE. These homologues were calculated from the estimated amount of c-PentaBDE (or c OctaBDE) by considering the percentages of homologues in the commercial mixtures given in Table 16.

Table 16: Estimation of POP-PBDEs homologues present in the transport sector (in kg) for the relevant life cycle stages

POP-PBDEs homologues present in the transport sector (kg)	Distribution homologues c-PentaBDE	POP-PBDEs in vehicles still in use	POP-PBDEs in imported vehicles (2010-2014)	POP-PBDEs in end-of-life vehicles in the inventory year (2015)	POP-PBDEs recycled from transport sector (2015) (in kg	POP-PBDEs disposed off in the past from the transport sector (2000-2015)
Inventoried c-PentaBDE		**32,640**	3,300	1,500	369	4,450
TetraBDE	32 %	10445	1056	480	118	1424
PentaBDE	56 %	18278	1848	840	206	2492
HexaBDE	9 %	2938	297	135	33	401
HeptaBDE	0.5 %	163	16.5	7,5	2	22

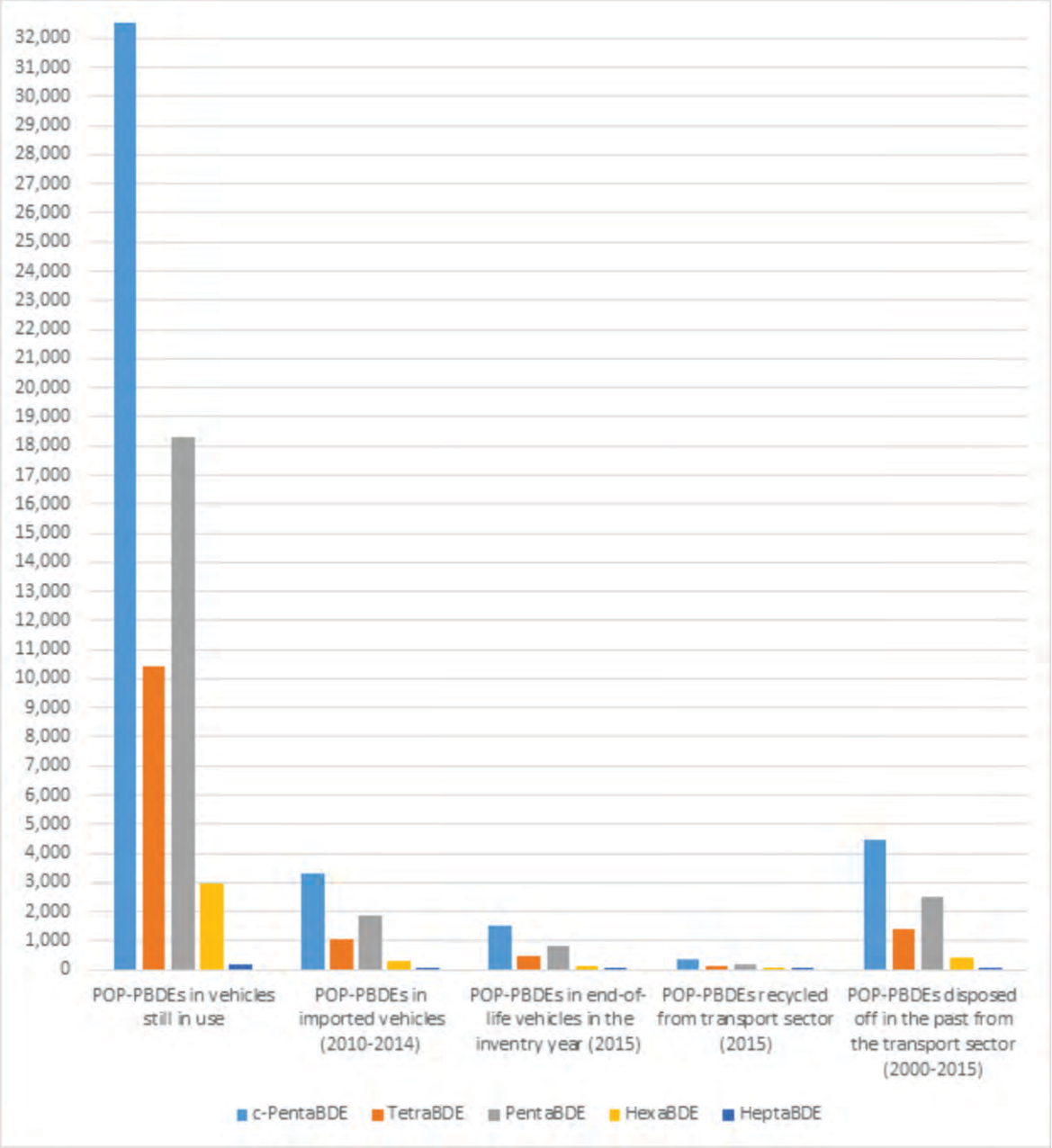

Figure 9: Estimation of POP-PBDEs homologues present in the transport sector (in kg) for the relevant life cycle stages

2.3.3.4 POP-PBDEs in Furniture and Insulation Materials for Buildings

The overall use of c-PentaBDE in PUR foam in furniture is estimated to represent approximately 60 % of total production but actual levels are closely linked to the flammability standards in a country. Ghana has no specific flammability standards for furniture/mattresses and is therefore considered to have low levels of POP-PBDEs in furniture and mattresses. However, there has been a tremendous importation of furniture from China into the country for a decade but it is unclear whether China has specific flammability standards (such as that of the United States and United Kingdom).

The data collected from Ghana Export Promotion Authority (under Ministry of Trade and Industry) on furniture was not used for the estimation of POP-PBDEs because no flammability standard exists for these articles in Ghana and it is therefore considered that PBDE were not used in furniture. These and other products need to be checked for bromine using sliding spark or handheld XRF equipment. Analysis of the positive tested samples could then determine the c-PentaBDE content (or indicate other BFRs present).

There is no record on POP-PBDE-containing furniture/mattresses in Ghana. Hence an inventory of the amount of historically deposited POP-PBDEs-from furniture, mattresses, rebond etc. was difficult to undertake to assess the environmental risks that may arise from wastes in landfills.

2.3.3.5 Use of POP-PBDEs alternatives

Currently it is not known what flame retardants are used in Ghana (e.g. in the textile industry, polymer production and in construction). Also, it is not known what alternative flame retardants are imported in products such as polymers or textiles. It is suspected that DecaBDE may be present in these articles and processes. DecaBDE was listed in the Convention at its 8th COP meeting in 2017 with a range of exemptions. There is an urgent need to assess what alternatives are used or imported in articles to Ghana.

The most effective alternative would be to find non-halogenated substitutes for POP-PBDEs. Currently, decabromodiphenyl ethane, with several positive environmental attributes and economic viability has been deemed as the suitable substitute for DecaBDEs. Non-halogenated flame retardants such as phosphorus or mineral based compounds have been gaining attention in recent years.

Further assessment is needed and might be done within the frame of sustainable chemistry approach.

2.3.3.6 Legal, Institutional, Regulatory and Enforcement Systems for POP-PBDEs Management

Large amounts of plastics containing PBDEs are still in use and must be disposed of after their lifetimes, creating outdoor reservoirs for the future dispersal of PBDEs into the environment. Thus, concerted action is needed not only to regulate the importation and use of POP-PBDE-containing articles in Ghana, but also to find ways to effectively manage waste electrical and electronic products and end of life vehicles that contain PBDEs.

Ghana currently has a regulatory framework for the management of hazardous waste including waste electrical and electronic equipment and end of life vehicles (Act 917,2016 and its regulation LI 2250 have There is an on-going process to establish the needed mechanism for the full implementation of provisions of the legislation.

2.3.4 Assessment with respect to DDT (Annex B, Part II chemicals)

2.3.4.1 Import, export and Use of DDT

DDT had been used extensively in Ghana in the past for both agriculture and public health purposes. The Ministry of Food and Agriculture, the Ghana Cocoa Board and the Ministry of Health were the major importers of DDT prior to its ban in 1985

.

DDT was officially used in agriculture as the main insecticide against cocoa capsids and for malaria and filariasis control programmes by the Ghana Cocoa Board and Ministry of Health respectively.

There is general paucity of data on DDT import and application in Ghana. There is also no information on export of any kind.

Information obtained from the Ministry of Health shows that in the late 1950s and the early 1960s, DDT was used for indoor residual treatment and malaria control in Ho, in the Volta Region. However, there are no available figures on quantities imported or used for that activity. Information obtained from the Cocoa Research Institute of Ghana (CRIG) at Tafo, indicates that, DDT was introduced in Ghana (then Gold Coast) after the Second World War and for use on cocoa farms. In 1944-1945, 2.5% DDT formulation was recommended for use against capsids on cocoa since this formulation made excellent emulsion.

Other DDT formulations that were used at the time were: (a) 10% DDT dusting powder- against mealy bugs and ants and (b) 25% DDT fog applied with smoke generators – against capsids and mealy bugs. Apart from the "Square Mile" area at CRIG (Tafo), DDT was also used extensively at Akwadum and Adonkwanta areas in Eastern Region

In the early 1950s DDT was replaced with Gamma-BHC (Lindane) and used extensively on cocoa in Ghana. (Ghana National Implementation Plan (NIP, 2007).

Information gathered from the Ghana Statistical Service indicates that there had been some unofficial importation of DDT into the country in 2001-2002 (Table 17 below).

Table 17: Imports of Hexachlorobenzene and DDT in 2001 and 2002

Year of Import	Area of Application	Pesticide(s)	Quantity/kg	Country of Origin
2001	Not available	Hexachlorobenzene and DDT	20	Germany
2002	Not available	Hexachlorobenzene and DDT	10 800 200	Italy Egypt USA

SOURCE: GHANA STATISTICAL SERVICE

The current inventory review did not register any DDT stocks in the country. There is wide level of awareness among the users that DDT is banned and hence it is illegal to possess the product in Ghana.

2.3.4.2 Legal, Institutional, Regulatory and Enforcement Systems for DDT

Act 490 is the regulatory framework for the control and management of all pesticides in Ghana. DDT is one of the current known POP-pesticides that have been banned under the Act 490, and subsequently listed in the gazetted register of pesticides (see Table 3, section 2.2.4.1.5).

2.3.5 Assessment of PFOS, its salts, PFOSF and related substances (Annex B, Part I chemicals)

2.3.5.1 General considerations

Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF) are fully fluorinated compounds. They are commonly used as salts or incorporated into larger polymers. PFOSF is used as an intermediate to produce different PFOS related substances (approximately 165 substances). PFOS can be formed by degradation from this large group of PFOS related substances (PFOS precursors). PFOS and related substances have been used in different industrial and consumer applications and products since the 1950s. The perfluorinated carbon chain has both hydrophobic and lipophobic properties. They can repel grease, dirt as well as water. These unique properties make them valuable for various industrial and consumer applications as surface active substances. PFOS/PFOSF are present in aqueous film forming foams (AFFFs), which are used to extinguish flammable hydrocarbon liquid fires by rapidly discharging oxygen from fire environment.

PFOS/PFOSF is today mainly produced in China with possible minor production in Germany. The main producing company 3M in 2003 announced the phase-off of PFOS/PFOSF and the production amount dropped from approximately 4500 tonnes (in 2000) to about 200 tonnes (from 2002 on). However, PFOS/PFOSF is still found in high concentrations in different environmental samples (ground water, surface water, sediment and biota, breast milk and food). PFOS related substances are degraded over time into PFOS. PFOS/PFOSF is practically non-degradable under normal environmental conditions and therefore is highly persistent. Several of them are considered toxic and bio-accumulative in the environment.

2.3.5.2 Production of PFOS and related substances

There is no production of PFOS or related substances in Ghana.

2.3.5.3 Import of PFOS or related substances

All products and articles, which may contain PFOS and related substances in Ghana, enter or entered the country through importation. As Ghana is party to the Convention, official importation of PFOS and related substances is prohibited since there is currently no listed exemption for PFOS. However, PFOS might be imported to the country unrecognized, in products. .

2.3.5.4 Uses of PFOS and related substances

Information on industries producing products which potentially use PFOS including producers of cleaners/surfactants, paper production, paint production, plastic industry or furniture industry indicate that none of these industries in Ghana is manufacturing products or articles containing PFOS or its related substances.

Other industries suspected to possibly use products containing PFOS and related substances which were assessed included: firefighting foam dealers, firefighting foam users, the mining sector, and industries such as the oil and gas, metal plating, photography and food packaging. The main users found were those using firefighting foams. For other industries the use of PFOS could not be confirmed. However, these companies might use other per- and polyfluorinated alkylated substances (PFAS), which are not yet listed under the Convention.

In this inventory the main stocks and possibly used products containing PFOS were found to be firefighting foam from governmental firefighters and from companies (Table 18). For some of the companies PFOS in firefighting foam could be confirmed. For some of the AFFF it was not clear if they contained PFOS or other PFAS. In this inventory all of these foams are listed as possible PFOS containing foams, which will need to be assessed through a detailed inventory preparation (Tier III inventory).

Table 18: Users of Possible PFOS-containing products and PFOS-related substances in Ghana.

No.	User category	Name of currently used firefighting foams
1	Tema Oil Refinery	Fomtec AFFF 1%F, 3% & 6%
2	Ghana Ports and Harbours Authority, Fire Safety Dept.	Cold fire foam concentrate
3	Tema Metropolitan Fire Station	Aqueous forming foam compound (6%) medium expansion
4	Ghana National Fire Service, Abelemkpe Fire Station, Accra	AFFF
5	Ghana National Fire Service, Regional Headquarters, Accra	AFFF
6	Madina Fire Station	AFFF
7	Bulk Oil Storage and Transportation Company (BOST)	Aqueous film forming foam low expansion concentrate (3%)
8	Accra City Fire Station, Makola	AFFF (6%)
9	Ghana National Fire Service, Weija Fire Station	AFFF

The quantity of suspected specific firefighting foam used per year for firefighting and the sites in which they were used was gathered from the stakeholders identified, namely Ghana Fire Service, Bulk Oil Storage and Transportation Company, Tema Oil Refinery as well as Ghana Ports and Harbour Authority (Tables 19 and 20).

In the areas of training exercise, the estimated total quantity of PFOS used based on 26,833 kg firefighting foams used were between 134 kg and 402.5 kg.

According to the inventory, the total amount of firefighting foams used in actual fire events for the past 20 years was 118,588 kg, which contained an estimated amount of PFOS ranging from 593 to 1,779 kg. Since it could not be confirmed that all these foams contained PFOS coupled with the fact that other PFAS might have been released from this total amount as well within the time period, this estimate can be seen as upper estimate for PFOS for the identified fire events since 1990s. Moreover, since PFOS foams have been used since the 1970s, the total release of PFOS via firefighting foams might be considerably higher than the estimated quantities for the last 20 years.

All areas where the firefighting foams have been used can be considered as possible PFOS contaminated sites (see below).

Table 19: Usage frequency and quantity of PFOS based foam used for training purpose/year

User category	Number of times used per year	Training location	Quantity of PFOS base-foam used, (L)
Tema Oil Refinery	3 (2001) 6 (2001 – 2003) Several (1998 – 2015)	Municipal drain in front of TOR Oil Jetty/Valco Whaff Tank Farm, loading Gantry	1000 L 4500 L 20,000 L
Ghana Ports and Harbour Authority, Fire Safety Dept.	3	Port Fire Station	207 L
Tema Metropolitan Fire Station	2	GNFS, RHQ, Tema	400 L
Ghana National Fire Service, Ablemkpe Fire Station, Accra	No data available	No information available	No data available
Ghana National Fire Service, Regional HQ,	No data available	No information available	No data available

User category	Number of times used per year	Training location	Quantity of PFOS base-foam used, (L)
Madina fire station	No data available	No information available	No data available
Bulk oil Storage and Transportation Company	2	BOST Accra Plains Depot, Kpone Barrier, Tema	200 L
Accra City Fire Station, Makola.	No data available	No information available	No data available
Ghana National Fire Service, Weija Fire Station	No data available	No information available	No data available
TOTAL			26,307 L

Table 20: Location and quantity of PFOS based foam used in actual fire events (for past 20 years)

User category	Date	Location of large fire event	Quantity of PFOS base-foam used,
Tema Oil Refinery	July, 1997 May, 2000 24/4/2005 19/1/2012 29/4/2014	CDU Plant Municipal drain in front of TOR Valco Whaff (Harbour) Loading Gantry CPC Harbour pipeline	9,000 L 20,000 L 36,000 L 17,000 L 25,000 L
Ghana Ports and Harbour Authority, Fire Safety Dept.	25/3/2005 26/9/2010 29/4/2014 30/1/2016	Oil jetty and dry dock Midland tank farm TOR pipelines Medical stores, Tema	2,000 L 1,242 L 1000 L 416 L
Tema Metropolitan Fire Station	25/3/2005 2009 17/2/2015	Tema shipyard and dry dock Loading Gantry – TOR Tema medical stores	600 L 1200L 800L
Ghana National Fire Service, Ablemkpe Fire Station, Accra	Unknown	Unknown	No data available
Ghana National Fire Service, Regional HQ, Accra	9/3/2016 10/3/2016	Tetegu Weija Road Kingdom furniture warehouse	200 L 800
Madina fire station	9/10/2013 7/11/2015	Aben Nsuo – Amanfrom Atomic junction	600 L 200 L
Bulk oil Storage and Transportation Company	Unknown	Unknown	No data available
Accra City Fire Station, Makola.	4/6/2013 19/12/2013 3/1/2015 3/6/2015	Makola No. 2 Old parliament House Melcom warehouse Circle Goil Station	No data available
Ghana National Fire Service, Weija Fire Station	27/3/2010 9/3/2016 6/4/2016	White Cross Tatop junction Iron city	70 kg 100 kg 40 kg

2.3.5.5 Identified Stockpiles of PFOS/PFOSF Waste

As already indicated, in this inventory the main stocks and possible products likely to contain PFOS and related substances used in Ghana were found to be firefighting foams. Stockpiles of possible PFOS/PFOSF-containing foams held by different stakeholders (Table 21) as at 2016 indicated that the Tema Oil Refinery and the Bulk Oil Storage and Transportation Company involved in petroleum operations have large quantity of stockpiles of possible PFOS//PFOSF-based foams. The Tema Oil Refinery uses the bulk of their stock in training activities. The Ghana National Fire Service headquarters handles the purchase of all relevant consumables for the National Fire Service and supply them to the various stations across the country. The Ghana National Fire Service Training School also handles all the training needs of its subsidiaries and substations.

Both the TOR and the BOST are the largest users which may result from the frequency of incidents and the support they lend to other sectors of the state whenever there is a fire outbreak. Annual consumption varies among user categories with figures ranging from 39.33 – 36,000 litres. This is partly related to frequency of incidents and training needs.

Table 21: Stockpile of PFOS/PFOSF in Ghana

User category	Name of currently used firefighting foams	Stockpiles of likely/possibly PFOS-based foams	Year of Purchase
Tema Oil Refinery	F 1%F, 3% & 6%	56, 000 L (57,120 kg)	2010 – 2012
Ghana Ports and Harbours Authority, Fire Safety Dept.	Cold fire foam concentrate	624 L (636.48 kg)	2014
Tema Metropolitan Fire Station	Aqueous Forming foam compound (6%) medium expansion	800 L (816 kg)	2016
Ghana National Fire Service, Abelemkpe Fire Station, Accra	AFFF	1200 L (1224 kg)	2011
Ghana National Fire Service, Regional Head Quarters, Accra	AFFF	400.98 L (409 kg)	2015 - 2016
Madina Fire Station	AFFF	400.98 L (409 kg)	2015 - 2016
Bulk Oil Storage and Transportation Company	Aqueous film forming foam low expansion concentrate (3%)	3000 L (3060 kg)	2010
Accra City Fire Station, Makola.	AFFF (6%)	588.24 L (600 kg)	2012
Ghana National Fire Service, Weija Fire Station	AFFF	No information provided	2011
Total		**63,014.2 L (64,274.48 kg)**	

The above table indicates that a total of 63,014 L or 64, 274.48 kg of stockpiles of likely/possible PFOS-based firefighting foams were in the country within the period under review.

Considering the suggested concentration range of 0.5 to 1.5% PFOS in these foams a total amount of 321 kg PFOS as low estimate and 964 kg as high estimate can be made. Since for some of these foams the active ingredient might be another PFAS, this can be seen as upper estimate.

2.3.5.6 Legal, Institutional, Regulatory and Enforcement Systems for PFOS and related substances

Currently, there is no specific regulatory framework for PFOS and related substances. Section 10 of the Act 490 establishes a Hazardous Chemicals Committee to advice the Agency on the regulation and management of hazardous chemicals and to perform any other function relating to chemicals. Act 917 and its regulations LI 2250 also provides for the control, management and disposal of hazardous wastes among other things. A regulatory framework for PFOS and related substances need to be developed during the NIP implementation phase.

The capacity and practical experiences in PFOS and related substance management in Ghana, is also limited. There are no specific laws on the control and management of PFOS and related substances in Ghana but they are partially dealt with under Acts 490 and 917. Although there is collaboration among the EPA, CD-GRA and the Ghana National Fire Service in the importation, monitoring and application of PFOS, however, there no formal procedures and other capacities for PFOS waste management (including empty containers).

2.3.6 Assessment of release of unintentionally produced chemicals (Annex C chemicals)

2.3.6.1 General considerations

Polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) together with polychlorinated biphenyls (PCBs), polychlorinated naphthalenes, hexachlorobenzene (HCB), pentachlorobenzene (PeCB), and hexachlorobutadiene (HCBD) are listed in Annex C of the Convention as unintentionally produced POPs (UPOPs). PCBs, PCNs, HCB and PeCB have also been industrially produced and used in several applications. HCBD was also partly sold as commercial product but stem from the recycling of residues from solvent production. PCDDs/PCDFs were not produced commercially[9] and they have no known use.

Formation of PCDDs/PCDFs and the other UPOPs and/or releases arises mainly from four types of sources (of which three releases are process related[10,13]), namely:

(1) Chemical production processes – for example the production of chlorine, chlorinated phenols and other chlorinated aromatic compounds, the production of chlorinated solvents and the oxychlorination of mixed feeds to make certain chlorinated solvents, the use of chlorine in industrial process like the production of magnesium or titanium oxide using elemental chlorine, pulp and paper using elemental chlorine for chemical bleaching;

(2) Thermal and combustion processes: destruction of POPs and other organochlorine containing waste, general incineration of wastes, the thermal processing of metals, in particular metal production from metal scraps and open burning processes;

(3) Biogenic processes or photolytic processes, which can form PCDDs/PCDFs from precursors mostly of anthropogenic origin such as pentachlorophenol and some other chlorinated aromatic pesticides[11]. Also, the degradation of certain organochlorines can form unintentionally produced POPs e.g. pentachloronitrobenzene (PCNB) or Quintozene is partly degrading to unintentional Pentachlorobenzne (PeCBz) and is considered one of the largest sources of PeCBz[12].

(4) Probably the largest source is related to historic releases of PCDD/PCDF and related contamination:
   (i) Reservoir sources from production and application of organochlorine pesticides/chemicals and landfills/dumps of wastes containing PCDDs/PCDFs and other UPOPs. Historic PCDDs/PCDFs inventories reveal that they have exceeded by far the documented releases from contemporary sources[13]. In particular the production and use of PCB, PCP and some other pesticides were associated with high PCDDs/PCDFs releases[14].

   (ii) Also in respect to HCB, PeCB and HCBD, the historic disposed waste and contaminated soils/sediments exceed current releases by orders of magnitudes. HCB/PeCBz wastes have been disposed/stored in the order of 10,000 tonnes at single factories producing chlorinated solvents (e.g. tetrachloroethene, trichloroethene, tetrachloromethane, EDC)[15].

   (iii) Waste deposits, soils and sediments having accumulated PCDDs/Fs and other UPOPs in the past are secondary UPOPs sources for current exposure mainly from animals used for food (cattle, chicken/egg)[16].

Under the Convention, Parties are required to reduce total releases from anthropogenic sources of the chemicals listed in Annex C with the goal of continually minimizing and, where feasible, ultimately eliminating releases of these unintentionally generated chemicals. Toward this end, Parties must develop inventories and action plans as part of the NIP to identify, characterize, and address the releases of unintentional POPs listed in Annex C. According to Article 5 of the Convention, action plans shall include evaluation of current and projected releases that are derived through the development and maintenance of source inventories and release estimates, taking into consideration the source categories addressed in Annex C.

Based on the requirement of Article 5, the purpose of the inventory was to evaluate the situation of Ghana concerning the release and presence of PCDDs/PCDFs and other UPOPs.

For most sources, PCDDs/PCDFs are formed together with other UPOPs and are indicative of the releases[17].

This is true for all thermal sources. For these sources, PCDDs/PCDFs and UPOPs can be minimized or eliminated by the same measures that are used to address PCDDs/PCDFs releases. Therefore when a comprehensive inventory of PCDDs/PCDFs is elaborated, it allows to identify priority sources, set measures and develop action plans to minimize releases of all unintentional POPs. It is thus recommended, for practical reasons, that inventory activities be focused on PCDDs/PCDFs, as these substances are indicative of the presence of other unintentional POPs for most sources.74 They are considered to constitute a sufficient basis for identifying and prioritizing sources of all UPOPs as well as for devising applicable control measures for all Annex C POPs and for evaluating their efficacy for most sources. For some sources, in particular in the organochlorine production, PCDDs/PCDFs are not always indicative and for such sources inventories need to be developed for other UPOPs (e.g. as described in HCBD or PCN inventory guidance documents).

The UPOPs inventory was conducted using the "Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs" updated by UNEP Chemicals in 201374. The Toolkit assists countries in identifying sources and estimating releases of PCDDs/PCDFs. The five-step wise approach/procedures proposed by the toolkit were used namely:

- Apply Screening Matrix to identify Main Source Categories;
- Check source categories to identify existing activities and sources in the country;
- Gather detailed information on the processes and classify processes into similar groups by applying the Standard Questionnaire;
- Quantify identified sources with default/measured emission factors; and
- Apply nation-wide to establish full inventory and report results using guidance given in the standard format;

The estimated emissions are presented for the source groups and categories.

2.3.6.2 Main Source Categories for PCDDs/PCDFs in Ghana

As proposed by the UNEP toolkit, the current inventory focused on PCDDs/PCDFs, since for the sources present in Ghana, the PCDDs/PCDFs are also indicative for other UPOPs and the reduction of PCDDs/PCDFs will similarly address and reduce other UPOPs.

The main source groups/categories of PCDDs/PCDFs present in Ghana, has been identified for the inventory year 2016.

The emissions of PCDDs/PCDFs to air, water, land, products, and residues for ten source groups are summarized in Table 22. The inventory estimates are based on industry and statistical data available in Ghana and using the emission factors from "Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs, January 2013".

Waste incineration, ferrous and non-ferrous metal production, power generation and heating, are the main sources of PCDDs/PCDFs in Ghana. For these sources also, the most reliable data are available.

A total of 1,929 g TEQ of PCDDs/PCDFs was emitted from known sources compared to 668.16 g TEQ of PCDDs/PCDFs in the baseline inventory year 2002 (recalculated using the 2013 toolkit). This shows an increase in PCDDs/PCDFs emissions levels by more than 100%. This could, however, to a large extent be attributed to the more comprehensive inventory and availability of data for the 2015 inventory year compared to data collected in 2002. Additionally, some production volumes (e.g. for the metal industries) have increased.

The largest source of emissions of PCDDs/PCDFs to air according to the inventory, was from the waste incineration sector, which emitted a total of 1,081 g TEQ/a with major emission to air (1,055 g TEQ/a), corresponding to 56% of the total emissions.

The second largest source was open waste burning of dumpsites. The releases from open waste burning for 2015 was estimated at 487.8 g TEQ/a. The largest share was from open burning on landfills. Waste generated in the country is collected for disposal at designated dumpsites and landfill sites. Open burning of waste occurs at official dumpsites and these may either be accidental as in most cases or authorized. In all cases, information on quantities of the materials burnt is very difficult to obtain. Since dumpsite fires are frequent, it is estimated that over a period of one year, 25% of the waste (1,186,250 tonnes) on the landfills and dumpsites, is burning or smouldering. This resulted in a total estimated release of 735.5 g TEQ (355.9 g to air and 11.9 g to residues).

The burning of biomass was the major source of the 2002 inventory. With the change in emission factor the

estimated releases have decreased. Furthermore, forest fires are better controlled and have reduced from 24,300,000 tonnes to 8,100,000 tonnes with an estimated release of 9.3 g TEQ/year.

Agricultural burning and savannah and grassland fires, have not changed compared to the baseline inventory and are estimated to 9.3 g TEQ/year.

Another relevant source was the heat and power generation sector (178.6 g TEQ/a; 13 % of the total emissions). Major emitters were household heating and cooking with contaminated wood/biomass fired stoves (102.3 g TEQ/a) and stoves with virgin wood (10.1 g TEQ/a) and charcoal fired stoves (2.7 g TEQ/a). Biomass fired power plants with mixed input had an estimated release of 63.5 g TEQ/a.

Another high release (90 g TEQ/a) was estimated for cable smouldering and e-waste burning which are of high concern due to the direct exposure of people at the open burning sites. Other releases from metal production, are attributed to iron and steel industry (3.7 g TEQ/a) and lead production (1.6 g TEQ/a).

For category 7 source release (chemicals and consumer goods), the major release was estimated for 2,4-D and derivatives use with 30.4 g TEQ/a. For textile production, the release estimate was 1.0 g TEQ/a.

There were some accidental fires with associated releases. Based on data from the Ghana National Fire Service of accidental fires in houses and vehicles for 2015, a release of 2.3 g TEQ from fires of buildings and 0.2 g TEQ from vehicle fires were calculated. A number of accidental fires occurring in many parts of the country are unreported. Therefore, the release from this source is underestimated.

The releases from bio-mass burning could not be estimated for 2016 due to a lack of data.

Regarding release vectors into compartments, the largest emission vector of PCDDs/PCDFs from the various sources was due to air (1783.2 g TEQ/a; 92.4 %) followed by residue (75.7 g TEQ/a; 3.9%). However, since PCDDs/PCDFs are quickly adsorbed by particles and then deposited, the major amount of PCDDs/PCDFs is finally adsorbed into soil/land.

