Appendix A6.1

Cambodia POPS Training Workshop

Hatfield
CONSULTANTS

Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia

Report of the National Training Workshop

Siem Reap, Cambodia Janauary 19 - 21, 2009

Canadian International Development Agency
Agence canadienne de développement international

Hatfield CONSULTANTS

2007 Award Recipient
For Excellence in Corporate Social and Ethical Responsibility

REPORT OF THE NATIONAL TRAINING WORKSHOP, SIEM REAP, CAMBODIA JANUARY 19 – 21, 2009

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POP1406

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Acronym	Description
CALUX	Chemically Activated Luciferase Gene Expression
CCME	Canadian Council of Ministers for the Environment
CIDA	Canadian International Development Agency
EDC	Electricite du Cambodge
GCMS	Gas Chromatography Mass Spectroscopy
GIS	Geographic Information System
HHRA	Human Health Risk Assessment
HPT	Hatfield POPs Project Team
NC	National Consultant
NFP	National Focal Point for POPs
NIP	National Implementation Plan
PCBs	Polychlorinated Biphenyls
PF	Problem Formulation
PIP	Project Implementation Plan
POPs	Persistent Organic Pollutants
POPs Project	Regional Capacity Development Program for Management of Health Risks of Persistent Organic Pollutants in South East Asia
RA/RM	Risk Assessment/Risk Management
SEDCW	Sambour EDC Warehouse (study site)
SOPs	Standard Operation Procedures
USEPA	United States Environmental Protection Agency
XDS	Xenobiotic Detection Systems Inc.

ACKNOWLEDGEMENTS

Hatfield Consultants and the POPs Project Team express our sincere appreciation to the many individuals who have played significant roles to date in the *Regional Capacity Development Program for Management of Health Risks of Persistent Organic Pollutants (POPs) in South East Asia* (hereafter referred to as the POPs Project).

Special acknowledgements are due to the World Bank Project Task Team, including Dr. Jitendra (Jitu) Shah, Dr. Catalina Marulanda and Mr. Manuel Cocco, for their support and assistance with all aspects of project implementation. We would also like to thank the Canadian International Development Agency's (CIDA) POPs Fund, for their financial support for the POPs Project.

We thank H.E Mr. Heng Nareth, MOE Advisor, and Director of Department of Environment Pollution Management and Control, Ministry of Environment (MOE), and Mr. Ken Choviran, the POPs National Focal Point for Cambodia for their support. We especially thank all key MOE staff members, Mr. Chen Sophanna and other participants from Electricite du Cambodge (EDC), and Mr. Roath Sith, National Consultant, for their technical contributions and positive collaboration, which ultimately led to the success of the case study development and other project activities.

Our thanks also go to all relevant national agencies for their active support and invaluable contributions to the POPs Project. Our special thanks also go to the participants from relevant Cambodian ministries, universities, and research institutes, and participants from China, Indonesia, the Philippines, and Viet Nam for their active participation in the Cambodian National Training Workshop.

1.0 INTRODUCTION

The enclosed report for the *Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia* (POPs Project) provides a brief summary of the National Training Workshop which took place in Siem Reap, Cambodia from 19 – 21 January, 2009.

The POPs Project was developed to complement the National Implementation Plans (NIP) for the Stockholm Convention on Persistent Organic Pollutants (POPs). Funding for the POPs Project is provided by the Canadian International Development Agency's (CIDA) POPs Fund, and is coordinated by the World Bank. Hatfield Consultants Partnership (Hatfield) was commissioned by the World Bank to implement the technical components of the Project. Complementary program activities are also being implemented by national consultants and World Bank staff.

The National Training Program and training material were developed through series of consultations with the key stakeholders in the World Bank and all participating countries. The Project Team and the World Bank conducted three rounds of consultations with the National Focal Points and other key National Stakeholders in Cambodia, Lao PDR, Malaysia and Thailand (in August, November, and December 2008). During the missions to Asia, the Project Team discussed potential involvement of other regionally participating countries – China, Indonesia, the Philippines and Viet Nam – in one of the National Training Workshops. The Training Workshop participants were identified by the Project Team (Hatfield and National Consultant) and approved by the respective National Focal Points.

Cambodia's National Training Workshop was organized by the World Bank and the Ministry of Environment of Cambodia in Siem Reap from the 19th to 21st of January 2009 (the final training schedule is provided in ***Appendix A1***). The Hatfield Project Team was responsible for preparing the training material for the workshops, for delivering its content, and for providing facilitation and moderation of ensuing discussions.

In Cambodia, 42 participants took part in the National Training Workshop. The participants were from various government agencies and academic institutions of Cambodia, and 8 government officials from China, Indonesia, the Philippines, and Viet Nam. The World Bank and Hatfield Project Team took part in the training as facilitators, and resource persons (***Appendix A2***).

1.1 OBJECTIVES OF NATIONAL TRAINING WORKSHOP

The primary objective of the POPs Project is to enhance the capacity of the key government officials and decision makers in the South East Asia Region[1] to apply Risk Assessment (RA) in the setting of Risk Management (RM) strategies to reduce chemical exposure-related human health risks to an acceptable level. Improved regional cooperation on a broader chemical agenda is a secondary objective of the program.

In line with the overall objective of the POPs Project, the main objective of the National Training Workshop was to provide participants from key government agencies, academic institutions and other relevant organizations with background knowledge about risk assessments and management of POPs contaminated sites, and also to raise awareness of available information and tools in the POPs Toolkit website (www.popstoolkit.com).

[1] This includes relevant agencies in the program countries - Cambodia, Lao PDR, Malaysia, and Thailand, as well as countries which were invited to participate in the regional workshops, namely China, Indonesia, the Philippines, and Viet Nam.

2.0 OPENING SESSION

Dr. Jitu Shah, on behalf of the World Bank, welcomed all participants. He expressed appreciation to the Royal Government of Cambodia and Siem Reap Province for hosting and welcoming other international participants form Viet Nam, China, Indonesia and the Philippines to the National Training Workshop. He also expressed his appreciation to the Canadian Government for funding the POPs Project. Dr. Shah noted that the National Training Workshops in the four participating countries would include 200 government officials and researchers in many South East Asia countries. He encouraged all participants to take an active part in the Training Workshop, and to use the POPs Toolkit in the future for human health risk assessment and management for POPs and other persistent toxic substances.

Mr. Thomas Boivin, on behalf of the POPs Project team, thanked the Royal Government of Cambodia for hosting the workshop, and all Cambodian and international representatives for participating. Mr. Boivin explained that POPs management involves various disciplines – science/toxicology, social sciences, economics and governance issues, and requires collaboration among concerned government agencies and stakeholders at the national and local levels. Mr. Boivin stated that at the Training Workshop, the participants would become familiar with the methodologies, tools and step-by-step process of POPs human health risk assessment and management, and invited them to provide comments and suggestions for improving/finalizing the POPs Toolkit.

Mr. Oum Somantha, Deputy Governor of Siem Reap Province, delivered an opening speech to the participants. He extended his warmest welcome to all national and international participants, the World Bank Team and the POPs Project team. He thanked the World Bank and Ministry of Environment for selecting Siem Reap as venue for the Training Workshop. He then briefly discussed the impacts of chemical substances on social and economic development, and the growing human health and ecological risk from improper management of chemical substances. Mr. Oum Somantha emphasized that, even though the use of chemicals was relatively low in Cambodia compared to other countries, the potential risk was extremely high due to a lack of technology, capacity and awareness. He encouraged the participants to actively participate in the training workshop, and to share their knowledge/experiences.

Figure 2.1 Opening Session of National Training Workshop, Siem Reap, Cambodia, January 19, 2009

3.0 OVERALL WORKSHOP PROGRAM

The National Training Workshop covered the following training modules/sessions:

- Session 1: Key Objectives of the National Training Workshop, and Background on the POPs Project and POPs Issues;
- Session 2: Introduction to the POPs Toolkit;
- Session 3: Overview of Human Health Risk Assessment;
- Session 4: Site Prioritization Tool - Overview and Hands-on Application;
- Session 5: Key Steps in the Risk Assessment Process;
- Session 6: National Presentation on POPs Issues in the Country, and the Sambour EDC Site Case Study;
- Session 7: Introduction to the Preliminary Quantitative Risk Assessment (PQRA) Tool – Overview and Hand-on Application;
- Session 8: Introduction to the Economic Analysis Training Module
- Session 9: Risk Governance Framework - Risk Management Process and Group Discussion on the Risk Management Strategy for the Selected Study Site; and
- Session 10: Wrap-up and Evaluation of the Toolkit and Workshop.

3.1 SESSION 1: KEY OBJECTIVES OF THE NATIONAL TRAINING WORKSHOP AND BACKGROUND ON POPS PROJECT AND POPS ISSUES

Thomas Boivin presented background information on POPs issues, the POPs Project, and the key objectives of the National Training Workshop. The presentation is provided in **Appendix A3**.

3.2 SESSION 2 – INTRODUCTION TO POPS TOOLKIT

Thomas Boivin introduced key sections and sub-sections, and other features and links available in the POPs Toolkit. He stressed that the main objective of the session was to familiarize the participants with content and features of the Toolkit. A summary of the Toolkit in English and Khmer languages is provided in **Appendix A4**.

3.3 SESSION 3 – OVERVIEW OF HUMAN HEALTH HAZARD AND RISK ASSESSMENT

Session 3 included a presentation and plenary discussion, as described below:

3.3.1 Presentation

Mike Rankin presented an overview of the Risk Assessment Process (**Appendix A5**). The presentation covered the following key areas:

- Main Characteristics of POPs;
- Rationale and Objectives of Risk Assessment;
- Integrated Risk Management Framework for Contaminated Sites;
- Basic Elements to Successful Risk Assessment;
- Key Questions for Multi-Site POPs Programs;
- Concepts and Components of Risk;
- Elements and Steps of Risk Assessment; and
- Risk Characterization.

3.3.2 Question and Comments about Risk Assessment

In reply to the participant's question about the critical exposure pathway, Thomas Boivin explained that from Hatfield's experience in POPs management in Asia, Europe and Canada, the most critical pathway was food ingestion. Fish were one of the key media to monitor for POPs in order to protect human health.

The discussion centred on the applicability of risk assessment methodologies and tools in the POPs Toolkit for other hazardous substances. The Project Team emphasized that the POPs Toolkit could also be used for assessing risks from other contaminants (e.g. lead, arsenic, etc.). The participants also discussed how to address national capacity, especially analytical capability to generate reliable data for assessing risk. The lack of a proper mechanism for sharing information and collaboratively developing and monitoring risk management options was also discussed.

Some participants suggested that associated human health and ecological risk from pesticides should have given more attention in the country's chemical risk management strategy. All participants agreed that Cambodia needed to properly prioritize issues to be addressed, within its available resources. Limited availability of funds and national capacity makes Cambodia more dependent on external support.

3.4 SESSION 4 - SITE PRIORITIZATION TOOLS

Session 4 included an introduction to the site prioritization tools (pre-screening tool and site prioritization tool), as well as hands-on application of the tools, and a general discussion.

3.4.1 Overview of the tools

Mike Rankin presented the background on site prioritization emphasizing the need for countries to select the most important contaminated sites for assessment (**Appendix A6**).

3.4.2 Hands-on Application of the Tools and General Discussion

The participants were split into small groups of three people and used the Toolkit to prioritize their sites (real or make believe). In general, the participants found the tool very useful in supporting decision-making of priority sites for risk assessment and management. The following were key comments and suggestions:

- The tool was received positively by participants; however, the possibility for saving the working files for future reference was strongly requested;
- Each question in the site prioritization tool should be numbered for easy reference; and
- The participants appreciated addition of a new functionality in the site prioritization tool, allowing changes to be made to the scores provided for relevant questions.

The pre-screening tool was provided used to assess suitability of the sites according to the following: i) data availability; ii) presence of chemical hazards of concern; and iii) safety for conducting risk assessment – e.g. potential risk from landmines and UXO.

Figure 3.1 Plenary Session and Hands-on Application of the POPs Toolkit, Siem Reap, Cambodia

3.5 SESSION 5: KEY STEPS IN THE RISK ASSESSMENT PROCESS

Mike Rankin introduced the key steps in the Risk Assessment process (**Appendix A7**), including:

- Preliminary Data Collection;
- Field Data Collection and Analysis;
- Problem Formulation and Risk Assessment Problem Formulation Worksheet Tool;
- Identification of Chemical Hazards:
- Identification of Receptors;
- Identification of Exposure Pathways;
- Conceptual Site Exposure Model;
- Exposure Analysis;
- Toxicity Analysis; and
- Risk Characterization.

3.6 SESSION 6: POPS ISSUES IN CAMBODIA AND SAMBOUR SITE CASE STUDY

Session 6 covered two major national presentations: i) POPs Issues and Management in Cambodia; and, ii) Case Study of the Sambour EDC Warehouse Site.

3.6.1 Presentation on POPs Issues and Management in Cambodia

Mr. Roath Sith made a presentation on POPs Issues and Management in Cambodia on behalf of Mr. Ken Choviran, National Focal Point for POPs, Ministry of Environment. The presentation is provided in **Appendix A8.**

3.6.2 Presentation on Sambour EDC Warehouse Case Study

Mr. Roath Sith with the support from the Hatfield Project Team, presented the Case Study of the Selected Study Site in Cambodia – Sambour EDC Warehouse (SEDCW) Site (**Appendix A9**). The presentation was followed by a 40-minute plenary discussion.

3.6.3 Comments and Discussion

The participants found the results of the risk assessment for SEDCW Site impressive. They proposed that the results be disseminated to policy makers and the responsible authorities, so that immediate action could be taken. They also recommended the Ministry of Environment to undertake public awareness campaign on PCB hazards in Cambodia. The importance of information sharing, information flow and role of youth and students, as well as other civil society organizations, in risk assessment and management was also highlighted in the discussion.

Dr. Catalina Marulanda, World Bank Team, encouraged the participants to do more research to determine if there might be other sites that may be of greater concern requiring application of risk assessment and management approach.

The participants also discussed about risk management level for the site. Some participants suggested elevating the site from Level B – action is likely needed, to Level A – action is required now. However, the workshop participants agreed that further investigation or detailed assessment would be also required.

3.7 SESSION 7: RISK CALCULATION TOOL – PRELIMINARY QUANTITATIVE RISK ASSESSMENT (PQRA)

Session 7 included an introduction to the risk calculation tool, hands-on application of the tools, and a general discussion.

3.7.1 Presentation and Hands-on Application of Risk Calculation Tool – Preliminary Quantitative Risk Assessment (PQRA)

Mike Rankin introduced the Preliminary Quantitative Risk Assessment (PQRA). The session covered selected risk assessment tools available in the POPs toolkit for estimating human health risks (***Appendix A10***).