Table 22: Main Source Groups for PCDDs and PCDFs in Ghana and related estimated releases

		Annual Releases (g TEQ/a) – 2016 Inventory						
Group	Source Groups	Air	Water	Land	Product	Residue	Total	%
1	Waste Incineration	1054.7	0.0	0.0	0.0	26.1	1080.8	
2	Ferrous and Non-Ferrous Metal Production	90.8	0.0	0.0	0.0	4.5	95.3	
3	Heat and Power Generation	178.7	0.0	0.0	0.0	0.0	178.7	
4	Production of Mineral Products	0.02	0.0	0.0	0.0	0.0	0.02	
5	Transportation	0.001	0.0	0.0	0.0	0.0	0.001	
6	Open Burning Processes	459.0	0.0	28.35	0.0	0.0	487.8	
7	Production of Chemicals and Consumer Goods	0.001	0.0	0.0	31.5	0.001	31.50	
8	Miscellaneous	-	-	-	-	-	-	
9	Disposal	0.0	0.45	0.0	9.4	45.1	54.95	
10	Hot-Spots	-	-	-	-	-		
1-9	**Total**	**1,783.2**	**0.45**	**28.8**	**40.9**	**75.7**		**100.0**
	Grand Total	**1,929**						

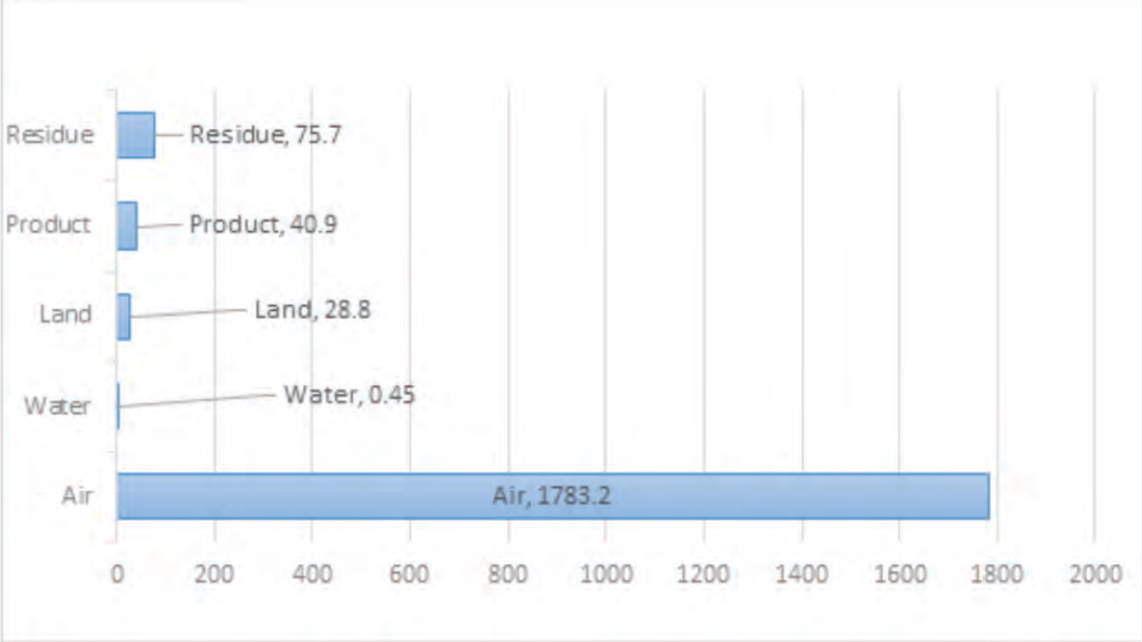

Figure 10: Total annual release (g TEQ/a) of PCDDs/PCDFs from release vectors in Ghana

Several potential unintentional POPs contaminated sites have been discovered and are compiled (see section on Unintentional POPs Contaminated Sites). The sites could not be further assessed in the current inventory activity but needs further assessment within the NIP implementation.

2.3.7 Information on the state of knowledge on POP stockpiles, contaminated sites and wastes, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites

2.3.7.1 POPs Pesticides Stockpiles, Waste and Contaminated Sites

2.3.7.1.2 POPs Pesticides Stockpiles and the Clean Farms Ghana Project

The Clean Farms Ghana Project, which was spearheaded by Croplife Ghana in close collaboration with the Agency and MoFA, was initiated in 2008 to identify obsolete pesticides in the country for safeguarding and final disposal. The inventory process registered about 70 MT of obsolete pesticides and an estimated 6 MT of used empty pesticide containers (Clean Farms Ghana Project Report, 2011). Endosulfan constitutes the only POP-pesticide obsolete stocks identified. The details of the quantities of Endosulfan, which were collected during the Clean Farms project, is indicated in Table 23 below.

Table 23: Quantities of Endosulfan collected during the Clean Farms Ghana project

Chemical	Packaging type and quantity	Quantity (Litres)
Endosulfan	1 Drum	200 Litres
Endosulfan	1 Drum	200 Litres
Endosulfan Waste Materials	3 Drums	Unknown
Endosulfan Containers (brittle)	1 Bag	Unknown
Endosulfan Waste	1 Drum	Unknown
Contaminated Endosulfan boxes	1 Bag	Unknown
Endosulfan waste materials	1 Drum	Unknown
Contaminated Endosulfan boxes	1 Bag	Unknown
Endosulfan Containers (brittle)	1 Bag	Unknown
Endosulfan	1 Drum	200 Litres
Endosulfan waste materials	1 Drum	Unknown

2.3.7.1.3 Pesticides Stockpiles Management and Capacity Building for the Elimination of PCBs in Ghana project

Quantities of obsolete pesticides stockpiles that had been safeguarded and stored in the temporary storage site at the PPRSD premises in Pokuase, near Accra, were exported and destroyed as part of the Capacity Building for the Elimination of PCBs in Ghana project. In all an estimated 110.2 MT of obsolete pesticides stockpiles, which included POP-pesticides (Endosulfan) were collected and safely disposed of at the end of the project (EPA, PCB Project Report, 2015).

2.3.7.1.4 POPs pesticides stockpile and FAO Assessment project

Further assessment of pesticides stockpiles in Ghana, including the remaining quantities of obsolete pesticides that were successfully undertaken under the TCP/GHA /3503FAO assistance project. There were no POP-Pesticide found.

2.3.7.1.5POPs pesticide contaminated sites

Pesticide contaminated sites may arise from locations where pesticides have been stored, buried, formulated, repackaged; accidentally spilled and warehouse fires have occurred. There are a number of small storage-units pesticides retail outlets that due to improper management, lead to leakages and spills resulting in such storage sites being contaminated. Some of the contaminated sites identified during the various inventories conducted include, (i) The temporary storage site (TSS) at Pokuase, near Accra; (ii) Crop Services Directorate (CSD) warehouse of MoFA; and (iii) Warehouses of the Ghana Cotton Company Limited (GCCL), in Tamale. Other sites may include two pesticide warehouses destroyed by fire (with unspecified quantities of pesticides burnt) in Kumasi, and a number of cocoa input warehouses located within the cocoa growing areas of Ghana.

It was also clear from the inventory that little or no information exists to accurately identify locations where pesticides may have been used and stored in the past. There has not been any investigation done to verify these sites as well as ascertain their level of contamination. A typical example was the assertion made during the preliminary inventory (Ghana NIP, 2007), that in the early 1970's some quantities of pesticide containers, including POP-pesticides, were buried within the premises of the PPRSD as well as at the Tono and Vea Irrigation sites in the Upper East Region. There has not been any effort to locate the exact sites for verification and possible remediation.

The current inventory has also brought to light, the fact that, there are a number of warehouses belonging to the Cocoa Input Company, the COCOBOD, some importers and retailer plantations, and many others where pesticide products had been stored, used, or are being used currently that are either contaminated or are likely to be contaminated sites. A comprehensive investigation may be required to ascertain what kind of contaminant exists as well as their levels in all of these sites.

There are measures in place under the TCP/GHA/3503 FAO assistance project for Ghana to remediate the immediate site or location where the stockpiles of obsolete pesticides were stored in Pokuase. There are no remediation measures in place for the remaining contaminated sites identified during the current inventory. Consequently, data on releases are not available.

2.3.7.2 PCBs Stockpiles, Wastes and Contaminated Sites

The GEF/UNITAR/UNDP/EPA-Ghana Project on Capacity Building for the Elimination of PCBs in Ghana, succeeded in building on the preliminary inventory conducted as part of the first Ghana NIP to identify the major stockpiles and proper handling and management, as well as safe disposal of the PCB-containing equipment and waste streams so as to reduce PCBs releases in Ghana and regionally. PCB-containing wastes were found at the ECG main sub-station H and the VRA materials stores at Tema. These are primary stations where broken-down transformers from all over the country were and are stored. Obsolete capacitors in the basement of the Achimota Sub-Station H were safely moved to temporary storage site (ECG Training School in Tema) and stored in maritime containers. These comprised 65 pieces of 33kVA capacitors of 78 kg each, and 51 pieces of 11kVA capacitors of 75 kg each giving a total of 8,895 kg and 6 tonnes of PCB oils.

A technically sound central storage site was constructed and operated in Accra-Tema area, as part of the project where:

- Two (2) forty-footer containers were installed at the main temporary storage site (ECG Training School in Tema) to receive obsolete capacitors from Achimota and Tema;
- Ten (10) pieces of PCB-contaminated transformers that are out of service and belonging to NEDCO/VRA were transported from Wa and Tamale to the temporary storage site in Tema; and
- Twenty-three (23) drums of PCB-contaminated oil that was drained from transformers in service at the Golden Star Wassa Mines, were also transported to the temporary storage site in Tema.

In total, about 40 metric tonnes of PCB wastes was stored at the temporary storage site in Tema. The site has since been decommissioned following the shipment of the PCBs waste and other wastes for final disposal abroad.

Vehicles used during the transportation of the PCBs waste were in compliance with national and international standards for transportation of dangerous goods, ensuring appropriateness of road vehicles used for PCBs transport. A total of 53 MT consisting of capacitors (pure PCBs), PCB oils and PCB contaminated solid waste, was shipped for disposal. The composition was segregated as follows: 9 MT capacitors (with pure PCBs), 28 MT of PCB contaminated oils, 16 MT of PCBs contaminated solid wastes (Table 24).

Table 24: Estimated Quantities of PCBs and PCB Wastes, Disposed of Under the Ghana PCB Elimination Project

PCB Wastes	Concentration Status	Quantity (MT)
Capacitors	Pure PCBs	9
PCB-contaminated oils	Contaminated	18
PCB-contaminated oil from ECG	Contaminated	10
PCB-Solid contaminated wastes	Contaminated	16

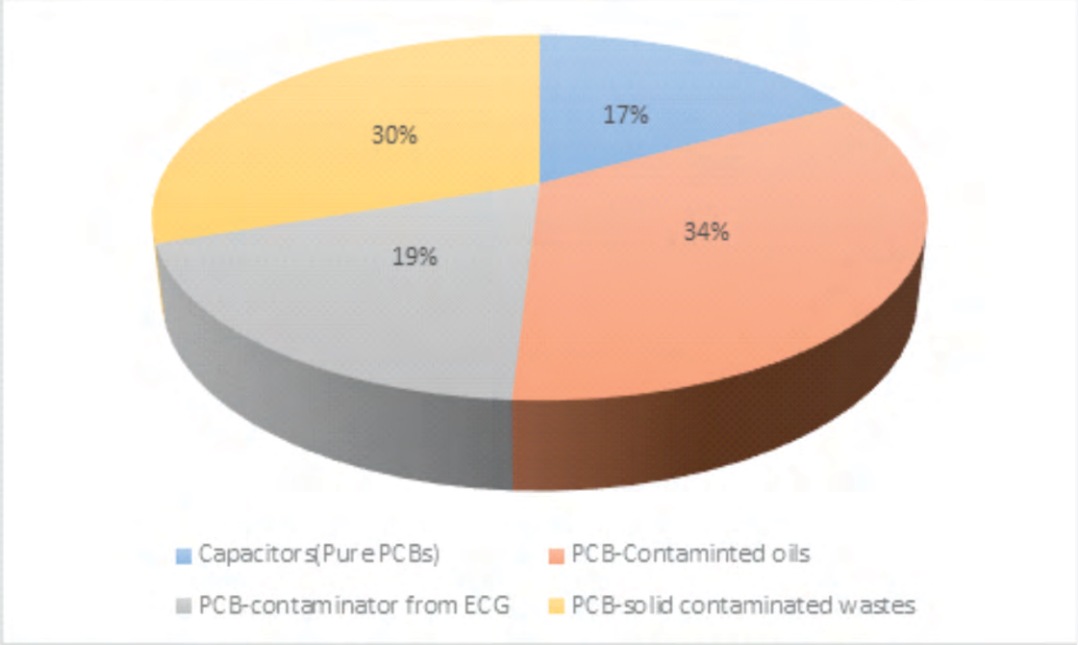

Figure 11: Estimated Quantities of PCB waste and PCB waste, disposed of under the Ghana PCB Elimination project quantity (Mt)

2.3.7.3 POP-PBDEs Stockpiles, Wastes and Contaminated Sites

The total amounts of PBDE in electronics and vehicles have been compiled. Large volumes of e-waste plastic and polymers from cars are accumulating in dumpsites and at sites where end-of-life vehicles and WEEE are managed.

Currently there is no specific storage for polymers from WEEE or end-of-life vehicles in Ghana. Also, there is no specific collection point or storage for EEE/WEEE or end-of-life vehicles. All the damaged vehicles are sold as scrap, which are used as sspare parts or sold to the steel recycling industries.

Additionally, a large part of these polymers are finally burnt in the open, dumped or otherwise thrown away in the wider environment, abandoned in car repair shops, and may partly end up in the ocean contributing to marine pollution.

Large quantities of the end-of-life vehicles and domestic electric appliances, are also collected by scavengers, most of which are sold as scrap that can be used as sources for spare parts. Those that cannot be reused are dismantled manually and treated in unapproved workshops in backyards or in unregistered small factories, where the recovery processes are crude and primitive.

Open burning of unwanted scrap and wastes is a common practice in Ghana. The Convention BAT/BEP guidance[19] and the PBDE BAT/BEP guidance[20] warn about the contents of shredder residues, which are dioxin precursors and may result in the formation of PCDD/PCDF or other dioxin-like compounds when burnt., Evaporation, runoff, and leaching

into the environment of many toxic chemicals, such as PBDEs and polybrominated dibenzo-p-dioxins/furans (PBDDs/PBDFs) occur as a result of these crude operations and associated leakage[21]. In addition, dumping of PBDE-containing materials and equipment also results in further contamination of dumping sites. Again, landfill/dump fires are frequently happening dumpsites country-wide resulting in the release of PBDEs, PCDDs/PCDFs and PBDDs/PBDFs. An initial monitoring of PCDDs/PCDFs; PBDDs/PBDFs and other dioxin-like compounds have been made under a Ghana-Japanese cooperation arrangement[20]. Uncontrolled small-scale backyard electronic waste recycling contributes significant emissions of PBDEs.

This highlights the urgent need for strict enforcement of Act 917 and its regulations LI 2250 to control all e-waste recycling operations. The legislation has integrated informal collection with formal recycling, where collection and refurbishment and reuse can be handled informally but equipment would be passed on to the formal sector for proper dismantling, recycling and final disposal.

A national policy on plastic management is being developed. This policy needs to cover waste plastic from WEEE and end-of-life vehicles. As an immediate action the open burning of these plastics and other polymers should be banned. All polymers should be managed in an environmentally sound manner. The PBDE containing materials should be managed within the collection and management of WEEE and end- of-life vehicles. The ESM of these plastic fractions, should be integrated into the overall management of polymers in Ghana.

As a first step, appropriate facilities for collection and disposal of e-wastes should be developed.

2.3.7.4 PFOS, its salts and PFOSF Stockpiles, Wastes and Contaminated sites

2.3.7.4.1 Stockpiles and Wastes of PFOS, its salts and PFOSF

Stockpiles of likely PFOS/PFOSF-containing foams held by different stakeholders have been compiled within the inventory development (Table 25) as at 2016. The inventory indicated that the TOR and the BOST involved in petroleum operations have large quantity of stockpiles of PFOS and PFOS-related substances-based foams. The TOR also commits more of their stock into training activities. The Ghana National Fire Service headquarters handles the purchase of all relevant consumables for the Service and supply them to the various stations across the country. The Service Training School also handles all the training needs of its subsidiaries and substations.

Both the TOR and the BOST are the largest users of likely PFOS/PFOSF-containing foams and this may be due to the frequency of incidents and support they lend to other sectors of the state whenever there is a fire outbreak. Annual consumption varies among user categories with figures ranging from 39.33–36,000 litres. This is partly related to frequency of incidents and training needs.

For some of the foams, a confirmatory test is required to determine whether the foam contains PFOS or other PFAS since the active ingredient are not indicated. Also, PFAS containing foams need to be managed when used in firefighting for protection of ground or surface water and soils.

Stockpiles of likely PFOS/PFOSF-based firefighting foams and other foams indicated that a total of 63, 014.2 L (or 64, 274.48 kg) of PFOS/PFOSF were in the country as of 2016. Out of this amount 321.37 kg low net PFOS/PFOSF and 964.12 kg of high net PFOS/PFOSF were released.

Waste generated from application of firefighting foam, expired products and spills, are not scientifically managed in an environmental sound manner at the national level. The waste that is deposited in an area after firefighting is not treated. The waste storage is usually in the open area under direct sunlight, therefore the waste at the fire scene is absorbed by the soil, ending in the atmosphere or washed by water which empties into the drains and finally enter natural water bodies.

Table 25: Stockpiles of PFOS, its salts and PFOSF in Ghana (2016)

User category	Name of currently used firefighting foams	Stockpiles of likely PFOS-based foam,	Year of Purchase
Tema Oil Refinery	F 1%F, 3% & 6%	56, 000 L (57,120 kg)	2010 – 2012
Ghana Ports and Harbours Authority, Fire Safety Dept.	Cold fire foam concentrate	624 L (636.48 kg)	2014
Tema Metropolitan Fire Station	Aqueous Forming foam compound (6%) medium expansion	800 L (816 kg)	2016
Ghana National Fire Service, Abelemkpe Fire Station, Accra	AFFF	1200 L (1224 kg)	2011
Ghana National Fire Service, Regional Head Quarters, Accra	AFFF	400.98 L (409 kg)	2015 – 2016
Madina Fire Station	AFFF	400.98 L (409 kg)	2015 – 2016
Bulk Oil Storage and Transportation Company	Aqueous film forming foam low expansion concentrate (3%)	3000 L (3060 kg)	2010
Accra City Fire Station, Makola.	AFFF (6%)	588.24 L (600 kg)	2012
Ghana National Fire Service, Weija Fire Station	AFFF	No information provided	2011
Total		**63014.2 L (64274.48 kg)**	

It is noted that, in this first inventory, no other stockpiles from industrial sectors, articles or insecticides were identified. Contaminated consumer articles and products like carpets, textiles or paper could also not be addressed in this first PFOS inventory. There are large volumes of synthetic carpets, textiles and furniture in use, which might have been treated with PFOS. Since the major use of PFOS and related substances for surface treatment was before 2002, it is expected that a share of these articles and products, have entered end-of-life and have been disposed of in landfills and dumpsites. Paper products treated with PFOS and related substances, have largely ended in dumpsites.

PFOS have been substituted mainly by other PFAS after 2000. These chemicals are also highly persistent or have persistent degradation products. Therefore, PFAS are an issue of concern under SAICM and also need to be addressed and managed properly in Ghana.

2.3.7.4.2 PFOS, its salts and PFOSF contaminated sites

PFOS has high chemical stability and low volatility and due to these properties, it is persistent in the environment. As a result, they can be found in soil and groundwater as contaminants after decades of use. Waste is not segregated in Ghana and is managed as bulk waste hence different products and articles containing PFOS may enter into the waste stream after the end of their useful life. Companies using firefighting foams, indicated that their waste is disposed of in the public drainage system and finally ends up in sewage water or sludge. Areas suspected to be contaminated with PFOS/PFOSF and its related salts include the training and equipment testing sites where fire drills are held, stockpiles storage areas where accidental spills or leakages may occur and fire scenes where large volumes of firefighting foams were used, as well as dumpsites across the country. In the area of training exercises, the total quantity of PFOS used was calculated to be 26,833 kg and this contained between 134.17 kg low net PFOS and 402.50 kg high net PFOS and related substances.

According to the inventory, the total amount used in actual fire events for the past 20 years was 118,588.15 kg which contained between 592.94 kg (low estimate) and 1178.82 kg (high) estimate PFOS.

The sites where these foams have been used can be considered contaminated. Therefore, the suspected areas contaminated with PFOS-based foam after a preliminary site investigation (stage 1), are the training and equipment testing sites where fire drills are held, stockpiles storage areas where accidental spills or leakage may occur and fire scenes where large volumes of firefighting foams are used, as well as dumpsites across the country.

Initial screening of rivers and drinking water have been undertaken by a study[22]. The inventory revealed that substantial levels of PFOS/PFOSF have been detected in river and drinking water in Ghana. Essumang et al, (2016)[22] reported contamination of tap water, Pra and Kakum Rivers in the Central Region of Ghana with PFCs (PFOA, PFOS, PFHxA, PFDA and PFPeA). The mean concentrations of ∑ PFCs in the Kakum and Pra Rivers were 280.80 and 397.63 ng/L respectively, while tap water (supplied from the treatment of water from those rivers) contained concentrations of 196.57 and 200.29 ng/L. The risk quotient (RQ) attributed to drinking of tap water, was estimated at 1.01 and 1.74 for PFOA and PFOS, respectively. For a country that does not produce these compounds, the risk quotient (RQ) raises concern particularly about contamination from such emerging pollutants in local water sources[22].

2.3.7.5 Unintentional POPs Contaminated Sites

A number of potential UPOPs-contaminated site were discovered during the inventory. These sites have however not been assessed for their contamination levels. The following site types are present in Ghana and need further assessment during the NIP implementation phase.

2.3.7.5.1 Application sites of PCDD/PCDF-containing pesticides and chemicals

PCP has been used in the past for the treatment of wood and leather in Ghana. The current inventory found the extensive use of 2,4-Dichlorophenoxy acetic acid (2,4-D) an organochlorine herbicide as defoliant in the control of water hyacinth. However, since the beginning of the last decade, its use rapidly increased to control broad leaf plants in different plantations. PCDD/PCDF may be released from the use of 2,4-Dichlorophenoxy acetic acid (2,4-D) and PCP.

2.3.7.5.2 Timber manufacture and treatment sites

Woods that are locally produced for electricity poles or construction, might have been treated with PCP with associated contamination of these wood treatment sites.

2.3.7.5.3 Textile and leather factories

. Sites where wastes from tanneries and the textile industry have been disposed of or released, might be contaminated with PCDD/PCDF.

2.3.7.5.4 Sites were PCB were used, stored and disposed

The following locations are potential PCDD and PCDF-contaminated sites:

Areas where PCBs are currently stored;
Areas where PCBs have been stored in the past;
Areas of the companies which do or have done maintenance of transformers;
Sites where PCB transformers have been used and have leaked; and
Sites where fires involving transformers or condensers have occurred.

2.3.7.5.5 Waste incineration

The releases from waste incinerators in Ghana are high. The areas impacted by releases from these incinerators, can become contaminated with UPOPs over time. Also, areas where ashes from these incinerators are disposed of or spread, can be considered contaminated with UPOPs.

2.3.7.5.6 Metal industries and copper/e-waste smouldering

The releases from copper cable and e-waste burning sites are high and result in the generation of PCDD, PCDF and other UPOPs-contaminated sites. Large open burning activities of e-waste takes place in Agbogbloshie and smaller sites in Ghana with associated soil pollution.

2.3.7.5.7 Fire Accidents

Areas where large fire accidents took place in the past, might be contaminated with UPOPs. In particular, where major fire accidents took place. Also, the sites where two pesticide warehouses were recently destroyed by fire resulting in the burning of an unspecified quantities of pesticides in Kumasi, might be contaminated with UPOPs.

2.3.7.5.8 Dredging of sediments and contaminated flood plain

Dredging of sediments have taken place in a number of water bodies in Ghana.. Since dams have been constructed for hydropower plants, sludge may have been generated through dredging. Contaminated sludge may also have been dredged from harbours. The extent of these activities, their contamination levels and the fate of chemicals such as UPOPs in the sludge, should be assessed during the NIP implementation phase.

2.3.7.5.9 Dumps of wastes/residues (from categories Groups 1-9)

Sources of UPOPs releases include the following areas:

- Dump sites and landfill where wastes have been disposed of;
- Disposal sites for ashes from incinerators;
- Disposal sites for ashes from the metal industry; disposal sites for the sludge from the textile industry and leather tanneries or where tanneries and textile industries released or release their effluents. Most of the large industrial facilities, like sugar factories, tanneries, and textiles industries. dispose of their wastewater either into rivers or open spaces; and
- Sites where waste is and have been burned in the open for extended periods of time.

2.3.7.5.10 Kaolin or Ball Clay Sites

High concentrations of mainly PCDD were found in mined ball clay from some African countries, USA and

Germany. However, only a part of the Kaolinite is impacted by PCDD. Ghana has clay/kaolin resources and industrially apply the kaolinite. Presently, no estimation can be made about whether the Kaolinite in Ghana is impacted by PCDD or not. This is an important assessment that needs to be carried out since some women eat clays especially during pregnancy and research has shown that in some African countries, contaminated clay has had an impact through elevated PCDD levels in human milk.[23]

2.3.8 Summary of requirements for Exemptions and use

2.3.8.1 POP-Pesticides

There is no need for exemption of POP-pesticides use such as PCP, Endosulfan, and Lindane. Alternative chemicals currently in use should be assessed to evaluate their appropriateness in the context of sustainable chemistry.

2.3.8.2 POP-PBDEs

No exemption for recycling of PBDE-containing plastic is needed at the moment.

2.3.8.3 DDT

No exemption is needed for DDT.

PFOS, its salts and PFOSF

No exemption for the use of PFOS is needed. Alternatives to PFOS in firefighting foams are available. Alternative chemicals currently in use should be assessed to evaluate their appropriateness in the context of sustainable chemistry.

2.3.9 Existing programmes for monitoring releases and environmental and human health impacts, including findings

Article 11 of the Convention places an obligation on Parties, within their capacities, at the national and international levels, to undertake appropriate research, development, monitoring and cooperation pertaining to POPs and, where relevant, to their alternatives and to candidate POPs. Specific areas of concern include (i) sources and releases into the environment; (ii) presence, levels and trends in humans and the environment; (iii) environmental transport, fate and transformation; (iv) effects on human health and the environment; (v) socio-economic and cultural impacts; (vi)release reduction and/or elimination; and (vii) harmonised methodologies for taking inventories of generating sources and analytical techniques for the measurement of releases.

Studies and activities in this area are however scanty in Ghana. Currently, there is no well-established national system for monitoring POPs releases in Ghana, though the potential sources of POPs have been identified and releases estimated. This notwithstanding, there are on-going studies and activities by a number of institutions and researchers that provide some estimate of the impact of POPs on the population. Ultimately, comprehensive analyses needs to be conducted to obtain an overall effect of POPs releases on human health and on the state of the environment as whole.

2.3.9.1 Declaration and Reporting of Priority Pollutant Releases

The Agency has a system in place that mandates industrial establishments and others whose activities serve as potential sources of releases of criteria pollutants, to monitor and report on such releases. However, these do not specifically address releases of POPs to the environment, due to inadequate laboratory infrastructure and analytical capability in the country.

2.3.9.2 Current Monitoring Activities on POPs in Ghana

The Agency has in place environmental quality monitoring programmes. The monitoring programmes include the following:

- Monitoring and establishment of the status and trends of air (ambient and vehicular) and water quality;
- Compliance monitoring in selected areas and undertakings to establish trends in environmental quality; and
- Quarterly monitoring of effluent quality from industries.

The air quality programme is aimed at collecting and collating baseline vehicular exhaust emissions data for the development of vehicular exhaust emission standards and regulations. The programme forms part of the overall goal of improving urban and roadside air quality under the World Bank Clean Air Initiative for Sub-Saharan African cities. It is envisaged that the programme will be extended in future to measure emissions resulting from Annexes A and C chemicals (PCBs, HCBs and PCDDs/PCDFs), when the requisite capacity is developed. The Agency is also collaborating with other stakeholders (such as DVLA) to monitor emissions from vehicles.

The Agency in collaboration with the Ghana Atomic Energy Commission, has conducted air monitoring studies on POPs in ambient air since 2007. These monitoring studies, constitute part of the GEF funded projects (under the Stockholm Convention Global Monitoring Plan in collaboration with UNEP) and the MONET Africa project activities, undertaken in collaboration with the Research Centre for Toxic Compounds on the Environment (RECETOX) of the Czech Republic.

The Water Research Institute of the CSIR and other research and academic institutions (such as Ecolab, UG, KNUST, UCC), have also conducted limited studies on the presence, levels and trends in humans and the environment with respect to PCBs, dioxins and furans,

and BFRs. However, there is currently no programme for regular monitoring of POPs.

2.3.9.3 Results of Recent POPs monitoring activities in environmental media, biota and humans

Results of recent POPs monitoring activities in environmental media, biota and humans carried out by some institutions and researchers are presented below.

2.3.9.3.1 POP-pesticides residues in fish from the Densu River Basin in Ghana

In a study carried out by Fianko et al. (2013), levels of organochlorines were quantified in fish species sampled from the Densu river basin. Among the pesticide residues detected, DDE, α-endosulfan, γ-HCH, δ-HCH, heptachlor and endosulfan sulphate, were predominant in all the samples. In almost all the fish species analyzed, DDE was the predominant compound having a mean value of 7.99 μgkg^{-1}. In a related study, Kuranchie-Mensah et al. (2013)[24] reported 10 different organochlorine pesticides including DDTs, HCHs, DRINs and endosulfan in five different types of fish sampled from the fish landing site of the Densu river at Weija. The mean concentration of the pesticides in the fishes ranged from 0.034 to 1.44 ng g-1 (*Chrysichthys nigrodigitatus*), 0.009–1.93 ng g-1 (*Hepsetus odoe*), 0.034–1.19 ng g-1 (*Tilapia zilli*), 0.016–1.46 ng g-1 (*Heterotis niloticus*) and 0.03–4.43 ng g-1 (*Oreochromis niloticus*). The study further revealed that the concentrations obtained were below standards set by some international organizations s such as WHO and FAO.

2.3.9.3.2 POPs pesticides residues in water and sediment from the Densu River Basin in Ghana

A study carried out on the Densu River which is a source of drinking water in the southern part of Ghana, revealed a number of pesticides such as dieldrin, DDT, DDE, endosulfan sulphate, endosulfan and HCH in water samples. Detectable levels of aldrin, dieldrin, endosulfan, endrin and chlordane were above the recommended limits of 0.03 μgL^{-1}, 20.0μgL^{-1}, 0.6μgL^{-1} and 0.2 μgL^{-1} respectively for drinking water. The ratios of DDE/DDT in environmental matrix were quite high indicating historical use of DDT and significant degradation. Similarly, a study carried out by Kuranchie-Mensah et al. (2013)[24] reported significant concentrations of organochlorine pesticides in sediment than water from the Densu River. Aldrin and endosulfan sulfate were found to be the highest pesticides recorded for both sediment and water with mean concentrations of 10.98 μgkg^{-1} dry weight and 0.185 μgL^{-1} respectively.

2.3.9.3.3 POPs in edible fish from three freshwater bodies (Lake Volta, Lake Bosumtwi and Weija Lake) in Ghana

Organochlorine pesticides (OCPs), dioxin-like PCBs (dl-PCBs), and PCDD/Fs were measured by a high-resolution gas chromatograph–high resolution mass spectrometer (HRGC/HRMS) in selected edible fishes from three freshwater bodies namely Lake Volta, Lake Bosumtwi and Weija Lake in Ghana (Adu-Kumi et al., 2010a)[25]. The levels of organochlorine pesticides measured in this study, were generally low. The highest concentration of OCPs was measured for (DDT compounds (p,p′-DDT, o,p′-DDT, p,p′-DDE, o,p′-DDE, p,p′-DDD and o,p′-DDD), followed by chlordane compounds (CHLs) (trans-chlordane, cis-chlordane, trans-nonachlor and cis-nonachlor), hexachlorobenzene (HCB) and gamma-hexachlorocyclohexane (gamma-HCH). The relatively high ratio of p,p′-DDT/p,p-DDE in tilapia and catfish with an extremely high value in catfish purchased from a local market at Madina, a suburb of Accra, however, suggests the fresh contamination of technical DDT in Ghana. Although PCDD/Fs and dl-PCBs showed relatively low levels, the concentrations are, however, comparable with recent data of some developed countries. There is a potential health risk from DDTs, PCDD/Fs and dl-PCBs for the general population of Ghana because fish is one of their important protein sources. It is therefore necessary to estimate the total intake of DDTs, and to assess the health risks for the general population of Ghana (Adu-Kumi et al., 2010a)[25].