The presentation was followed by a 45 minutes hands-on application of the PQRA and data from the SEDCW Site Case Study Report to calculate exposure (i.e., dose) via ingestion, inhalation and dermal contact for various groups of receptors – workers, and residents (children and adults). The estimated doses

were then used to calculate expressions of human health risk: i) Hazard Quotients (HQs) for non-carcinogens; and, ii) Incremental Lifetime Cancer Risk (ILCRs) for carcinogens.

3.7.2 Comments and Discussion

The Hatfield Project Team explained that to determine if a chemical was present at potentially hazardous concentrations, site chemical data were screened against environmental quality guidelines. For the purposes of the SEDCW Site risk assessment, the USEPA Risk Based Concentrations were chosen because they are relatively complete, covering a large number of potential chemical contaminants. In addition, by using a common guideline, risk assessments could be compared between each of the four participating countries (Lao PDR, Cambodia, Thailand and Malaysia).

Since Cambodia does not have robust environmental guidelines for screening and evaluating chemical hazards, the participants recommended that Cambodia should consider adapting internationally accepted guidelines (e.g, from Canada, US and/or Netherlands).

The workshop also emphasized the importance of ensuring high quality data are used in the risk assessment. Quality assurance and quality control (QA/QC) and proper procedures for data collection and handling need to be followed strictly at every step in the risk assessment process. The participants generally agreed that the PQRA tool was only as effective as the quality of the data inputs. They stressed the need to invest more resources in data management, data and information sharing, and collaboration across agencies/sectors in risk assessment and management.

The participants from the Philippines shared the approach they used in prioritizing samples for lab analysis by using the organic vapour monitor to reduce the lab analysis cost. Discussion also ensued on new/emerging technology for POPs monitoring, such as CALUX, etc.

The participants also suggested that the risk calculation model should have a function allowing the users to save the working file for future reference.

3.8 SESSION 8: ECONOMIC VALUATION OF POPS IMPACTS

Thomas Boivin introduced to the participants the main objective and progress of the economic valuation component – an important part of the overall risk assessment and risk management process. He also presented the training module on economic aspects, focusing primarily on the preliminary results of the economic analysis, and the significance and usefulness of such analysis for policy-making (**Appendix A11**).

3.9 SESSION 9: RISK MANAGEMENT DECISION MAKING PROCESS

Session 9 included two major parts, namely the presentation of the risk management process, and a group discussion on the proposed risk management strategy and action plan for the SEDCW site.

3.9.1 Presentation on Risk Management Decision Making Process

Sokhem Pech presented the role of risk management in the overall risk governance framework and major steps and characteristics of successful risk management (See **Appendix A12**). The presentation was followed by a group discussion session to develop the risk management strategy and action plan for the SEDCW site.

3.10 GROUP DISCUSSION ON RISK MANAGEMENT FOR SAMBOUR EDC WAREHOUSE SITE

The participants were assigned into 4 discussion groups (See **Appendix A13**). The topics for the Group Discussion were prepared by the Project Team in consultation with the World Bank and National Consultants (***Appendix A14***).

The Group Discussion was followed by the presentation and plenary discussion of the outcomes (***Appendix A15.1-4***). The revised risk management goals, objectives, indicators, and shortlisted risk management options were incorporated into the risk management section of the Risk Assessment Report for SEDCW Site (**see Appendix A4** of Progress Report 2).

Figure 3.2 Group Discussion on Risk Management Strategy and Action Plan for the SEDCW Site

Key outcome from the group discussion are summarized as follows:

- Given limited resource available, the risk management focus should be primarily on elimination of the pathway that connects the chemical hazards to the receptors;
- Experience and the risk calculation exercise showed that a change in human behaviour drastically changes the risk level; therefore, the emphasis of the risk management should be on capacity building, public awareness and putting in place and enforcing health and safety plans and other emergency prevention and control procedures;
- Priority should be placed on monitoring the health of the workers at the site;
- Risk reduction for workers and residents should focus on the exposure via food ingestion pathway, uncontrolled release of contaminants into

the environment, and on regular monitoring of health and environmental conditions at the site;

- Controls on fishing and hunting must be complemented by providing other alternative sources of livelihood, and education;
- Simple and cost-efficient risk management options for the site should be the priority. Simple options can be implemented easily, with more detailed clean-up operations later (if required);
- Involving all key stakeholders, governmental and non-governmental actors, in the discussion of the risk management options and their implementation was essential;
- Cambodia needs to go through the RA process for the other potential hot spot sites, to prioritize the list of sites requiring treatment;
- Management measures should focus on cost effectiveness and long-term sustainability of any mitigation measure;
- Sustainable funding, participation, monitoring, evaluation and enforcement are all critical for success; and
- Costing the risk management options was challenging due to uncertainties related to: 1) time limitation for group discussion; 2) number of options to be considered; and 3) lack of functional parameters on the site and the scope of work that needs to be done.

3.11 SESSION 10: WRAP-UP OF THE TRAINING WORKSHOP

Ms. Chan Somaly, on behalf of the Ministry of Environment and all participants expressed her appreciation to the World Bank and Hatfield Project Team for conducting the training workshop. Ms. Somaly stated that the training workshop and the POPs Toolkit were very useful for future contamination management in Cambodia.

Dr. Catalina Marulanda, World Bank thanked the participants for their active participation. She presented a summary of the National Training Workshop, as follows:

What Was the Purpose of This Training?

- Workshop was designed to provide decision-makers with tools to evaluate the risks of environmental problems (e.g. exposure to hazardous chemicals from a hotspot).

Why?

- Too many problems and not enough resources - financial, human, or technical:

- Need to prioritize to make better use of resources, and
- Need to be strategic to maximize impacts.

How Will this Training Help?

- Goal is to strengthen local capacity to:
  - Assess health risks from exposure to chemicals;
  - Manage risks
- Identify and prioritize interventions, and
- Put in place adequate measures to reduce risks;
  - Promote regional cooperation when tackling complex environmental problems.

Risk Assessment/ Risk Management Training

- Training has provided the foundation to conduct risk screening – Practice will be needed to become expert risk assessors/managers;
- Methodology for RA can be applied to all types of chemicals from all types of sources;
- Risk communication is critical as the first step in risk management (i.e. awareness raising); and
- Economic valuation/assessment is also key to convince policy-makers that the problem is important.

Information Exchange

- Interagency coordination is key;
- Decision makers from all relevant sectors should be involved in order to make the right decisions;
- Regional cooperation will be critical in the future to tackle the complex challenges of environmental management – Experience is available in the region, and there is no need to reinvent the wheel; and
- www.POPsToolkit.com will continue to exist beyond the lifetime of the project. Website can be used to share information between country participants (e.g. public awareness initiatives and material, regulatory frameworks, etc.). Discussion board is available to participants from eight countries for ease of information exchange, until the end of the project.

Project Final Workshop

- The Final Regional Workshop will be conducted in late May 2009;
- All 8 countries will be invited to participate; and
- Venue to be decided.

In recognition of the successful completion of the training program, Dr. Catalina Marulanda and Thomas Boivin presented all participants with a Certificate of Completion of the RA/RM Training.

4.0 POPS TOOLKIT AND NATIONAL TRAINING WORKSHOP EVALUATION

The participants were asked to complete questionnaires/evaluation forms at the end of the National Training Workshop. The POPs Toolkit and National Training Workshop Evaluation forms were administered among the participants by the World Bank Team. The Responses to the workshop were generally very positive.

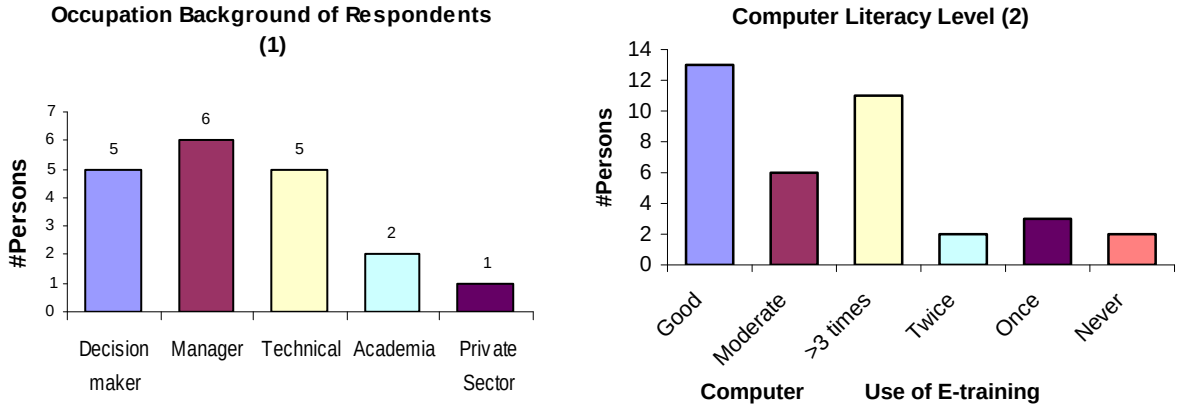
The Hatfield Project Team greatly appreciates the feedback provided by all respondents. The results allowed the Project Team to evaluate the technical content, usability and user-friendliness of the POPs Toolkit, and the quality of the training workshop. The responses by participants are summarized in the figures and graphs in the following sections.

4.1 RESPONDENTS BACKGROUND

Only 19 out of the total of 33 trainees (58%) submitted their Evaluation Forms. All 8 international participants provided an evaluation. 52% of the respondents were male and 48% were female. The Evaluation Forms were decoded, data were entered into spreadsheet, and then results plotted on charts for presentation.

The respondents represented a mixed group of people with different professional and educational backgrounds – decision makers, environmental and health managers, technical experts, students and the private sector. Figure 4.1 below depicts the distribution of the participants by their occupation and level of computer literacy.

Figure 4.1 Respondents' Occupational Background and Internet/computer Literacy Level (Total respondents N=19).



About respondents had access to the internet at work, but only 58% of them (N=11) had internet access at home. However, many Cambodian respondents said that their internet connection was poor (i.e, slow). Around 68% of all

respondents (N=13) said they had good experience with computers - email, internet browsing, spreadsheet, word processing and some programming. 32% (N=6) said they had a moderate experience with computers. Most respondents (N=13) have used web-based learning tools or e-learning platforms more than once before.

4.2 SELF ASSESSMENT OF RELEVANT KNOWLEDGE BEFORE AND AFTER TRAINING WORKSHOP

Figure 4.2 (charts 1, 2, 3 & 4) presents the participants' self assessment of their knowledge prior to and after completing the Training Workshop.

Figure 4.2 Self Assessment of Knowledge about POPs, Stockholm Convention, Site Prioritization Tools, and Selected Site Case Study (Total respondent N=19).

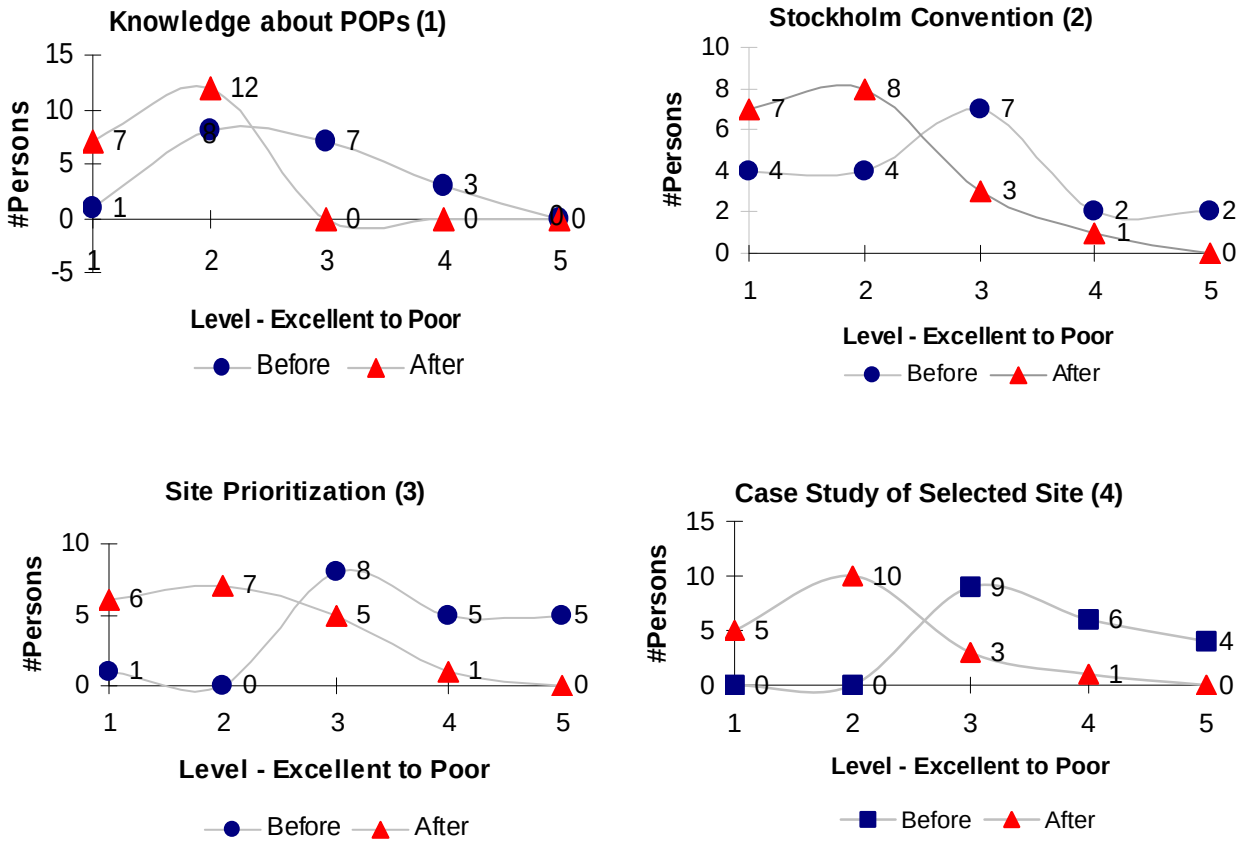


Figure 4.2 (chart 1) shows that all respondents (N=10) had "fair" to "good" knowledge about POPs before the training. After the training, 12 stated they had a "very good" knowledge of POPs, and 7 claimed to have "excellent" knowledge.

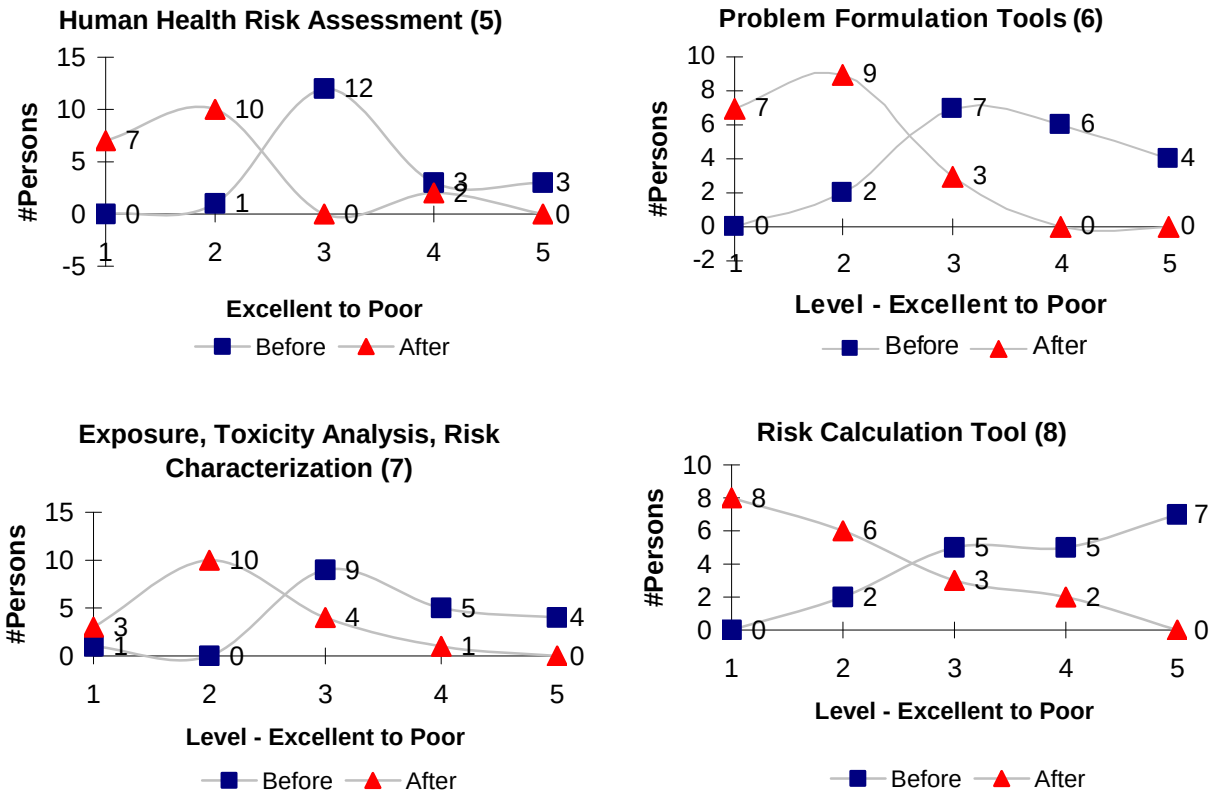
Only two respondents had poor knowledge about the Stockholm Convention, while the rest had from good to excellent knowledge about the Convention. All

respondents assessed that their knowledge about the Stockholm Convention improved after the training.

Chart 4 (Figure 4.2 above) also shows that 95% (N=18) of the respondents had a "good", "very good" or "excellent" knowledge about the Case Study after the training. This increase was impressive, since prior to the training, the Project Team had worked very closely only with the Ministry of Environment and EDC in developing the case study.

Most participants (N=13) stated that they had very limited knowledge of risk calculation tools before the training (Figure 4.3); after the training, respondents (N=17) stated that their knowledge level had increased significantly. Charts 5, 6 and 7 also show an increase of knowledge in the following POPs components: Human Health Risk Assessment (HHRA); Problem Formulation; and Exposure Pathways, Toxicity Analysis and Risk Characterization.

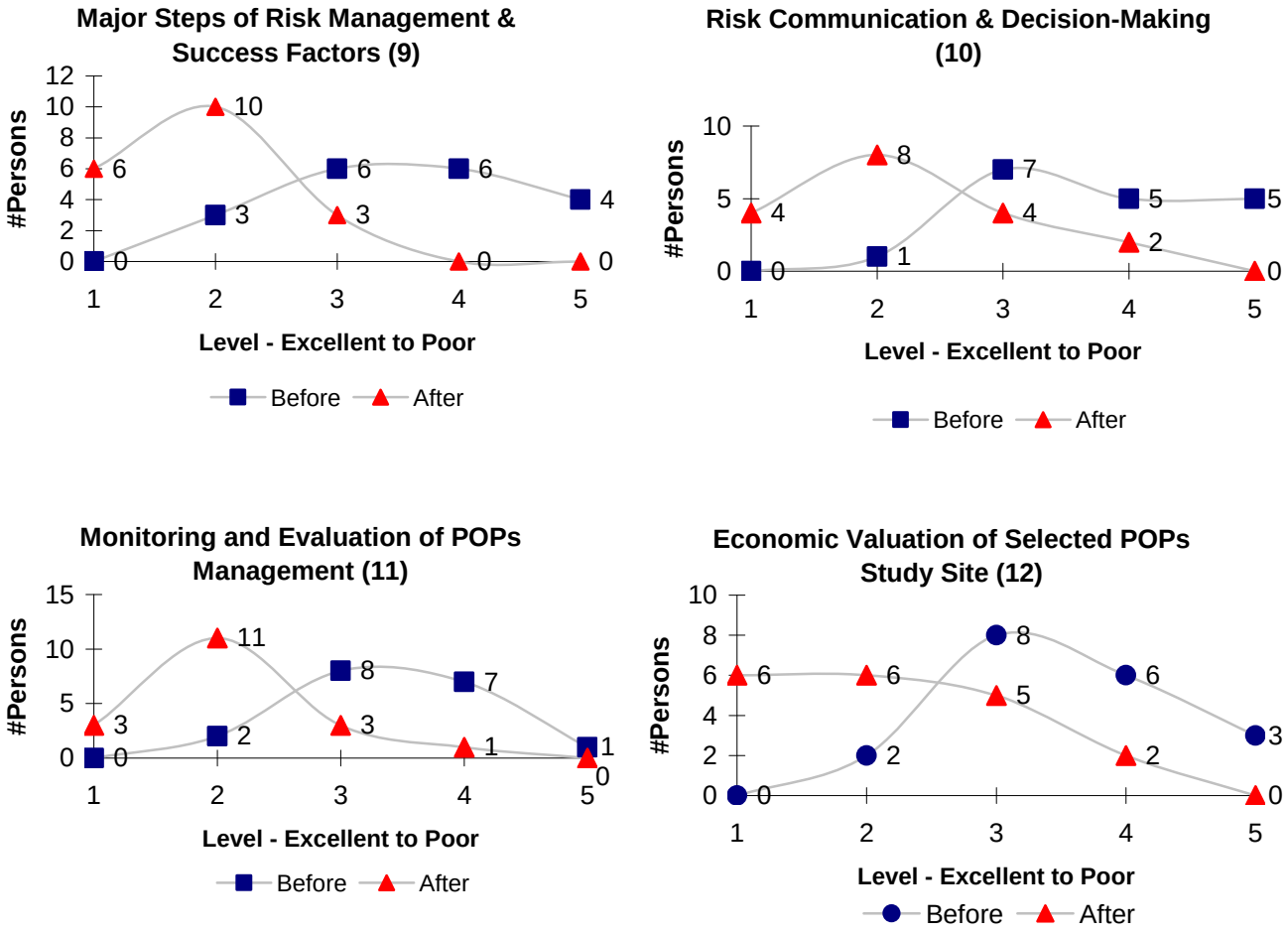
Figure 4.3 Self Assessment of Knowledge about Risk Assessment Framework
(Total respondents N=19)



As shown in Figure 4.4, many respondents (N=10) stated that their knowledge about risk management, key steps of the risk management process, and economic valuation was low (poor and fair) before the training. Their knowledge level after the training increased to "good", "very good" or "excellent". The respondents

requested further training in risk management and economic valuation (to be discussed more in sub-section 4.6 on future training needs).

Figure 4.4 Self Assessment of Knowledge about Risk Management, Risk Communication and Economic Valuation (Total respondents N=19)



4.3 USER EVALUATION OF THE POPS TOOLKIT TECHNICAL CONTENT

Figure 4.5 presents the participants' overall assessment of the POPs Toolkit technical content. In general, the participants gave the POPs Toolkit an extremely high rating. As illustrated by the pie chart, 42% of the participants (N=8) thought the toolkit technical content was 'excellent', and 45% (N=8) thought it was 'very good', and another 12% (N=2) rated it as "good".

Figure 4.5 Overall Evaluation of the POPs Toolkit Technical Content (Total respondents N=19)

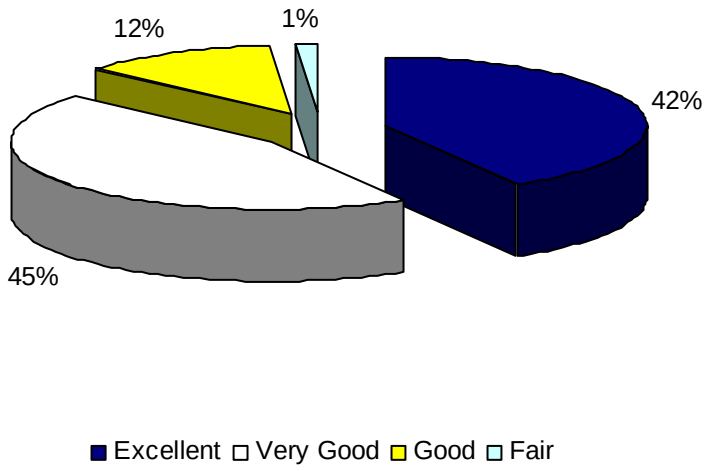


Table 4.1 provides the participants' ratings of the toolkit technical content by section and sub-sections of the Toolkit. In general, all sections were rated very high by the respondents. However, the results also indicate the needs for further improvement in the following sections: knowledge sharing and collaboration; POPs in use in South East Asia; and Economic Valuation.

Table 4.1 Detailed Evaluation of POPs Toolkit Technical Content (Total respondents N=19)

Section/subsection of Toolkit	Total Number	Excellent (1)	V. Good (2)	Good (3)	Fair (4)	Poor (5)
Home Page	19	9	8	2	0	0
Knowledge & Collaboration	19	9	6	2	1	1
About POPs Section	19	12	5	2	0	0
Human Health Implication	19	11	5	3	0	0
Exposure Pathway	19	8	9	2	0	0
POPs Convention	19	9	7	3	0	0
POPs Profile	19	8	8	3	0	0
POPs in Asia	19	6	8	4	1	0
POPs Articles	18	8	7	1	2	0
POPs Websites	18	9	5	3	1	0
Site Pre-Screening	18	9	7	2	0	0
Site Prioritization	19	8	9	2	0	0
SOPs	18	4	13	1	0	0
Field Sampling Design	19	7	10	2	0	0
QA/QC	19	5	10	4	0	0

Section/subsection of Toolkit	Total Number	Excellent (1)	V. Good (2)	Good (3)	Fair (4)	Poor (5)
Field Organization	18	4	13	1	0	0
Field Equipment	19	6	10	2	1	0
Data Sheets	18	7	9	1	1	0
Sampling & Analysis	18	5	11	2	0	0
Sampling Methodologies	18	4	12	1	1	0
HHRA	18	8	8	2	0	0
RA Framework	18	8	7	3	0	0
Pre Data Collection	18	5	10	3	0	0
Problem Formulate	18	7	10	1	0	0
Exposure Analysis	18	7	8	2	1	0
Risk Characterization	18	8	9	1	0	0
Risk Calculation tool	18	10	6	2	0	0
Eco RA	18	9	6	3	0	0
References	18	11	6	1	0	0
RM Introduction	18	10	6	2	0	0
Baseline Review	18	9	9	0	0	0
Setting Goals	18	11	4	3	0	0
Developing RM Options	18	7	10	1	0	0
Risk Communication	18	9	7	2	0	0
Monitoring & Evaluating	17	8	8	1	0	0
RM Option Tool	18	8	7	3	0	0
References	16	8	7	1	0	0
Economic Valuation	18	2	9	6	1	0
Case Study	18	6	9	3	0	0
Glossary	17	4	8	5	0	0
Summary	18	7	8	3	0	0

4.4 EVALUATION OF THE POPS TOOLKIT USER FRIENDLINESS AND USABILITY

Figure 4.6 and Figure 4.7 below illustrate the participants' overall assessment of user friendliness and usability of the POPs Toolkit. The participants gave the POPs Toolkit an extremely high rating in overall. 41% of the participants (N=8) thought the toolkit format, style and scientific content was 'excellent'; 39% (N=7) thought it was 'very good'; and 11% (N=2) thought it was good. However, 8% of the respondents rated the toolkit's usability and user friendliness as "fair" (N=1) or "poor" (N=1).