2.3.9.3.4 Levels and seasonal variations of organochlorine pesticides in urban and rural background air of southern Ghana

Urban, suburban and rural background air samples were collected in southern Ghana in 2008 employing polyurethane foam disc passive air samplers (PAS). PAS were analysed for organochlorine pesticides (OCPs), namely HCH (α-, β-, γ- and δ-HCH), DDT including metabolites (o,p′- and p,p′- DDT, DDE and DDD), hexachlorobenzene, pentachlorobenzene, aldrin, dieldrin, endrins (endrin, endrin aldehyde and endrin ketone), isodrin, heptachlors (heptachlor, heptachlor epoxide A and heptachlor epoxide B), chlordanes (α, β-chlordane, oxychlordane and trans-nonachlor), endosulfans (α- and β-endosulfan and endosulfan sulphate), methoxychlor and mirex using a gas chromatograph coupled to a mass spectrometer. The levels of OCPs ranged for the individual pesticides from below limit of quantification to 750 pg m−3 (for α-endosulfan), and current agricultural application seemed to be the main primary source of most abundant pesticides. Revolatilization of previously used pesticides from contaminated soils, could not be ruled out as potential secondary source of contamination, especially in warm and dry seasons and periods of intensive agricultural activities. Higher atmospheric concentrations were observed in November and December during the dry season compared to lower concentrations observed in June, July and August when the country experiences heavy rains. The highest seasonal variation was observed for currently used pesticides as α-endosulfan. A p,p′-DDT/p,p′- DDE ratio suggested recent inputs of fresh technical DDT (Adu-Kumi et al., 2012)[26].

2.3.9.3.5 Atmospheric burden of organochlorine pesticides in Ghana

Applying polyurethane foam (PUF) disk passive air samplers (PAS), the levels of OCPs in the atmosphere and their spatial resolution, were investigated. It was the first nationwide coverage of OCPs monitoring in Ghana. PDDTs and endosulfans constituted the highest burden of atmospheric OCPs in Ghana, at average concentrations of 156 ± 36 and 153 ± 28 pg m^{-3}, respectively. Mirex had the lowest concentration (0.2 ± 0.01 pg m^{-3}). From the chemical signatures of the various OCPs, it was deduced that DDT, endosulfans and heptachlor were freshly applied at certain sites, which were all agricultural sites. The OCPs were spatially resolved as a function of the types of crops cultivated in different areas, legacy issues and recent applications (Hogarh et al, 2012)[27].

2.3.9.3.6 Human breast milk studies

A number of studies have been undertaken in the area of human exposure to POPs (OCPs, PCBs, PBDEs and HBCDs in Ghana using breast milk in recent times:

- In 2009 Ghana participated in the WHO-UNEP human milk survey as part of the activities under the Global Monitoring Plan (GMP) of the Stockholm Convention. Ninety-two individual breast milk samples were collected from lactating mothers (first child mothers) in six districts, within three regions (representing the south, middle and north) in Ghana between January and March 2009, taking into account the variations in dietary patterns (excluding local contaminated areas). The results indicated that most organochlorine pesticides banned 20–25 years ago were below or around detection limits in Ghanaian human milk samples. DDT compounds (mainly p,p'-DDE) showed the highest concentration followed by HCH compounds (mainly β-HCH and γ-HCH), HCB, Chlordane compounds and Dieldrin, in that order. The levels of DDT were however relatively low compared with other participating countries. The mean total concentration of dioxin-like compounds (sum of PCDD/PCDFs and dl-PCBs) in human breast milk in the general population of Ghana was 6.07 ± 1.11 pg TEQs/g lipid weight (upper bound). This was comparatively lower than those of most other participating countries of the WHO-UNEP Human Milk Studies (Adu-Kumi et al., 2010b)[28].
- Human exposure to polychlorinated biphenyls (PCBs) and brominated flame retardants (BFRs) such as polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecanes (HBCDs) was evaluated using breast milk samples collected in 2004 and 2009 (Asante et al., 2011)[29]. The study revealed that in spite of the fact that Ghana is a non-industrialized country when compared with many of the Asian and European countries, significant increases were found in the concentrations of PCBs and PBDEs over the years, while no significant increase was observed for HBCDs. Mean levels and ranges of PBDEs (4.5; 0.86–18 ng/g lw), PCBs (62; 15–160 ng/g lw) and HBCDs (0.54; 0.01–3.2 ng/g lw) observed in the study, were unexpectedly high. Some nursing mothers had daily intake (DI) values exceeding or close to the RfD (1 µg/kg/ day) for PCBs as derived by Health Canada (Oostdam et al., 1999). Moreover, when the minimal risk level of 0.03 µg/kg/day for PCBs (ATSDR, 2000) was considered, the DI values of all the nursing mothers grossly exceeded the RfD, indicating potential health risk to their children. The study highlighted the need for further monitoring of these contaminants in Ghana using matrices like fish, food and dust to elucidate the source(s) of exposure and evaluate possible long-term impacts to human health, especially infants. As BFRs are endocrine disrupting chemicals, (EDCs), these chemicals could have dire consequences on human health. The aim of this study was to determine the types and levels of organochlorine pesticide residues in the breast milk of some first birth mothers in Ada, a rural community in the greater Accra region of Ghana. Liquid-liquid extraction procedure was employed and extract clean-up was done using silica gel solid phase extraction. Thirteen different organochlorine pesticide residues namely, p,p'-DDT, p,p'-DDE, gamma-HCH, delta-HCH, heptachlor, aldrin, endrin, endrin-ketone, alpha-endosulphan, endosulphan sulphate, gamma-chlordane, dieldrin, and methoxychlor, were identified and quantified in the individual breast milk samples using a Gas Chromatograph (GC) with an Electron Capture detector. Gamma-HCH recorded the highest incident ratio of 95.2% and p, p'-DDE, endosulphan sulphate, delta-HCH and dieldrin also recorded incidence ratios of 90.5%, 81.0%, 66.7% and 57.1% respectively in the twenty-one individual human breast milk samples. The mean concentrations of organochlorine pesticide residues in the human breast milk samples, ranged from 0.682 to 63.803 µg/kg fats. Endosulphan-sulphate recorded the highest concentration of 63.803 µg/kg fats, which is about three times greater than the Australian Maximum Residue Limit (MRL) of 20 µg/kg for milk. The mean concentrations for all the other organochlorines detected, were below their respective maximum residue limits (Osei-Tutu et al., 2013)[30].

2.3.9.3.7 POPs in e-waste and contaminated soils

Although complex mixtures of dioxin-related compounds (DRCs) can be released from informal e-waste recycling, DRC contamination in African e-waste recycling sites, has not been investigated. Therefore, Tue et al., 2016a[31] examined the concentrations of DRCs including chlorinated, brominated, mixed halogenated dibenzo-p-dioxins/dibenzofurans (PCDD/Fs, PBDD/Fs, PXDD/Fs) and dioxin-like polychlorinated biphenyls (DL-PCBs) in surface soil samples from the Agbogbloshie e-waste recycling site in Ghana. PCDD/F

and PBDD/F concentrations in open burning areas (18–520 and 83–3800 ng/g dry, respectively) were among the highest reported in soils from informal e-waste sites. The concentrations of PCDFs and PBDFs were higher than those of the respective dibenzo-p-dioxins, suggesting combustion and PBDE-containing plastics as principal sources. The median total WHO toxic equivalent (TEQ) concentration in open burning soils, was 7 times higher than the U.S. action level (1000 pg/g), with TEQ contributors in the order of PBDFs » PCDD/Fs > PXDFs. The study concluded that people living in Agbogbloshie are potentially exposed to high levels of not only chlorinated but also brominated DRCs, and human health implications need to be assessed in future studies.

In a related study, Nishimura et al. (2017)[32] focused on soil contamination by halogenated polycyclic aromatic hydrocarbons (PAHs) from open burning at Agbogbloshie e-waste soil and detected chlorinated and brominated PAHs (Cl- and Br-PAHs) in the range of tens to hundreds of nanogram per gram (dry weight) in soils from the open-burning areas at the Agbogbloshie e-waste site, but at very low or non-detectable levels in the soil samples from non-burning areas and non-e-waste locations, indicating e-waste burning as the major emissions source. The results showed elevated concentrations in open e-waste burning areas (160–220 and 19–46 ng/g dry weight for Cl- and Br-PAHs, respectively) with substantial contribution from unidentified compounds (respectively, more than 36 and 70%, based on the total areas of potential peaks). Considering the continuous exposure of e-waste workers in Agbogloshie to not only high levels of dioxins, but also complex mixture of potential mutagens, including PAHs and their derivatives, a comprehensive assessment of the cancer risk is necessary.

2.3.9.3.8 POPs in fruits and vegetables

Regarding the organochlorine pesticides, a field survey conducted by Bempah et al., (2011)[33] to assess the knowledge, attitudes, and peoples' perception concerning the use of pesticides by farmers in fruit production as well as the potential health risks associated with the exposure to these pesticides, revealed that residues varied from <0.01 µg/g to as high as 0.11 µg/g, depending on the pesticides monitored. The analysis of health risk estimates revealed heptachlor, heptachlor epoxide, endrin, aldehyde and endrin ketone levels exceeded the reference dose, suggesting a great potential for systemic toxicity in children considered the most vulnerable population subgroup.

Similarly, Bempah et al., (2012a)[34] conducted residual levels of organochlorine pesticides (OCPs) in 240 samples of vegetables collected from selected markets from the Greater Accra region of Ghana. The results showed that, pesticides were found in 71.9% of all the vegetable samples analyzed indicating high incidence of these xenobiotics in the vegetables from the markets and 31.48% samples were above the maximum residue levels (MRLs). The most frequently found and abundant pesticides, were the metabolites of DDT (o,p'-DDE, p,p'-DDE and o,p'-DDD), followed by lindane and then o,p'-DDT. The residue levels and the detection rate of the OCPs indicated that, vegetables from supermarkets had higher OCPs levels, followed by roadside grocery stores and open markets.

Another study conducted by Bempah et al., (2016) on the dietary exposure to chlorinated pesticide residues in fruits and vegetables from Ghanaian markets revealed that, 20% of the fruit and vegetable samples were above MRL, 73% were below MRL and 7% contained no detectable level of the monitored pesticides. In addition, the estimation of dietary intake of pesticides from fruit and vegetables revealed that, pesticides detected in fruits and vegetables, did not cause dietary intake risks.

The Pesticide Residues laboratory of the Ghana Standards Authority, has been monitoring the pesticide (organochlorine, organophosphorus and synthetic pyrethroids) residue levels in fruits and vegetables in the country and the results are not too alarming. The laboratory, in collaboration with other research institutions, had also determined the levels of POPs in plants and animal products.

Following the acquisition of new equipment (GC-MS/MS and LC-MS/MS), the Authority is now in a position to monitor more pesticides and POPs compounds in the country.

2.3.9.4 Previous Monitoring Activities on POPs in Ghana

Prior to this current updated NIP on POPs, some earlier studies conducted have been summarized below:

- Pesticide Residue analysis on Anloga shallot fields using brine shrimp lethality test (Lumor, 2001). Samples of soil, water and shallots were analysed for pesticide residues. More pesticides residues were extracted from soil samples as compared to shallots and water. Residues from soil also showed higher activity than residues from water and shallot.

- Persistence and fate of ^{14}C-Lindane applied to soil in a maize ecosystem. In *Environmental Behaviour of Crop Protection Chemicals*. Proceedings of an International Symposium on the use of Nuclear and Related Techniques for studying the behaviour of Crop Protection Chemicals[35]. ^{14}C-Lindane which was applied to soil surface in a maize ecosystem (one month after planting), was taken up by the plant. Within the first 25 days of treatment, ^{14}C-Lindane or its metabolites were found within the entire plants with the greatest concentration in the lower leaves; and a sharp build-up of Lindane concentration towards the tip of each leaf. Radioactivity and hence pesticide concentration was uniformly distributed in the plant with time, to the extent that measurable

levels were detected in the tussel cob and the grain. This indicated that soil-applied ^{14}C-Lindane, dissipates faster in soils of lower organic matter content. The levels of surface applied ^{14}C-Lindane that was bound in the soil increased with time and also with increasing organic matter content. Radioactivity was associated mainly with the topsoil layer (0-3cm).

- Seed yield and residue levels of Endosulfan in Asutem cowpeas following Cypermethrin and Endosulfan treatments. . Asutem cultivar of cowpea was sown on two plots each measuring 50 m x 50m. Endosulfan marketed as Thiodan 3EC was applied at a rate of 0.7 kg/ai. 53 Days after planting, following two successive treatments with Cypermethrin at 50 g/ai, the mean Endosulfan residue level of 0.05 µg/kg detected on seeds from treated plots at harvest time, was lower than the recommended permissible level of the FAO.

- Evaluation of XE-340 as a Trapping Medium for Airborne Organochlorine Pesticides.

- Evaluation of XE-340 as a Trapping Medium for Airborne Organochlorine Pesticides. XE-340 resin has been demonstrated to be an effective medium for trapping such chlorinated organochlorine (e.g. Chlordane, Lindane Heptachlor, Aldrin and Dieldrin) in air.

- Organochlorine Pesticide and PCB residues in plant foliage (Mangnifera indica) from West Africa (Bacci E. et al., 1988). Mango leaves at the end of their natural cycle, collected in 71 sites in 5 different countries, were used for a study on contamination by chlorinated insecticides (Lindane, p,p' DDT and related compounds), HCB and PCBs in terrestrial ecosystems of West Africa. The role of this region in the global circulation of these contaminants is briefly discussed. The results indicated that PCBs were identifiable and quantifiable together with other insecticides and HCB residues in one rare sample; however, undetectable or exceptionally low levels of HCB and PCBs, characterized all other samples. For HCBs, DDT and its derivatives, the levels were high, or at the very least, detectable.

- Pesticides in the Lake Volta. Results of analysis of samples of lake water, showed the presence of -endosulfan, -endosulfan, HCB, Lindane, p,p-DDT, p,p-DDE and p,p-DDD. The presence of such chemicals, though below allowable limits for drinking water purposes, is an indication of the increasing application of pesticides in large-scale agriculture in the catchment areas of the Volta Lake (Environmental Impacts Assessment, Volta Lake Debre Shoals Removal and Maintenance Dredging Project).

- Pesticides Concentrations in Fishes in Lake Volta. Fishes caught in the environs of dredging sites of the Volta Lake were analysed for the presence of pesticides in their bodies. The analysis showed substantial amounts of HCB, -endosulfan, -endosulfan, Lindane, p,p-DDT, p,p-DDE and p,p-DDD. (Environmental Impacts Assessment, Volta Lake Debre Shoals Removal & maintenance dredging Project).

- One group of chemicals analysed, is the organochlorine pesticides majority of which are listed as POPs. The outcome of the analysis of human organs and fluids, foods and drinks at the Drug, Cosmetic and Forensic Department of Ghana Standards Authority, which was conducted in collaboration with the Department of Pathology at the University of Ghana Medical School, include the following: out of 1,215 toxicological cases examined between 1989 and 1997, 963 cases tested positive for chemical poisoning, 30% of which was directly related to the misuse of pesticides. Seventy-four (in 1988 and 1997) and 77 deaths (up to 2002), due to organochlorine pesticides, were recorded.

  From the above results, it can be deduced that the incidence of organochlorine poisoning was higher during the years 1989-1992. There were reductions of incidence of organochlorine poisoning from 1993-1995 and 1998 to 2002. However, there was a significant increase in 1997.

- A field survey to examine the extent of pesticide associated symptoms in farmers involved in irrigation projects in Ghana (based on self-reporting of symptoms by farmers), revealed that 36% of the farmers interviewed, had experienced adverse effects after applying pesticides. The most significant symptoms included headaches, dizziness, fever, blurred vision, nausea and vomiting (Clarke et al., 1995).
  Apart from this epidemiological study among farmers, and few case studies, there are no countrywide statistics on the extent of pesticide poisoning of farmers. Most of the existing information is based on knowledge, attitudes, practices and behavioural (KAPB) studies among farmers, which revealed the following.

- In a 2008 study, the most comprehensive analysis of pesticide contamination on farmers in Ghana found the presence of organochlorine pesticide residues, including DDT, in the breast milk and human blood of vegetable farmers. Some women farmers had accumulated pesticide residues in breast milk above the 'tolerable daily intake' guidelines beyond which they have adverse health effects on their children. Yet, policy makers know little about

the real extent of pesticide poisonings since there are no official figures (Daniela Horna et al., 2008).

- This research revealed lapses in knowledge, attitudes and practices of farm and industry workers with regard to the safe use of POPs-pesticides and POPs industrial chemicals.

2.3.10 Current level of information, awareness, and education among target groups; existing systems to communicate such information to the various groups

Regarding POPs pesticides, some level of awareness exist especially among the main relevant stakeholder institutions namely the MOFA, Pesticide Importers Association, Non-Governmental Organizations, CropLife Ghana and the Ghana Input Dealers Association among others. There are, however, gaps regarding awareness of POPs-pesticides among end users, particularly farmers and those engaged in public health pest control activities, who are unable to distinguish POPs-pesticides from other pesticides. There is also evidence of knowledge gap among Customs Officers at the border points regarding the proper identification and regulatory requirements of POPs pesticides.

With respect to other POPs categories, the situation is not different for the main relevant stakeholders and end users, except for PCBs. There is little awareness for example among fire-fighters on PFOS; among e-waste recyclers on PBDE; among building and construction industry workers on HBCD, and among end users. For PCBs, the level of awareness among the main stakeholder institutions, is encouraging as a result of the PCBs Elimination Project in Ghana.
There is the need to increase public awareness among end users and other identified stakeholders on the knowledge of POPs in general and their potential impacts on human health and the environment.

2.3.10.1 Overview of the Mechanisms in Place to Convey Environmental and Chemical-Related Information to the Public

According to Ghana's Environmental Action Plan, the success of any environmental policy depends on the fact that all sections of the population understand the functioning of the environment and the problems it presents. The implication of this is that environmental education should reach all sectors of the community. To this end, continuous and detailed education programmes are being implemented at all levels of society so that every Ghanaian becomes aware of the problem and fully assumes responsibility in safeguarding the environment. In the formal system, environmental Education has been integrated into the curriculum of schools.

In the non-formal system, sustained efforts are being made to promote awareness among policy makers to provide training for resource managers at appropriate levels and promote greater public awareness and motivation for environmental action. Indeed, there are sectors responsible for providing education in all forms throughout the country. Some of the institutions and organisations, which have a role in the disseminating of environmental and chemicals-related information to the public, include the following:

- Non-Governmental Organisations and Community Based Organisations;
- Ghana Education Service;
- Metropolitan, Municipal and District Assemblies;
- Media;
- Religious Organisations or Faith Based Organisations;
- Universities and Research Institutions; and
- Traditional Institutions.

(a) Non-Governmental Organisations (NGOs)
Various NGOs operate in the environment sector in the country and create awareness through their activities. Currently, a number of NGOs have registered with the Agency, even though several of them are inactive. The NGOs who are in touch with the local communities reach the people through various inter-personal contacts. Some have newsletters through which they reach the reading public

(b) Ghana Education Service
During the development of the Environmental Action Plan, the Agency, in collaboration with the Ghana Education Service (GES) integrated environmental education into the syllabuses of schools in the form of themes and topics related to the environment. These topics are currently being taught in the various first and second cycle schools nationwide. The students serve as agents of change and information to their parents and siblings.

In Ghana, through the Free Compulsory Universal Basic Education (FCUBE) programme, all children of school going age, irrespective of their religious and social circumstances or physical constraints, are required to be in school. The literacy rate in Ghana is 76.6 % (Male: 82.0 %; Female: 71.4 %- World Bank, 2015 estimate). Currently, there is free secondary education policy at the senior high school level. It is expected that through the successful implementation of both policies the literacy rate would increase significantly.

(c) Metropolitan, Municipal and District Assemblies (MMDAs)
District Environmental Management Committees (DEMCs) have been formed within each District/Municipal/Metropolitan Assembly. The DEMCs are responsible for mobilising and educating the people for sound environmental management practices. The MMDAs, being the highest political bodies in the

communities, have various means of reaching their local people; they have Assemblymen and women and other Unit Committee representatives who are expected to meet constantly. However, not all DEMCs are active but it is easy to reactivate the dormant DEMCs. Some of the MMDAs implement projects in the environment sector.

(d) Media

There is currently an unprecedented realisation of the importance of the media in creating awareness on various issues including the environment in Ghana. The electronic, print and social media are heavily patronised in Ghana. Currently, there are several state-owned and private newspapers in circulation. Editorials and features placed in these dailies create awareness on environmental issues.

Government and private media journalists serve as channels for public information on the management of the environment that the general public needs to know. The Agency and other environment-related institutions have been involving journalists as active participants in workshops and seminars to create awareness.

Advertisements, jingles and environmental messages are played on radio and television. Radio and television discussions and interviews on environmental topics are held to provide information to the public as well as raise awareness on related environmental issues.

Documentaries on environmental issues are also screened on television. Billboards carrying environmental messages are placed at vantage points. Stakeholders organise seminars, workshops, meetings and durbars. During such gatherings, information prepared is circulated among the public and the press also publicise these for the information of people who did not participate. Public participation in environmental impact assessment (EIA) also ensures that information about the environment gets to the people.

(e) Religious Bodies/Faith-Based Organisations

Many religious bodies have departments for development and environment. For example, the Christian Council with a large membership of denominations has a Development and Environment Department. The Department has environment, health, agro-forestry and sustainable agriculture programmes. The Environment and Health programme unit, among other things, organises educational programmes through church development groups. The Catholic Church supports and encourages communities to go into agro-forestry. The church has agro-forestry projects in all the dioceses in the country. The church also has NGOs operating in the environment sector, which are responsible for the environmental projects. These are, the Centre for Human Development and the Eco Office.

(f) Universities and other Research Institutions

Many departments in the universities (both governmental and private) offer courses, which have some relationship to the conservation and/or preservation of the environment, that lead to the creation of environmental awareness. Most of the universities now offer courses that include environmental science; environmental education; environmental law; natural resources and other environment- related courses.

(g) Traditional Institutions

It is evident that there is some awareness of the value of the environment and the need for its conservation, protection and management in the traditional value systems. In this context, the people see themselves as part of the natural environment whose proper management and well-being is essential for their existence and further development.

In the coastal communities, it is forbidden to go fishing on Tuesdays. This reduces pressure on the fish population and aids in the process of conservation of aquatic ecosystem. In the forest areas, certain days have been set aside when no farming activities take place. This also serves to reduce the pressure on the clearing of the vegetation and therefore preserves bio-diversity.

Equally important, is the role of groves around the country that have been declared sacred. Entry into these groves is prohibited except with permission from the elders. Such permission is also required for the felling of any tree in those forests. These and other environmental protection methods have been handed over from generation to generation through informal traditional educational methods such as proverbs, totems, and festivals.

In Ghanaian culture, chiefs are well respected in the community. The local people will be more comfortable with messages from their chiefs. Consequently, communities regarded as “hot spots” for POPs, 'would need to be sensitized about issues regarding POPs and their co-operation sought in the implementation of the Convention. The sensitization will involve assisting the Communities to identify the problem, causes and effects of the problem, what the current situation is, what will happen if nothing is done about the situation and what should be done.

2.3.10.2 Specific Practices by Government and Stakeholders in Ensuring Public Awareness and Involvement

Government public information policy and practice related to the environment can be found in the 1992 constitution and a number of laws. The major ones are Act 490, Act 917, LI1652 and LI 2250. Additionally, some institutional policies on the environment, forest, etc. have been documented. Section 2 of Act 490 spells out the functions of the Agency in relation to education, information and awareness creation. The Agency is empowered to:

- Initiate and pursue formal and non-formal

education programmes for the creation of public awareness of the environment and its importance to the economic and social life of the country;
- Develop a comprehensive database on the environment and environment protection for information of the public; and
- Conduct seminars and training programmes and gather and publish reports and information relating to the environment.

In the formal system, the Agency in collaboration with the Ministry of Education have integrated environmental education into the syllabus of schools. Environmental themes and topics are taught in the schools and colleges. In connection with the development of databases on the environment, the Agency has the following:
- Ghana Environmental Database (GHANED): GHANED gives the sources of information on environmental issues including chemicals and POPs. The information involves titles of documents authors and the location of such documents;
- NGO database: The database on the NGOs includes the names of the NGOs, their location, contact persons, address and their activities; and
- Soil Data Base Management: This database involves soil attribute data for 789 soil profiles stored in soil database.

In the non-formal sector, the Agency conducts seminars, training, publishes reports on the environment, publishes newsletters and carries out environmental awareness campaigns including through exhibitions.

2.3.10.3 Tools and Techniques for Disseminating Environmental and Chemical-Related Information

UNEP Governing Council Decision 19/13 C, adopted in 1997, promotes international action to protect human health and the environment through measures to reduce and/or eliminate releases and discharges of persistent organic pollutants (POPs), including the development of an international legally binding instrument. The decision also calls for immediate actions including improved availability of information on alternatives to POPs. To help achieve these laudable goals, there is the need to develop effective information dissemination tools related to chemicals. These information dissemination tools, should include a well-defined strategy, which is consistent and coherent with National Environmental Policy and Action Programmes as follows:
- Magazines;
- Newsletters;
- Reports;
- Journals;
- Brochures;
- Flyers;
- Newspapers;
- Radio/TV;
- Posters;
- Billboards;
- Internet;
- Stickers;
- Public Fora; and
- T-Shirts and Souvenirs.

The tools, techniques and mechanisms, used to disseminate environmental and chemicals related information, include among others:
- Seminars, Workshops and Symposia;
- Durbars;
- Publications;
- Teaching;
- Interviews on Radio/TV;
- Discussion on Radio/TV;
- Advertisements on Radio/TV;
- Presentation of messages on Billboards and posters;
- Jingles;
- Radio/TV drama;
- Focused group meetings;
- Festivals and anniversary celebrations;
- Press Releases;
- Presentation of statements on the floor of Parliament by Members of Parliament (MPs) on chemicals including POPs;
- Religious meetings;
- Essay competition for schools and colleges;
- Songs; and
- Social media.

There are specific tools, techniques and mechanisms for disseminating environmental and chemicals related information in some organizations and NGOs.

2.3.10.4 Education and Awareness Creation Campaign Strategy for the Sound Management of Chemicals in Ghana

The use of chemicals, probably including POPs for agriculture, public health and industrial purposes, has increased over recent decades in Ghana. Benefits derived from the use of chemicals include increased agricultural productivity, improved quality of life, disease control and protection of the environment. Best practice shows that chemicals can be used widely, cost effectively, and with a high degree of safety.

In Ghana there is evidence to suggest that best practice is very often not followed due to the general lack of knowledge and information on the potential hazards and risks of chemicals on human health and the environment and this has led to mismanagement and misapplication. There is therefore the need to sensitise and educate the general public, especially end-users, on the sound management of chemicals. An effective education and

awareness programme, will minimise the potential adverse impacts of chemicals on human health and the environment whilst maximising their benefits.

The overall objective of the education and awareness creation programme, is to develop and implement an effective information and communication strategy for the sound management of chemicals in Ghana for the purpose of achieving the following outputs:

a) To develop and produce awareness creation materials for the general public and training manuals for specific professionals on sound management of chemicals;
b) To create awareness among policy/decision makers and opinion leaders on sound management of chemicals;
c) To provide the general public, target groups and resource persons with information on the potential hazards and risks of chemicals on human health, the environment and measures to promote safe use; and
d) To train the end users on best practices (including handling, storage, transport and disposal).

2.3.10.5 Mechanism for the Exchange of Information among Parties of the Convention

The exchange of information among parties to the Convention is crucial to the successful implementation of the provisions of the Convention. This is important in view of the fact that some of the Parties to the Convention have more experience in the management of POPs in terms of financial, technical and technological aspects. It is therefore vital that effective mechanisms and channels of communication are established for the mutual benefit of all parties. Presently, such mechanisms for the exchange of information with other parties have not been officially established. Generally, the existing methods adopted include non-formal and formal interactions, bilateral arrangements, visits and correspondences.

An attempt has been made through the Chemical Information Exchange Network (CIEN) to develop the capacity for chemical information exchange among parties to the Convention, particularly the developing country parties. One of the key aims of this network is to enhance the capacities of countries to obtain and share information needed for their national decision-making especially in the field of chemicals management.

Ghana hopes to explore all available technologies and strategies to establish an effective and functional communication system for the smooth exchange of information with other parties to the Convention.

2.3.11 Mechanism to report under Article 15 on measures taken to implement the provisions of the Convention and for information exchange with other Parties to the Convention

Article 15 of the Convention requires, among others, that each party shall report to the COP on the measures it has taken to implement the provisions under the Convention and on the effectiveness of such measures in meeting the objectives of the Convention.

For the first three reporting under the Convention Ghana has not been effective in meeting the reporting requirements.

Ghana has obtained funding under the Special Programme Trust Fund to strengthen institutional capacities in Ghana for an integrated, sustainable sound management of chemicals and waste throughout their lifecycle. One of the proposed measures to be executed under the project, is to enhance the skills and knowledge in information gathering and reporting on sound management of chemicals and waste and the chemicals-related MEAs and SAICM in Ghana for staff within the relevant Ministries and Authorities.

The project seeks to provide training on various modules on sustainable sound management of chemicals and waste using training materials from the IOMC toolbox and other useful guidelines for all focal persons in identified institutions in terms of knowledge for the implementation of all MEAs and SAICM activities. When this is achieved, information from all stakeholder institutions will be available to the Agency, which is the focal institution for the chemical-related MEAs and SAICM and responsible for reporting to the Secretariats of these MEAs and SAICM.

Based on the updated inventories within the NIP update, the reporting requirements under the Convention, was met for the forth reporting during the project implementation phase.

2.3.12 Relevant activities of national stakeholders

Various national stakeholders (such as NGOs; Ghana Education Service; MMDAs; Media; Religious Organisations; Universities and Research Institutions; and Traditional Institutions), operate in the environment sector in the country and create awareness through their activities. Some have newsletters, brochures, posters, leaflets and information bulletins through which they reach the public. In addition to creating awareness, the stakeholders (e.g. NGOs) engage in advocacy, training workshops, and small environmental-related projects in schools and local communities. The local population at the grassroots, is reached mainly through inter-personal contacts, round table discussions on environment and public meetings.

Communication between the Agency, as the POPs focal point and the national stakeholders, is maintained by both the inclusion of representatives of the stakeholders on the National Coordinating Team (NCT), as well as sub-committees and also by active participation in workshops and other POPs-related activities. Due to inadequate logistics and expertise, activities of stakeholders,

particularly NGOs, are mainly of a general nature and where specific, they are mostly related to issues regarding natural resource management.
NGOs such as Environment Youth Action Network (EYAN) and Ecological Restorations, collaborate and undertake activities in the area of POPs at both global and national levels with International POPs Elimination Network (IPEN) which has played active roles in the area of POPs over the years.

2.3.13 Overview of technical infrastructure for POPs assessment, measurement, analysis, alternatives and prevention measures, research and development – linkage to international programme and projects

2.3.13.1 POPs pesticides analysis

There are some institutions in Ghana with the capacity to analyse POP pesticides. These include the Ghana Standards Authority, the Ghana Atomic Energy Commission, and a number Universities among others.
It may be recalled that the Drug, Cosmetic and Forensic Department of Ghana Standards Authority in collaboration with the Department of Pathology at the University of Ghana Medical School in the past has carried out some analysis of organochlorines in human organs and fluids.

A number of research works were reported, to have been carried out on pesticides some of which included POP pesticides during the preliminary inventory of the preparation of the first NIP.
Students and other researchers have also carried out studies, some of which were on POPs and other pesticide residues in crops, in recent times,. However, these have not been well coordinated in terms of official reporting, and further work may have to be carried out to coordinate these research works and for additional follow ups.

2.3.13.2 Capacity and Infrastructure for Environmental Monitoring

There is some capacity for the monitoring of POPs in the environment, food, feed and humans, even though such activities are not well coordinated. There are certain institutions in Ghana, which though not concerned primarily with the identification of POPs, have some capacity deal with pesticides analysis in the course of their work.
The Drug, Cosmetic and Forensic Department of the Ghana Standards Authority is charged with the analysis of organic and inorganic poisons which includes pesticides in post-mortem tissues, foods, drinks etc. The laboratory provides forensic toxicology services to the Ministry of Health. The Food and Agriculture Department of the Ghana Standards Authority undertake the monitoring of pesticide residue analysis in fruits and vegetables in the country.