Figure 4.6 Overall Evaluation of POPs Toolkit Usability and User Friendliness
(Total respondents N=19)

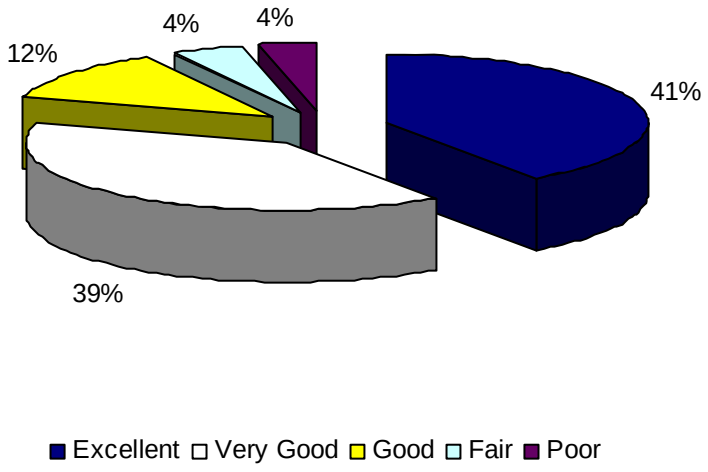
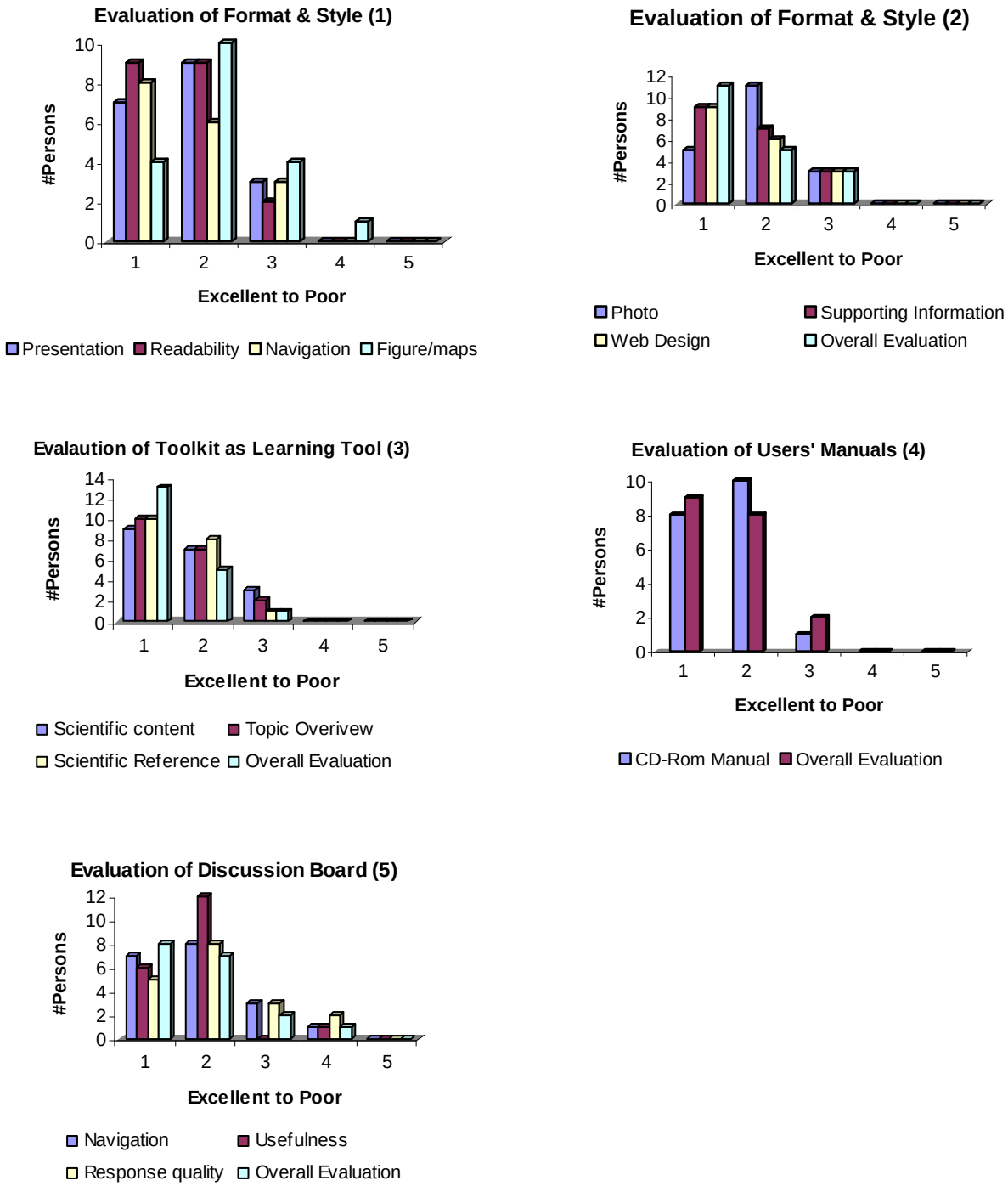


Figure 4.7 presents the detailed evaluation of each section of the toolkit for their usability and user friendliness. The results reveal the need for further improvement in "figures" and "map" and the "services of the discussion board".

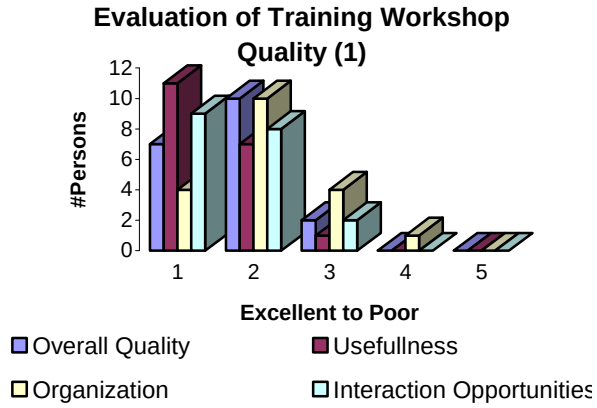
Figure 4.7 Detailed Evaluation of Key Format, Style and Features of the POPs Toolkit (Total respondents N=19).

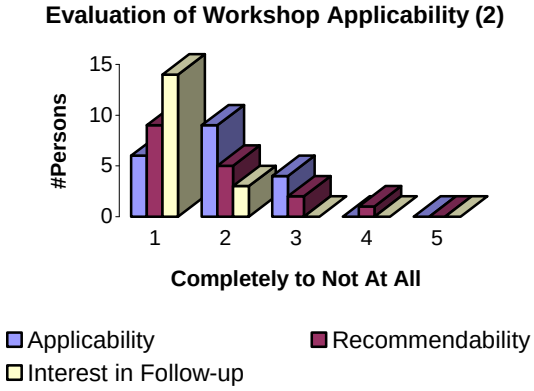


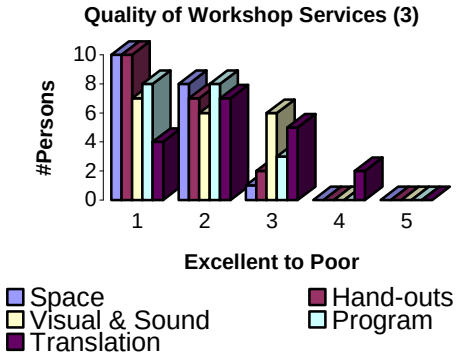
4.5 GENERAL COMMENTS ON NATIONAL TRAINING WORKSHOP

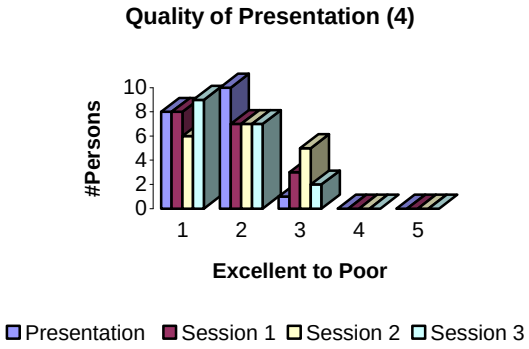
Figure 4.8 illustrates the participants' assessment of the quality of the National Training Workshop. As shown by the bar chart, the participants were impressed by the high quality of the National Training Workshop. For example, 95% of respondents (N=18) rated the presentation of the training workshop as 'excellent' or 'very good'. Also 89% of respondents (N=17) rated the presenters and facilitators as 'excellent' or 'very good'.

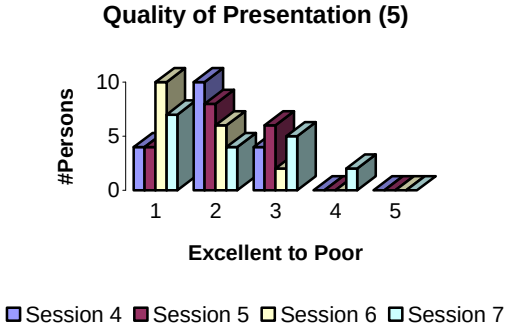
Figure 4.8 Detailed Evaluation of National Training Workshop (Total respondents N=19)

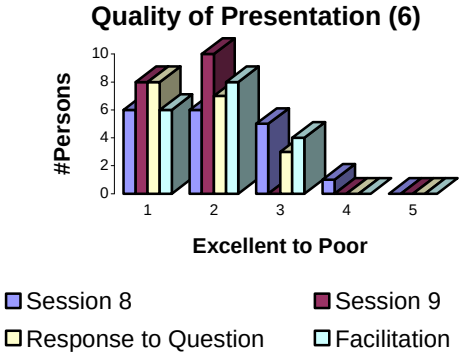












Most (79%, N=15) of the respondents thought that the training workshop was "completely" or "to great extent" applicable to their work. The remaining 21% (N=4) found the training relevant to their work "to some extent".

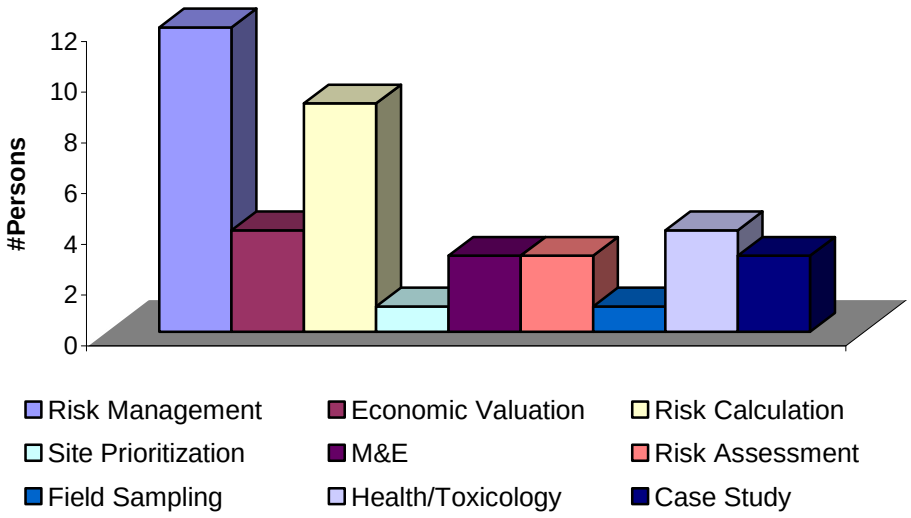
In general, all respondents rated the National Training Workshop very positively. Nonetheless, seven of the respondents (37%) thought that the duration of the workshop (2.5 days) was too short to cover all the topics and materials in the toolkit and the complex subject of risk governance framework.

4.6 FUTURE TRAINING NEEDS

Most respondents (89%; N=17) expressed their interest in attending follow-up training at a more advanced or intermediate level (workshop/seminar, interactive distance learning and self-study). 84% of all respondents thought that they would recommend the training workshop to others (see Chart 2, Figure 4.8 above).

Figure 4.9 presents an overall assessment by the respondents of the top 2-3 topic areas for which the participants wish to receive further training. As shown in the bar graph, the respondents (84% of them) want to receive further training in: Risk Management (63%); Risk Calculation (47%); POPs and Human Health Effects (21%); Economic Valuation of POPs Impacts (21%); Monitoring and Evaluation/Risk Communication (16%); POPs Case Study (16%); Risk Assessment Framework (16%); Site Prioritization; and Field Sampling Procedures (5% each).

Figure 4.9 Preferred Topics For Further Training (Total respondents N=19)



4.7 OTHER COMMENTS

All respondents commented on the usefulness of the National Training Workshop, especially the Risk Assessment and Risk Management related content. They appreciated the simplicity, comparability and applicability of the Toolkit as a planning and decision making instruments. The respondents also recognized the benefits of interactions between countries. Most respondents said that the POPs Toolkit has an educational value for students, workers, government employees and can be used for informed decision making.

The respondents appreciated the POPs Toolkit for its user-friendliness and usability; however it requires practice and hands-on training to master some of the key tools. Some figures and graphs are not easy to understand and need to be simplified and/or explained in more detailed in future workshops.

The use of web-base POPs Toolkit may be limited due to internet connection problems. The respondents found the risk calculation tool to have a great potential for use in chemical and POPs risk management, but more information is needed on sample collection and analytical results, data input table treatment, etc. They suggested using the case study for further training.

Some participants suggested an improvement to the POPs Toolkit with additional features like interactive GIS mapping of hotspots, a database of POPs and other chemicals beyond POPs, and more detailed references and linkages to background information.

The respondents rated the training workshop very high. They thought that the training was conducted according to the needs and speed of the respondents, in spite of a wide diversity of participants in their educational and occupational background.

The workshop duration (2.5 days) was considered by many respondents a bit short given the complexity and interest in the subject material. Some respondents would have preferred more time for group discussion and to visit to the selected site.

5.0 CLOSURE

We trust the above information meets your requirements. If you have any questions or comments, please contact the undersigned.

HATFIELD CONSULTANTS:

Approved by: _____ February 26, 2009

Sokhem Pech , Assistant Project Manager — Date

Approved by: _____ February 26, 2009

Thomas Boivin, Project Manager — Date

APPENDICES

Appendix A1

Final Training Schedule

Canadian International Development Agency

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Appendix A1

National Training Workshop on Human Health Risk Assessment and Management of Persistent Organic Pollutants

City Angkor Hotel, Siem Reap, Cambodia, January 19-21, 2009

Day I: January 19, 2009

Time	Description	Person Responsible
08.00 – 08.30	Arrival and registration of participants	Amara Khiev
08:30 – 09:00	Opening Session: Welcome, National Anthem ▪ World Bank Welcoming Remarks by Mr. Jitendra J. Shah, Country Sector Coordinator for Cambodia; ▪ Hatfield remarks by Mr. Thomas Boivin, President, Hatfield Consultants ▪ Opening remarks by H.E. Oum Ssmantha, Deputy Provincial Governor of Siem Reap Province.	Bunlong Leng, MC.
09.00 – 09.05	Group Photo & Coffee Break	
09.05-10.30	Key Objectives of the National Training Workshop, and Background on POPs Project and POPs Issues	Thomas Boivin
10.30– 11.00	Introduction to the POPs Toolkit	Thomas Boivin and Sokhem Pech
11.00 – 12.30	Human Health Hazard and Risk Assessment: Theory and Approach	Mike Rankin
12.00 – 13.30	Lunch Break	
13.30 – 14.15	Site Prioritization Tool – Overview	Mike Rankin
14.15 – 15.00	Hands-on Application of Site Prioritization Tool	All participants, facilitated by Mike Rankin, Thomas Boivin and Sokhem Pech
15.00 – 15.15	Coffee Break	
15.15 – 16.30	Problem Formulation, Exposure Analysis, Toxicity Analysis, Risk Estimation and Characterization	Mike Rankin
16. 30 – 17.30	Discussion	All Participants, Facilitated by Thomas Boivin and WB
18.30 – 20.30	Reception Dinner hosted by the World Bank at City Angkor Hotel	All participants

Day II: January 20, 2009

Time	Description	Person Responsible
08.00 – 08.30	Feedback and Recap of Day I	Sokhem Pech
08.30 – 10.00	▪ National Presentation on POPs Issues in the Country and at the Selected POPs Project Case Study Site ▪ Presentation and Discussion: EDC Sambour Case Study	Roath Sith, National Consultant.
10. 00 – 10.30	Coffee Break	
10.30 – 12.00	Introduction to Preliminary Quantitative Risk Assessment (PQRA) Tool	Mike Rankin
12.00 – 12.30	General Discussion	All Participants, Facilitated by Sokhem Pech and Thomas Boivin
12:30 – 13:30	Lunch Break at City Angkor Hotel	
13:30 – 15.00	Hands-on Application of PQRA Tool	Mike Rankin, Sokhem Pech and Thomas Boivin
15.00 – 15.45	Discussion on Application of PQRA Tool	All participants Facilitated by Thomas Boivin and National Consultant
15.45 – 16.00	Coffee Break	
16.00 – 17.00	Introduction to Economic Analysis Training Module	Thomas Boivin
18.30 – 20.30	Dinner Hosted by Hatfield at Selected Restaurant	All Participants

Day III: January 21, 2009

Time	Description	Person Responsible
08.00 – 08.15	Feedback and Recap of Day I & II	Thomas Boivin
08.15 – 09.15	Introduction to Risk Management Decision-Making Process	Sokhem Pech
09.15 – 11.00	Group Discussion on: 1. Developing risk Management Goals, Sub-goals (Objectives), and Indicators; 2. Long-listing and Short-listing of Management Options (developing selection criteria, weighting factors, and management options) – EDC Sambour Case Study Example.	Sokhem Pech, Thomas Boivin and all Participants (coffee is served)
11. 00 – 11.50	Presentation of Group Discussion Results of Risk Management Options for Sambour Site.	Groups Leaders and All Participants
11.50 – 12.00	Wrap-up and closing/Training Evaluation	Manuel Cocco, World Bank and Host Ministry
12.00 -	Lunch at City Angkor Hotel, Siem Reap	All participants
Afternoon	Participants can return home or depart on January 22, 20009	

Appendix A2

List of Participants

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Appendix A2

REGIONAL CAPACITY BUILDING PROGRAM FOR RISK MANAGEMENT OF POPS IN SOUTH EAST ASIA

LIST OF NATIONAL PARTICIPANTS

National Training Workshop on Human Health Risk Assessment and Management of POPs

City Angkor Hotel, Siem Reap, Cambodia, January 19-21, 2009

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Appendix A3

Presentation on Background of POPs Issues, the POPs Project, and the Key Objectives of the National Training Workshop

Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia Program

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"Key Objectives of the National Training Workshop, and Background on the POPs Project and POPs Issues"

by Thomas G. Boivin

National Training Workshop

Siem Reap, Cambodia, January 19, 2009

Canadian International Development Agency | Agence canadienne de développement international | Hatfield CONSULTANTS

Background

- Stockholm Convention on Persistent Organic Pollutants (POPs) was adopted in 2001 and entered into force in May 2004;
- Overall goal is to protect human health and the environment;
- Targets 12 particularly toxic POPs for reduction and eventual elimination; and
- Establishes a system for tackling additional unacceptably hazardous chemicals.

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POPs Project Objective

- The POPs Program is designed to :
  - Improve the ability of government agencies in the South East Asian Region to manage POPs and other POPs-like chemicals using a health risk-based approach.
  - Improve inter-governmental cooperation on hazardous chemicals issues in the region.

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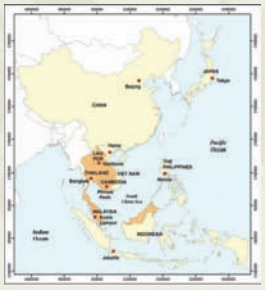
Geographical Scope and Stakeholders

- Participating: Cambodia, Lao PDR, Malaysia, and Thailand.
- Other participating countries (regional workshops)
  - China;
  - Indonesia;
  - Japan;
  - Philippines; and
  - Viet Nam.



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Key Project Elements

- Key Activities:
  - Identification of Key Issues/Hot Spots;
  - Collection of background information;
  - Sampling and analysis of environmental media (supplementary data collection);
  - Risk Assessment/Risk Management;
  - Economic Assessment;
  - POPs Toolkit (www.popstoolkit.com);
  - Training Workshops (4) + Regional Workshop (2); and
  - Reporting and Documentation.

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Key Activities and Achievements

- Regional Launch Workshop April 3-4, 2008 – official start of the project and approval of Project Implementation Plan.
- Hatfield Project Team visited candidate study sites in Cambodia, Lao PDR, and visited Thailand and Malaysia in April 2008:
  - To discuss site selection;
  - To collect available data; and
  - To recruit national consultants.

Key Activities and Achievements (2)
Selection of Study Site for Risk Assessment

Sambour EDC site, April 2008, Cambodia

Sok Pa Loung EDL site, April 2008, Lao PDR

MEA Site, Samut Prakan Thailand, late May 2008

Air Hitam Landfill, Malaysia, August 2008

Key Activities and Achievements (3)
1st Field Sampling Program May 2009

- Environmental sample collection in Lao PDR and Cambodia 12 – 24 May 2008:
  - Training on field sampling and analysis;
  - Stakeholder Consultation on POPs activities; and
  - Hands-on demonstration on field sampling.
- Site reconnaissance visit in Samut Prakan, Thailand, 15 – 17 May 2008.

Key Activities and Achievement (4)
2nd Field Sampling Program July-August 2009

- Environmental sample collection in Thailand July 28 – Aug 2, and Malaysia 16-22 Aug 2008:
  - Stakeholder Consultation on POPs activities;
  - Training on field sampling and analysis; and
  - Hands-on demonstration and field sampling.
- Blood sample collection in Lao PDR August 1-5, and Cambodia August 6-8, 2008:
  - Training on blood sampling and analysis;
  - Stakeholders Consultation on POPs activities; and
  - Hands-on demonstration on blood sampling.

Key Activities and Achievement (4)
Samples Analysis by Hiyoshi, Japan and AXYS, Canada

- 121 environmental samples were collected in triplicate - 33 samples from Lao PDR, 30 from Cambodia, 40 samples from Thailand and 18 from Malaysia.
- 25 blood samples were collected from potentially impacted people in Lao PDR and Cambodia.
- All samples were handled according to Standard Operation Procedures (SOPs) that meet international standards.

Key Activities and Achievement (5)
Risk Assessment and Risk Management

- Last CALUX results received from Hiyoshi on October 4, 2008.
- Last batch of analytical results was obtained from AXYS on December 30, 2008.
- Steps were taken to organize data into a form appropriate for a risk assessment.
- Analytical results were reviewed and the risk assessment reports for all selected study site were drafted jointly with the key stakeholders from Dec 1 – 19, 2008.
- Economic Valuation Report for each site was drafted.

Key Activities and Achievement (6)
Capacity Building & Knowledge Sharing

- POPs Toolkit (www.popstoolkit.com)
- Consultation on toolkit and training program were conducted in August – Dec 2008

Key Activities and Achievement (7)
Capacity Building & Knowledge Sharing

- On-the-job training and 'learning by doing';



- National Training Program – 19 – 31 January 2009

Key Project Goals and National Training Workshop Objective

Primary objective of the POPs Project

To enhance the capacity of government agencies in the South East Asia region to manage POPs and POPs-like chemicals using a health risk-based and regional approach.

National Training Program Objective

To provide background knowledge on risk assessment methodologies and management of POPs contaminated sites, and also raise awareness of available information and tools in the POPs Toolkit website.

Overview of Training Workshop Agenda

- Opening and closing by Senior Government Official;
- Session 1: Key Objectives of the National Training Workshop and Background on the POPs Project and POPs Issues;
- Session 2: National Presentation on POPs Management;
- Session 3: Introduction to the POPs toolkit;
- Session 4: Human Health Risk Assessment Overview & Site Prioritization:
  - Hands-on application of Site Prioritization Tool;


Overview of Training Workshop Agenda (2)

- Session 5: Risk Assessment Steps;
- Session 6: Case Study of Selected Study Sites;
- Session 7: Risk Calculation Tools
  - Hands-on application of Preliminary Quantitative Risk Assessment (PQRA) Tool;
- Session 8: Economic Valuation of Sambour Case Study Site;
- Session 9: Risk Management Decision-Making Process
  - Group Discussion on Development and Selection of Risk Management Options for Selected Sites.


Thank You

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Appendix A4

Summary of the POPs Toolkit

Summary of POPs Toolkit

The Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia Project, referred to as the "POPs Project", was developed to complement the National Implementation Plans for the Stockholm Convention on POPs. The POPs Project was designed to enhance the capacity, understanding and use of risk-based approaches to manage POPs and POP-like chemicals in South East Asia. The four countries participating in the POPs Project include Cambodia, Lao PDR, Malaysia, and Thailand. However, China, Indonesia, Japan, Philippines and Viet Nam are also included in regional activities under the program. Improved regional cooperation on a broader list of pollutants, including persistent toxic substances (PTSs) is a secondary objective of the program.

Funding for the POPs Project was provided by the Canadian International Development Agency's (CIDA) POPs Fund, and is coordinated by the World Bank. Hatfield Consultants (Vancouver, Canada) was commissioned by the World Bank to implement the technical components of the Project. Complementary program activities are also implemented by national consultants and World Bank staff.

Objective of the POPs Toolkit:

POPs Toolkit is the main output of the health risk management component (Component 2) of the POPs Project. The goal of this component is to enhance the capacity of key decision makers to apply the understanding gleaned from the risk assessment (RA) activities in order to set risk management strategies and identify priority interventions to reduce POPs risks to an acceptable level. The **health risk management toolkit** provides guidance on:

(i) evaluating health risks from exposure to chemicals in locally relevant sectors based on standardized guidelines; and

(ii) developing strategies for the management of human health risks through regulation, monitoring, and evaluating alternative scenarios.

The toolkit is also used as a repository of the training materials for the National Training Workshops organized in Cambodia, Malaysia, Thailand and Lao PDR from 19 – 31 January 2009. The training is intended to provide general knowledge on the risk assessment process and management for POPs, and also to raise awareness of information and tools available on the POPs Toolkit website.

Main characteristics of Toolkit:

The purpose of the POPs Toolkit is to provide general information on POPs, and to guide readers through the risk assessment process. The POPs Toolkit website – located at www.POPsToolkit.com – will be a valuable resource for POPs researchers in future. The web-based POPs toolkit has been designed for an audience with diverse backgrounds and levels of experience; hence the toolkit has to accommodate readers with a variety of educational backgrounds, English language skills, and differing levels

of experience in the use of e-learning tools. The navigation, interactivity, content and appearance of the POPs Toolkit have been developed with these key points in mind.

Key Architecture of Toolkit:

The content in the toolkit is presented using a combination of HTML, JavaScript and Adobe Flash. Interactive tools have been developed using both JavaScript and Microsoft ASP.Net technologies. The use of these technologies ensures compatibility with all web browsers.

Following internal quality control procedures, the final phase of quality assurance is client and end-user review of all content. This client and end-user review has included three steps:

- The Review Mission by the World Bank and Hatfield Project Team to the four countries in October and November 2008;
- Toolkit Consultation Meetings in all four countries from December 1 – 19, 2008; and
- On-line discussion using the Discussion Board in the Knowledge Sharing and Collaboration section of the POPs Toolkit.

Toolkit Content:

Major toolkit themes/sections include:

- Information About Persistent Organic Pollutants;
- Knowledge Sharing and Collaboration;
- Site Prioritization for Risk Assessment;
- Field Sampling Procedures;
- Human Health Risk Assessment;
- Risk Management;
- Economic Valuation of Health Impacts from POPs; and
- Case Studies.

Each main theme/section is accompanied by a sub-topic menu that contains interactive tools and training materials.

The following is a brief description of each section and sub-section:

1.0 About persistent organic pollutants:

This section contains information about POPs, their health and environmental impacts, background on the Stockholm Convention on POPs, profiles of various POPs, and links to major POPs related web-sites.

The reader may find more useful information by clicking on relevant links such as:

- The Concern About POPs;
- Human Health Implications;
- Possible Human Exposure Pathways;
- The Stockholm Convention;
- POP Substance Profiles;
- POPs Use in South East Asia;
- Articles about POPs; and
- Links to POPs Websites.

2.0 Knowledge Sharing and Collaboration

The section was designed for key stakeholders in the POPs project to share data, information, knowledge, and tools, and to post their comments and exchange their stories and experience.

This section includes:

- ***Document/Data Library***: for downloading or uploading documents or data related to the POPs project – including project reports and workshop outputs;
- ***Image Library:*** for downloading or uploading maps, images or photographs of project activities – including photos of the Launch Workshop and field sampling activities;
- ***Schedule & Events:*** for communicating with stakeholders on planned activities and events under the POPs Project; and
- ***Discussion Forums:*** for offering to key stakeholders and the project team an arena to discuss the progress of POPs project implementation, and exchange experiences in POPs management.

3.0 Site Prioritization for Risk Assessment

The Site Prioritization for Risk Assessment section of the toolkit aims to provide countries with the tools to prioritize contaminated sites for further investigation among multiple sites in a country.

In this section, two semi-quantitative tools – a ***Site Pre-Screening Tool*** and a ***Site Prioritization Tool*** - are provided that allow the user to determine which sites should be assessed, and then to prioritize sites based on their potential for causing unacceptable risks to humans and/or the natural environment. The tools leads the user through a series of questions regarding: contaminant characteristics; off-site migration potential; exposure; and, socio-economic factors. Based on the user's answers, a semi-quantitative score for a site is given which indicates the site's priority for risk assessment.

4.0 Field Sampling Procedures

The section "**Field Sampling Procedures"** contains important guidance and key steps for collection and analysis of samples for selected risk assessment sites. The use of Standard Operation Procedures (SOPs) facilitates sampling and analysis in a consistent and coordinated manner which helps ensure quality and comparability of the laboratory analytical results. The SOPs provided in the Toolkit were developed based on the 2007 UNEP Guide Guidance for Analysis of Persistent Organic Pollutants (POPs), Hatfield's Standard Operation Procedures Manual (2008), and Hatfield's first-hand knowledge and experience with similar field assignments in the South East Asia and Canada.

In addition to striving for simplicity and clarity of the sampling program design, and establishing clear expectations for analytical performance and QA/QC, the SOPs help foster continuity, inclusiveness and transparency during data collection and analysis.

The section covers a wide-range of topics, including:

- Objectives of Standard Operating Procedures and General Principles;
- Field Sampling Design;
- Quality Assurance and Quality Control (QA/QC);
- Field Sampling Organization;
- Field Equipment;
- Example Field Data Sheets;
- General Sample Collection and Analysis;
- Sampling Methodologies of Key Media;
- Sample Handling;
- Number of Samples Needed;
- Data Quality Analysis and Management; and
- References for further reading.

5.0 Human Health Risk Assessment

This section of the POPs Toolkit provides an introduction to Human Health Risk Assessment (HHRA) as well as several interactive tools – a ***Problem Formulation Tool*** and a ***Risk Calculation Tool***.

After reviewing this section the reader should:

1. Know the different components of the risk assessment process;
2. Know how risk assessments are conducted;
3. Be able to use some basic equations to calculate human exposure to contaminants via ingestion, inhalation and dermal contact;
4. Be able to make screening level risk estimates using exposure data; and
5. Understand the difference between threshold and non-threshold contaminants.