2.3.13.3 Capacity and Infrastructure for Monitoring Effects of POPs on Human Health

One of the conclusions of the inventory conducted by the Health Task Team, indicated that currently there are no specific programmes for monitoring the effects of POPs on human health. The survey identified among other things, inadequate personnel and facilities required to effectively monitor the effects and assess the impact of POPs on the population. There is therefore the need to train health personnel in particular and other related institutions and equip existing laboratories to carry out proper assessment of POPs on human health on a continuous basis.

2.3.13.4 Capacity and Infrastructure for Research and Development

A situational analysis was conducted on the monitoring, research and development capacity of the various institutions in the fields of:

- Environmental chemistry and fate of POPs;
- Socio-economic and cultural impacts of POPs; and
- Effects of POPs and measurements on human health and the environment.

It became clear from the country analysis that, the chemical effects of POPs on economic, social and health activities are quite well known. However, it is difficult to assess the institutional capacity to deal with the problems that may arise in terms of monitoring, research and development of its human and material resources. The following academic and research institutions as well as other governmental institutions in Ghana, have the potential to develop and to meet the challenges identified:

- Environmental Protection Agency;
- Ghana Standards Authority;
- University of Ghana;
- University of Cape Coast;
- University of Development Studies;
- Kwame Nkrumah University of Science and Technology;
- Ministry of Trade and Industry;
- Ghana Atomic Energy Commission;
- Noguchi Memorial Institute on Medical Research;
- Council for Scientific and Industrial Research;
- Food and Drugs Authority;
- Electricity Company of Ghana;
- Ghana Revenue Authority, Customs Division;
- Volta River Authority.
- Ghana Grid Company Limited
- NEDCO

The above institutions have similar and basic problems including inadequate facilities, personnel and infrastructure required for effective research and development. There is therefore the need to resource the institutions to enable them undertake local research and development and also contribute to the ongoing activities under the Global Monitoring Plan (GMP) on POPs

towards the effectiveness evaluation of the Convention as required under Article 16.

2.3.13.5 Capacity and Infrastructure for Information Management

The Agency initiated the process of developing a comprehensive chemicals information management system to assist in the sound management of chemicals including POPs. The information system was expected to be networked with relevant public and private institutions, to facilitate the exchange of information on chemicals and to make the systems easily accessible to the general public. This system, which was expected to serve as the national focal point for the exchange of information and a clearinghouse mechanism for information on POPs, as required under Article 9 of the Convention, needs to be revisited and established as a matter of urgency.

Effective implementation of the NIP would provide inputs to the chemicals information system. This would require the development of expertise among relevant stakeholders to improve the management of POPs.

2.3.13.6 Institutional Capacity Gaps

The gaps identified are in terms of human and institutional capacity to monitor and manage POPs in Ghana include the following:

- All the institutions involved with POPs regulation or management in Ghana have qualified experts. The number of experts is however woefully inadequate. As a result, there is heavy work pressure on the few experts. The Agency's (Chemicals Control and Management Centre) and Ghana Health Service (Occupational and Environment Programme), are typical examples.
- The remuneration and motivation in most state institutions are so low that, experts in the relevant fields are often enticed by foreign and private organisations to leave the government sector. In the Universities, the chemistry and other departments, are often under-staffed.
- The lack of personnel is exacerbated by the absence of other resources like equipment to carry out experiments and monitor activities related to POPs. For instance, the GSA, an institution responsible for metrology, standardisation, testing and quality assurance, does not have adequate reference analytical standards and equipment for their activities in the area of POPs. The laboratory requires accreditation as a reference laboratory. The FDA, an institution in charge of regulating the manufacture, importation, sale and use of foods, drugs, household chemicals and medical devices, is also understaffed and lack laboratory equipment to carry out the necessary tests for POPs.
- Overlap of functions: an example is the Agency and FDA. The FDA has powers analogous to those of the Agency, although the former's mandate is limited to regulating, monitoring and enforcing activities related to foods and consumable drugs. It however does not deal with POPs directly. There are also overlaps in the functions of the two institutions where pesticides are concerned.
- The NMIMR, a research institute for health and educational purposes, could be helpful in research into the effects of POPs on soil and water resources but requires reagents and enzyme consulates of the various POPs for their determination by the ELISA method.
- The Ghana Atomic Energy Commission has been carrying out research and monitoring activities on POPs for several years (e.g. work on Aldrin for the past fifteen years). The Commission however requires financial support and institutional capacity to research into and deal with POPs issues.
- The CSIR conducts research, monitors and evaluates the contamination of soil, plants and water resources. The institution has done some research on chemical residues in food and water. Though this is not limited to POPs specifically, they are capable of doing similar research on POPs. However, the chemicals for such analysis are expensive and the individual cannot pay for such services.
- Efforts should be made to enforce Act 490 because most of the POPs contamination in Ghana seem to result from pesticides.
- The ECG used to import transformers containing PCBs. Most of these plants are out of use but have not been properly stored or disposed of. They therefore contaminate groundwater and affect animal life. The ECG also lack the resources to deal with storage and destruction of PCBs. Their activities need professional support and monitoring to ensure compliance where pesticides and chemicals are concerned.
- The Agency as focal institution as well as other relevant institutions, lack the requisite institutional capacity (especially human, infrastructural, financial resources, as well as logistics), to deal with POPs.
- Ability of institutions to undertake toxicological studies. The human resource capacities in terms of a multidisciplinary team of personnel (such as toxicologists, epidemiologists, occupational health and public health specialists, etc.) exist, although inadequate. Funding is therefore required to facilitate the conduct of toxicological studies.

2.3.14 Overview of technical infrastructure for POPs management and destruction

2.3.14.1 Waste management and waste management facilities

Waste management has become one of the biggest challenges confronting developing countries, including Ghana. Increased population growth and rapid urbanization have resulted in increased volumes of waste generated in our cities. Within a period of fifteen years, Accra has grown very rapidly with a population of about 5

million inhabitants and with an annual growth rate of 4% making it one of the fastest growing metropolises in Africa. This phenomenal growth has contributed to the myriad of municipal waste management problems facing the city. 2800 metric tons of municipal solid waste is generated per day in Accra. Approximately 2,200 metric tons is collected leaving a backlog of 600 metric tons in open drains, and water bodies, which results in flooding during the raining season. Almost 97% of all publicly owned and managed sewage/faecal treatment plants are non-functional (Accra, Tema). Out of the 35 institutional treatment plants in the country, only 4 are operational. This implies that only 1% of the sewage generated in the country, is treated. 23% of households practice open defecation. In terms of basic sanitation, it is reported that 54% of households use shared facilities, which is generally unhygienic, while 13%, have access to unimproved toilets. Health threatening pan latrines, still exist in our cities and towns.

General Waste Management in Ghana is the responsibility of the Ministry of Local Government and Rural Development, which supervises the decentralized Metropolitan, Municipal and District Assemblies (MMDAs). However, regulatory authority is vested in the Agency under the auspices of the MESTI. The Metropolitan, Municipal and District Assemblies, are responsible for the collection and final disposal of solid waste through their Waste Management Departments (WMDs) and their Environmental Health and Sanitation Departments. The policy framework guiding the management of hazardous, solid and radioactive waste includes the Local Government Act (1994), Act 462, the Environmental Protection Agency Act (1994), Act 490, the Environmental Assessment Regulations 1999, (LI 1652) the Environmental Sanitation Policy of Ghana (1999), the Guidelines for the Development and Management of Landfills in Ghana, and the Guidelines for Bio-medical Waste (2000). All these Acts and Regulations emanate from the National Environmental Action Plan.

With respect to Hazardous Waste Management, there are currently no clearly distinguishable methods for the disposal of hazardous waste. However, the Agency is responsible for the provision of guidelines for such wastes. The Hazardous Waste Control and Management Act, 2016 (Act 917) and the Regulations (LI 2250) is expected to address the situation. The practice has been that custodians of hazardous waste including industry obtains permit from the Agency to dispose of their waste. Majority of hazardous waste generators mix their waste with the general waste without segregation and the few who segregate are discouraged because waste collectors do not have separate vehicles for collecting the various waste segments.

To date there are only three engineered landfill sites in Ghana with dedicated cells for hazardous waste. Nonetheless, managing these cells has been a challenge because most of the waste comes to the landfill sites unsegregated.

Most programmes and projects aimed at enhancing the role of local authorities have been initiated at the national level through the MLG&RD and other relevant Ministries, Departments and Agencies. Specific programmes and policies include the World Bank-supported Urban Projects (Urban I–V Projects) in municipalities and other large urban centres to manage solid and liquid waste and infrastructure such as storm drainage. A number of projects that will eventually promote sustainable settlement have been initiated or being implemented. Among them is the construction of waste treatment facilities like landfill sites and waste stabilization ponds in major settlements. In response to the global mandate for environmentally sound management of hazardous, solid and radioactive wastes, Ghana, has, among other things, embarked on a life-cycle approach to address chemicals and other hazardous wastes management in an integrated manner.

Solid waste is collected and disposed of at designated landfill and waste dump sites by public and private waste management firms. The issue of landfill site location has been a matter of strenuous negotiations with rising population pressure continuing to impact on waste generation and management. The sound management of hazardous, solid and radioactive wastes has received serious attention from Government, human settlement planners, real estate developers, environmentalists and many non-governmental organizations. Bio-medical and other hazardous wastes are currently being managed through land-filling.

There are proposals to convert waste into energy at the various closed and active waste dump sites.

Clean and environmentally sound technologies are promoted through activities, which ensure that industries meet national environmental standards and at the same time, promote the more efficient use of resources. Under the auspices of the MESTI, a Waste Management Stock Exchange is to be established as a means of identifying and making waste available to other consumers who need such waste materials for their production activities. Through this arrangement, another company for its own production activities could, for instance, identifies wastes generated by that company for use. This should help in reducing the quantities and types of waste generated in the country. The country's steel and paper industries, and to some extent the plastic industry, are engaged in programs of recycling wastes. A number of small-scale aluminium fabrication companies have been assisted to improve on their production systems. Though these programs were initially meant to address the environmental problems associated with their operations, the improved production systems also led to improved

efficiency in the use of materials and reduction in waste from the industries.

The management of plastic waste is receiving attention. Currently MESTI is preparing a plastic policy for the consideration by cabinet, which also expected to address POPs in plastics. Some technologies have been developed to assist recycling of waste. A number of small-scale plastic waste recycling plants have been set up in the Greater Accra Region. There are plans to set up similar ones in other metropolitan, municipal and urban areas of the country. The management of other solid and hazardous waste is also being researched at the Ghana Atomic Energy Commission and the Council for Scientific and Industrial Research (CSIR). Exogenous technologies are also being studied for their appropriate adoption and transfer for local use.

A few of the major hospitals such as the Korle Bu and Komfo Anokye Teaching Hospitals employ simple batch incinerators to manage health care waste.

There are activities in Ghana on waste management, which are related to the management of some POPs groups. In recent years, Ghana has initiated activities on improving e-waste management. Recently a GIZ project, among other initiatives, has started to improve the overall situation of e-waste management including e-waste plastic management. The first e-waste plastic has been shipped from Ghana to Austria for recycling.
The Ghana PCB Elimination project has built capacities within public sector institutions for the sound management of PCB-containing equipment.

Currently there are four privately owned hazardous waste management companies registered and operating in Accra and Takoradi. These are Zeal Environmental Technologies limited, Zoil Ghana limited, Safety Transport and Logistics Company Limited and Zoompack Limited. Both Zeal and Zoil are specialized in managing oily waste and other hazardous waste from the oil industry as well as the adjoining mining industries in the Western Region of Ghana. Most of the non-oil based hazardous wastes they receive, is incinerated. The rest are treated before discharge or disposed of at the landfill site. Zoompack specializes in the management of infectious waste from hospitals and healthcare facilities. They provide special bins to encourage segregation of the waste, which is collected with special vehicles for treatment before disposal. Safety Transport and Logistics Limited specializes in the management of cyanide-related waste. They also receive other types of hazardous waste, which are mostly incinerated. Some of the mining companies manage their own hazardous waste at their mining sites.

A Survey conducted by Masen Kafui Koranteng, (2015) indicated that 60 percent of hazardous waste generated in Ghana is disposed of by landfilling, whilst 30 percent is incinerated. Only 10 percent is recycled or reused with twenty percent of the sampled respondents indicating that they do not use any system in particular. It is expected that with the passage of the Hazardous and Electronic Control and Management Act, 2016 (Act 917) and its regulations (LI 2250), hazardous waste management in Ghana will improve and would perhaps commit stakeholders to put in measures improve on the infrastructure required to effectively manage hazardous wastes in Ghana.

2.3.14.2 POPs destruction capacity

Currently there are no POPs destruction capacities in Ghana. However some cement plants might have the technical preconditions for POPs destruction. This needs, however, be assessed in future.

2.3.14.3 Capability and Infrastructure for Contaminated Sites Securing and Remediation

In Ghana the infrastructure and capability for the securing and remediation of contaminated sites, are underdeveloped. The inventory of contaminated sites identified some sites, which require urgent attention. There is therefore the need to build capacities and develop the requisite infrastructure to manage contaminated sites in the country. Relevant national stakeholder institutions have a major role to play in the development of capacity for contaminated sites management, including remediation. The roles that would be played by such institutions within the framework of NIP implementation would include:

- Enhancement of their capabilities for the assessment of POPs contaminated sites and remediation;
- Research on appropriate scientific methods for identification of contaminated sites and guidelines for remediation; and
- Provision of information on Best Available Techniques (BAT) and Best Environmental Practices (BEP) for POPs contaminated sites assessment, securing and remediation.

2.3.15 Identification of impacted populations or environments, estimated scale and magnitude of threats to public health and environmental quality, and social implications for workers and local communities

Exposure to POPs may cause birth and developmental defects, chronic illnesses, serious health problems including cancers, dysfunctional immune and reproductive systems, greater susceptibility to disease, diminished intelligence and death (Birnbaum, 1994). Studies have shown that many POPs are endocrine disruption chemicals (EDCs). Low-level exposure to POPs during critical developmental periods of the foetus, new-borns and children, can have lasting effects throughout their lifespan (Crisp *et al,* 1998). People and

animals are exposed to POPs mostly through their diet and occupations.

POPs destroy natural habitat of fish which may result in a reduction in medium to long-term fish production; a situation that is likely to lower profits of fisher folks. In order to increase catches, fisher folk may use chemicals or illegal fishing methods, which further destroy the habitat and the fishing industry. This may lead to increase in migration where young people, especially boys, are forced to leave their communities for greener pastures. This migration may lead to massive demographic shifts where persons of working age become non-existent, thereby reducing the economic capabilities of the communities leading to further impoverishment of these communities.

On the other hand, urban areas become overcrowded resulting in the increase of slums and certain social vices. . In the fishing communities, lower incomes mean less money is spent on educating children, leading to increase in school dropout rate. This cycle may also apply to farmers who are exposed to POPs.

POP-PBDEs:
E-wastes are an important source of environmental contamination from PBDEs and other POPs (PCBs, PCDD/Fs) and a wide range of heavy metals (e.g. lead, cadmium, mercury, antimony) in most developing nations including Ghana. Humans can be exposed to PBDE along the entire life-cycle of PBDE from production, use, recycling up to end-of-life treatment. Consequently, there has been an increased research activity and public awareness campaign concerning these chemicals.

Elevated concentrations of PBDEs in the environment around e-waste sites as well as in human beings have been reported[39,40]. Also eggs around dump sites impacted by e-waste and other PBDE containing waste have been detected in West Africa[41]. Several studies have examined human health impacts from exposure to PBDEs. There is evidence suggesting that PBDEs can affect neuro-development, neuro-behavior, and thyroid hormone regulation in exposed animals and individuals[42]. The endocrine-disrupting properties of PBDEs (BFRs) was reviewed recently by Legler and Brouwer[43].

Furthermore PBDD/PBDFs and PCDD/PCDFs are formed from open burning of e-waste (Weber & Kuch 2003). Food producing animals like chicken or cattle take up the PCDD/PCDF, and other POPs from the contaminated soils (Weber et al. 2019). A recent study in Ghana revealed extreme high chlorinated and brominated dioxin and dl-PCB levels in eggs in Agbogbloshie 220 times and 171 times above TDI along with high contamination with PBDEs, HCB and PeCB[45].

High PBDE levels in breast milk have been associated with increased incidence of cryptorchidism in male infants[46]. The concentration of PBDEs in human breast milk within the populations in developing countries is normally lower compared to those in developed countries. (particularly countries with (former) elevated use levels of PBDE/BFR such as the United States, Canada or the UK)[47].

Recycling activities at numerous small workshops within the scrap yard often take place directly on unpaved surfaces. As a result of the crude e-waste recycling methods harmful substances may be released directly into the soil and sediment leading to serious contamination of the receiving environments. . Previous studies revealed that the soil at an open burning site at Agbogbloshie and Koforidua[48] showed elevated levels of heavy metals and halogenated chemicals (examples include PBDEs, used as flame retardants, especially in monitor and TV casings and PCBs, often found in old condensers as well as phthalates commonly used as plasticizers in flexible PVC). Sediments collected from a shallow lagoon located near WEEE dismantling and open burning areas within the Agbogbloshie market, contained a very similar profile of metal concentrations and organic chemicals, to those obtained from more contaminated soil and ash samples. Impacts on human health from WEEE recycling activities in Agbogbloshie, have been investigated in a sampling campaign carried out by the Ghana Health Service, Green Advocacy Ghana, the Blacksmith Institute and the Hunter College as part of the Human and Environmental Exposure Surveys (as part of the Ghana e-Waste Project)[49]. The study collected blood and urine samples of scrap yard workers as well as Makola market porters as a control group.

A similar study was conducted in China focused on the uptake and concentration levels of PBDEs in human matrices at e-waste recycling sites. These included maternal and foetal blood from the general population in South China, umbilical cord blood in Guiyu, blood serum in Taizhou, Zhejiang Province, blood serum from e-waste workers in Guangdong, breast milk from the general population in South China and in Taizhou, and hair of residents living at an e-waste site in Taizhou, hair of e-waste recycling workers in Fengjiang, Taizhou, Luqiao and Wenling. The results revealed elevated levels of PBDEs in e-waste recycling sites and these were significantly higher than those from reference locations[50].

Observations that PBDEs levels in EEE/WEEE and end-of-life vehicles have increased in recent years, combined with data indicating adverse effects on human health, underscore the need for formulation and implementation of effective policies to manage these chemicals.

2.3.15.1 Survey on impact of POPs on Identified Populations in Ghana

In the light of the issues raised above, a survey was carried out to identify the impact of POPs on identified key

stakeholders, namely refuse dump operatives and scavengers, e–waste handlers, fishmongers, singeing of animals and health service providers from the Ghana Health Service (GHS). Also interviewed were the Volta River Authority and Electricity Company of Ghana (generators and distributors respectively of electricity in Ghana).

The objectives were to:

- identify areas of use or production of substances containing POPs among vulnerable groups of workers; and
- identify processes that might predispose vulnerable workers to POPs.

Groups of persons interviewed whose activities make them potential generators of POPs included e-waste workers, general waste dump/landfill site operatives and scavengers, fish mongers, health care workers, users or potential users of POPs containing substances (eg transformer oils).

The methods used consisted of key informant interviews or focus group discussions with various stakeholders whose income generating activities include the use of substances containing POPs or have the potential to generate UPOPs. Questions sought to explore the understanding of respondents regarding the nature and risks from POPs that they encounter in their work and livelihood. The results of focus group discussions and stakeholder interviews are summarized below:

2.3.15.1.1 E-Waste Workers

Municipal solid waste (MSW) landfills represent the dominant option for waste disposal in many parts of the world due to the comparatively high costs of other treatment and disposal alternatives particularly in developing economies (Brunner and Fellner, 2007). Increasing waste generation due to population growth, societal lifestyle changes and development and consumption of products that are less biodegradable, have led to diverse challenges for MSW management in various cities around the world (Asase *et al*, 2009).

Incineration is regarded as a controversial method of waste disposal, due to the fact that it poses the greatest environmental and human health concern including discharge of particulate matter (PM), gaseous pollutants; dangerous substances such as polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans (PCDD/Fs) and toxic heavy metals. PCDD/Fs are known to be generated from incomplete combustion.

Landfill represents a hazard that can lead to damage of receptors such as human health or environmental media such as groundwater. As a result, some level of risk is associated with the landfill. Weber e*t al*, 2011 reported that a large amount of chlorinated, brominated and fluorinated POPs have been deposited in landfills and dumps over the past 40 to 80 years. Experiences at many of these sites have revealed that the slow release of POPs from landfills/deposits impact ecosystems, pollute ground and drinking water, and the food chain including, for example, fish; cattle grazing on floodplains; irrigation water, etc. At the same time, human reliance on water resources and food (including fish) supply, is likely to increase. In order to evaluate the associated risks for human exposure and biodiversity, inventories of deposited POPs and other persistent toxic substances need to be established.

Odusanya *et al*, 2009 analysed PBDEs in leachates from landfills in South Africa and found the mean concentrations of PBDEs to range from ND (not detected) to 2,670 pg/L, ND to 6,638 pg/L, ND to 7,230 pg/L, 41 to 4,009 pg/L and 90 to 9,793 pg/L for the Garankuwa, Hatherly, Kwaggarsrand, Soshanguve and Temba landfill sites, respectively. They concluded that considering the leaching characteristics of brominated flame retardants, there is a high possibility that with time, these compounds may infiltrate into the groundwater around the sites, since most of the sites are not adequately lined.

Although complex mixtures of dioxin-related compounds (DRCs) can be released from informal e-waste recycling, DRC contamination in African e-waste recycling sites, has not been investigated. Therefore, Tue *et al*, 2016a examined the concentrations of DRCs including chlorinated, brominated, mixed halogenated dibenzo-p-dioxins/dibenzofurans (PCDD/Fs, PBDD/Fs, PXDD/Fs) and dioxin-like polychlorinated biphenyls (DL-PCBs) in surface soil samples from the Agbogbloshie e-waste recycling site in Ghana. PCDD/F and PBDD/F concentrations in open burning areas (18–520 and 83–3800 ng/g dry, respectively) were among the highest reported in soils from informal e-waste sites. The concentrations of PCDFs and PBDFs were higher than those of the respective dibenzo-p-dioxins, suggesting combustion and PBDE-containing plastics as principal sources. The median total WHO toxic equivalent (TEQ) concentration in open burning soils was 7 times higher than the U.S. action level (1000 pg/g), with TEQ contributors in the order of PBDFs » PCDD/Fs > PXDFs. The study concluded that people living in Agbogbloshie are potentially exposed to high levels of not only chlorinated but also brominated DRCs, and human health implications need to be assessed in future studies.

In a related study, Tue *et al*, 2016b focused on soil contamination by halogenated polycyclic aromatic hydrocarbons (PAHs) from open burning of Agbogbloshie e-waste soil and detected chlorinated and brominated PAHs (Cl- and Br-PAHs) in the range of tens to hundreds of nanogram per gram (dry weight) in soils from the open-burning areas at the Agbogbloshie e-waste site, but at very low or non-detectable levels in the soil samples from non-burning areas and non-e-waste locations, indicating e-waste burning as the major

emission source. The results showed elevated concentrations in open e-waste burning areas (160–220 and 19–46 ng/g dry weight for Cl- and Br-PAHs, respectively) with substantial contribution from unidentified compounds (respectively, more than 36 and 70%, based on the total areas of potential peaks. Considering the continuous exposure of e-waste workers in Agbogloshie to not only high levels of dioxins, but also complex mixture of potential mutagens including PAHs and their derivatives, a comprehensive assessment of the cancer risk is necessary.

A visit to Agbogbloshie in Accra, to interview e-waste workers burning copper wires to recover copper, revealed that many of them had been in the business of burning e-waste for copper and other materials for at least 11 years. They expressed their consciousness of the hazards associated with the burning of the e-waste. They indicated that they often experience coughs, chest pain, and eye irritation, darkening of the skin and sometimes injuries from the heat. A resultant effect of such activities imply costs for medication for their health care. Some e-waste workers have confirmed spending their average daily wage of ten Ghana cedis (GH₵10) on medication, thus affecting their ability to fend for their families and also contribute to the social development of their communities. They confirmed that a number of lives have been lost through illnesses due to the prolonged exposure to the smoke and other harmful chemicals the names of which they did not know. They indicated that some government and non-governmental agencies come to sensitize them from time to time and even advise them to quit the venture because of the associated health complications. Though not satisfied with their current work-environment conditions, they had resigned themselves to this job, as they do not have access to alternate sources of livelihood. They shared their consciousness of the environmental damage from their activities that include massive air pollution. They finally added that nobody sleeps at the burning site because of the magnitude of pollution and unavailability of potable running water.

2.3.15.1.2 Workers at general waste dump site, Agbogbloshie

A focus group discussion with scavengers at a waste dump site located at Agbobloshie, revealed that many of them had been in the business of re-sorting, dumping and burying of garbage of various kinds for at least 3 years. Many expressed their consciousness of the hazardous chemicals and other hazards they were exposed to in their activities and added that though they try to go for regular medical check-ups, many others do not visit the hospitals for regular check-ups, and thus are prone to having all sorts of illnesses that later result in the death of some of them. The general health complaints of the workers at the dump site include catarrh and irritations of the eye and skin, among other ailments.

2.3.15.1.3 Singers of animal carcasses

Interview conducted with those who singe animal carcasses at the Old Fadama Central Market, Accra, just adjacent to the e-waste site, revealed that many of them had been in the business of singeing livestock (sheep and goats) for at least 12 months. They indicated that burning of refuse and e-waste occurred in the surroundings, generating smoke which causes massive air pollution perceived as dangerous to their health as they inhale the contaminated air. They stated further that the smoke from the burning of e-waste in the surrounding area also pollutes the meat to be consumed by humans and other animals. They expressed their dissatisfaction with the quality of the environment, which is threatening their lives and business. They said that firewood and LPG are the main sources of fuel used for their activities. They also expressed their consciousness of the risks associated with the use of used car tyres for singeing meat as practised by other carcass singers. At the site however, there were remnants of rubber tyres, an indication that some persons continue to use tyres in singeing.

Carcass singers at the James Town Slaughter House located at Boodey in Accra, said that they also use firewood and LPG. They had previously used lorry / car tyres for singeing because it was cost effective. Upon advice from the Accra Metropolitan Assembly, however, the use of these tyres has stopped.

2.3.15.1.4 Fish mongers

Fish mongers at Chorkor indicated that they have been in business for over 40 years as fish mongering is known in their community to be a multi-generational business. They smoke fish brought directly from the sea by their counterpart fishermen or from cold stores. They expressed their consciousness of the hazards associated with their activities and complained that they suffer eye irritation; problems associated with smoke inhalation, and waist pains due to long periods of standing while attending to the fish during fish smoking. They expressed satisfaction with their environmental conditions. They however expressed the need for improvement and modernization.

2.3.15.1.5 Waste handlers in health sector

Health care institutions are perceived to be a major source of POPs exposure due in part, to the use of disposable products. The chemicals used in the health sector are varied and include organic and inorganic solvents, acids, gases, cleaning and disinfecting agents among others. Workers who employ these chemicals may get exposed leading to temporary or long lasting effects. Workers in the health sector involved in cleaning and keeping the environment, may be considered as vulnerable. The use of detergents in cleaning, disinfectants, weedicides, pesticides for clearing weeds and fumigation, may result in exposure among these vulnerable groups. This group is also responsible for waste management, which includes incineration in many healthcare facilities. According to

the USEPA (1998), medical waste is the third leading source of dioxin emissions in the US (Harris, 2005; USEPA, 1998). Medical waste contains 14% plastics, whereas municipal waste contains 50%. Polyvinyl chlorides (PVCs) are used in intravenous bags (IV bags), IV tubing, blood bags, collection and specimen bags, anaesthesia masks, examination gloves, catheters, feeding tubes, dialysis tubing, sharps containers, bed pans, inflatable splints, and many other uses right down to patient I.D. bracelets (Harris, 2005).

An inventory of potential emission of dioxins and furans (UPOPs) from incinerator use conducted by the Ghana Health Service (GHS) and the Ghana Atomic Energy Commission (GAEC) in 2004, showed the potential for levels of these substances to be higher than comparable parameters in Europe in the mid 1980s. Another carried out by MoH and UNDP in 2013, also showed high levels of these pollutants being released by the health care facilities in the country into the atmosphere.

Convenient sampling was used to select two health facilities in the Greater Accra Region: Ridge Regional and La General Hospitals. At each facility**,** focus group discussions were employed to gather data from participants. The vulnerable worker population was defined as health workers who are involved in cleaning, weeding and waste management, and those working within the X-ray department. A total of 22 participants were involved in the discussions comprising 10 males and 12 females. Four of the workers managed the incinerators. Eight out of the total had been working for less than 10 years, 7 had spent between 10 and 20 years while the remaining 7 had worked for more than 20 years. Three out of 4 workers who managed incinerators were aware that the process led to release of hazardous chemicals into the atmosphere. One male worker stated

"*Oh I know that once I set the incinerator up, I just need to leave the place, so that I don't breathe in certain things which can make me sick.*"

The greatest potential source of POPs in this assessment, is likely to be incinerators. This represents a major source of concern since that is the main mode of treatment available in health facilities for the bulk of healthcare waste**.**

No chemical containing POPs was however identified among the chemicals being used in the facilities. The majority of the health workers however do not have the requisite education on the potential health effects of the chemicals they use.

2.3.15.1.6 Health Manager

Below is a summary of responses to relevant issues raised regarding POPs from a health manager:

(a) Waste management in the health sector

The use of low or medium temperature incinerators in the health sector, increases the risk of release of dioxins, furans, mercury, benzopyrene and other pollutants into the environment, thus posing a health risk to health workers and the community at large

(b) Preventive measures for the mitigation of health effects from chemical exposures

There is an occupational health and safety policy for the health sector, which provides guidelines governing the safe use of working implements in the health facilities. It stipulates the need for the health and safety of personnel using chemicals and working implements to be adequately protected. Health facilities are required to provide personal protective equipment (PPE) like gloves, aprons, respirators, etc. to workers. Other measures include awareness/education of those at risk, improvement in design of workplaces to provide more ventilation, fume chambers, etc.

(c) Relating health disorders with environmental chemical exposures

Sometimes clinicians relate specific ailments to exposures to certain chemicals in the environment when the relationship or linkage is direct or obvious. At other times, the relationship may not be very obvious. Usually, once a clinician is certain of the linkage between the ailments and the exposure, it is recorded in the patient's notes and diagnosis is entered into the consulting room register. It is also recorded in an aggregated form in the harmonized health data platform for the Ghana Health Service, the District Health Management Information Systems (DHMIS). The platform however does not support entry of individualised data e.g. underlying cause of ailments, exposures, etc. Though there are reported cases of diseases associated with hazardous chemical exposures, there is no systematic documentation or reporting of such incidents in the workplace. The existing Occupational Health and Safety (OHS) Surveillance system, (which is part of the DHIMS) designed to improve reporting of work related accidents and diseases, is underutilized due to inadequate funding to disseminate and promote its use.

2.3.15.1.7 Firefighters

Firefighters are subject to an elevated risk of coronary heart disease (Fahy *et al*, 2014; Kales *et al*, 2007) and certain cancers. A meta-analysis (LeMasters *et al*, 2006; IARC, 2010) of 32 studies of cancer in firefighters ranked elevated risks of testicular and prostate cancer, non-Hodgkins lymphoma and multiple myeloma in firefighters as "probable." The authors also reported a "possible" elevated risk of eight additional cancers, including malignant melanoma and brain cancer. There is a high incidence of cardiovascular disease and certain cancers in firefighters that may be related to their occupational exposure to hazardous substances. Exposure may result from contaminated personal

protective gear, as well as from direct exposure at fire scenes. Hori *et al*, 2010 reported HpCDD concentration of 45.6 pg/g lw for high exposure groups of World Trade Centre firefighters.

In some other studies (Fabian *et al*, 2014; Stull *et al*, 1996; Alexander and Baxter 2014), contaminants that have been identified on firefighter personal protective gear include heavy metals, plasticizers and polycyclic aromatic hydrocarbons (PAHs).

Polyhalogenated hydrocarbons such as PBDEs and phthalate diesters are highly lipophilic and would be expected to be readily absorbed through the skin, especially at the elevated skin temperatures experienced in firefighting situations (Chang and Riviere, 1991). In a study by Shaw *et al*, 2013, blood samples from 12 San Francisco firefighters who had responded to a fire within the previous 24 hours, were found to contain a range of chlorinated, fluorinated, and brominated chemical species, including PBDE flame retardants. Measured levels of PBDEs were 2–3 times the levels detected in the general U.S. population (Shaw *et al*, 2013)[51]. They also reported the presence of octabromodibenzofuran (OBDF) in the serum of firefighters and found that 50% of the firefighter serum samples contained, on average, 2,987 (range: 1,350–5,640) pg/g lipid wt, OBDF. In a recent study by Park *et al*, 2015, blood samples were collected from 101 Southern California firefighters. PBDE levels in the blood serum were very similar to those found for the San Francisco firefighters. In a Russian study by Schecter *et al*, 2002, the body burdens of PCBs, PCDD/Fs in serum of firefighters showed elevated total concentrations of PCDD/Fs total Toxic Equivalent (TEQ) of approximately 100 ppt in two firefighters.

Though there is no substantial data available on the links between POPs exposure and diseases among Ghanaian firefighters, occupational hazards arise from smoke inhalation and exposure to POPs during a fire outbreak or during clean-ups after quenching of fires. In the first quarter of 2016, Ghana recorded 2,469 fire outbreaks and noted an increase of 21 % over fire outbreaks in 2015 (Ghana National Fire Service (GNFS), 2016). Over 50 % of fire outbreaks were attributed to domestic electrical fires (GNFS, 2016).

Early on in 2016, a recommendation by the Acting Head of Public Relations of the GNFS was to introduce or apply flame retardants to electrical poles; this would presumably delay the time it takes for a material to burn out- right upon exposure to flames. However, the presence of flame retardants in polymeric materials results in the production of toxic by-products upon combustion, exposure to noxious substances in smoke, soot and fumes.

The following conclusions were drawn by the survey:

- Activities identified which are likely to increase the risk of exposure to POPs include burning or incineration operations at landfill sites, management of healthcare waste and e-waste, as well as among animal singers using discarded car tyres as fuel. Potential for exposure of operatives of power companies like the ECG also exists.
- In all cases of occupational groups that employ burning in the course of their economic activities, there was a general awareness of exposure to noxious substances in smoke, soot and fumes as is evident from activities of general and e-waste workers, fish mongers, waste incinerators in health facilities, etc. Despite the awareness, they did not know the exact number of chemicals contained in these emissions or levels of risk it poses to their health and well-being.
- Government agencies that are potential users of POPs in the form of pesticides and transformer oils, are aware of these substances and have done away with them (in the case of pesticides) or are in the process of eliminating their use in equipment. There is a need for continuous monitoring for their presence in the environment.
- Persons whose health is adversely affected as a result of exposure to POPs, may lose income resulting in increasing levels of poverty, especially where alternate sources of livelihood are not easily available. Poverty may in turn result in reduced access to food within communities leading to poor nutritional status. Social problems like child delinquency, school drop-outs, and indulgence in criminal activities and prostitution to earn an income, and other social vices may increase.
- There is however very little evidence on the magnitude of health problems caused by exposure to POPs and there is the need for research into the manifestations of POPs on human health.
- Research needs to be carried out into modern and sustainable technologies for healthcare waste management including the use of non-burn techniques such as hydroclaves and their use adopted for hazardous waste streams. In the e-waste sector, informal dumpsites operating in major cities must be abolished or considered for re-designation, and the status changed to formal recycling centres as stipulated by the Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917).

2.3.16 Details of any relevant system for the assessment and listing of new chemicals

There is a well-structured system and procedure for the registration of pesticides in Ghana under Act 490. The stringent evaluation criteria for pesticides (both existing and new) include assessment of POP properties of all candidate products. Pesticide products for which the Agency as the registration authority has given approval for sale and use, following the evaluation of

comprehensive scientific data demonstrating that the product is effective for the intended purpose, and that it does not pose an unacceptable risk to human or animal health or to the environment, are contained in pesticide register which is gazetted. The pesticide register thus contains the list of registered (approved) and banned pesticides (including all Stockholm Convention POPs pesticides) in Ghana.

No specific system or procedure currently exists for the assessment of industrial and consumer chemicals. However, a regulation which will take into account the potential for POPs properties and other adverse effects of chemicals (including POPs), is under preparation.

There is also no specific assessment of chemicals in products imported or chemicals in products.

Ghana intends developing a policy on green and sustainable chemistry. Within this scope, criteria can be developed to assess new chemicals on the market.

2.3.17 Details of any relevant system for the assessment and regulation of chemicals already in the market

The Agency has assessed the pesticides currently on the market as part of its post-surveillance monitoring through its regional offices in collaboration with other relevant national stakeholders (PPRSD, GRA-CD, etc.) involved in chemicals control and management in Ghana. All chemicals on the market found to be in breach of conditions for their registration, are recalled with accompanying sanctions. The Agency establishing a pesticide quality control laboratory in Tema for testing pesticides products already on the market as well as those imported into the country.

Currently Ghana does not have a registration system in place for the assessment of the industrial chemicals already in the market as well as chemicals in products. Often it is not known which chemicals are in products imported into the country.

Ghana has initiated the implemented the Globally Harmonised System (GHS) of Classification and Labelling of chemicals and it is expected that the GHS implementation will also provide the needed information on the chemicals currently on the market.

2.4. Implementation status of the Stockholm Convention

Within the framework of the implementation of the Convention, many activities have either been conducted or are currently on-going with a focus on the following main tasks:

- Establishing policies and developing regulations for the sound management of POPs;
- Strengthening the national capacity for the sound management of POPs;
- Environmentally Sound Management (ESM) of PCBs and pesticide stockpiles and wastes;
- Promoting research and applying science, technological and innovative solutions in the sound management, reduction, destruction and elimination of POPs;
- Enhancing training and awareness roles and responsibilities of national stakeholders at different levels and sectors of the economy; and
- Expanding and improving the efficiency of international cooperation.

The level of compliance with the Convention requirements is compiled in Table 27.

Since currently the measures for reduction with the aim of final elimination of the new listed POPs have not started, the compliance with the SC provision in respect to new listed industrial POPs will be carried out and presented in the future NIP updates. The action plans for the new listed POPs and initial POPs are presented in Chapter 3.

Table 26: Ghana's level of NIP implementation status (compliance with the SC requirements) in respect to initial POPs listed in the Convention Annexes

Convention Article	Level of compliance	Comments
ARTICLE 3 Measures to reduce or eliminate releases from intentional production and use	For POPs pesticides **see *section 2.3.1. on Assessment of POPs Pesticides (Annex A, Part I chemicals): historical, current, and projected future production, use, import, and export; existing policy and regulatory framework; summary of available monitoring data (environment, food, humans) and health impacts***	Inventory and assessment have been done. For initial POPs there is no production and use in Ghana. All POPs pesticides have been banned in accordance with the Part 11 of Act 490.
	For PCBs **see *section 2.3.2. on Polychlorinated Biphenyls (PCB) (Annex A, Part II chemicals)***	Initial inventory compiled. GEF funding for management was allocated. PCBs and PCB-containing equipment banned in accordance with Hazardous and Electronic Waste Management Act, 2016 (Act 917).
	For DDT see ***section 2.3.4. on Assessment of DDT (Annex B, Part II chemicals)***	Information gathered from the Ghana Statistical Service indicates that there was unofficial importation of DDT into the country in 2002. The current inventory review did not register any DDT stocks in the country. There is high level of awareness among the users that DDT is banned and hence it is illegal to tradein and use DDT in Ghana.
ARTICLE 4 Register of exemptions	Ghana has not registered for any specific exemptions as stipulated in SC Annexes.	The country has no need for exemptions for any of the listed chemicals. However, if it becomes necessary, exemptions will be registered.
ARTICLE 5 Measures to reduce or eliminate releases from unintentional production	See section ***2.3.6. on Assessment of releases of unintentional produced chemicals (Annex C chemicals)***	Ghana developed its preliminary UPOPs inventory in 2002 and updated same in 2015. However up to now no funding of BAT/BEP measures have been allocated for implementation.
ARTICLE 6 Measures to reduce or eliminate releases from stockpiles and wastes	See section ***2.3.7 on Information on the state of knowledge on POP stockpiles, contaminated sites and wastes, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites***	Inventory of stockpiles and wastes of pesticides, PCBs and DDT have been compiled. The Clean F arms Ghana Project was initiated to identify obsolete pesticides in the country for safeguarding and final disposal. The inventory process registered about 70 MT of obsolete pesticides and an estimated 6 MT of used empty pesticide containers (Cleanfarms Gh ana Project Report, 2011). Part of these stocks were disposed of as part of the GEF/UNDP project " Capacity Building for PCB Elimination in Ghana." An FAO project is on -going to collect the remaining obsolete stocks. The GEF/UNDP project " Capacity Buildi ng for PCB Elimination in Ghana" safely disposed an estimated 120 tonnes of pure PCB oils (in 460 tonnes of equipment) and 100 tonnes of PCB contaminated oils (in 400 tonnes of equipment).
ARTICLE 7 Implementation plans	Ghana submitted its first NIP on 21/01/2008.	The updated inventory is expected to be submitted in 2018.
ARTICLE 8 Listing of chemicals in Annexes A, B and C	Up to now Ghana has not submitted a proposal on the listing of new chemicals in Annexes A, B and C to the COP.	There is the need to build the national capacity to undertake the requisite research to determine the need for listing new chemicals in the future.
ARTICLE 9 Information exchange	***See 2.3.10.5 on Mechanism for the Exchange of Information among Parties of the Convention***	Presently, such mechanisms for the exchange of information with other Parties have not been officially established. Ghana will explore all available technologies and strategies including the use of CIEN to establish an effective and functional communication system for the smooth exchange of information with other Parties to the Convention.
ARTICLE 10 Public information, awareness and education	See ***section 2.3.10. on Current level of information, awareness, and education among target groups; existing systems to communicate such information to the various groups***	Ghana had conducted several awareness raising workshops on POPs targeting all stakeholders . Ghana aims to continue and increase information and awareness on POPs in the country. A communication strategy will be developed to communicate information on POPs to targeted groups.

ARTICLE 11 Research, development and monitoring	See ***section 2.3.9. Existing programmes for monitoring releases and environmental and human health impacts, including findings***	The EPA has in place environmental quality monitoring programmes. The monitoring programmes include the following: • Monitoring and establishment of the status and trends of air and water quality; • Compliance monitoring in selected areas and undertakings to establish trends in environmental quality; • Quarterly monitoring of effluent quality of industries. Through the Global Monitoring Plan (GMP) project under the auspices of UNEP and the MONET Africa project with RECETOX periodic air monitoring and bio -monitoring studies on POPs, have been carried out since 2007. It is envisaged that the A gency's environmental quality monitoring programmeswill be extended in future to measure emissions resulting from Annexes A and C chemicals (PCBs, PeCB, PCNs, HCBs and PCDDs/PCDFs), when the requisite capacity is developed.
ARTICLE 12 Technical assistance	Ghana is a recipient developing country Party. Since the first NIP, Ghana has received technical assistance from the following developed countries/international organizations: UNEP, UNIDO, UNDP, UNITAR, GEF	Considerable technical assistance is needed from all perspectives.
ARTICLE 13 Financial resources and mechanisms	As part of its commitment to achieve the objectives of the Convention in accordance with the national plans, priorities and programmes, Ghana continues to provide in kind contributions in terms of human resource and infrastructure capacities in support of their implementation.	A considerable number of national experts contribute their working time and expertise as in - kind contribution to support project implementation. The Agency also provides staff and infrastructure towards the implementation of the projects.
ARTICLE 15 Reporting	Ghana have not submitted the first, second and third national reports pursuant to Article 15 of the Convention . Based on the updated NIP the fourth report could be successfully submitted.	Failure to report in accordance with Article 15 of the Convention, is mainly as a result of administrative lapses and limited human resource capacity. The situation is being addressed. The first national report was submitted in 11/2018.
ARTICLE 16 Effectiveness evaluation	Ghana contributed to the effectiveness evaluation of the SC through GMP activities.	Ghana participated in GMP1 and GMP2. Human breast milk, air and water samples are the matrices contributed by Ghana.
ARTICLE 17 Non-compliance	As the procedures and institutional mechanisms for determining non -compliance are not yet approved and developed, the country's compliance cannot yet be verified	Ghana subscribes to the approval of a compliance mechanism which ensure s the ef fectiveness and success of the Conventions implementation
ARTICLE 19 Conference of the Parties	Ghana has attended to all Stockholm Convention COPs	Ghana plays an active role and has served on the bureau of the C onvention (as president of COP-8) and other subsidiary bodies (POPRC) and intersessional working groups.
ARTICLE 21 Amendments to the Convention	Ghana has accepted all the Stockholm Convention amendments	Ghana has not yet registered for any exemptions for the listed chemicals.
ARTICLE 22 Adoption and amendment of annexes		
ARTICLE 24 Signature	Ghana signed the Stockholm Convention on the 23/05/2001	
[illegible]	Ghana ratified the Convention on 30/05/2003	
ARTICLE 26 Entry into force	The Stockholm entered into force for Ghana on 17/05/2004	

CHAPTER 3: STRATEGY AND ACTION PLAN ELEMENTS OF THE NATIONAL IMPLEMENTATION PLAN

3.0 Introduction

This chapter comprises a formal policy statement and the implementation strategy for the NIP. The implementation strategy sets out specific action plans or strategies to achieve the obligations of the Convention and any additional objectives.

3.1 Policy Statement

Ghana participated in the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil in 1992. At this Conference, Governments adopted "Agenda 21" – a document that seeks, among other things, to enhance sound management of chemicals. The document, outlined responsibilities of every nation towards the collective achievement of sustainable development.

Of particular relevance for chemicals management is Chapter 19 of "Agenda 21" which deals with environmentally sound management of chemicals, including illegal international traffic in toxic and dangerous products. Under this chapter, governments are expected to develop actions and priorities relating to:

- Information exchange on toxic chemicals and chemicals risks;
- Harmonisation of classification and labelling of chemicals;
- Expanding and accelerating international assessment of chemical risks;
- Establishment of risk reduction programmes;
- Prevention of illegal international traffic in toxic and dangerous products;
- Strengthening national capabilities and capacities for the management of chemicals.

Ghana has also signed on to the 2030 Agenda for Sustainable Development. Sound management of chemicals and wastes is central to achieving the three dimensions of sustainable development (namely social, economic, and environment) and the SDGs. It is also critical to addressing poverty, food security, achieving human rights particularly for women, children and vulnerable populations, and has linkages to climate change and protection of biodiversity. The SDGs have many links to chemicals and waste management with a specific target under SDG 12 on Sustainable Consumption and Production. Sound management of chemicals and waste also impacts on SDG 3 (Good Health and Well-being) and SDG 6 (Clean Water and Sanitation). Goal 12 aims to achieve, by 2020, the environmentally sound management of chemicals and all wastes throughout their life cycle and significantly reduce their release to air, water and soil. Goal 3 on the other hand targets to reduce substantially, by 2030, the number of deaths and illnesses from hazardous chemicals and air, water, soil pollution and contamination.

In response to this global concern, the Government of Ghana has taken concrete steps and measures to achieve sustainable environmental protection and economic development, by incorporating the 17 Sustainable Development Goals (SDGs) into her Medium Term Development Plan. The ultimate aim of Ghana's overall national environment policy, is to improve the surroundings, living conditions and the quality of life of the entire citizenry, both present and future. It seeks to ensure reconciliation between economic development and natural resource conservation, making a high quality environment a key element, supporting Ghana's economic and social development. The policy, specifically, seeks to:

- Maintain the ecosystems and ecological processes essential for the functioning of the biosphere;
- Protect or restore clean water, soil and air;
- Ensure sound management of natural resources and the environment;
- Adequately protect humans, animals and plants, their biological communities and habitats against harmful impacts and destructive practices, and preserve biological diversity;
- Guide development in accordance with quality requirements to prevent, reduce, and as far as possible, eliminate pollution and nuisances;
- Integrate environmental considerations in sectoral, structural and socio-economic planning at the national, regional, district and grass roots levels; and
- Seek common solutions to environmental problems in West Africa, Africa and the world at large.

3.1.1 Government's Commitment to Address the POPs Issue

Within the context of chapter 19 of Agenda 21, the 2030 Agenda for Sustainable Development, and in line with the Ghana Environmental Action Plan, the Government of Ghana's policy on the environment, seeks among other things, to "take appropriate measures, irrespective of the existing levels of environmental pollution and extent of degradation, to control pollution and the importation and use of potentially toxic chemicals".

POPs fall under the category of potentially toxic chemicals. Ghana is committed to the effective implementation of the provisions and obligations of the

Convention. This is clearly demonstrated through the early adoption and ratification of the Convention by the Government of Ghana. The Agency is expected to play a lead role in promoting sound management and use of chemicals (including POPs) for industrial, agricultural, public health and consumer uses in order to avoid damage to human health, the ecosystems, and the environment in general as a way of ensuring sustainable development.

As a first step to ensure sound management of chemicals in Ghana, a national profile for chemicals management was prepared in 1997. The document provides a comprehensive assessment of the national chemicals management infrastructure relating to the legal, institutional, administrative and technical aspects, along with an understanding of the nature and extent of chemicals availability and use. The profile will be updated to address specific issues on POPs. A national action programme for an integrated chemicals management programme in Ghana was also initiated in 1997.

The overall objective of the sound management of POPs in Ghana, is to strengthen the national capacity and capability to deliver a comprehensive assessment of the threats posed by POPs, reduce and where possible, eliminate the exposure of the populations and the environment, to POPs. Appropriate actions, activities and strategies prepared in the NIP, will then be implemented to reduce and ultimately eliminate POPs from the environment, as envisaged under the Convention. The NIP takes into account the existing work and assessments and forms an integral part of the national integrated chemicals and hazardous wastes management programme. It also takes due account of the aims of the national sustainable development agenda in terms of social, economic and environmental policies and actions, in order to maximize their overall benefits. This will avoid "reinventing the wheel" and link the NIP to related national chemicals and waste management initiatives where possible, to ensure maximum efficiency and reduce duplication of effort.

Ghana is aware that POPs are only a part of the sound chemical management and hazardous waste management challenge. Therefore, the Agency is aiming to link and harmonize the different activities on chemicals (SAICM focal issues) and hazardous waste management (POPs, mercury, ozone depleting substances) and climate change mitigation (considering short-livedclimate pollutants, black carbon emission reduction) to UPOPs source reduction including open burning and resource recovery.

There is also a large overlap in the reduction of UPOPs and mercury in a range of industrial sectors Ghana will therefore aim to harmonize the implementation of the Convention on POPs and the Minamata Convention on Mercury where appropriate.
Additionally, waste management and the destruction of hazardous chemicals need to be addressed in a holistic manner and covers all type of hazardous chemical wastes and their destruction and where appropriate securing co-funding in implementation.

It is Ghana's view that dealing with the POPs issues in an integrative manner, as part of the country's framework action plans (chemicals management plans, waste management plans, contaminated sites action plans, draft plastic policy etc.), will result in an effective implementation of the issues, as well as build confidence to attract our international development partners.

Ghana also recognizes the need for scientific research in various disciplines, especially in the field of POPs and its goal is to build capacities for POPs monitoring.

Finally, the Government of Ghana is fully aware that undertaking just legislative measures is insufficient for the implementation of the international commitments with regards to the sound management of POPs. In this vein, other measures are contemplated and applied, including allocation of financial resources from the state budget, as well as additional financial resources from international and intergovernmental funding programmes.

Ghana has proved to be a serious partner in several projects implemented for sound management of chemicals and wastes and aims to build further on its image with international development partners in order to attract more funding for environment issues, including POPs management, reduction and phase out.

3.1.2 Endorsement of NIP

The process of the development of the NIP involved the active participation of a broad-base of relevant national stakeholders, including government ministries, departments and agencies; research institutions and academia; non-governmental organizations (including women and children activists), community-based organizations and the media. The NIP has been validated and endorsed by national stakeholders.

3.2 Implementation Principles and Strategy

An effective implementation of the Convention on POPs, hinges on a well-fashioned strategy. The essential elements of such an implementation strategy are outlined below. The implementation strategy is based on the following principles:

3.2.1 Public and Stakeholder Participation

At the governmental level, all relevant ministries will be involved in the implementation of the NIP in which various Ministries, Department and Agencies will have different responsibilities with respect to their mandate.

An inter-ministerial coordinating mechanism is considered vital in addressing chemicals and waste management issues (including POPs) as an important link to the SDGs under the 2030 Sustainable Development Agenda.

A coordinated approach will be adopted, with co-operation among all relevant stakeholders at all levels and all sectors. Responsibilities related to the sound management of chemicals and waste, as well as those involved in activities that influence chemical safety, including the private sector, industry, labour and public interest groups, will be assigned. Women and children's groups in particular, will be empowered and encouraged to actively participate in the implementation of the NIP.

3.2.2 Transparency in Information Sharing and Exchange

Data and information will be collected and where necessary generated, especially those specific to the national or local situation and made available to the general public. National chemical databases will provide information on the amounts of chemicals imported, formulated and traded in the past and present. Clinical, epidemiological, and environmental data are needed to support decision-making as well as assess and manage risks under local conditions.

3.2.3 Adequate legal, institutional, administrative and technical infrastructure

Adequate legal, institutional, administrative and technical infrastructure will be pursued. This includes the existing legal framework, and appropriate reviews based on the action plans developed, including the application of the Extended Producer Responsibility (EPR) and Polluter Pays Principle (PPP) approaches. This will help enforce the regulatory provisions of the Convention.

3.2.4 Integration with Overall Environmental Management and Sustainable Development Policies and integrated approach with implementation of other Conventions

Implementation of the NIP is expected to contribute to the promotion of sound management of chemicals (including POPs) and hazardous wastes for industrial, agricultural, public health and consumer purposes in order to avoid damage to human health, the ecosystems, and the environment in general. This will ensure the attainment of the SDGs and sound management of chemicals and hazardous wastes in general contained in the Ghana Environmental Action Plan.

The NIP also aims for an integrated approach to link where appropriate integrate the reduction of UPOPs with the reduction of greenhouse gas emissions and with the implementation of cleaner production.

3.2.5 Integrating POPs management into general chemicals/waste and resource management with the consideration of green and sustainable chemistry

The management and control of POPs will be addressed as an integrated part of sound management of chemicals and waste. Waste management need to become an integral part of resources management towards a (more) circular economy. For the protection of recycling cycles and circular economy, POPs and other hazardous chemicals need to be strongly controlled and where feasible, phased-out by substitution with green and sustainable chemicals. Ghana is committed to promoting the concept of green and sustainable chemistry and will utilize this approach for the substitution of POPs-like substances and other hazardous chemicals.

Furthermore, the management of POPs in a range of waste categories, can only be addressed by establishing the management of the respective waste category (e.g. WEEE, end-of-life vehicles, waste oil, waste wood, synthetic carpets). While the overall management of these waste categories go beyond the pure POPs management, the management of such waste categories, is crucial for its implementation. By including the development of environmentally sound management (ESM) of these waste categories, it can be assured that these activities are better addressed in the agenda of the government. Furthermore, it is an important synergy with the implementation of the Basel Convention on the Control and Transboundary Movements of Hazardous Wastes and their Disposal. In recent years, the importance of synergy in the implementation of chemical-related conventions has been emphasized. At the international level, the Conferences of Parties to the three Conventions (namely, Basel, Rotterdam and Stockholm) have called for greater cooperation and coordination among the three Conventions, and that measures should be taken for a more harmonized implementation at both international and national levels. This harmonized implementation approach will therefore be considered at the national level as a policy and strategy. Ghana is a signatory and Party to the Basel, Rotterdam and Stockholm (BRS) conventions as well as a range of other international conventions and multi-lateral environmental agreements, and is also aware that at the national level, efforts need to be made to synchronize the implementation of the BRS Conventions and where appropriate other conventions. Appropriate implementation of hazardous chemicals and wastes management measures constitute an important prerequisite for the effective implementation of the Stockholm, Basel, as well as the Minamata Convention on mercury. Furthermore, international efforts (Montreal Protocol and Vienna Convention) in protecting the ozone layer have waste management aspects such as the management and destruction of Ozone Depleting Substances (ODS) present in air conditioners including cars, and buildings. The inventory of vehicles and

electronic waste in the framework of the Convention for POP-PBDEs and the initiation of their end-of-life management, can at the same time be used for a better management of ODS present in vehicles and other ODS-containing devices. Similarly, the inventory and management of polystyrene in housing and construction, can possibly be combined with the inventory and management of polyurethane (PUR) foam containing chlorofluorocarbons (CFCs).

Extruded polystyrene (XPS) normally contain 8% HFC (HFC-134a) as blowing agent with a high global warming potential (GWP) value of 1300.

The expensive and time-consuming waste management and export efforts for PCBs, POPs pesticides, ODS and GHGs, have prompted the government and the private sector, to seek a more sustainable management of chemicals and articles containing POPs and other hazardous chemicals. It is thus obvious that another policy for imports of chemicals and articles containing hazardous chemicals, is urgently needed. This becomes in particular more obvious considering new POPs containing waste fractions like electronic waste, waste from end-of-life vehicles or impregnated synthetic carpets, textiles or paper containing POPs or POPs-like chemicals. Such high volumes of wastes containing hazardous chemicals, have entered Ghana by the thousands of tonnes over the last three decades and are currently largely dumped or burned in the open. This non-environmentally sound disposal of waste in Ghana, contaminates the soils and threatens precious ground water resources. This justifies the need for another waste management and import policy, to deal with the materials and articles containing POPs in order to move to a more sustainable consumption and production pattern considering green and sustainable chemistry towards a more circular economy.

3.2.6 Prevention of generation of stockpiles of new listed POPs and other hazardous chemicals

There are a range of POPs with exemptions and current use often in products (HBCD, DecaBDE, SCCP, PFOS, PCP). The further use of these POPs will generate new POPs stockpiles and waste. The implementation strategy is not to use any POPs but alternatives considering green and sustainable chemistry principles. Furthermore there are hundreds of POPs-like chemicals, and chemicals of concern (SAICM issues) which need to be controlled to protect human health and the environment.

3.2.7 Adherence to and Use of Technologies and Applications of International Standards

The risk of POPs to human health and the environment will be assessed using internationally recognised criteria, standards and limits to the extent possible. Risk management based on sound principles and use of Best Available Techniques and Best Environmental Practices (BAT/BEP) will be applied.

3.2.8 Commitments Regarding Awareness and Education of all stakeholders

Efforts will be made to train and sensitise identified stakeholder groups (policy makers, industry, science community, civil society, vulnerable groups) and the general public on POPs, hazardous chemical and waste issues. An informed population is recognised as vital in achieving public co-operation and confidence in sound chemicals and waste management including POPs management. The management of chemicals, waste and resource will be integrated into curricula at all levels from primary school to university including information/modules on green and sustainable chemistry and the waste hierarchy including managing POPs and other pollutants.

POPs and the challenges of managing POPs and substitution of POPs by green and sustainable chemistry will be used as a tool for the creation of awareness on chemicals within the activities on sustainable production and consumption (SDG 12) for all stakeholder groups.

3.2.9 Adherence to International Requirements

Decisions concerning manufacture, formulation, import and use of individual and candidate POPs will be reassessed periodically, on a scheduled basis and in response to the availability of significant new information so as to meet international requirement including those of the European Union (EU).

3.3 Priorities Areas of National Concern

The main priority areas of national concern have been identified as follows:

i. Education and awareness creation for all stakeholder groups including the general public;
ii. Monitoring, control and evaluation;
iii. Development of new legislation and harmonizing of existing legislation;
iv. Updating/refining of inventory including developing inventories of recently listed POP chemicals and identification of contaminated sites;
v. Final elimination of remaining Polychlorinated Biphenyls and initiation of action on the management of PCNs and SCCPs in these applications;
vi. Capacity building and implementation of BAT and BEP for source reduction of unintentional and industrial POPs emissions;
vii. Strengthening the institutional capacity in terms of legal, technical infrastructure and human resource (e.g. training of Customs Officers and Environmental Inspectors etc.) to manage POPs;
viii. Management of stockpiles and wastes of POPs;
ix. Information Exchange and Networking;
x. Identification and management of contaminated

sites including securing and possibly remediation;

xi. Further research into the extent of exposure of the population to POPs and development of capacity for risk and socio-economic assessments; and

xii. Development of sustainable chemistry and sustainable production policies and the search for safer alternatives and related substitution.

The implementation of the above priorities will require expertise in various areas including the following:

i. Information and communication technology;
ii. Monitoring and evaluation;
iii. Planning and policy analysis;
iv. Risk assessment and risk management;
v. Toxicology and ecotoxicology;
vi. Hazardous waste management;
vii. Municipal waste management;
viii. Securing and remediation of contaminated sites;
ix. Chemical engineering;
x. Analytical chemistry;
xi. Gender analysis;
xii. Social science;
xiii. Occupational health and safety;
xiv. Poison control and management;
xv. Law;
xvi. Environmental science;
xvii. Industrial management;
xviii. Chemicals control and management;
xix. Research;
xx. Environmental economics; and
xxi. Etc.

The Government of Ghana is expected to commit resources towards the effective implementation of the NIP. In addition, project proposals will be developed and submitted to bilateral, multilateral and private agencies for assistance to implement some of the planned activities. This is expected to augment the financial arrangements and technical assistance programmes established under the Convention (Articles 12, 13 and 14).

3.3.1 Major Milestones/Performance Indicators

Specific milestones given by the performance indicators have been set within each of the action plans with mechanisms for reporting progress at stipulated periods, assuming optimal conditions in terms of institutional and financial arrangements for implementation of the NIP.

3.3.2 Institutional/Organisational Arrangements and Assignment of Responsibilities

The outline framework mechanism for the above strategy is presented in Table 28.

3.3.3 Implementation Approach

The implementation approach is outlined in the action plan and strategies, which indicate the implementation of certain specific activities. It includes objectives, activities, performance indicators, timeframes, resource requirements and responsible and involved stakeholder institutions in the execution of activities specified in the plan. An overview on stakeholders and institutions are listed in the Responsibility Assignment Matrix (Table 28) and the involvement in individual activities, are cited in the respective action plan.