5.1 Human Health Risk Assessment Overview

In this section, the reader is led through an iterative process to help in the quantification of potential risk due to POPs at a contaminated site.

The main components of a risk assessment are:

- ***Preliminary data collection*** - to choose data quality objectives and to gather data;
- ***Problem formulation*** – to define the problem by identifying the three **components** of risk (chemical hazard, pathway and receptors) and developing a conceptual exposure model to illustrate and explain how these three components form the potential for health risk;
- ***Exposure and toxicity analysis*** – to quantify exposure (or dose) as well as the toxic potency of the chemical hazard(s); and
- ***Risk characterization*** – to integrate the information from the exposure and toxicity analysis to derive a quantitative estimate of human health risk.

5.1.1 Preliminary Quantitative Risk Assessment (PQRA)

Risk assessments start off simply, using a minimum of data, making simple assumptions and using simple calculations. At this initial stage, the methods and assumptions prescribed in a PQRA are conservative and generally ensure that risks are not underestimated. Thus, if acceptable or negligible risks are predicted, then it is almost certain that risks are either acceptable or negligible. If the earliest iterations of the risk assessment predict high potential of risk, it doesn't necessarily mean that there is elevated risk, but additional work needs to be done to refine the risk assessment.

5.1.2 *Risk Assessment Problem Formulation Worksheet Tool*

In the Risk Assessment Section, a tool has been provided that helps the risk assessor to identify the components of the risk assessment. The reader may use this worksheet to work through all parts of the problem formulation.

5.1.3 *Risk Calculation Tools*

Two quantitative risk calculation tools are provided that help to calculate contaminant exposure (i.e., dose) via ingestion, inhalation and dermal contact. Because of their differing characteristics, two calculation tools are provided based on the chemical of concern:

- ***Risk Calculation Tool for a Non-Carcinogen*** (Threshold) Contaminant - for a non-carcinogenic (involving cancer) substance or agent; and
- ***Risk Calculation Tool for a Carcinogen*** (Non-Threshold) Contaminant – for a substance or agent that is capable of causing cancer in humans or animals.

5.1.4 *Ecological Risk Assessments and Other References*

The Risk Assessment Section also provides background information on conducting ecological risk assessments, and key references for further reading.

6.0 Risk Management

The Risk Management section of the POPs toolkit leads the reader through the process related to managing unacceptable human health risks at POP contaminated sites. After reviewing this section the reader should:

- be familiar with the process leading to the choice of risk management strategies; and
- be able to identify priority interventions to reduce risks to an acceptable level.

6.1 Risk Management Linkages with Risk Assessment and Economic Valuation

Quantitative Risk Assessment results, and the results from the first stream of the economic valuation (where cost of impacts are estimated) feed directly into the Risk Management phase. With this information, the Risk Management process is used to:

- Decide whether a level of risk is acceptable in a larger context (socially, economically and politically);
- Select risk reduction options (i.e., either technical or policy-based solutions); and
- Conduct a Simple Economic Valuation to calculate the cost-benefit of selected remediation or risk management options.

6.2 *Key Characteristics of Effective Risk Management*

In order to be effective and successful, risk management strategies need to remain ***up to date***, be ***participatory;*** be ***well informed*** and be ***contextual*** (***i.e. be appropriate to the local*** political, cultural and socio-economic context).

6.3 *Five Steps in the Risk Management Process*

The Risk Management Training Module includes five major steps:

(i) Baseline Review;

(ii) Setting Risk Reduction Goals;

(iii) Developing and Evaluating Management Options;

(iv) Risk Communication and Policy Making; and

(v) Monitoring and Evaluation.

This five step process can be used for planning risk management activities on either a site-specific or a nation-wide basis.

6.3.1 Step 1 - Baseline Review:

Conducting a baseline review includes developing two key statements:

- The **Situation Statement** that assesses: i) where challenges and opportunities may exist; ii) strengths and weaknesses of the legal, technical, administrative or institutional aspects, and knowledge; iii) why exposure to a chemical is occurring; and, iv) the broader environmental and socio-economic context of a chemical-related problem; and

- The ***Problem Statement*** which: i) relates the main conclusions of the situation analysis to the broader chemicals management context; ii) develops the problem statement, i.e. the main reasons for risk reduction measures (magnitude of severity; persistence; reversibility; current or potential etc.); iii) characterizes associated key environmental and human health risks; and iv) specifies particularly vulnerable target groups or stages in the chemical's life-cycle.

6.3.2 Step 2 - Setting Risk Reduction Goals:

Setting clearly defined goals that protect human health and/or the environment from POPs-related risks provides the framework and benchmarks for monitoring and evaluating Risk Management Options. Setting Risk Reduction Goals involves the following sub-tasks:

- Developing well-defined risk reduction goals to address the chemical problem through a transparent and participatory process;

- Prioritizing problem-solving sub-goals in order to reduce risks to human health and the environment in order of importance;
- Linking the selected goal and/or sub-goals into the wider national chemicals forum; and
- Establishing qualitative and quantitative indicators to benchmark progress towards attainment of the goal and/or sub-goals.

6.3.3 *Step 3 - Developing and Evaluating Management Options:*

The main output of the *Developing and Evaluation Management Options* step is an evaluation of the advantages and drawbacks of various risk reduction options that can be used to prevent, reduce or mitigate the risk of concern. This involves:

- Compiling an open-ended list of known risk reduction measures as options, technologies and processes to address the identified POPs risk;
- Identifying the options that make existing measures more effective, and outline new initiatives;
- Considering whether all the options listed will achieve the required risk reduction goal, bearing in mind risk factors;
- Obtaining key stakeholder agreement on which decision-criteria to use in order to select management options; and
- On the basis of the decision-criteria, evaluating strengths and weaknesses of each option.

6.3.4 *Step 4 - Risk Communication and Policy Making:*

The main purpose of the ***Risk Communication and Policy Making*** step is to discuss how Risk Management strategies can be communicated to the public, and be mainstreamed into the national political agenda.

This step involves:

- Identifying the decision-makers who need to endorse/adopt relevant documents (policies, strategies, programs, projects, etc.) and provide them with relevant knowledge and information;
- Selecting and conducting appropriate communication approaches and activities for different stakeholders;
- Identifying whether any initial steps are needed to ensure effective implementation, e.g. training of those involved in implementation; and
- Involving interested and affected parties and identifying milestones and other important timelines.

6.3.5 *Step 5- Monitoring and Evaluation:*

Monitoring and evaluation are integral parts of the risk management decision-making process. Monitoring and evaluating involves looking at how management measures were implementation in order to check for any deviation from the plans, and documenting the reasons for any changes over time.

This step involves:

- Assessing if the agreed-upon goal and sub-goals were met or achieved, and if the actions were cost-effective;
- Evaluating if further action is required to modify the strategy and/or to continue with the implementation; and
- Evaluating what lessons can be learned regarding the basis for the strategy, i.e. a review of adverse problems, unexpected effects, and institutional cooperation.

6.4 Risk Management Options Evaluation Tools

The Risk Management section also contains two tools:

1. A Tool to Develop a Long List of Risk Management Options to address components of risk – chemical hazards, pathway, and receptors; and
2. A Tool to Evaluate Risk Management Options that helps users to assess and prioritize risk management options against selected criteria/balancing factors including:
    - Effectiveness;
    - Long term Reliability;
    - Ease of Implementation;
    - Implementation Risk;
    - Cost for Implementation; and
    - Cost for Operation and Maintenance.

7.0 Economic Valuation of Health Impacts from POPs

7.1 Objectives of Economic Valuation

The objectives of the economic valuation in the POPs Toolkit are to:

- Estimate (in *quantitative* terms) the dollar value of the human health impact of POPs contamination at a designated 'hot spot ';
- Compare the estimate with the cost of remediation measures; and

- Describe (in *qualitative* terms) the value of POPs impacts on other economic and environmental activities.

After reviewing this section the reader should:

- Know how to include an economic element in the prioritization of POPs contaminated sites by quantifying human health impact in physical terms (i.e., in Disability Adjusted Life Years - DALYs); and
- Be able to quantify human health impact in monetary terms using the benefits transfer approach.

7.2 Place of Economic Valuation within the Overall Risk Assessment and Risk Management Framework

The quantitative component of the economic valuation is closely integrated with the Human Health Risk Assessment through:

- The detailed implementation of the valuation methodology;
- The actual calculation of the economic costs of human health impacts; and
- The incorporation of the economic valuation methodology into the risk management options.

7.3 Selection of Methodology

Several methodologies for establishing an economic value were considered, including: i) Value of a Statistical Life (VSL); ii) Damage Function approach; or iii) Disability Adjusted Life Years (DALY). Each approach requires significant data collection to ensure accuracy of the results.

The DALY approach was selected because of:

- **Conceptual simplicity**: DALY covers both mortality and morbidity in one number. The equations are straightforward and can be linked to potential health impacts of POPs;
- **Data availability**: WHO has estimated DALY rates per 100,000 population for all countries, not just the four countries participating in the POPs study; and
- **Ethically Acceptable**: The DALY approach does not place a value on a human life; rather it places a value on the risk shared by members of an exposed population. As such, it avoids the ethical concerns over the valuation of a human life.

7.4 What is a DALY?

The disability-adjusted life year (DALY) is a measure of overall disease burden. Originally developed by the World Health Organization, it is designed to quantify the impact of premature death and disability on a population by combining them into a single, comparable measure. In so doing, mortality and morbidity are combined into a single, common metric.

One DALY can be thought of as one lost year of "healthy" life. The sum of these DALYs across the population, or the burden of disease, can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability.

7.5 Economic Valuation Steps

The Training Module includes a step-by step cost-benefit analysis for a POPs contaminated site. Further, an interactive tool is provided that allows for these steps to be followed in an online, interactive manner.

The five steps involved in this process include:

- Step 1 – Obtain DALY;
- Step 2 – Scale DALY to Local Site;
- Step 3 – Calculate Unit Price per DALY;
- Step 4 – Estimate site remediation costs;
- Step 5 – Estimate Benefit of Remediation; and
- Step 6 – Calculate Cost-Benefit of Remediation.

8.0 <u>Case Studies</u>

The Case Studies section includes the preliminary risk assessment reports for POPs sites selected in Cambodia, Lao PDR, Malaysia and Thailand. These case studies present the results of human health risk assessment and risk management techniques applied in each country, including a description of each POPs site, sampling undertaken, and calculation of human health risk from POPs. Case studies were developed by the POPs Project Team, and will be a key component of the National Training Workshops in January 2009.

Appendix A5

Overview of the Risk Assessment Process

Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia Program

Canadian International Development Agency | Agence canadienne de développement international

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"**Human Health Risk Assessment Overview**"

presented by Mike Rankin

National Training Workshop

Siem Reap, Cambodia January 19, 2009

Canadian International Development Agency | Agence canadienne de développement international

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Why Assess and Manage Health Risk?

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In Many Countries - Driven by Regulation

- Federal Regulations typically forbid contamination, and require remediation with option of risk management:
  - e.g., Canadian, US EPA, European, Australian Legislation
  - Protection of Human and Ecological Health
  - Protection of Livestock, Fisheries and Wildlife
  - Complements Environmental Numerical Standards
  - "Polluter Pays" principle
- Provisions for voluntary/mandatory and flexible risk management solutions
- Makes good sense and is also economically advantageous

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Environmental Risk Management of POPs – Why?

- Health protection at POPs contaminated sites and prevention of long-range POPs transport
- Environmental Stewardship – *sustainability* makes good economic sense
- Stockholm Convention – *compliance* makes good sense to foster international trade

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Environmental Risk Management of POPs – Why? (2)

- Performed proactively – avoid/reduce risk (e.g., environmental and economic impact assessment)
- Performed retroactively – remediate/reduce health risk, economic gains
- Informed decisions are needed to manage human or ecological health risks

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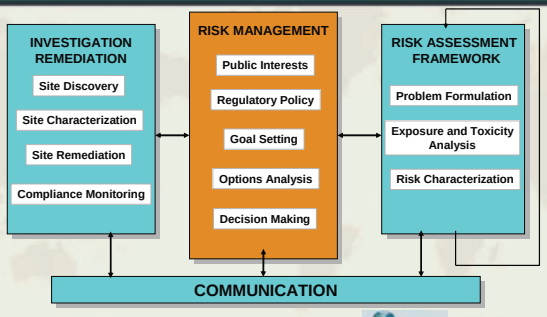
Integrated Risk Management Framework for Contaminated Sites



 SLIDE 7

Integrated Environmental Management Process

 SLIDE 8

Successful Risk Management Decisions

Three Basic Elements to Risk Management Decisions

- Technically feasible and cost effective option
- Result in acceptable risk
- And...socially acceptable!

 SLIDE 9

Key Questions for Multi-Site POPs Program

- Which sites are most in need of risk reduction, based on human and ecological considerations?
- Where can the greatest risk reduction be achieved for (a) human health, (b) ecological?
- How can I achieve the greatest risk reduction per remediation dollar that is available?

 SLIDE 10

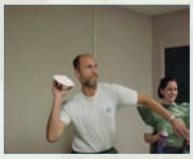
Concepts of Risk

- Risk – *probability* of *undesirable event*
  - Risk of losing money
  - Risk to corporate reputation/public opinion – business devalues
  - Risk to health and safety of people
  - **Risk to health from POPs**
- Risk Management – identification and actions to avoid/reduce risk to an acceptable level

 SLIDE 11

What Is Risk?

- Risk is an intrinsic part of life
- Any activity is associated with some risk
- For a risk to exist there needs to be some kind of hazard
  - e.g., chemical, explosive, mechanical hazard



 SLIDE 12

What is Environmental Risk?