Table 27: Responsibility Assignment Matrix

Roles	Responsible Institutions/Organizations
National inter-sectoral coordination;	MESTI, MLGRD, EPA, GRA-CD, CSIR, MoH/GHS, MoFA, GS A, FID, GNAFF, ECG, Universities, AGI, GTPCW -TUC, GAEC , Ministry of Gender , Children Social Protection (MOGCSP), Ministry of Energy
Regulatory and enforcement	EPA, LUSPA , Mines Dept., Minerals Commission, GRA-CD, MoH/GHS, FDA, VSD/MoFA, PPRSD/MoFA, GS A, GAEC, Energy Commission, GPHA, WRC, FID, AG's Dept., Judiciary, GPS, CSD/COCOBOD, Pharmacy Council, Ghana Armed Forces, GNFS
Monitoring and Research	EPA, LUSPA , Mines Dept., Minerals Commission, ECG, GWCL, , MoH/GHS, FDA, VSD/MoFA, PPRSD/MoFA, GS A, GAEC, Energy Commission, GNPC, GPHA, Regional Maritime Academy, WRC, FID, AG's Dept., Judiciary, GPS, CSD/COCOBOD, IDA, Pharmacy Council, Universities, Ghana Armed Forces, CRIG, CSIR, National Security
Policy	NDPC MESTI, MLGRD, MoLF, M oF, MoE, MoH, MoFA, MoTI, MoRT , MoSWR, MoJ/AG'sDept., MoI, MoD,
Risk communication, education and public awareness	MESTI, MLGRD; EPA; CSIR, LUSPA MoLF, Mines Department; MoC, MoF, GRA-CD, MoE, MoH/GHS, FD A, GTPCW -TUC, MoFA; PPRSD/MOFA, MoFA/VSD, MoTI, GS A, Energy Commission, GAEC, GNPC, MoRT, MoPH; GPHA, RMA; MoWW&H, WRC, FID, Ag's Dept., GPS, IDAG, COCOBOD, MoWCA, MoI, MoD, GAF, GNAFF, CRIG, AGI, ECG, GWCL, VRA, Universities; Environmental NGOs , MOGCSP, Ministry of Interior, Ghana National Fire Service, Police, Ministry of Fisheries, National Commission for Civic Education, National Security
Review, reporting, evaluation and updating of the NIP	MESTI, EPA

3.3.4 Review Mechanisms for Implementation Strategy

A hierarchy of implementation arrangements would be established comprising the NCT as the overall supervisory body; National Programme Director and the NIP Secretariat.

The National Programme Director will be responsible for the overall coordination of the NIP and ensure that periodic reports are submitted to the Convention Secretariat in line with the reporting mechanisms established under Article 15. The Programme Director would also appoint external monitoring and evaluation experts to monitor progress of NIP implementation based on agreed performance indicators and where necessary, recommend any adjustments to the NIP. Officers of the Secretariat would be designated as project managers for the execution of the various sub-projects during the implementation phase and would be required to supervise specific activities assigned to stakeholder agencies and report to the National Programme Director.

3.4 Activities, Strategies and Action Plans

The following strategies, activities and actions have been outlined with the view to accelerate the national efforts towards the fulfilment of the country's obligations under the Convention.

3.4.1 Activity: Institutional and Regulatory Strengthening Measures

In Ghana, the issue of hazardous chemicals including POPs is of great concern. However, there is no comprehensive legislation for chemicals management in the country although some aspects are covered in various laws. The Convention requires Parties to take certain measures to achieve the objective of the Convention. Furthermore other chemical Conventions should be considered in particular the Rotterdam and Basel Conventions. The SAICM also has related emerging policy and other issues of concern. A successful implementation of the Convention in Ghana would therefore involve the integration of some of these provisions into the current institutional and regulatory framework for managing chemicals in the country.

The objective is to prevent the production and use of new pesticides and industrial chemicals that are deemed to be candidates of POPs. This action plan therefore aims at strengthening the existing institutional and regulatory framework in Ghana.

Table 28: Institutional and Regulatory Strengthening Measures

Objectives	Activities	Key performance indicators	Time Frame	Implementers	Resources / Needs
(1) To harmonize existing legal and policy framework on hazardous chemicals including POPs in Ghana	• Update and compile inventory of existing legal instruments that address the management of hazardous chemicals including POPs. • Review relevant existing legislation in the management of POPs to assess need for modification and strengthening. • Draft and promulgate regulations to prohibit/eliminate the production, use, importation and exportation of chemicals listed in Annexes A, B a nd C of the Convention. • Consolidate all legislation related to chemicals and develop a chemicals management law.	Compiled and updated inventory. Proposals for legislative and policy review. Draft regulation. A draft chemicals management law.	5 years	EPA, CEPS Parliament, Attorney General's, Department Research Institutions	Finance, Logistics, Resource Personnel, Capacity Building, Training.
(2) To identify needs of relevant regulatory institutions to manage POPs and other hazardous chemicals in the life cycle	• Design and pilot test survey questionnaire. • Administer and analyse questionnaire • Prioritise needs of institutions • Determine costs for upgrading Physical capacities	Needs assessment conducted Modalities for upgrading physical capacities in place	4 months	EPA, Relevant Stakeholders	Finance, Resource Personnel
(3) To sensitize relevant institutions on compliance and enforcement of regulations on POPs and other hazardous chemicals (SAICM)	• Organize sensitisation workshop	Workshop organised	1 month	EPA, Relevant Stakeholders	Finance, Logistics, Resource Personnel

Objectives	Activities	Key performance indicators	Time Frame	Implementers	Resources / Needs
(4) To assist relevant institutions implement compliance and enforcement strategies on POPs. (i) POPs Pesticides (ii) PCBs (iii) new industrial POPs (iii) Dioxins/Furans etc. and other hazardous chemicals (SAICM)	• Prepare Memorandum of Understanding (MOUs) with relevant institutions and assign them with specific responsibilities towards the implementation of the Convention. • Form a Compliance and Enforcement Network on managing POPs and hazardous chemicals over their life cycle. • Build capacity of personnel from all relevant institutions. e.g. recruitment and training of staff. • Develop monitoring plan of activities for relevant institutions.	MOU in place Compliance and enforcement network operational. Well-equipped institutions Operational monitoring plans	2 years	EPA, Relevant Stakeholders AG, Police, GRA-CD	Finance, Legal Experts

3.4.2 Activity: Measures to Reduce or Eliminate Releases from Intentional Production and Use

In Ghana there is no intentional production of POPs chemicals although there are several POPs in use including PBDEs in articles or PFOS in products and articles, Furthermore recently listed POPs such as short chain chlorinated paraffins and DecaBDE, have a range of exemptions which have not yet been assessed for Ghana in the current NIP update and are likely to be used in some processes and are certainly present and used in articles and products. Beside PCBs, which are still used in electrical equipment, there is no intentional use of POPs chemicals in Ghana which is legal. Furthermore, certain POPs pesticides as well as PCBs, may be used illegally. This is either from existing stockpiles or from illegal importation. It is therefore necessary to identify measures to ban and prohibit the illegal importation and use of POPs pesticides as well as the illegal use of PCBs. Article 3 of the Convention summarizes activities that must be put in-place to reduce and eliminate releases from intentional production. These activities include legal and administrative measures. The action plan presented below, identifies measures to reduce or eliminate releases from intentional production and use of POPs.

Table 29: Measures to Reduce or Eliminate Releases from Intentional Production and Use

Objectives	Activities	Key performance indicators	Time Frame	Implementers	Resource / Needs
(1) To reduce/eliminate releases from use of POPs. (2) To restrict or prohibit import of Annex A & B chemicals (See section 3.3.1, activity 1)	(a) Update inventory of annex A and B chemicals imported and used in Ghana considering also the recently listed SCCP, DecaBDE and PCP. (b) Analyse pattern of usage of annex A and B chemicals (c.) Control and reduce release (d) Phase out of current use of identified POPs and substitution	Database of Annex A & B Chemicals currently in use in Ghana Use pattern and processes of Annex A & B chemicals identified Substitution by more sustainable chemicals and non-chemical alternatives	5 years	The Agency, Relevant Stakeholders	Financial assistance, Technical assistance / expertise

3.4.3 Activity: Production, Import and Export, Use, Stockpiles and Wastes of Annex A POPs Pesticides (Annex A, Part I Chemicals)

There has not been any previous production of the listed POP pesticides (initial POPs pesticides and pesticides listed in 2009 and 2011) in Ghana and the country does not envisage any possibility of producing any of these POP pesticides in the future. There is also no approved current use of these POP pesticides in Ghana. All POPs pesticides listed until 2015 are banned.

PCP listed in 2015 has not been assessed in this NIP update and therefore is the need for assessment and control in future. Activities required are included in this action plan.

The following action plan details activities to be undertaken in respect of the production, import and export, use, stockpiles and waste of Annex A Part I pesticide.

Table 30: Production, Import and Export, Use, Stockpiles and Wastes of Annex POPs Pesticides (Annex A, Part I Chemicals)

Objectives	Activities	Key performance indicators	Time Frame	Implementers	Resource / Needs
(1) To update inventory of Production, Import and Export, Use, Stockpiles and Wastes of Annex A part I chemicals (see 3.3.2, activity 1)	Carry out further inventory into the illegally Imported, and Use, Stockpiles and Wastes of Annex A part 1 chemicals	Inventory report	1 year	EPA, Relevant Stakeholders	Financial assistance, Personal protective equipment, Technical assistance / expertise
(2) Develop data management system for the POPs pesticides (Annex A part I chemicals)	Archiving and data management system	Data base established	1 year	EPA, Relevant Stakeholders, CEPS,	Computer equipment, Computer hard ware and software, computer accessories and Training
Regulatory frame for PCP treated wood within a frame of waste wood regulatory frame	Development of an overall regulatory frame of waste wood including PCP treated wood	Draft legislation (adopted regulation?)	2 year	EPA, Relevant Stakeholders	Financial assistance, Personal protective equipment, Technical assistance / expertise
Inventory of PCP and PCP treated wood	Development of a PCP inventory in major source categories	PCP inventory report	1 year	EPA, Relevant Stakeholders, CEPS,	Computer equipment, Computer hard ware and software, computer accessories and Training
Assessment of POPs properties and other health risk of pesticides in use including monitoring of imported pesticides	Assessment of current used and imported pesticides by research group and policy makers	Report on health risk of current used and imported pesticides assessed for their	3 years	EPA, Relevant Stakeholders	Financial assistance, Personal protective equipment, Technical assistance / expertise
Monitoring/analysis of POPs and highly hazardous pesticides to understand the risk to humans and environment	Analysis of humans and selected environment POPs and other relevant	Completed risk assessment of POPs and other pesticides in Ghana	2 year	EPA, Relevant Stakeholders, CEPS,	Training, monitoring equipment, Computer hard ware and software,
Substitution of POPs pesticides and HHPs and selection of the most sustainable alternatives.	Compilation of information on alternatives to POPs pesticides and HHPs selection of the most sustainable alternative including IPM and organic farming	Assessment studies on alternatives, IPM and organic farming Share of IPM and organic farming significantly increased	5 years	EPA, Relevant Stakeholders, CEPS,	Training, financial assistance, technical assistance
For POPs pesticide contaminated site action plan activity see chapter on contaminated sites below in 3.4.11					

3.4.4 Activity: Production, Import and Export, Use, Identification, Labelling, Removal, Storage and Disposal of PCBs and Equipment Containing PCBs (Annex A, Part II chemicals)

Available information indicates that there has never been any production of PCBs in Ghana. All PCB in Ghana have entered by the importation of equipment.

The Ghana PCB with UNITAR project succeeded in helping to identify the major stockpiles and proper handling and management as well as safe disposal of the PCB containing waste streams so as to reduce the releases of these POPs in Ghana and regionally. PCB- containing wastes were found at ECG main sub-station H and the VRA materials stores at Tema. These are primary stations where broken down transformers from all over the country were/are stored. Obsolete capacitors in the basement of the Achimota Sub-station H were safely moved to temporary storage site (ECG Training School in Tema) and stored in maritime containers. These comprised 65 pieces of 33kVA capacitors of 78 kg each and 51 pieces of 11kVA capacitors of 75 kg each giving total of 8,895 kg and 6 tonnes of PCB oils. A technically sound central storage site was constructed and operated in Accra/Tema area. The site has since been decommissioned following the shipment of PCBs waste to Gdynia Poland by Veolia Es Field Services. Vehicles used during the transportation of PCBs Waste were in compliance with national and international standards for transportation of dangerous goods, ensuring appropriateness of road vehicles used for PCBs transport. All PCBs waste was packed and transported out of the country for final disposal by Veolia Es Field Services Limited. A total of 53 tonnes consisting of capacitors (pure PCBs), PCBs oils and PCBs contaminated solids waste were shipped. The composition was segregated as follows: 9 Mt capacitors (with pure PCBs), 28 Mt of PCBs contaminated oils, 16 Mt of PCBs contaminated solid wastes (Table 6).

The proposed activities define specific actions in respect of managing PCBs, both in the short and the long term in a manner that is consistent with the obligations of the Stockholm Convention. The overall objective is a reduction and ultimate elimination of PCBs use, the prevention of releases of the chemical into the environment, and to provide for environmentally sound disposal or final elimination of PCBs waste.

Table 32: Production, Import and Export, Use, Identification, Labelling, Removal, Storage and Disposal of PCBs and Equipment Containing PCBs (Annex A, Part II chemicals)

Objectives	Activities	Key performance indicators	Time Frame	Implementers	Resource / Needs
To finish the detailed inventory on PCBs and equipment containing PCBs (Annex A, Part II Chemicals)	• Monitoring the remaining PCB equipment including unclassified closed transformers and capacitors. • Identify remaining PCBs and PCB-containing equipment • Identify PCB -contaminated sites and evaluate risk • Secure PCB-contaminated sites and evaluate remediation options.	Complete inventory of PCBs and PCB containing equipment updated Contaminated sites mapped, evaluated and secured	8 months	EPA, Relevant Stakeholders	Financial Assistance, Vehicles
To ensure safe management of remaining PCBs and PCB containing equipment	Identifying and finalizing arrangements for the disposal of remaining PCB and PCB containing equipment. Identify appropriate technology for disposal of PCBs. Packaging of equipment for disposal Disposal of remaining PCBs.	Mechanism for disposal established. Technology for disposal identified Procedures for packaging for disposal developed Equipment disposed	5 years	EPA, VRA, ECG, International consultants	Training, financial assistance, technical assistance
To clarify the relevance of PCBs, PCNs and SCCPs in open application and development of a (preliminary) inventory	• Develop strategy and capacity for monitoring PCBs, PCNs and SCCPs in open applications • Identify the presence of PCB, PCN and SCCP in open applications and development • Assessment of the impact of PCB, PCN and SCCP on recycling cycles and circular economy.	Analytical capacity for at least to compound groups established Preliminary inventory developed	3 years	EPA, Relevant Stakeholders	Financial assistance Analytical capacity

3.4.5 Activity: Production, import and export, use, stockpiles, and wastes of hexaBDE and heptaBDE (Annex A, Part IV chemicals) and tetraBDE and pentaBDE (Annex A, Part V chemicals) (and HBB, where applicable (Annex A, Part I chemicals))

According to the PBDE inventory a large amount of POP-PBDE listed in 2009 has been imported via electrical and electronic equipment in vehicles and possibly other goods and is present in stocks at consumer levels or as wastes. The amount of POP-PBDE is considerably higher than the current inventory since DecaBDE has been listed in 2017 and is present in these articles and wastes in considerably higher concentration.

The action plan focuses on setting actions and measures whose implementation will lead to managing and controlling POPs-PBDEs containing products still used by consumers, currently recycled, stockpiled, or landfilled. Also, actions on strengthening the collaboration among stakeholders are included to bridge the gaps in the information required for the future in-depth quantitative estimation of the POPs-PBDEs.

For managing PBDEs, the life cycle management (import, export, use, recycling, destruction) of POPs containing articles/products and waste needs to be developed, in particular for EEE/WEEE and vehicles and end of life vehicles. In addition, HBCD and to a less extend PBDE are used in insulation of housings (polyurethane and polystyrene).

For these three large material and waste flows also resource recovery and recycling need to be considered, following the waste management hierarchy for the recovery of resources. At the same time pollutants such as PBDE, HBCD and other POPs/PTS need to be phased out of the recycling.

Table 33: Production, import and export, use, stockpiles, and wastes of hexaBDE and heptaBDE (Annex A, Part IV chemicals) and tetraBDE and pentaBDE (Annex A, Part V chemicals) (and HBB, where applicable (Annex A, Part I chemicals))

Objectives	Activities	Performance indicators	Time Frame	Implementers	Resource / Needs
Regulatory frame for PBDE, PBB and HBCD and related articles and wastes	• Inclusion of PBDEs, PBB and HBCD in list of restricted substances. • Assessment of regulatory framework • Development of regulatory frame of PBDE and HBCD containing materials and waste • Development of regulatory frame for vehicles (import, end of life management) • Development of regulatory frame of EEE and WEEE • Development of regulatory frame for HBCD in insulation	▪ PBDE, PBB and HBCD restricted ▪ Overview of international regulations compiled ▪ Regulatory frames for EEE/WEEE and vehicles developed ▪ Regulatory frame for HBCD insulation foams developed	3 years	EPA, Ministry of Transport, Ministry of Trade, Relevant Stakeholders AG,	Financial assistance, Training, Equipment, Technical expertise / consultants
Updating and refining the inventory of PBDEs (including DecaBDE) and HBCD containing articles and wastes as well as developing/updating appropriate databases for information management	▪ Refined inventories of EEE/WEEE, vehicles, polymers in construction (including all POP-BFRs). Including assessment of illegal imports ▪ Dynamic material and substance flow analysis •Data management system for waste and waste containing POP-BFRs	▪ Updated inventory reports ▪ Dynamic material and substance flow analysis ▪ Databank for EEE/WEEE, vehicles, established	2 months	EPA, Relevant Stakeholders EPA, Relevant Stakeholders CEPS,	Financial assistance, Personal, technical assistance/ expertise Computer equipment, Computer hard ware and software, computer accessories and Training
Waste management of WEEE by implementation of the Hazardous and Electronic Waste Control and Management Act 2016 (Act 917) in the life cycle	• Compilation of information of management situation of POP-BFR containing products and waste and fate of other pollutants • Including the POP-PBDEs and related plastic management into the EEE waste management strategy • Prepare Memorandum of Understanding (MOUs) with relevant	▪ Overview report on management situation ▪ EEE plastic and related PBDE management is addressed in WEEE ▪ ▪ MOU in place ▪ Compliance and enforcement	2 years	EPA, Relevant Stakeholders AG, Police, CEPS	Finance, Legal Experts

	institutions and assign them with specific responsibilities for the implementation of the Act 917. ● Form a Compliance and Enforcement Network of the Act 917. ● Build capacity of personnel from all relevant institutions. e.g. recruitment and training of staff. ● Develop monitoring plan of activities for relevant institutions.	network operational. ▪ Institutions have appropriate capacity ▪ Operational monitoring plans in place			
Management of other PBDE and HBCD waste categories (end of life vehicle, insulation foam, and possibly textiles, furniture, matrasses)	▪ Develop guidelines on safe handling of EoL vehicles including POP - BFR polymers. ▪ Develop guidelines for management of POP -BFRs containing insulation foam from construction. ▪ Assessment of recycling[55], option of P BDE containing wastes considering waste hierarchy. ▪ Establish criteria and selection of appropriate storage areas for POP -BFR containing wastes ▪along with the collection and management systems of WEEE and end of life vehicles ▪Development of sound management of POP-BFR containing plastic and other polymer in end of life vehicles within the frame of hazardous substance management in the life cycle of vehicles.	▪ Guidelines on safe handling developed. ▪ Guidelines for collection and transport of PBDEs in place ▪ Export or recycling of plastic from WEEE and ELV is established including separation of POP - BFR containing plastic.	5 years	EPA, E-waste Operators	Financial assistance, Training, Equipment, Technical expertise / consultants

[55]Please note that the largest volume of polymers from WEEE and end of life vehicles can be recycled

	Development of sound management of POP-BFR containing plastic and other polymer in buildings and construction within the frame of POPs (PCBs, PCP, POP-pesticide in wood, SCCP) and hazardous substance management in buildings and construction				
Assessing the destruction capacity options for POP-BFRs containing waste categories in Ghana and development of management plan (link to plastic policy)	▪ Identify destruction options for POP-BFR containing plastic and polymers. ▪ Develop destruction options for identified POP-BFR sources (cement kiln; others). ▪ Management and destruction of POP-BFR containing wastes	▪ Phase out/destruction options identified. ▪ Phase out/destruction options programmes in place	7 years	EPA, E-waste operators CEPS	Technology Transfer, Finance assistance, Logistics
To assess alternatives and select the most sustainable alternatives to POP-BFRs (DecaBDE and HBCD) in used/ exempted applications.	▪ Compilation of information on alternatives to DecaBDE (considering activities of POPRC; UNEP BAT/BEP group). ▪ Compilation of information on alternatives to HBCD containing EPS/XPS insulation (see SC BAT/BEP guidance; POPRC). ▪ Education and capacity building on alternatives assessment. ▪ Selection of the most sustainable alternative chemicals and non- chemical solutions in the different applications. ▪ Phase in of sustainable chemicals and non-chemical alternatives.	▪ Suitable alternatives identified and selected ▪ Alternatives used	3 years	EPA, ministry of industry; ministry of trade; Academia and research institutions	Financial assistance, vehicles, Training, Technical expertise / consultants

	chemicals and non-chemical alternatives.				
Strengthening the capacity to inspect and monitor the enforcement of the policy and regulatory requirements on WEEE and ELV management	▪ Identify the resource persons ▪ Carry out policy and regulatory needs assessment ▪ Develop training materials and programmes.	▪ Resource persons identified ▪ policy and regulatory Needs assessment report	1 year	CEPS, EPA, E-waste operators	Financial assistance, Technical Expertise, Equipment
Strengthening the capacity to inspect and monitor the enforcement of the policy and regulatory requirements on WEEE and ELV management and related polymer and POP-PBDEs management	▪ Identify the resource persons ▪ Carry out policy and regulatory needs assessment ▪ Develop training materials and programmes. Develop procedures on inspections and maintenance of stockpiles and waste.	▪ Resource persons identified ▪ policy and regulatory Needs assessment report ▪ Training materials developed Procedures on inspections and maintenance of stockpiles and waste developed.	1 year	CEPS, EPA, E-waste operators	Financial assistance, Technical Expertise, Equipment
Awareness on POP-BFR containing articles and waste	▪ Develop awareness creation strategy on environmental and health impact of POP-BFRss. ▪ Conducting awareness creation campaigns to reduce/eliminate the practice of open burning of EEE/WEEE and ELV unwanted scrap	▪ Development of awareness creation materials	5 years	EPA, ministry of industry; ministry of trade; E-Waste Operators, garage, scrap dealers	Financial assistance, vehicles, Training, Technical expertise / consultants

The POP-PBDE contaminated site part is below in chapter below 3.4.11

3.4.6 Activity: Production, Import and Export, Use, Stockpiles and Wastes of DDT (Annex B Chemicals) if used in country. (See also 3.3.2 and 3.3.1 Activity 4)

DDT was used extensively in Ghana in the past both for agriculture and public health purposes. DDT has been officially banned for all its uses in Ghana since 1985 (EPA Updated pesticide list 2015). The current inventory review did not register any DDT stocks in the country. There is a wide level of awareness among the users that DDT is banned and hence illegal to possess in Ghana. There is no information on export of any kind. There is however general paucity of data on illegal DDT import and application in Ghana limited record and estimates have been made to show the extent of use of DDT in Ghana.

Table 34: Production, Import and Export, Use, Stockpiles and Wastes of DDT (Annex B Chemicals)

Objectives	Activities	Key performance indicators	Time Frame	Implementers	Resource / Needs
(1) To further assess and control illegal imports of pesticides including DDT	Further assessment of illegal import activities including counterfeit pesticides Training of custom to control imports of illegal pesticides in the different regions	Report on the import Training on illegal pesticide import included in general training for customs	2 year	EPA, MOH/GHS, Relevant stakeholders Ghana Revenue Authority Custom Division	Finance, Laboratory Equipment, Human Resource

3.4.7 Activity: Production, import and export, use, stockpiles, and wastes of PFOS, its salts and PFOSF (Annex B, Part III chemicals)

According to the inventory report, PFOS and related substances are not manufactured in Ghana. There is a considerable gap in information of PFOS and related substances in articles and products. Most of the consumer products and articles containing PFOS enter into the country through import but none of them was identified during the inventory due to the challenges of non-existing HS codes, GHS and lack of measurement capacity.

Firefighting foams are present in stocks and large volumes of firefighting foams have been used in the past with generation of potentially contaminated sites. Also a river and related drinking water have been found contaminated above health advisory limit.

PFOS has been substituted the last 15 years mainly by other PFAS. PFAS are listed in SAICM as emerging policy issue of concern and need to be assessed and controlled in future. No information on used PFAS in Ghana is available.

Table 35: Production, import and export, use, stockpiles, and wastes of PFOS, its salts and PFOSF (Annex B, Part III chemicals)

Objectives	Activities	Performance	T i m e	Impleme	Resource / Needs
Development of regulatory frame for PFOS and related substances and PFAS	▪ Assessment of regulatory frames for controlling PFOS and related substances and PFAS ▪ Amend existing laws, or develop new laws related to the control and management of PFOS and PFAS. ▪ Banning of PFOS with possible exemptions ▪ Custom control and improvement of the traceability of chemicals and	▪ Report on regulatory control ▪ PFOS listed as banned chemical ▪ Regulations developed	3 years	EPA	
To update inventory of Import and Export, Use, Stockpiles and Wastes of	▪ Refining inventory of PFOS and other PFAS in firefighting foam ▪ Refining of inventory of PFOS and other PFAS in consumer product ▪ Refining of inventory of PFOS and PFAS in industrial use	▪ Updated and refined inventory report	3 year	EPA, Ghana National Fire Service, GAEC,	Finance, Laboratory Equipment, Human Resource

Essumang DK, Eshun A, Hogarh JN (2016), Perfluoroalkyl acids (PFAAs) in the Pra and Kakum River basins and associated tap water in Ghana. Science of the Total Environment 579, 729-735.

Objectives	Activities	Performance	Time	Impleme	Resource / Needs
Training and awareness raising for stakeholder groups on PFOS and PFAS and establishing approach for information	▪ Inform and sensitize stakeholders (e.g. fire fighters; users of aviation fluids) and public on the environmental and health impact, environmentally sound management and on alternatives of PFOS and related substances. ▪ Development of related education and awareness materials (considering already available	Number of sensitize stakeholders workshops/seminar conducted Education materials developed Awareness created Number of trained	Continues	MoE, 4NGOs, MoEd, MoH, universities and research institutes	40,000
Assessment of alternatives to PFOS and	▪ Compilation of alternatives to PFOS and related substances ▪ Selection of the most	Sustainable alternatives identified	5 years	EPA, Ghana National	Technical expertise, Financial assistance. Cooperation
Analysis and monitoring of PFOS and PFAS in priority areas	▪ Assessment of options for monitoring of PFOS and PFAS (international collaboration or development of own capacity) ▪ Establish of monitoring approach for PFOS/PFAS ▪ Monitoring of major drinking water supplies ▪ Improvement of inventory by monitoring approach where knowledge gaps have been found. ▪ Monitoring biota and soil samples for PFOS especially in vicinity of suspected contaminated sites (see contaminated site action plan). ▪ Monitoring of PFOS and PFAS.in	▪ Options assessed and selected ▪ Monitoring approach for PFOS and related substances has been established. ▪ Inventory gaps by measurements reduced	5 years	EPA, Ghana National Fire Service, UCC, GAEC , MOH, Researc	Technical expertise, Financial assistance.
Assessment, management, database of potentially PFOS and PFAS contaminated sites and securing /remediation needs	▪ Develop/update legislation to set criteria for determining contaminated sites. Legislation on liability related to contamination and clean-up procedures. (general activity on contaminated site framework) ▪ Develop guidelines for identification and assessment of PFOS/PFAS contaminated sites ▪ Training in identification and management of contaminated sites ▪ Database and maps of potentially contaminated sites and prioritization of the sites (risks) for further assessment and clean-up ▪ Analytical confirmation of POPs contamination for the identified	Contaminated site criteria defined and legislation developed Guidelines on identification developed Workshops conducted, staff trained Priority sites determined Pollution assessed	3 years	EPA, Ghana National Fire Service, Ghana water, GAEC, academia & research	Financial assistance Vehicles, Training and Technical Expertise
The PFOS and related substances contaminated site part is below in chapter 3.4.11					

3.4.8 Activity: Register for Specific Exemptions and continuing need for Exemptions (Article 4)

Article 4 of the Stockholm Convention on POPs requires the establishment of POPs register for the purpose of identifying parties that have specific exemptions listed in Annex A or B. All registrations of specific exemptions are subject to periodic review. Ghana has assessed the chemicals (Lindane, DDT, PFOS and recycling of PBDEs) and did not find the need to apply for any exemption under the Stockholm Convention.. However in the event of a need for an exemption, the activities listed in the table below will be undertaken to meet the obligations under Article 4.

Table 36: Register for Specific Exemptions and the Continuing need for Exemptions (Article 4)

Objectives	Activities	Key performance indicators	Time Frame	Implementers	Resource/Needs
To establish an informed registration process for needed specific exemptions of POPs.	(a) Organize stakeholder consultation to establish criteria for assessment and selection of exemptions for chemicals listed under Annex A or B . (b) Assess for PFOS, PFOA, HBCD, DecaBDE, and SCCP future listed POPs with exemptions. (c) Notification of Convention Secretariat on specific exemptions if needed (d) Periodic review to assess need for continued exemptions or otherwise	Stakeholder meetings held Notification reports submitted and exemption listed Review report	Annually	EPA, MES, CEPS	Financial assistance, Computer,

3.4.9 Activity: Measures to Reduce Releases from Unintentional Production (Article 5)

In this section activities are proposed for the action plan to reduce the release from unintentionally produced POPs (PCDD/PCDF and UPOPs PCB and HCB). In the action plan the activities have been set by considering the listing of the priority sources in Annex C of the SC, the total amount of contemporary releases as an outcome of the inventory process and considering point sources with potential risk to humans. In addition

While Ghana has relatively low PCDD/PCDF and PCB levels in human milk, still the levels are exceeding the TDI for breast fed children as in all other countries. Since human milk is the best nutrition for a baby and the benefits of breastfeeding far outweighs the presence of POPs human milk is exclusively recommended for at least 6 month by WHO. Therefore further reduction of PCDD/PCDF release in Ghana and globally is a priority task. PCDD/PCDF and other unintentional POPs are endocrine disrupting chemicals (EDCs) and contribute to overall exposure of humans to other EDCs. Also the overall exposure to EDCs need to reduced considering the high external cost to society.

For an adequate assessment of UPOP emissions and emission sources, the total impact of release reduction from industrial emissions, open burning, indoor cooking/heating and transport including other major pollutants need to be considered for an appropriate priority setting on air and soil pollution prevention. Other pollutants to consider include:

- other releases from open burning, cooking/heating, transport (e.g. particulate matter (PM), carbon black, PAHs, heavy metals)
- other releases from industrial processes (e.g. particulate matter (PM), carbon black, PAHs, heavy metals).

Since these releases are one of the main sources for ambient air pollution causing 12.6 million deaths including 2.2 million in African region (WHO 2016[57]), the reduction of the release of these pollution as a whole (Dioxins/UPOPs, particulate matter, heavy metals, PAHs, black carbon) is a priority for Ghana. Lack of technical expertise and resources limits the country's ability to identify and estimate the actual health and environmental impacts from PCDD/PCDF, and other pollutants. Ghana needs to take all necessary actions to safeguard and assess the quality of its food, water, land and air in order to protect the health of its people and avoid any potential for damage to the economy. Integrated measures to address the different sources and the multiple pollutants must be implemented if the exposure of the human population is to be significantly decreased. This proposal therefore is an action plan for reducing the unintentional releases from chemicals in article 5 of the Stockholm Convention as well as other relevant pollutants from these sources (particulate matter (PM), black carbon, PAHs, heavy metals).

[57] WHO (2015) http://www.who.int/mediacentre/news/releases/2016/deaths-attributable-to-unhealthy-environments/en/

Table 37: Measures to Reduce Releases from Unintentional Production (Article 5)

Objectives	Activities	Key performance indicators	Time Frame	Key Implementers	Resource/Needs
(1) To establish appropriate policy and legislation for effective regulation and enforcement of prevention of unintentional production of PCDD/F, and other UPOPs in Ghana. (See also 3.4.1)	▪ Draft new regulations. ▪ Prepare memorandum of understanding (MOUs) with industry groups on phasing out equipment and machinery, which are sources of releases. ▪ Introduce substitute technologies or modify materials and processes to prevent formation and releases. ▪ Institute a chemical and materials policy, which aims to reduce/eliminate PCDD/F, HCBs and PCBs. ▪ Integrate industry commitment into existing EPA permitting system. ▪ Develop regulatory frame for open burning ▪ Education and awareness of stakeholders on legal issues. (See 3.3.13).	Regulations in place. Modalities for MOUs established Investigations into finding substitutes initiated Policy determined Permitting system integrated Workshops/seminars	3 years	EPA, AG Parliamentary select committee on environment, (PSCE), MES, DA	Financial assistance, Technical expertise / Consultant
(2) To regularly update sources inventories of unintentional production of PCDD/F and other listed UPOPs.	▪ Regularly update the inventory. ▪ Incorporate new unintentional POPs. ▪ Collect and collate data from identified source categories	Inventory regularly updated and considered in article 15 reporting	5 year	Task team, EPA	Financial assistance, tool kit
(3) To develop data management systems for unintentional production of PCDD/F, and other UPOPs and release in Ghana.	▪ Develop common database for inventory of releases (UPOPs, GHG, mercury, heavy metals) ▪ Evaluation if a Pollution Release Transfer Register is useful and feasible and possibly establishment ▪ Archiving and data management	Database developed Decision if PRTR developed and plan for development Regularly updated database	3 year	EPA, Consultant	Training
(4) To phase out chemicals and materials containing chlorine that are sources of unintentional releases of PCDD/F, and other UPOPs	▪ Identify activities using chemicals containing chlorine (e.g. PVC production, chlorine in water treatment, pesticides) and evaluate their release of UPOPs. ▪ Develop phase out programmes for identified sources. ▪ Identify and promote feasible and affordable alternatives to activities, which are chlorine based, and sources of releases.	Chlorine based activities identified. Phase out/substitution programmes in place Sustainable alternatives identified and promoted	15 years	EPA, AGI, GWCL, MLG, GRA-CD MES, MWH, MI/PSI MOH/GHS	Technology Transfer, Finance assistance, Logistics

Objectives	Activities	Key performance indicators	Time Frame	Key Implementers	Resource /Needs
(5) To reduce/eliminate release into environment of PCDD/F, and other UPOPs from uncontrolled burning activities, including waste burning, biomass burning and accidental fires.	▪ Waste management regulation including waste hierarchy (towards more circular economy) ▪ Review and develop by-laws, guidelines and procedures for uncontrolled burning activities. ▪ Improve and/or develop regulations ▪ Implementation of regulations	Waste management law updated By-laws and guidelines on waste burning reviewed Regulations developed. Open burning reduced (50%)	2 years	EPA, MLGRD	
	▪ Implementation of waste hierarchy –(3 R concept; circular economy) ▪ Development of a waste to energy concept (co -combustion) within the waste hierarchy frame ▪ Coordination with national plastic management plan ▪ Reduce and control chlorine containing material and chemicals which contribute to UPOPs release Expand on-going sanitary landfill site. ▪ Establish concept/mechanism and training for the prevention and early detection/stop ▪ Stop of other waste burning (e-waste, household) ▪ Strengthen institutions to implement the waste hierarchy and cleaner technologies and BAT/BEP	Waste reduced; Recycling rates increased (20%). Co-combustion of waste which cannot be recycled or reused Harmonized plastic approach Policy to reduce or ban chlorine containing products in place Sanitary landfills developed Mechanism in place; Workshops for waste managers Reduction of open burning (50%)Training on waste hierarchy, BAT/BEP, cleaner technologies	10 years	EPA, DA, Traditional Authorities, MLG, AG, GNFS, NGO'	Financial assistance, Vehicles, Training, Technical Expertise, Technology Transfer
	▪ Develop approach for reducing open biomass burning (bush clearing, post-harvest residues etc.) ▪ National concept of biomass use ▪ Promote and implement strategy in using biomass including agriculture residues in energy production (biogas, biomass boilers etc.) ▪ Production of compost and organic fertilizers (target). ▪ Assessment bio-refinery concept (sustainable chemistry)	Open biomass burning minimized. Nation biomass concept Share of biomass in energy mix with controlled release increased significantly. Composting target (25%) Bio-refinery concept in national R&D program	5 years		
	▪ Develop educational material on the health and environmental effects of burning of materials suspected to be emission sources. ▪ Awareness, education and training to minimize and eliminate open burning	Educational materials developed Outreach to the main stakeholders (policy, public, farmers, waste management).			

Objectives	Activities	Key performance indicators	Time Frame	Key Implementers	Resource / Needs
(6) To eliminate/reduce releases of PCDD/F and other UPOPs from incineration of medical waste	▪ Develop a phase out strategy of all old and existing methods of incineration in hospitals and health centers. ▪ ▪ Promotion of w aste segregation and non-combustion technology use ▪ ▪ Construct modern incinerators with designs to improve combustion of medical waste. ▪ Develop institutional and human resource capacity to implement national medical waste management guidelines	Stop of open burning and non - BEP incineration Efficient waste management systems established at all health centres. Medical waste incinerators built and operational. Workshops/training; Implementation performance	5 years	EPA MOH/GHS, Das	Technical Expertise, Consultant, Technology Transfer, Financial assistance
(7) To promote the use of alternative methods of	▪ R&D of alternative energy sources in households. ▪ Promotion of gas-fired stoves, solar systems and ovens depending on R&D outcomes. ▪ Establish alternative energy use demonstration centers	Alternatives energy sources assessed, and available. Policy on LPG reviewed and on solar established & implemented	2 yéars	MOE, EPA, DAs, CSIR, MLG, Private Sector Development	Technical assistance, Technology transfer,

Objectives	Activities	Key performance indicators	Time Frame	Key Implementers	Resource / Needs
(6) To eliminate/reduce releases of PCDD/F and other UPOPs from incineration of medical waste	▪ Develop a phase out strategy of all old and existing methods of incineration in hospitals and health centers. ▪ ▪ Promotion of w aste segregation and non-combustion technology use ▪ ▪ Construct modern incinerators with designs to improve combustion of medical waste. ▪ Develop institutional and human resource capacity to implement national medical waste management guidelines	Stop of open burning and non - BEP incineration Efficient waste management systems established at all health centres. Medical waste incinerators built and operational. Workshops/training; Implementation performance	5 years	EPA MOH/GHS, Das	Technical Expertise, Consultant, Technology Transfer, Financial assistance
(7) To promote the use of alternative methods of household fuel for cooking[58]	▪ R&D of alternative energy sources in households. ▪ Promotion of gas-fired stoves, solar systems and ovens depending on R&D outcomes. ▪ Establish alternative energy use demonstration centers ▪ Sensitize public on the environmental and health impacts of burning wood fuels and benefits that accrue from energy efficiency initiatives.	Alternatives energy sources assessed, and available. Policy on LPG reviewed and on solar established & implemented Demonstration centres established. Awareness created. Switch to alternative energy (40%)	2 yéars	MOE, EPA, DAs, CSIR, MLG, Private Sector Development	Technical assistance, Technology transfer, Financial assistance.
(8) To reduce/eliminate releases of PCDD/F, and other UPOPs and pollutants from the transport sector. (link to climate change activities)	▪ Assessment to what extent polychlorinated paraffins are used as engine oils and possible impact on PCDD/F and UPOPs releases. ▪ Sensitize motorists on the need for the adoption of fuel efficiency initiatives. ▪ Encourage reliance on mass transportation system to reduce fuel consumption. ▪ Develop vehicle emission regulations and standards. ▪ Enforce permitting conditions for fuel service centres.	Market survey on CP engine oils use and report on effect of PCDD/F release. Sensitisation workshops carried out. Compliance and Enforcement Network established. Emission regulations standards developed. Compliance and Enforcement Network monitoring.	5 years	EPA, MOE, MOT, MPRH, DVLA, Police, Transport Unions / associations	Equipment, Technical Expertise, Financial Assistance.

Objectives	**Activities**	**Key performance indicators**	**Time Frame**	**Key Implementers**	**Resource /Needs**
(9) To promote the adoption of best practice in foundry process to reduce/eliminate emissions	▪ Develop best practice guidelines on the selection of scrap metal for processing for small-scale foundry set-ups. ▪ Develop and integrate discharge limit for secondary metal processing into draft regulations on emissions. ▪ Integrate control of chlorine content in waste discharge by industry into permitting system.	Workshops to develop guidelines on best practice. Discharge limits developed Permitting system reviewed and updated to include discharge limits of chlorine content in waste.	5 years	EPA, AGI, NBSSI, GRATIS, IIR/CSIR, KNUST, Research institutions.	Financial assistance, Technical expertise, Equipment, Technology transfer.
(10) To create awareness on the health and environmental effects of release from PCDD/F, and other UPOPs.	▪ Sensitize industry and relevant stakeholders on the generation elimination/reduction of PCDD/F, HCBs and PCBs, through seminars, workshops and training programmes. ▪ Sensitize the general public on the health effect of PCDD/F, HCBs and PCBs. through Radio and Television discussions and advertisement. ▪ Develop educational /awareness materials on the health and environmental effects of PCDD/F HCBs and PCBs. ▪ Develop a comprehensive database on PCDD/F, HCBs and PCBs.	Workshop and seminars organised. TV and radio discussions held Education materials developed Database on PCDD/F, HCBs and PCBs	5 years	EPA, NGOs, GES, MOH, ISD, media	Financial assistance, Environmental fund, Vehicles, Technical expertise / Consultants
(11) To monitor the release of PCDD/F, and other UPOPs	▪ Monitor conditions, types and sources of generation of PCDD/F, and other UPOPs ▪ Sample and analyse human tissues/organs and foods samples. ▪ Continuous study of conditions and processes generating the emissions. ▪ Integrate information/results into database management system	Functional laboratories in place for monitoring Sampling Programme established Study initiated Database in place	10 years	EPA, GSB, Noguchi, Universities	Financial assistance, Vehicles, Equipment, Technical expertise / consultants Laboratories

[58]Assess and possibly link to project of MOE

3.4.10 Activity: Identification and management of stockpiles, waste and articles in use, including release reduction and appropriate measures for handling and disposal (Article 6)

Toxic releases from stockpiles and waste constitute serious threat to human health and the environment. This calls for their safe, efficient and environmentally sound management. Activities geared towards the development of appropriate strategies and measures to stem releases through actions such as proper handling, collection and transport and disposal of such stockpiles and waste are outlined below.

For PCBs and pesticides a considerable part of the stockpiles have been managed. Information obtained from the preliminary inventories of new listed POPs stockpiles, articles in use and waste was insufficient to make detailed meaningful conclusions on needed management efforts. Furthermore for the POP-BFRs now DecaBDE has been listed in 05/2017, which will result in a considerable higher amount of POP-PBDE due to the higher volume of historic DecaBDE use and ongoing DecaBDE use. Furthermore, HBCD have been listed in 2015 and will add to the POP-BFR containing stockpile. A similar situation exist with PFOS and related substances (PFOS precursors) and related containing stockpile. Currently perfluorooctanoic acid (PFOA) and perfluorohexanesulfonic acid (PFHxS) are evaluated from POPRC as POPs and all perfluorinated alkylated substances are an issue of concern. Wastes containing these POPs and PBT chemicals need to be managed. For an accurate assessment of stockpiles, waste and articles in use to be done, it is necessary for these products to be properly identified and characterized. This is in particular challenging for POPs and POP-like chemicals in products. This strategy proposes steps that have to be taken to achieve the intended objective

Safe, efficient and environmentally sound management of stockpiles as well as proper handling and disposal of articles in use, which contain POPs, and other hazardous chemicals are paramount for the achievement of the country obligations under the Stockholm Convention (Article 6) and the Strategic Approach of Chemical Management (SAICM synergy). E.g. also related stockpiles and wastes containing perfluorinated alkylated substances (SAICM issue of concern) or persistent pharmaceutical waste (SAICM emerging policy issue) or hazardous chemicals in electronics (SAICM emerging policy issue) need to be managed that these and other hazardous chemicals do not enter the environment and impact humans and wildlife. Therefore appropriate measures are required in order to achieve such goals. Consider synergy with Basel Convention and related activities.

Table 38: Measures to Reduce Releases from Stockpiles and Wastes (Article 6)

Objectives	Activities	Key performance indicators	Time Frame	Implementers	Resource / Needs
Please note, The management of the stockpiles of the individual POPs (PCBs, pesticides, PFOS, PBDEs, HBCD) is in the respective section above					
(1) To identify stockpiles and sites and assess potential for releases from stockpiles and waste.	▪ Further i dentify sites where POPs and other hazardous chemicals have been stockpiled or waste dumped. ▪ Quantitative inventory of the potential for releases from stockpiles and waste into environmental media	▪ Sites identified ▪ A criteria for assessment of releases established	2 years	EPA, MOFA, GHS/MOH, Relevant Stakeholders	Financial assistance Vehicles, Training and Technical Expertise
(2) To asses mode and determined level of releases from stockpiles and waste	▪ Develop method for estimating the potential for releases. ▪ Sample soil, water, human tissues and fluids, tissue of fauna and fl ora from selected sites to determine residues and presence of annex A, B and C chemicals ▪ Review of health records of populations exposed to waste and stockpiles of annex A, B and C chemicals. ▪ Assess conditions and procedures for storage of stockpiles and waste of annex A, B and C chemicals.	▪ Method for estimating potential for releases developed ▪ Develop selection criteria and laboratory analysis carried out ▪ Health records of exposed populations collated and analysed. ▪ Assessment for storage of stockpiles and waste established	5 years	EPA, MOFA, Relevant Stakeholders Research Institution	Financial assistance Vehicles, Training and Technical Expertise
(3) To prevent the releases from waste and stockpiles of POPs and other hazardous chemicals in order to safeguard human health and environment.	▪ Secure and label sites having stockpiles and waste of POPs and other hazardous chemicals to prevent releases from spreading. Identify potential destruction or remediation technologies available. ▪ Train and upgrade skills of personnel in the application of identified remedial measures and safe handling. ▪ Establish regulations and guidelines for reporting of leakages or spillages and clean-up of contaminated sites ▪ Monitor surface and ground water. Establish programme for continued education and training in clean up in areas contaminated by waste and stockpiles. ▪ Develop procedures on inspections and maintenance of stockpiles and waste.	Sites identified and secured. Best destruction and remediation measures identified. Training programme developed. Guidelines and regulations established. Monitoring programme. Education programme developed Procedures on inspections and maintenance of stockpiles and waste developed.	15 years	EPA, MOFA, CSIR, Relevant Stakeholders GHS/MOH	Equipment, Vehicles, Technical expertise, Financial assistance.
(4) To make information accessible to the relevant stakeholders and the public	▪ Organise public awareness programme to disseminate information ▪ Establish collection points or scheme to encourage voluntary return of damaged or out of use equipment. ▪ Prepare of information and awareness education materials.	Workshops, Seminar, Radio and TV programmes organised. Collection points /scheme established. Awareness creation materials developed.	5 years	EPA, ISD, NGO'S	Financial assistance, Vehicles Technical Expertise / consultants.

Table 39: Identification of Stockpiles, Articles in Use and Wastes

Objective	Activities	Key performance indicators	Time frame	Implementers	Resource / Needs
Please note, The management of the stockpiles of the individual POPs (PCBs, pesticides, PFOS, PBDEs, HBCD) is in the respective section above					
(1) To identify POPs stockpiles	▪ Identify sources of information and stocks of POPs stockpiles in Ghana. ▪ Design questionnaire to collect information and quantify stocks of stockpiles. ▪ Collect information ▪ Organise workshops on the collation of data on stockpiles.	▪ POPs stockpiles identified and compiled. ▪ Survey to collect information carried out. ▪ Workshop on data collection organised.	6 months	EPA, Relevant Stakeholders	Finance, Personal Protective Equipment, Logistics, Human Resource.
(2) To identify POPs articles in use (See individual POPs action plans)	▪ Identify sources of information and stocks of POPs articles in use in Ghana. ▪ Design questionnaire to collect information and quantify stocks of articles in use. ▪ Collect information. ▪ Organise workshops on the collation of data.	▪ POP articles in use identified and compiled ▪ Survey to collect information carried out ▪ Workshop organised	6 months	EPA, Relevant Stakeholders	Finance, Personal Protective Equipment, Logistics, Human Resource
(3) To identify POPs waste	▪ Identify sources of information and stocks of POPs waste. ▪ Design questionnaire to collect information and quantify stocks of waste. ▪ Collect information. ▪ Organise workshops on the collation of data.	▪ POP waste identified and compiled. ▪ Survey to collect information carried out. ▪ Workshop organised	6 months	EPA, Relevant Stakeholders	Finance, Personal Protective Equipment, Logistics, Human Resource

Table 40: Measures to Manage Stockpiles and Appropriate Measures for Handling and Disposal of Articles in Use

Objectives	Activities	Key performance indicators	Time Frame	Implementers	Resource /Needs
Please note, The management of the stockpiles of the individual POPs(PCBs, pesticides, PFOS, PBDEs, HBCD) is in the respectiv e section above					
(1) To manage stockpiles in a safe and environmentally sound manner (See 3.3.3. and 3.3.4)	▪ Identify appropriate storage facilities for interim storage of stockpiles ▪ Upgrade existing information for safe management of stockpiles	▪ Meetings to develop guidelines for safe storage ▪ Facilities to handle stockpiles in place ▪ Workshops to train personnel in management of stockpiles	2 years	EPA, MOFA, DAS MOH/ECG, VRA	Financial assistance, Technical Expertise/Consultants
(2) To know option and limitations for the destruction of POPs and hazardous chemicals in Ghana and the current and future capacity needs and options	▪ Evaluation the option and limitation of cement kilns for destruction of waste (chemicals and chemicals in products) ▪ Evaluation the option and limitation of other facilities for destruction or other ESM measures for chemicals and chemicals in products (CiP) in Ghana ▪ Need assessment for improvement of destruction capacity	▪ Documentation on destruction capacity of cement kilns (positive and negative list) (report) ▪ Documentation of other destruction or otherwise ESM options in Ghana ▪ Need assessment report	2 years	E PA, MOFA, DAS MOH/ECG, VRA, cement industry, GIZ	Financial assistance, Technical Expertise/Consultants
(3) To develop measures for safe handling and sound disposal of stockpiles of chemical and articles in use. (See 3.3.9)	▪ Develop manuals for safe handling and disposal. ▪ Develop guidelines for the transport of articles in use to safe locations. ▪ Establish collection centres or scheme for articles in use.	▪ Meetings to develop manuals for safe handling and disposal ▪ Guidelines on transport developed ▪ Collections points/scheme for articles in use established	5 Years	EPA, MOFA, DA, MOH, ECG, VRA	Financial assistance, Technical Expertise/Consultants
Destruction of POPs and other hazardous chemicals and waste in an ESM	▪ Export of POPs and other hazardous chemical waste which cannot be treated in Ghana ▪ Destruction of POPs containing waste and other hazardous chemicals containing waste in an ESM in Ghana ▪ Disposal of selected hazardous waste	▪ POPs and other hazardous chemical waste (including hazardous chemicals in products) managed in ESM	10 years	EPA, MOFA, DAS MOH/ECG, VRA, cement industry	Financial assistance, Technical Expertise/Consultants

3.4.11 Activity and Strategy: Identification of Contaminated Sites (Annex A, B and C Chemicals) and Remediation in an Environmentally Sound Manner

Article 6 of the Stockholm Convention requires that Parties develop appropriate strategies for the identification of sites contaminated with chemicals listed in Annex A, B or C and remediation of such sites carried out in an environmentally sound manner. The country strategy is as outlined below:

Table 41: Identification of Contaminated Sites (Annex A, B and C Chemicals) and Remediation in an Environmentally Sound Manner

Objectives	Activities	Key performance indicators	Time Frame	Implementers	Resource / Needs
(1) Regulatory frame for contaminated sites	▪ Develop/update legislation to set criteria for determining contaminated sites ▪ Legislation on liability (PPP[1]) related to contamination and clean-up procedures.	Draft regulation developed	2 years	EPA, Task Team, Research institutions	
(1) Methodology to identify sites contaminated with Annex A, B and C chemicals	▪ Develop methodology to systematically identify contaminated sites ▪ To participate in the UNEP working group on POPs contaminated sites	General procedures for investigations developed Expert nominated for UNEP BAT/BEP group and participated	2 years	EPA, Task Team, Research institutions	Financial assistance Protective Equipment, Technical expertise, Vehicles
(2) To institute securing, and were feasible remediation measures for identified contaminated sites	▪ Standard procedures for s ecuring and labeling contaminated sites. ▪ Identify potential remediation technologies available. ▪ Establish regulations and guidelines for soil and clean-up of contaminated sites ▪ Train and upgrade skills of personnel in the application of identified remedial measures.	▪ Procedures Contaminated sites clearly identified and isolated. ▪ Compilation and selection of available environmentally sound remediation methods (report) ▪ Draft regulations and guidelines on clean up procedures ▪ Training of stuff on contaminated sites (XX); contaminated site expert in EPA	5 years	EPA, Task Team, Research institutions	Financial assistance Protective Equipment, Technical expertise,
(3) Countrywide database for POPs contaminated sites including relevant other pollutant	▪ Assessment of database systems for contaminated sites in other countries ▪ Selection of database approach	▪ Report on database with recommendation ▪ Database selected and established	3 years	EPA; ECG, VRA, GRIDco, Task Team, Research institutions	Financial assistance Technical expertise,
Assessment and securing of POPs pesticides contaminated sites	▪ Assessing and securing of potentially POPs pesticides contaminated sites (sites of formulation, storage, use and disposal) ▪ Overall risk assessment of the sites (toxicity of mixture present)[2]	Potential POPs pesticide contaminated sites are assessed, ranked for priority and secured	3 years	EPA, Ministry of agriculture, Task Team, Research institutions	Financial assistance Protective Equipment, Technical expertise, Vehicles
Assessment, securing and remediation of PCB contaminated sites	• Assessing and securing of pote ntially PCB contaminated sites (storage, use and disposal PCB equipment) ▪ Remediation of contaminated sites	Potential POPs pesticide contaminated sites are assessed, ranked for priority and secured	36 month	EPA, Relevant Stakeholders	Financial assistance Technical asstance Analytical capacity
Identification, assessment, securing and possibly remediation of POP - PBDE contaminated sites.[3]	▪ Develop method for risk assessment of sites where WEEE, EoLV have been treated ▪ Train and upgrade skills of personnel in the application of identified remedial measures and safe handling ▪ Assessment and securing and possibly remediation of contaminated sites	Method for risk assessment developed Best securing and remediation measures identified and personnel trained	5 years	EPA, E-waste operators GRA-CD, Research institutions	Financial assistance , Protective Equipment, Technical expertise, Vehicles

[1] Polluter Pays Principle

[2] See for example: Pieterse B, Rijk IJC, Simon E, van Vugt -Lussenburg BMA, Fokke BFH, van der Wijk M, Besselink H, Weber R, van der Burg B (2015) Effect -based assessment of persistent organic pollutant - and pesticide dumpsite using mammalian CALUX reporter cell lines. Environ Sci Pollut Res Int. 22:14442-14454.

[3] At sites where WEEE and end of life vehicle and other PBDE containing waste is treated the final pollution is a mixture of many pollutants (Wong et al. 2007). Wong MH, Wu SC, Deng WJ, Yu XZ, Luo Q, Leung AO, Wong CS, Luksemburg WJ, Wong AS (2007) Export of toxic chemicals - a review of the case of uncontrolled electronic-waste recycling. Environ Pollut. 149(2):131-140.

Assessment, management, database of potentially PFOS and PFAS contaminated sites and securing /remediation needs	▪ Use guidelines for identification and assessment of PFOS/PFAS contaminated sites ▪ Training in identification and management of contaminated sites ▪ Database and maps of potentially contaminated sites and prioritization of the sites (risks) for further assessment and clean-up ▪ Analytical confirmation of POPs contamination for the identified locations (according a prioritization list) ▪ Develop strategies for the environmentally sound management of POPs contaminated sites ▪ Take measures to secure the contaminated sites to stop human exposure and environmental releases ▪ Identification of clean-up measures and initiate clean-up procedures for high priority sites.	Contaminated site criteria defined and legislation developed Guidelines on identification developed Workshops conducted, staff trained Priority sites determined Pollution assessed Strategies for addressing sites developed ▪ Measures to secure sites implemented	3 years	EPA, Ghana National Fire Service, Ghana water, GAEC, academia & research	Financial assistance Vehicles, Training And Technical Expertise
Assessment, management, database of potentially PCDD/PCDF and other UPOPs contaminated sites and securing /remediation needs	▪ Use guidelines for identification and assessment of UPOPs contaminated sites ▪ Training in identification and management of contaminated sites ▪ Database and maps of potentially contaminated sites and prioritization of the sites (risks) for further assessment and clean-up ▪ Analytical confirmation of UPOPs contamination for the identified locations (according to prioritization) ▪ Develop strategies for the environmentally sound management of POPs contaminated sites ▪ Take measures to secure the contaminated sites to stop human exposure and environmental releases ▪ Identification of clean -up measures and initiate clean-up procedures for high priority sites.	Contaminated site criteria defined and legislation developed Guidelines on identification developed Workshops conducted, staff trained Priority sites determined Pollution assessed Strategies for addressing sites developed Measures to secure sites implemented	3 years	EPA, Ghana National Fire Service, Ghana water, GAEC, academia & research	Financial assistance Vehicles, Training And Technical Expertise

3.4.12 Activity: Public Awareness, Information and Education (Article 10)

The successful implementation of the Stockholm Convention on POPs in Ghana will only be achieved when the relevant stakeholders (policy makers, industry, science community, civil society and general population) are sensitised on the nature of POPs, other PBTs and hazardous chemicals and their effects on human health and the environment and get committed to the achievement of the objective. It is therefore important for action to be directed at promoting the continuous and detailed public awareness, information and training programmes on POPs. Such programmes will be targeted at the policy and decision makers as well as the general public. Various stakeholders in the POPs management will be trained and equipped to play their respective roles. The following activities will be pursued in the attainment of the said objectives.

Table 42: Facilitating or undertaking Information Exchange and Stakeholder Involvement

Objectives	Activities	Performance indicators	Time Frame	Implementers	Resources /needs
(1) To establish a national focal point for the exchange of information.	▪ Designate national focal point for information exchange ▪ Identify appropriate information required for information exchange ▪ Recruit professional and auxiliary staff e.g. data analysts, information technologists, public relations officers etc ▪ Purchase and install equipment e.g. communication gadgets, computers, ▪ Subscribe to Internet websites with links to sources listed in the national inventory. ▪ Develop internet website	▪ National focal point established ▪ Required information identified ▪ List of recruited professionals available ▪ Communications equipment installed ▪ Website developed	2 years	EPA, MESTI, Information Services Ministry of Information, MOC	Financial assistance, Technical Expertise, Equipment.
(2) To equip staff with relevant skills	▪ Train staff at focal point with relevant skills	▪ Trained staff at national focal point. ▪ Training workshop reports available.	18 months	EPA, MESTI,	Financial assistance, Technical Expertise, Equipment

(3) To strengthen national capacity to collect and use multi sectoral information.	▪ Identify the resource persons ▪ Carry out needs assessment ▪ Develop training materials and programmes. ▪ Carry out training.	▪ Resource persons identified ▪ Needs assessment report ▪ Training materials developed ▪ Training organised	1 year	CEPS, ECG, EPA, FDA, GSA, PPRSD, MOH etc	Financial assistance, Technical Expertise, Equipment
(4) To obtain Stakeholder commitment	▪ Identify relevant stakeholder institutions/partners ▪ Communicate with identified stakeholders ▪ Obtain feedback from stakeholders ▪ Involve stakeholders in programmes	▪ Communications equipment installed. ▪ Communication via internet	2 years	MESTI, EPA	Financial assistance, Equipment

Table 43: Awareness, information and Education (Article 10)

Objectives	Activities	Key performance indicator	Time frame	Key implementers	Resource/ Needs
(1) To develop and produce for stakeholder awareness programme on POPs, PBTs, SAICM emerging policy issues and GSC concept	▪ Develop and produce awareness raising materials e.g. brochures, flyers, posters, newsletters etc on POPs, PBTs, SAICM emerging policy issues and GSC concept ▪ Translate materials into local languages. ▪ Develop radio and TV education programmes e.g. prepare synopsis, write scripts for local drama etc to cater for the needs of women, children and the non-formal society ▪ Place articles for publication in both private and state-owned newspapers.	▪ Awareness raising materials developed and produced. ▪ Awareness raising materials in local languages produced ▪ Radio and TV programmes ▪ Feature articles published in newspapers	3 years	EPA, MESTI, ISD, Relevant stakeholders	Financial assistance, equipment, vehicles, digital cameras, recorders, video and projector.
(2) To create awareness among policy and decision makers/traditional authorities on POPs, PBTs, SAICM emerging policy issues, hazardous chemicals and GSC concept	▪ Identify relevant decision and policy makers/traditional authorities. ▪ Organise workshops/seminars to sensitise identified groups	▪ List of identified relevant policy/decision makers/traditional authorities. ▪ Workshops/seminars organized.	1 year	EPA, MESTI, Relevant stakeholders.	Financial assistance, training materials, technical expertise.
Include green and sustainable chemistry (GSP) into curricula	▪ Develop modules for Green and Sustainable Chemistry ▪ Collaborate with MOE/GES to integrate POPs management in the environmental education syllabus of basic and secondary schools ▪	▪ Modules ▪ Suggested syllabus on POPs in place.			
(3) To implement education programmes for the public and other stakeholders (for individual POPs specific awareness and education is included in the)	▪ Provide the Information Services Department and the media houses with information materials ▪ Explore and use social media for awareness creation ▪ Identify resource persons to carry out public education e.g. representatives of various organisations and institutions, public interest groups, NGOs, media, traditional authorities. ▪ Train identified resource persons. ▪ Design programme with electronic and print media houses to discuss/publish POPs related issues.	▪ Information on POPs for ISD ▪ List of resource persons ▪ Workshops organised for resource persons ▪ Allocated airtime and space.	5 years	EPA, GES, Media. Relevant stakeholders	Financial assistance, vehicles, sponsors.
Capacity for alternative assessment and promotion of GSCs	▪ Development of alternative assessment capacity on university or institution level and industry ▪ Promote the use of GSC alternatives to POPs and PBTs by incentives	▪ Capacity developed Promotion programmes in place (Green public procurement, tax incentives)			
(4) To promote public awareness in addressing effect of POPs, PBTs and other hazardous chemicals on human	▪ Organise programmes on POPs PBTs and other hazardous chemicals (e.g. SAICM issues) such as radio competitions, quizzes for schools, radio and TV phone-in programmes	▪ Programmes on POPs and Ghana relevant hazardous chemicals organised	5 years	EPA, Media Relevant Stakeholders	Financial assistance Vehicles, Technical Expertise

Objectives	Activities	Key performance	Time	Key	Resource/
(5) To compile and collate information on	▪ Establish Information Centre. ▪ Develop mechanisms for the	▪ Assessment of needs of information centre ▪ Mechanisms	2 years	MES, EPA Relevant Stakeholders	Financial assistance, Technical
(6) To promote and facilitate information	▪ Develop websites, and newsletters. ▪ To promote the	▪ Websites, newsletters. ▪ Leaflets, brochures		EPA, MES, MLG Relevant	Financial assistance, Technical
(7) To train workers, technical and managerial	▪ Develop course modules for various categories of personnel. ▪ Produce training materials	▪ Course modules designed. ▪ Training materials	2 years	EPA Relevant Stakeholders	Financial assistance, Vehicles, Technical

3.4.13 Activity: Effectiveness Evaluation (Article 16)

Article 16 of the Convention requires parties to establish mechanisms for providing comparable monitoring data on the presence of Annex A, B and C chemicals. This evaluation shall be conducted on the basis of available scientific, environmental, technical and economic information including national reports. The activities below provide details of actions to achieve the provisions of the Convention.