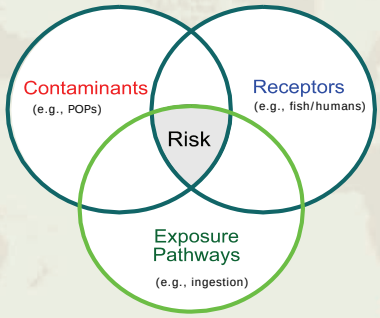
- Environmental Risk:

" ...probability of an adverse event due to disturbances in the environment "
Ontario MOE *Guidance* document

  - e.g., human health effect
  - e.g., fish health, reproduction
  - e.g., livestock health, livelihood

- But what causes environmental health risk?
  - Hazardous contamination

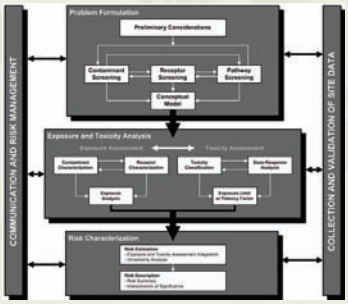
Health Risk Components



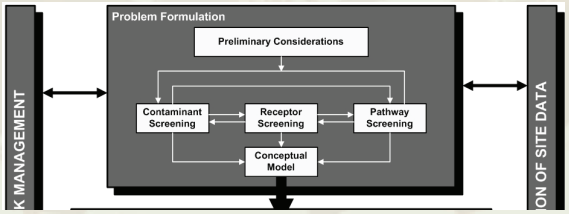
Elements of Risk Assessment

- Hazard Identification/ Assessment and Problem Formulation
- Toxicity Assessment
- Exposure Assessment
- Risk Characterization

Environmental Risk Assessment Framework



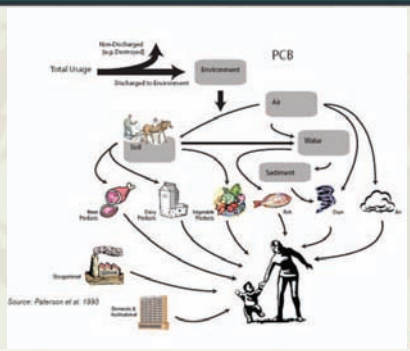
Environmental Risk Assessment Framework



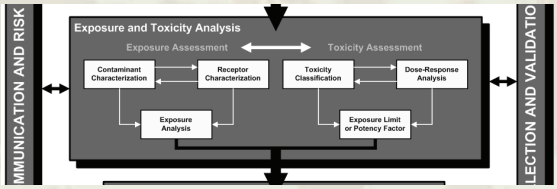
Contaminant Screening

- Contaminant screening generally involves comparison with criteria/standards
  - Criteria/standards typically risk-based using conservative scenarios
  - If contaminants don't exceed criteria/standards, likely safe, no further assessment required
  - Exceedances of criteria require further assessment (i.e. they "screen in" for our assessment)

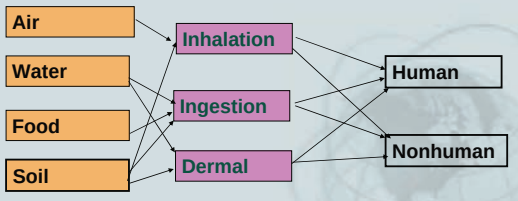
Human Exposure Pathways



Environmental Risk Assessment Framework



Intake Modelling

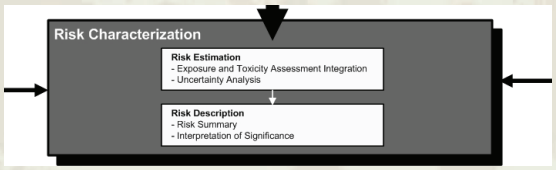


Example: Inhalation of Soil Dust and Particulates

$$\text{Dose} = \frac{Cs \times IRinh \times (1/PEF) \times EF \times ET \times ED \times PDD}{BW \times AT}$$

Dose = dose from dust/particulates inhalation (mg/kg body weight/day)
Cs = concentration of chemical in soil (mg/kg)
IRinh = inhalation rate (m^3/hr)
PEF = particulate emission factor (m^3/kg)
EF = exposure frequency (days/year)
ET = exposure time (hr/day)
ED = exposure duration (years)
PDD = portion of dry days (unitless)
BW = body weight (kg)
AT = averaging time (days): number of days in a lifetime for carcinogens
number of days in the exposure duration for non-carcinogens

Environmental Risk Assessment Framework



Risk Estimation for Threshold Substances

- Hazard Quotient (HQ) = Exposure Ratio
- HQ = Dose Rate/Reference Dose
- Hazard Index = ΣHQ for all pathways and similar toxic effects
- A HQ of <0.2 is often considered "acceptable"
- Other jurisdictions may use 1.0

Risk Estimation for Non-Threshold Substances

- Incremental Lifetime Cancer Risk (ILCR)
  - Probability of cancer occurring over a lifetime
  - Calculation requires cancer "slope factor" (SF) obtained from other studies
- ILCR = Dose Rate x SF
  - Acceptable cancer risk (ACR) < 1E-6 (Ontario)
  - Within Canada: typically 1E-6 to 1E-5
  - Within USA: typically 1E-6 to 1E-4

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 SLIDE 25

Risk Interpretation

- Uncertainty is inherent in risk assessments
- Caution is needed when interpreting the accuracy in risk estimates
- Understand the influence of conservative assumptions
- Perform sensitivity analysis for better insight on uncertainty

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 SLIDE 26

Risk Characterization Summary

- Integration of exposure and toxicity assessments
- Describe the nature and the magnitude of the risk
- Different methods used for evaluating risk for carcinogens and non-carcinogens
- Acceptable risk levels may differ between jurisdiction
- Site-specific criteria may be derived based on the RA results

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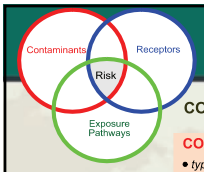
 SLIDE 27

Screening versus Comprehensive Risk Assessment

Screening Assessment		Comprehensive Assessment
simple	⇔	complex
qualitative	⇔	quantitative
descriptive	⇔	predictive
literature	⇔	field (site-specific)

Golder Associates

Risk Management Strategies



RISK COMPONENTS	RISK MANAGEMENT OPTIONS
CONTAMINANT • *type* • *concentration* • *distribution* • *release*	• *removal* • *treatment*
EXPOSURE PATHWAYS • *media* • *migration* • *fate*	• *interception* • *ventilation* • *containment*
RECEPTORS • *type* • *sensitivity* • *land use*	• *relocations* • *land use restrictions*

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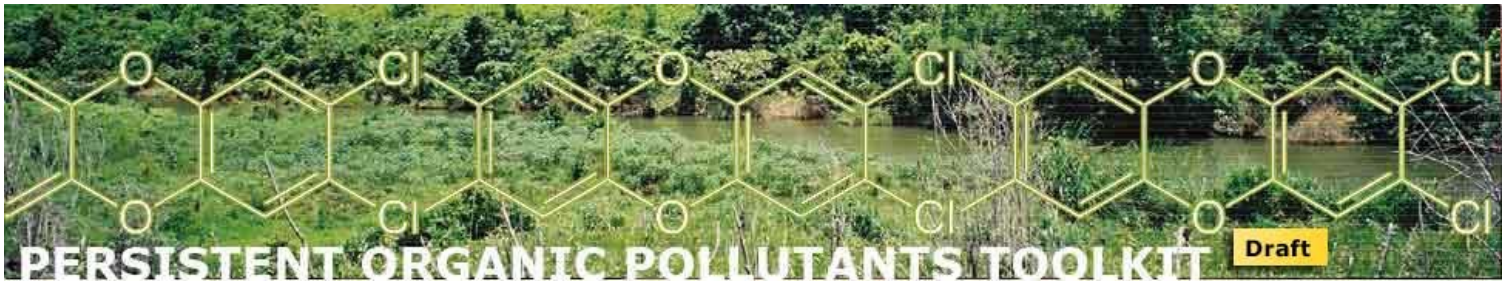
 SLIDE 29


Recreational Park overtop contaminated soil –
No exposure pathway, no migration, and no health
risk.
Golder Associates
Hatfield


Golder Associates
Hatfield

Appendix A6

Introduction to the Site Prioritization Tools



Human Health Risk Assessment Training Module

Learning Objectives:

After reviewing this section the reader should:

- Know the components of a risk assessment
- Know how risk assessments are conducted
- Be able to use some basic equations to calculate human exposure to contaminants via ingestion, inhalation and dermal contact
- Be able to make screening level risk estimates using exposure data
- Understand the difference between threshold and non-threshold contaminants

Transformer storage yard in Phenom Penh, Cambodia
Source: Hatfield Consultants
(click to enlarge)

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THE WORLD BANK

funded by the Canadian POPs Trust Fund through the Canadian International Development Agency / Agence canadienne de développement International

Human Health Risk Assessment Overview

Risk assessment is an iterative process leading to the quantification of potential risk. For the POPs project, the emphasis is on assessing health risks to humans resulting from exposure to persistent organic chemicals. The assessment looks at multiple exposure scenarios and calculates the incremental risks associated with each scenario, as well as the overall risk attributable to all the scenarios combined. Information provided by risk assessments is needed before appropriate risk management measures can be selected and implemented.

Transformer Storage Depot in Vientiane, Lao PDR
Source: Hatfield Consultants
(click to enlarge)

Risk assessments start off very simple, using a minimum of data, making simple assumptions and using simple calculations. At this initial stage, all assumptions should err on the side of caution. If the earliest iterations of the risk assessment predicts elevated risk, it doesn't necessarily mean that there is elevated risk, but additional work needs to be done to refine the risk assessment. In Canada, the earliest iteration is called a **Preliminary Quantitative Risk Assessment (PQRA)** (Health Canada 2004)**.** Subsequent refinements are often called Detailed Site-Specific Risk Assessments.

References:

Health Canada PQRA - 2004 *(external link)*

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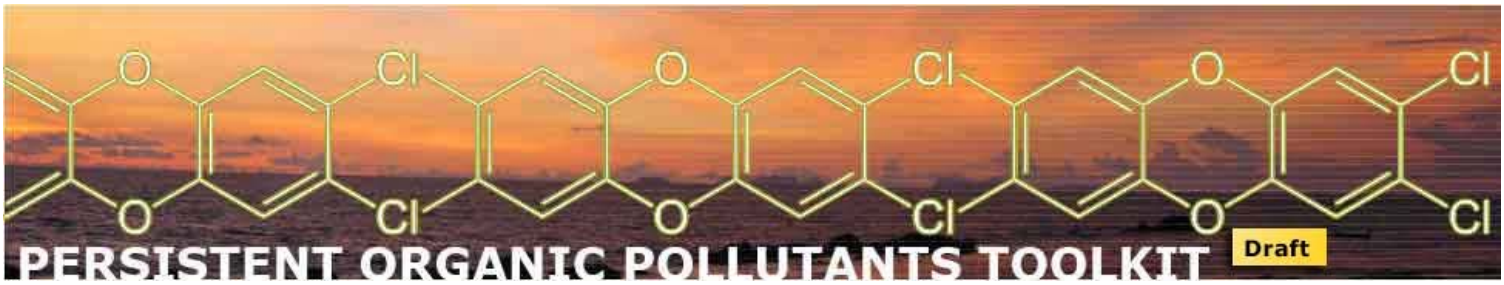


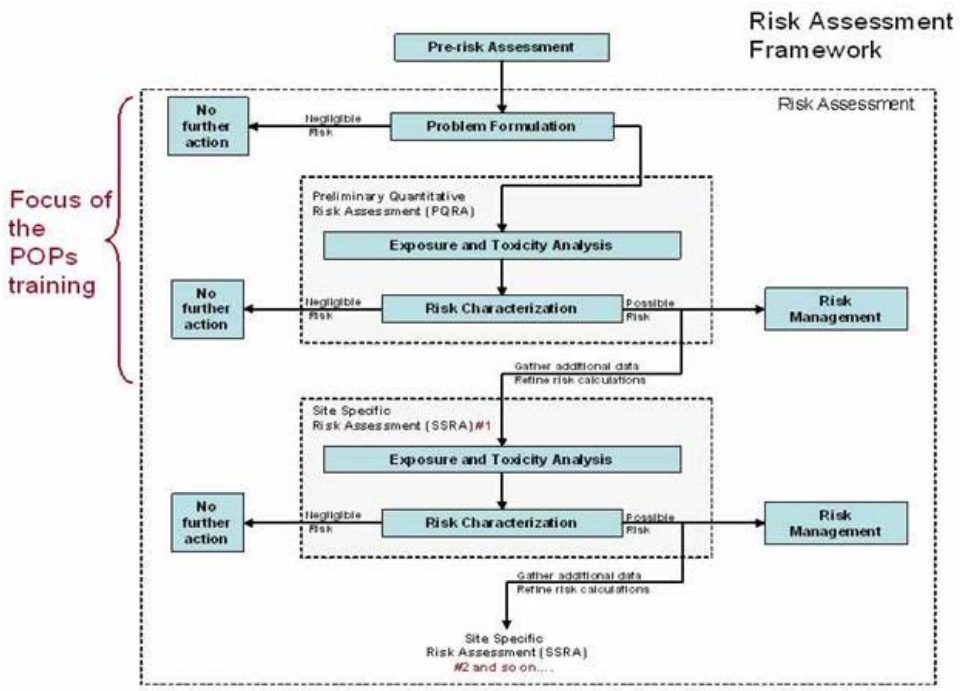
Risk Assessment Framework

Risk assessments can be broken down into several component parts. The framework utilized in the POPs project has been adopted primarily from Health Canada's **PQRA** (Preliminary Quantitative Risk Assessment) guidance for conducting human health risk assessments (Health Canada, 2004). The framework used is similar to those approaches used elsewhere in North America and in Europe.

The main components of a risk assessment are:

- **Preliminary data collection**
- **Problem formulation**
- **Exposure and toxicity analysis**
- **Risk characterization**

A PQRA will contain each of these components. More complicated risk assessments, site specific risk assessments (SSRAs), will contain additional exposure and toxicity analysis, and risk characterization.



References:

Health Canada PQRA - 2004 *(external link)*

Site Prioritization for Risk Assessment

One of the primary goals of the POPs toolkit is to provide countries with the capacity to perform simple Human Health Risk Assessments. When it comes to cleaning up multiple sites in a country the questions arise: where to begin? Which sites should be a priority for a risk assessment?

In this section, two semi-quantitative tools are presented that allow the user to determine which sites should be assessed and then to prioritize sites based on their potential for causing unacceptable risks to humans and/or the natural environment.

The purpose of the site prioritization is to classify contaminated sites based on their need for further action. Further action usually means risk assessment. The tools provided ask the user a series of questions regarding: contaminant characteristics, off-site migration potential, exposure and socio-economic factors. Then, based on the answers provided, calculates a total score for that site.

The purpose of Site Prioritization is to classify contaminated sites based on their need for further action
Source: Hatfield Consultants
(click to enlarge)

References:

The site prioritization tools are based on principals derived from the Canadian National Classification Tool for contaminated sites (CCME 2008). While the tools are applicable to any contaminated site, a greater emphasis has been put on POP's related contaminant issues.