Table 44: Effectiveness Evaluation (Article 16)

Objectives	Activities	Key performance indicator	Time frame	Key implementers	Resource / Needs
(1) Evaluate the effectiveness of the implementation by human milk trend	▪ Update of the human milk study	▪ Report on human milk study	2 years	EPA, Ministry of Health Relevant Stakeholders	Financial assistance, International cooperation Technical Expertise
(2) To evaluate the effectiveness of the implementation of the Convention in Ghana by other approach	▪ Develop an evaluation programme. ▪ Assessment of other performance criteria options. ▪ Develop further national performance evaluation criteria.	▪ Evaluation programme prepared. ▪ Assessment report on other options. ▪ Criteria Developed.	2 years	EPA, Relevant Stakeholders	Financial assistance, Technical Expertise
(3) To inform and disseminate on evaluation results	▪ Preparation of evaluation report and information materials ▪ Include results in the awareness raising activities	▪ Report and awareness materials. ▪ Information integrated in awareness activities and disseminated.	3 years	EPA, Relevant Stakeholders	Financial assistance, Technical Expertise

3.3.14 Activity: Reporting

Article 15 of the Stockholm Convention on POPs mandates parties to report to the Conference of Parties (COP) on measures taken to implement the provisions of the Convention as well as the effectiveness of the measures taken. In addition, each party is to provide to the Secretariat, statistical data on its total quantities of production, import and export of each of the chemicals listed in Annex A and B as well as a list of states from/to which it has imported/exported each of such substances. The article 15 reports provide a substantial input to the effectiveness evaluation of the Convention (Article 16), and are submitted every four years. This Action Plan therefore aims at collecting/collating all information relevant to the provisions of the Convention and packaging them in a suitable manner for reporting to the secretariat and the COP.

Table 45 Reporting

Objectives	Activities	Key performance indicator	Time frame	Implementers	Resource / Needs
Mechanism in place for article 15 reporting within given dates	▪ Develop a mechanism for complying with the reporting requirements by submission of reports within the given deadlines ▪ SC National Focal getting acquainted with the latest version of the reporting format and reporting manual; ▪ Identifying the possible data sources and human resources needs to compile the reporting questionnaire; ▪ Formation of a team dealing with reporting; ▪ Disseminate the information on the reporting format, modalities of filling the information and data that need to be included in the reporting format; ▪ Setting up clear responsibilities for data collection and filling team and appropriate timelines; ▪ Final check and review the data compiled.	▪ Mechanism established	1 year (for 2018 reporting)	Ghana EPA	Technical assistance
To comply with article 15 reporting	▪ Compile information for reporting (update needed inventories and other information) ▪ Submit report to the secretariat (website)	▪ Reporting submitted deadlines met	1 year (reporting 2018 and then cycles)	Ghana EPA; SC focal point	Technical assistance

3.4.15 Activity: Research, Development and Monitoring (Article 11)

Article 11 of the Stockholm Convention mandates parties to undertake appropriate research, development, monitoring and cooperation pertaining to POPs and where relevant to their alternatives and candidate POPs. From initial assessment conducted, it was established that the country lacks the requisite infrastructure and institutional capacities to handle research and development issues relating to POPs. This section therefore identifies various activities in addressing the research, development and monitoring needs of Ghana.

Table 46: Research, Development and Monitoring (Article 11)

Objectives	Activities	Key performance indicator	Time frame	Key implementers	Resource /Needs
(1) To develop institutional and research capacity to manage POPs and other PBTs and other hazardous chemicals	▪ Identify institutions with the potential to undertake research into POPs and other PBT pollutants ▪ Strengthen national scientific and technical research capabilities and infrastructure to promote assess to exchange of data and analysis ▪ Develop mechanism for networking among identified research institutions ▪ Undertake research aimed at alleviating the effects of POPs on reproductive health ▪ Establish procedures for communicating research and development findings to the public	▪ institutions identified, contacted ▪ Needs of national scientific and technical research capabilities relation to POPs established ▪ Meetings to identify proper avenues for networking ▪ Research into the alleviation of effects of POP on reproductive health initiated ▪ Linkages for communication established	10 years	EPA, Laboratory experts, GSB, GAEC, Tertiary Institutions, CSIR	Financial Assistance, Vehicles, Technical expertise Consultants
	▪ Develop research into Green and Sustainable Chemistry (G&SC)) ▪ Develop G&SC modules into curriculum ▪ Undertake research to identifying alternatives to POPs.	▪ Workshops on G&SC ▪ Research project(s) on G&SC developed ▪ G&SC modules included into curricula ▪ Research initiatives into finding alternatives to POPs		EPA; MESTI, Universities ISC3; Leuphana University	
(2) To identify appropriate laboratories and partners to monitor all POPs activities	▪ Compile list of existing laboratories (See National Profile on Chemicals). ▪ Develop criteria for the assessment of capacities of existing laboratories to analyse POPs. ▪ Assess and select laboratories. ▪ ▪ To identify cooper ation partners for POPs an PBT research ▪	▪ Data base of existing laboratory ▪ Stakeholder consultations to identify assessment criteria for listing laboratories ▪ Stakeholder consultation to assess and select laboratory. ▪ MOU signed with partner institutions and laboratories	1 year	EPA, Laboratory experts, GSB, GAEC, Tertiary institutions, CSIR Cooperation partners (TBD)	Financial Assistance, Vehicles, Technical expertise Consultants.
(3) To upgrade two laboratories capable of analyzing Annexes A and B Chemicals	▪ Upgrade infrastructure of two laboratories to analyse Annexes A and B chemicals.	▪ Laboratories established ▪ Equipment purchased ▪ Staff trained ▪ International standard methods selected ▪ Laboratories accredited for all relevant	5 years	EPA, GAEC, GSA, MFA, CSIR, Research Institutions Universities	Financial Assistance, Vehicles, Technical expertise Consultants.
(4) To monitor levels of concentration of POPs and other relevant PBTs in the environment.	▪ Select matrices to sample ▪ Determine appropriate methods of sampling and analysis to apply ▪ Analysis of soil, air water, human milk, other biota for presence of POPs.	▪ Sample matrices identified ▪ Methods for sampling selected ▪ Sample collected ▪ Analysis Results	10 years	EPA, GAEC, GSA, CSIR, Universities EPA, st akeholders	Financial Assistance, Vehicles, Technical expertise / consultants
(5) To undertake proper management of data	▪ Establish procedures for the management of analysis results ▪ Consider internationally recognized guidelines for data generation and interpreting monitoring results and presenting monitoring reports	▪ Procedure for management of analysis results established ▪ Good Laboratory Practice used, ▪ International standards accredited ▪ Harmonized methodology for reporting interpretation of results	2 years	EPA, customs, stakeholders	Training, Computer software.
(6) To establish mechanism for quality assurance and control of monitoring activities	▪ Establish effective quality assurance and quality control system ▪ Setting up of review panel to evaluate data prior to acceptance	▪ Protocol for ensuring QA/QC in place ▪ Procedure for data evaluation developed ▪ Workshop to identify review panel organised	2 years	EPA, GSA, stakeholders	Financial Assistance, Training

3.4.16 Activity: Technical and Financial Assistance (Articles 12 and 13)

The ability of Ghana to fulfil its obligations under the POPs Convention depends on the provision of adequate financial and technical assistance. The following actions would be required to enable the country obtain the needed financial and technical support required for the successful implementation of activities and actions to be carried out to achieve the POPs overall objectives. Further considerations on financial assistance and on financing considerations are compiled in chapter 3.6 below.

Table 47: Technical and Financial Assistance (Articles 12 and 13)

Objectives	Activities	Key performance indicator	Time frame	Key implementers	Resource/ Needs
(a) To source for technical assistance towards the successful implementation of the Convention (Article 12)	▪ Assess technical needs ▪ Identify sources of technical assistance	▪ Documentation of needs ▪ List of sources of technical assistance ▪ Number of proposals prepared and submitted and acceptance	1 year	EPA, MESTI, MOF, MFA&RI	Technical expertise, financial assistance
(b) To source for financial assistance towards the successful implementation of the Convention	▪ Financial needs assessment ▪ Identify sources of Financial assistance ▪ Requisition for financial assistance through proposal writing	▪ Documents showing financial needs ▪ List of potential donors identified ▪ Number of proposals prepared and submitted	1 year	EPA, MES TI, MOF, MFA&RI	Technical expertise, Financial assistance

3.5 Development and Capacity Building Proposals and Priorities

This section presents initial priority project proposals to operationalise the National Implementation Plan. The overall goal of the projects is to improve the management of risks to human health and the environment from Persistent Organic Pollutants. The specific projects and their respective objectives are summarized below.

Table 48: Development and Capacity Building Proposals and Priority Projects

No.	Project/Objectives	Activities	Time Frame	Budget (USD)
1	Strengthen human and institutional capacity for the management of POPs	• Develop policy and legislation for the management and control of POPs. • Develop guidelines for the safe and environmentally sound usage, transportation, storage, handling and disposal of POPs and POPs containing equipment. • Develop capacities in relevant institutions for the management of POPs. • Promote coordination of activities of relevant institutions on POPs	3 years	250,000
2	To develop capacity and capability for the identification, analysis and monitoring of POPs in the technosphere and the environment.	• Upgrade at least two (2) laboratories and acquire analytical equipment for analysing POPs • Train staff to run laboratories. • Assess levels of POPs in the environment.	5 years	3,218,000
3	To develop and implement information and communication system for the management of POPs.	• Establish national data and information centre on POPs • Formulate and implement communication strategy on POPs. • Promote networking among stakeholders at the national and international levels. • Establish poison information and management centres.	1 year	133,100
4	Investigate and assess the nature and severity of health effects experienced by humans as a result of exposure to Persistent Organic Pollutants (POPs)	• Estimate nature and severity of health effects experienced by high risk groups (workers, vulnerable population, infants) • Recommend opportunities for management interventions required to reduce identified adverse effects and risks to acceptable levels. • Strengthen capacity of health centres to handle POPs poisoning	2 years	347,200
5	To develop life cycle management of POPs (PCBs, pesticides, industrial POPs) and undertake safe and environmentally sound (SES) treatment and disposal of POPs, POPs-containing equipment.	• Enhance capabilities of line institutions and for the environmentally sound management (ESM) (collection, transportation and storage) of POPs. • Private sector participation in the SES collection, transportation, storage, treatment and disposal of POPs promoted. • Identify and rehabilitated and/or redesign facilities for the SES storage and disposal of existing POPs pesticides and POPs-containing equipment. • Develop procedures for the SES treatment and disposal of POPs pesticides, PCBs and industrial POPs -containing equipment and wastes. • Conduct treatment and disposal of existing stockpiles of POPs-containing wastes and equipment and POPs pesticides.	5 years	5,500,000

6	Reduction and phase out of POPs and products/articles containing POP-PBDEs, HBCD, SCCP, PFOS and related substances and selection of sustainable alternatives	• Assessment of the use of POPs and products containing POPs • Strengthening capacity of science and technology in alternative assessment and substitution of POPs and POPs-like chemicals (SAICM) • Assessment of alternatives to POPs in current use • Substitution of POPs and POP-like chemicals by green and sustainable chemistry	5 years	1,250,000
7	Control and emission reduction of UPOPs (within integrated pollution prevention and control).	• Assessment of technologies and approaches to reduce UPOPs • Assessment of reduction of co-pollutants and co-benefits when addressing UPOPs towards an integrated pollution prevention and control • Implementation of BAT/BEP for priority sources	5 years	1,500,000
8	Securing and remediation of POPs contaminated sites	• Development of inventory of POPs contaminated sites • Development of Database of POPs contaminated (within general database of contaminated sites) • Prioritization of contaminated sites • Securing of contaminated sites with high priority ranking (exposure)) • Remediation of contaminated sites with high priority ranking	10 years	2.500.000
9	Awareness raising of relevant organizations and individuals and community on risk related to exposure of POPs and other hazardous chemicals	• Stakeholder group assessment for awareness raising (policy makers, workers, science, the public, NGOs) • Assessment, compilation and adjustment of awareness raising materials for stakeholder groups • Education and information of individual stakeholder groups • Integration of POPs, alternatives to POPs and sustainable chemistry in curricula of secondary and tertiary school	3 years	500,000

3.6 Resource Requirements

The government of Ghana shall ensure the necessary resources, while mobilizing the contributions of international financing sources for the NIP implementation. The Government should create a legal basis and favourable conditions to encourage and attract the participation of all related economic sectors, domestic and foreign organizations, as well as investors for the implementation of the National Plan.

It is of crucial importance to also encourage investors, businesses, and social organizations investing to implement pollution remediation projects through incentives such as policies on land, tax reduction, tax exemption, favourable credits etc. in POPs management.

The coordination and integration of National Plan with other related national plans, programs and projects on sustainable development, waste management, climate change, natural resources management, programs on science and technology and other relevant programs, projects and activities in order to attract investments and increase capital efficiency.

Resource needs are tentative listed for the individual activity in the action plans. A detailed budget for an activity will be calculated during development of individual projects.

The NIP will be implemented through mobilization of various finance resources such as state budget, ODA grant aid, extended producer responsibility contribution, polluter pays principle contributions, loan, financing from organizations and individuals, etc.

One important source for financing the management of wastes and stockpiles are financing or co-financing from extended producer responsibility (EPR). For several waste fractions related to POPs the extended producer responsibility apply and need to be set up via policy and regulation. Some wastes related to POPs can be covered under the extended producer responsibility frame:

- E-waste including e-waste plastic
- End of life vehicle (including the polymers)
- Pesticides containers and stockpiles
- Synthetic carpets

Within a GIZ project the funding of e-waste management in Ghana is developed also covering e-waste plastic. The development of this financing scheme might then be modified to establish funding schemes for other waste categories.

In the set-up of funding of the waste management also the value of the waste need to be considered as co-financing source. E.g. vehicles have an inherent value (200 to 400 US$) mainly from metals and this value should be used to also manage the non-valuable fraction of plastic and other polymer. A system need to be developed which does not allowing to just pick out the valuables like metals (cherry picking) without managing the remaining non-valuable fraction.

The improvement of recycling and recovery schemes also can contribute to financing of waste management including POPs management. E.g. from experience in Europe, more than 50% of e-waste plastic can be recycled after separation with a reasonable price for the separated plastic fraction.

Furthermore Ghana has a National Plastic Policy which will be implemented in coming years. The efforts of this activity will also address some POPs related plastic and other polymer wastes.

The polluter pays principle (PPP) can likely be used in the area of contaminated sites and hot spots. Before the principle can be applied the related regulatory frame need to be set-up that the PPP can be used as co-financing source.

The elaboration, allocation, and cost estimate decisions, as well as the management, use and settlement of funds for implementation of the National Plan should be conducted in accordance with regulations.

Also, National Plan implementing authorities should take maximum advantage of the financial resources allocated by international financial organizations and other countries by conducting appropriate campaigns to attract capital from donors for the National Planning, creating a legal basis for encourage international sponsorship etc.

Strengthening international cooperation should be carried out in various areas such as technical cooperation, grant aid for project development, improve capacity, institutional improvement, supporting under projects, resolving health and social benefits problems for the stakeholders.

Tentative cost for priority project are listed in Table 47 on "Development and Capacity Building Proposals and Priority Projects".

APENDIX 1: MEMBERSHIP OF THE NATIONAL COORDINATION TEAM

NO.	NAME	ADDRESS/INSTITUTION
1	Mr. Daniel S. Amlalo/Mr. John A. Pwamang (National Project Director)	Environmental Protection Agency, Accra
2	Dr. Sam Adu-Kumi (National Project Coordinator)	Environmental Protection Agency, Accra
3	Mr. Peter Asigbe	Electricity Company of Ghana, Accra
4	Dr. Michael Dade	Volta River Authority, Akosombo
5	Ms. Shiela Kangberee	Ministry of Trade and Industries, Accra
6	Dr. O. D. Ansa-Asare	Council for Scientific and Industrial Research (Water Research Institute),
7	Mr. Anthony Mensah	Ghana Revenue Authority (Customs Division)
8	Mr. Emmanuel Gyimah	Association of Ghana Industries, Accra
9	Mr. Charles Nortey	Trades Union Congress (General Transport and Petroleum Chemicals Workers Union), Accra
10	Dr. Edith Clarke	Ghana Health Service, Accra
11	Mr. E. Appah-Sampong	Environmental Protection Agency, Accra
12	Mr. Fredua Agyeman	Ministry of Environment, Science, Technology and Innovation, Accra
13	Prof. James Ephraim	Catholic University College

APENDIX 2: MEMBERSHIP OF THE TASK TEAMS

NO.	NAME	ADDRESS/INSTITUTION
	ASSESSMENT OF POPs PESTICIDES TASK TEAM	
1	Mr. Joseph C. Edmund (Chairman)	Environmental Protection Agency
2	Mr. Emmanuel Aboagye	Ministry of Food and Agriculture/Plant Protection and Regulatory Services Directorate, Pokuase
3	Mr. Benjamin Dwomoh	Ghana Agricultural Input Dealers Association, Kumasi
4	Mrs. Felisa Owusu-Darko	Environmental Protection Agency
5	Mrs. Angela Owusu	Ghana Revenue Authority (Customs Division)

ASSESSMENT OF PCBs TASK TEAM		
1	Mr. Peter Asigbe	Electricity Company of Ghana
2	Mr. Michael Dade	Volta River Authority
3	Mr. Stephen Amoah	Ghana Grid Company (GRIDco)
4	Mr. John Pwamang	Environmental Protection Agency
ASSESSMENT OF POP-PBDEs/HBB TASK TEAM		
1	Prof. Shiloh D. Osae (Chairman)	Ghana Atomic Energy Commission, Kwabenya, Accra
2	Dr. Crentsil K. Bempah (Secretary)	Ghana Atomic Energy Commission, Kwabenya, Accra
3	Dr. Jonathan Hogarh	Kwame Nkrumah University of Science and Technology, Kumasi
4	Mr. Lovelace Sarpong	Environmental Protection Agency, Accra
5	Dr. Osmund Ansah-Asare	Council for Scientific and Industrial Research (Water Research Institute), Accra
ASSESSMENT OF PFOS/PFOS SALTS/PFOSF/HBCD TASK TEAM		
1	Prof. Joseph Fianko (Chairman)	Graduate School of Nuclear and Allied Sciences, University of Ghana, Legon
2	Prof. Kofi Essuman	University of Cape Coast, Cape Coast
3	Mr. Samuel Kwarteng	Ghana National Fire Service, Accra
ASSESSMENT OF RELEASES OF UNINTENTIONALLY PRODUCED CHEMICALS TASK TEAM		
1	Prof. J. H. Ephraim (Chairman)	Catholic University College, Fiapre, Sunyani
2	Mr. Joseph C. Edmund	Environmental Protection Agency, Accra
3	Mrs. Esi Neequaye-Tetteh	Environmental Protection Agency, Accra
4	Mr. Fred Ohene-Mensah	Department of Factories Inspectorate, Accra

HEALTH AND SOCIO-ECONOMIC ASSESSMENT TASK TEAM

1	Dr. Edith Clarke (Chairperson)	Ghana Health Service, Accra
2	Dr. Kwadwo Ansong Asante	Council for Scientific and Industrial Research (Water Research Institute), Accra
3	Mr. Charles Nortey	Trades Union Congress (General Transport and Petroleum Chemicals Workers Union), Accra
4	Dr. Paul Osei-Fosu	Ghana Standards Authority, Accra
5	Dr. E. Kyerematen-Amoah	Ghana Health Service, Accra
6	Mr. Emmanuel K. E. Appoh	Environmental Protection Agency, Accra
7	Mr. Anthony A. Fletcher	Ghana Health Service, Accra

References

[1]Stockholm Convention. 2012b. Guidance for the inventory of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on POPs (Draft).

[2]Secretariat of the Stockholm Convention (2015) Guidance for the Inventory of commercial Pentabromodiphenyl ether (c-PentaBDE), commercial Octabromodiphenyl ether (c-OctaBDE) and Hexabromobiphenyls (HBB) under the Stockholm Convention on Persistent Organic Pollutants. Draft.

[3]Stockholm Convention. 2012b. Guidance for the inventory of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on POPs (Draft).

[4]The estimation of fractions of vehicles originating from abroad were done by the DVLA and CEPs officials.

[5]Driver Vehicle and Licensing Authority, 2015.

[6]Secretariat of the Stockholm Convention (2015) Guidance for the Inventory of commercial Pentabromodiphenyl ether (c-PentaBDE), commercial Octabromodiphenyl ether

[7]Takahash S (2017) Contamination and Human Exposure to Micropollutants Including Dioxin-Related Compounds in Informal Recycling Sites for E-Waste and End-of-Life Vehicles Plenary lecture 37. Symposium on Organohalogen Pollutants, 20-25 August 2017, Vancouver, Canada.

[8]Diawuo FA. 2012. Waste to Energy (MEGE). Report on MSW Management Impact on GHG Emissions for Ghana, South Africa and Nigeria. Instituto Superior Technico, IST. Pp. 1-34

[9]With the exception of analytical standards.

[10]UNEP (2013) Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs under Article 5 of the Stockholm Convention on Persistent Organic Pollutants. Geneva (toolkit.pops.int).

[11]Holt E, Weber R, Stevenson G, Gaus C (2012) Formation of dioxins during exposure of pesticide formulations to sunlight. Chemosphere, 88, 364–370.

[12]Stockholm Convention document from the 6th POP Reviewing Committee meeting (UNEP/POPS/POPRC.6/INF/21)

[13]Weber R, Gaus C, Tysklind M et al. (2008) Dioxin- and POP-contaminated sites—contemporary and future relevance and challenges. . Env Sci Pollut Res 15, 363-393.

[14]PCDD/F contamination from pesticide production and use between 1950 and 1998 in Japan alone has been estimated at 460 kg TEQ.

[15] Stockholm Convention (2010) SC document from the 6th POP Reviewing Committee meeting (UNEP/POPS/POPRC.6/INF/21).

[16]Bell L, Weber R, De Borst B, Paun MC, Holoubek I, Watson A, Vijgen J (2016) Assessment of POPs contaminated sites and the need for stringent soil standards for food and feed safety. Working document for UNEP Dioxin Toolkit and BAT/BEP group. October 2016.

[17]Stockholm Convention (2017) Draft guidance on preparing inventories of polychlorinated naphthalenes (PCNs). Draft March 2017. UNEP/POPS/COP.8/INF/19.

[18]Stockholm Convention (2017) Draft guidance on preparing inventories of hexachlorobutadiene (HCBD). UNEP/POPS/COP.8/INF/18

[19]Stockholm Convention (2007). Guidelines On Best Available Techniques And Provisional Guidance On Best Environmental Practices Relevant To Article 5 And Annex C Of The Stockholm Convention On Persistent Organic Pollutants - Adopted at COP 3, May 2007. Geneva, Switzerland.

[20]Stockholm Convention (2012) Guidance on best available techniques and best environmental practices for the recycling and disposal of articles containing polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants; Draft July 2012

[21]Tue NM, Goto A, Takahashi S et al. (2016) Release of chlorinated, brominated and mixed halogenated dioxin-related compounds to soils from open burning of e-waste in Agbogbloshie (Accra, Ghana), Journal of Hazardous Materials 302, 151–157.

[22] Essumang DK, Eshun A, Hogarh JN (2016), Perfluoroalkyl acids (PFAAs) in the Pra and Kakum River basins and associated tap water in Ghana. Science of the Total Environment 579, 729-735.

[23]Reeuwijk NM, Talidda A, Malisch R et al. (2013) Dioxins (polychlorinated dibenzo-p-dioxins and polychlorinated dibenzo-furans) in traditional clay products used during pregnancy Chemosphere. 90(5), 1678-1685.

[24]Kuranchie-Mensah, H.; Yeboah, P. O.; Nyarko, E.; Golow, A. A., Studies on Organochlorine Pesticide Residue in Fishes from the Densu River Basin, Ghana. Bulletin of Environmental Contamination and Toxicology 2013, 90, (4), 421-426

[25]Adu-Kumi, S.; Kawano, M.; Shiki, Y.; Yeboah, P.; Carboo, D.; Pwamang, J.; Morita, M.; Suzuki, N., Organochlorine Pesticides (OCPs), Dioxin-like Polychlorinated Biphenyls (dl-PCBs), Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzo Furans (PCDD/Fs) in Edible Fish from Lake Volta, Lake Bosumtwi and Weija Lake in Ghana. Chemosphere 2010, 81, (6), 675-684.

[26]Adu-Kumi, S.; Kareš, R.; Literák, J.; Borůvková, J.; Yeboah, P. O.; Carboo, D.; Akoto, O.; Darko, G.; Osae, S.; Klánová, J., Levels and Seasonal Variations of Organochlorine Pesticides in Urban and Rural Background Air of Southern Ghana. Environmental Science and Pollution Research 2012, 19, (6), 1963-1970.

[27]Hogarh, J. N.; Seike, N.; Kobara, Y.; Masunaga, S., Atmospheric Polychlorinated Naphthalenes in Ghana. Environmental Science & Technology 2012, 46, (5), 2600-2606.

[28] Adu-Kumi, S., Malisch, R., Kotz, A., Kypke, K., Asante, K., Takahashi, S., Tanabe, S., Takasuga, T., Clarke, E., Weber, R., 2010b. Levels of persistent organic pollutants (POPs) in human breast milk samples from Ghana. Organohalogen Compounds 72, 1046-1049.

[29]Asante, K.A., Adu-Kumi, S., Nakahiro, K., Takahashi, S., Isobe, T., Sudaryanto, A., Devanathan, G., Clarke, E., Ansa-Asare, O.D., Dapaah-Siakwan, S., Tanabe, S., 2011. Human Exposure to PCBs, PBDEs and HBCDs in Ghana: Temporal Variation, Sources of Exposure and Estimation of Daily Intakes by Infants. Environment International 37, 921-928.

[30]Tutu, A. O.; Yeboah, P. O.; Golow, A. A.; Adu-Kumi, S.; Clarke, E.; Osei-Fosu, P., Levels of Organochlorine Pesticide Residues found in the Breast milk of some First-birth Mothers from a Rural Community (Ada) in Ghana. Elixir Int. J. 2013, 12668-12672.

[31]Tue NM, Goto A, Takahashi S, Itai T, Asante KA, Kunisue T, Tanabe SJ. Release of chlorinated, brominated and mixed halogenated dioxin-related compounds to soils from open burning of e-waste in Agbogbloshie (Accra, Ghana). Hazard Mater. 2016; 302:151-157.

[32]Nishimura C, Horii Y, Tanaka S, Asante KA, Ballesteros F Jr, Viet PH, Itai T, Takigami H, Tanabe S, Fujimori T Occurrence, profiles, and toxic equivalents of chlorinated and brominated polycyclic aromatic hydrocarbons in E-waste open burning soils. Environ Pollut. 2017, 225:252-260.

[33]Bempah, C. K.; Donkor, A. K., Pesticide Residues in Fruits at the Market Level in Accra Metropolis, Ghana, a Preliminary Study. Environmental Monitoring and Assessment 2011, 175, (1-4), 551-561

[34]Residues of organochlorine pesticides in vegetables marketed in Greater Accra Region of Ghana
Bempah CK et al. Residues of organochlorine pesticides in vegetables marketed in Greater Accra Region of Ghana. 2012 Food Control 25(2):537–542.\

[35]IAEA-SM-343/23. Vienna 163-170 (1997) (P. O. Yeboah, K. G. Montford, F. E. Appoh and D. K. Dodoo)

[36]Montford K. G., Yeboah P. O. and Klake R. K. Proceedings of First National Workshop on Food and Industrial Crop Protection, 141-145. ()

[37]Philip O. Yeboah and Wendel Kilgore). Bulletin of Environmental Contamination and Toxicology 33. 13-29 (1984).

[38] Shaw SD, Blum A, Weber R, Kannan K, Rich D, Lucas D, Koshland CP, Dobraca D, Hanson S, Birnbaum LS. 2010. Halogenated flame retardants: do the fire safety benefits Justify the Risks? Rev. Environ. Health, 25: 261–305.

[39]Ma J, Addink R, Yun SH, Cheng JP, Wang WH, Kannan K. 2009. Polybrominated dibenzo-p-dioxins/dibenzofurans and polybrominated diphenyl ethers in soil, vegetation, workshop-floor dust, and electronic shredder residue from an electronic waste recycling facility and in soils from a chemical industrial complex in eastern China. Environmental Science and Technology 43 (19): 7350-7356.

[40]Ma J, Cheng JP, Wang WH, Kunisue T, Wu MH, Kannan K. 2011. Elevated concentrations of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans and polybrominated diphenyl ethers in hair from workers at an electronic waste recycling facility in Eastern China. Journal of Hazardous Materials 186 (2-3), 1966-1971.

[41]Oloruntoba K, Sindiku O, Osibanjo O, Balan S, Weber R (2019) Polybrominated diphenyl ethers (PBDEs) in chicken eggs and cow milk around municipal dumpsites in Abuja, Nigeria. Ecotoxicology and Environmental Safety https://doi.org/10.1016/j.ecoenv.2019.04.045

[42] Kodavanti PRS, Coburn CG, Moser VC, MacPhail RC, Fenton SE, Stoker TE, Rayner JL, Kannan K, Birnbaum LS. 2010. Developmental exposure to a commercial PBDE mixture, DE-71: neurobehavioral, hormonal, and reproductive effects. Toxicological Sciences 116 (1): 297-312.

[43]Legler J, Brouwer A.2003. Are brominated flame retardants endocrine disruptors? Environ International 29:879-885.

[44]Weber R, Herold C, Hollert H, Kamphues J, Blepp M, Ballschmiter K (2018) Reviewing the relevance of dioxin and PCB sources for food from animal origin and the need for their inventory, control and management. Environ Sci Eur. 30:42. https://rdcu.be/bax79

[45]Petrlik J, Adu-Kumi S, Hogarh J, Akortia E, Kuepouo G, Behnisch P, Bell L, DiGangi J (2019) Persistent Organic Pollutants (POPs) in eggs: Report from Africa. Report from Arnika, IPEN and CREPD, April 2019.

[46]Main KM, Kiviranta H, Virtanen HE, Sundqvist E, Tuomisto JT, Tuomisto J, Vartiainen T, Skakkebaek NE, Toppari J. 2007. Flame retardants in placenta and breast milk and cryptorchidism in newborn boys. Environmental Health Perspectives 115 (10): 1519-1526.

[47]Ni K, Lu Y, Wang T, Shi Y, Kannan K, Xu L, Li Q, Liu S. 2013. Polybrominated diphenyl ethers (PBDEs) in China: Policies and recommendations for sound management of plastics from electronic wastes. Journal of Environmental Management, 30 (115):114-123.

[48]Brigden K, Labunska I, Santillo D, Johnston P. 2008. Chemical contamination at e-waste recycling and disposal sites in Accra and Korforidua, Ghana. Greenpeace research laboratories technical note. Retrieved from www.greenpeace.org

[49]Amoyaw-Osei Y, Agyekum OO, Pwamang JP, Mueller S, Fasko R, Schluep M. 2011. Ghana e-Waste Country Assessment. SBC e-Waste Africa Project. Basel Convention, Green Advocacy Ghana, Environmental Protection Agency, Ghana, EMPA, Switzerland. March 2011.

[50]Ni K, Lu Y, Wang T, Shi Y, Kannan K, Xu L, Li Q, Liu S. 2013. Polybrominated diphenyl ethers (PBDEs) in China: Policies and recommendations for sound management of plastics from electronic wastes. Journal of Environmental Management, 30 (115):114-123.

[51]Shaw SD, Berger ML, Harris JH, Yun SH, Wu Q, Liao C, Blum A, Stefani A, Kannan K. (2013)
Persistent organic pollutants including polychlorinated and polybrominated dibenzo-p-dioxins and dibenzofurans in firefighters from Northern California. Chemosphere. 91(10):1386-1394.