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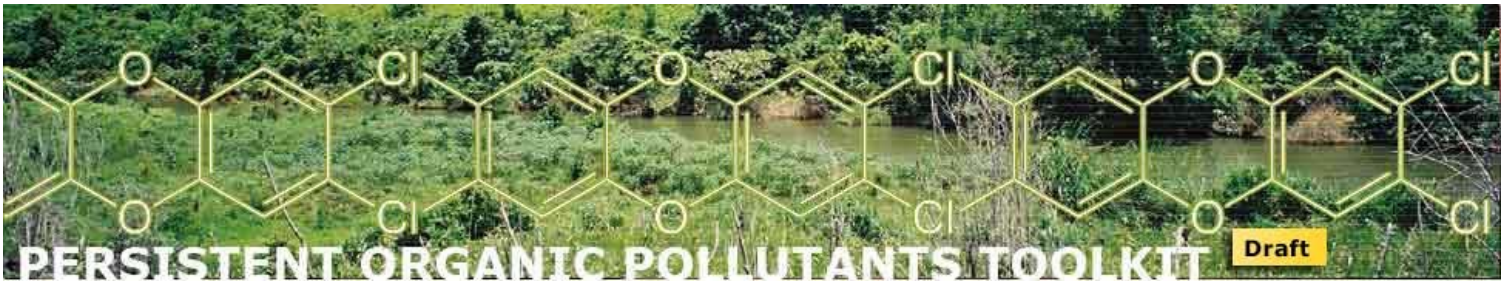

Pre-Screening Tool

The purpose of pre-screening is to identify which sites should be classified using the site prioritization tool.

Answers to the following four questions will determine whether the site:

- should be classified once a number of prescribed actions have been taken;
- will not require either classification or a risk assessment; or
- can proceed directly to classification using the site prioritization tool.

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Site Prioritization Tool

The purpose of the Site Prioritization Tool is to classify contaminated sites based on their need for a risk assessment.

The tool asks the user a series of questions regarding: contaminant characteristics, off-site migration potential, exposure and socio-economic factors. Then, based on the answers provided, calculates a total score for that site.

Using the total scores, the sites should be classified into the following categories:

- **Class 1** – High priority for risk assessment
- **Class 2** – Medium-high priority for risk assessment
- **Class 3** – Medium priority for risk assessment
- **Class 4** – Low priority for risk assessment
- **Class N** – Not a priority for risk assessment

Prioritizing a site without sufficient information

It is acknowledged that the user may not know the answer for many of the questions. Therefore, for most questions, one of the answer options is “do not know”, and an intermediate score is assigned to these questions. Once the tool has been completed, the percentage of questions answered “do not know” is calculated. If the percentage is greater than 30% of total responses, then the site is considered to have insufficient information. Additional information gathering should be conducted and the site ranked again.

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Appendix A7

Key Steps in the Risk Assessment Process

Preliminary Data Collection

Before conducting a risk assessment a number of preparatory steps are required. Two of the most important steps are:

- **To choose data quality objectives**
- **To gather data**

Soil Sampling in Vientiane, Lao PDR
Source: Hatfield Consultants
(click to enlarge)

Data Quality Objectives (DQO)

Data Quality Objectives provide criteria for developing a data collection design that includes: when to collect samples, where to collect samples, the maximum allowable error for the study, and how many samples to collect. Using the DQO process will help ensure that the type, quantity, and quality of environmental data used in the risk assessment and/or risk management is appropriate. In addition, the DQO process will help prevent the collection of unnecessary data (USDOE 2008). For more information on DQO's please visit: the US Department of Energy's Data Quality Objectives website.

Data Gathering

Before staring the risk assessment process, certain types of data will be required. Common tasks are as follows:

Collection of pre-existing data - if previous investigations have been done at the site, some of the required data may be available as printed material. Other information, such as former site use may be available in the historical literature.

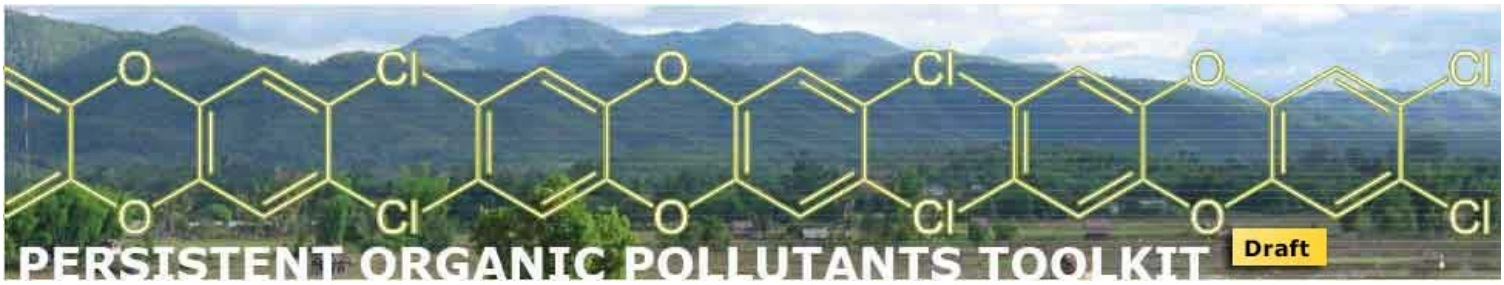
Conduct a site investigation - In addition to printed material, a site investigation is always recommended (Environment Canada 2003, USEPA 2008). By visiting the site, the Risk Assessor can collect current information which may not be available in the printed literature. A site investigation provides the risk assessor with data necessary to carry out a risk assessment. Information can include:

1) Visual Observations – i.e., What might be the contaminant of concern? What organisms might be exposed? How might organisms be exposed? Are there areas where soils appear to be darker or oily, or of a different color?

2) Collection Of Samples For Analysis – i.e., What are the average and maximum concentrations of contaminants in exposure media (i.e., soils, sediments, water or tissue etc.)? Are there unexpected contaminants of concern? What is the spatial distribution of contaminants?

Collect Ancilliary Data - Ancilliary data includes data that can be used for the risk assessment, but is generally not collected during the site investigation. Ancilliary data can include the results of interviews of people on site - i.e., What are the human behaviors at the site which might result in exposure? Have effects been observed? What is the duration or frequency of exposure?

More information will be provided regarding data in the next sections.

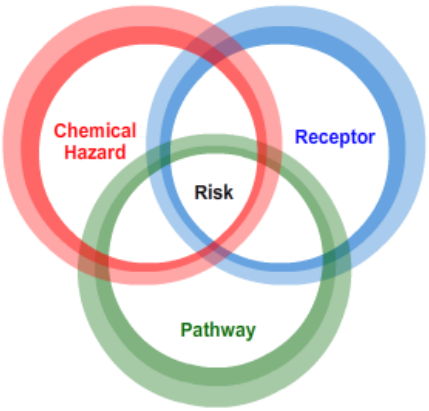


Problem Formulation

The very first step in the risk assessment is problem formulation which defines the problem. This process explicitly identifies the **components** and sets the stage for the Risk Assessment (Environment Canada 2003, Health Canada 2004). All three components are essential in order for a contaminant-based health risk to exist. Absence of any one will remove the possibility of an unacceptable health risk.

Components of Risk

(click on a component of risk to see questions raised by that component)



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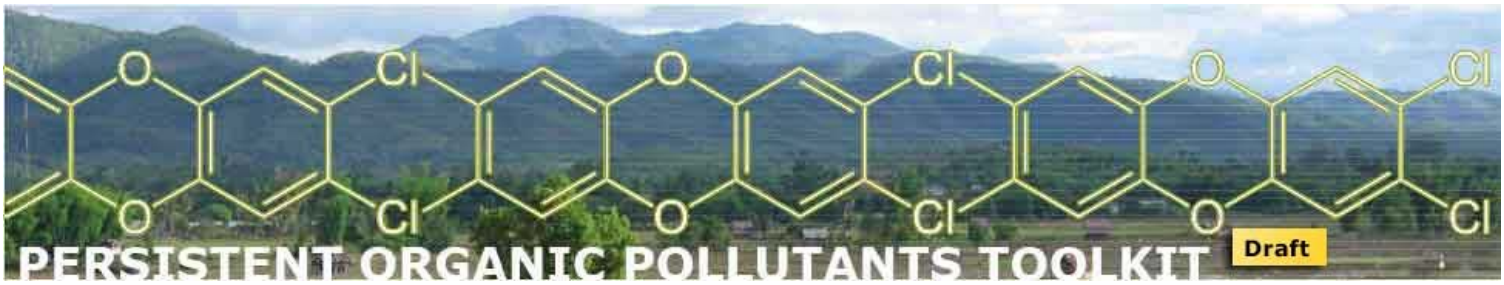

Risk Assessment Problem Formulation Worksheet Tool

The purpose of this worksheet is to help the risk assessor identify the components of the risk assessment. Use this worksheet to think through all parts of the problem formulation (see the problem formulation training module). A filled-in version of this worksheet should be included in your Risk Assessment report.

Potential land uses of the site

In this section, briefly describe the past, current and planned future land use of the site. Several categories are provided because some sites may have had more than one land use. Having this background information will help identify the types of chemical hazards possibly present at the site, the potential receptors and the pathways linking the chemical hazards with the receptors.

	Potential?	*Explanation*
Agricultural		
Residential/urban parkland		
Commercial		
Industrial - indoors		
Industrial - outdoors		
Recreational		
Other		

Humans receptors and pathways

Use this section to identify and describe the receptors (human and non-human) and pathways possibly present at the site.

Human receptor group

	On Site?	*Explanation*
General public or resident		
Employees		
School Children		
Other		

Human receptor ages

	On Site?	*Explanation*
Infant		

Toddler		
Child		
Teen		
Adult		
Other		

Human exposure pathways

	On Site?	*Explanation*
Accidental ingestion of soil		
Inhalation of soil particles		
Inhalation of indoor contaminant vapours		
Inhalation of outdoor contaminant vapours		
Ingestion of drinking water		
Dermal contact with soil		
Dermal contact with water		
Ingestion of contaminated food		

Non-human receptors and pathways

Non-human receptors

	On Site?	*Explanation*
Aquatic Animals		
Terrestrial Animals		
Plants		

Non-human exposure pathways

	On Site?	*Explanation*
Aquatic organism exposed via water		
Aquatic organism exposed via food		
Aquatic organism exposed via sediments		

	On Site?	*Explanation*
Terrestrial organism exposed via water		
Terrestrial organism exposed via food		
Terrestrial organism exposed via soil		

	On Site?	Explanation
Plants exposed via surface water or groundwater		
Plants exposed via soils		

Contaminant concentrations (highest measured concentrations)

To fill-in this section:

- *replace the column header "Chemical A, Chemical B, Chemical C..etc.", with a chemical contaminant name.*
- *enter the maximum concentration of that contaminant measured in the applicable row. Note that the concentration units of the concentration entered must match those shown in the first column.*
- *The maximum contaminant concentration can then be compared to environmental quality guidelines. If the measured maximum concentration exceeds the guidelines, then the contaminant is a Contaminant of Concern.*

add column

	Chemical A	Chemical B	Chemical C	Chemical D
Soil (*mg/kg*)				
Groundwater - source (*mg/L*)				
Drinking water (*mg/L*)				
Bathing/swimming water (*mg/L*)				
Outdoor air - particulate (*mg/m*^{3})				
Root vegetables (*mg/kg wet weight*)				
Other vegetables (*mg/kg wet weight*)				
Fish (*mg/kg wet weight*)				
Wild game (*mg/kg wet weight*)				

Print this worksheet

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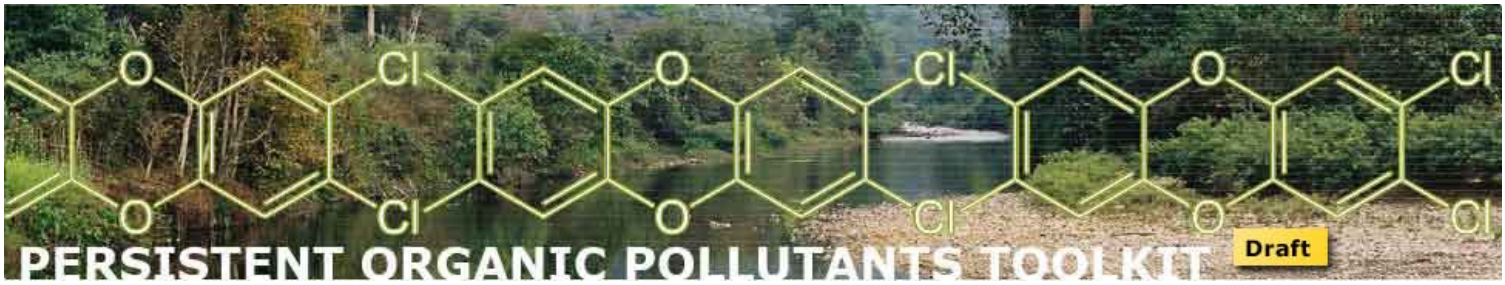

Chemical Hazards

To determine if a Chemical Hazard exists, site chemical data are **screened** against **environmental quality guidelines** (e.g., the CCME Environmental Quality Guidelines (external link) and Health Canada Drinking Water Guidelines (external link)). Concentration data is first summarized by calculating the mean, 95% upper confidence limit of the mean (UCLM), 95th percentile and maximum concentration.The summary statistics are then screened against the environmental quality guidelines. In addition to statistical summaries of concentrations, other information may need to be collected (e.g., for soil data).

Recreational Fishing at Xuan Lake, Viet Nam
Source: Hatfield Consultants
(click to enlarge)

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Screening of Chemical Hazards

Chemicals found at a site must be screened against environmental guidelines. To do this screening, the chemical measurement is compared against the **CCME Environmental Quality Guidelines** for protection of human health should be used. Where CCME human health guidelines are not available, other human health-based guidelines from reliable sources may be used. One source is the U.S. Environmental Protection Agency's (US EPA) preliminary remediation goals (**PRGs**). Another is US EPA risk based concentrations (**RBCs**). When compared against guidelines, Contaminants of Potential Concern (COPC) are identified.

Adjusting US EPA risk based concentrations

For non-carcinogens, PRG's or RBC's must be adjusted to reflect 20% of the US EPA toxicological reference value (TRV). A TRV is the maximum safe dose a human can be exposed to each day over a life time (mg/kg body weight/day). 20% of the TRV is taken to allow for exposure from other media and pathways.

Screening when a guideline is not available

In the event that a contaminant has no corresponding health-based soil quality guideline, the contaminant should be included as a Chemical of Potential Concern (COPC) for further risk assessment, unless the measured concentrations are consistent with natural or background concentrations.

Background Concentrations

Before a site is considered contaminated, concentrations of contaminants at the site, particularly natural elements (e.g., metals), should also be compared to background soil and groundwater concentrations (and surface water concentrations, if relevant), if data are available. If it is found that concentrations of contaminants at the site are representative of background levels, then the site may not be contaminated even though measured concentrations are greater than the guidelines. A further discussion of background levels is provided in Appendix A (external link) of the **PQRA guidance** document (Health Canada 2004).

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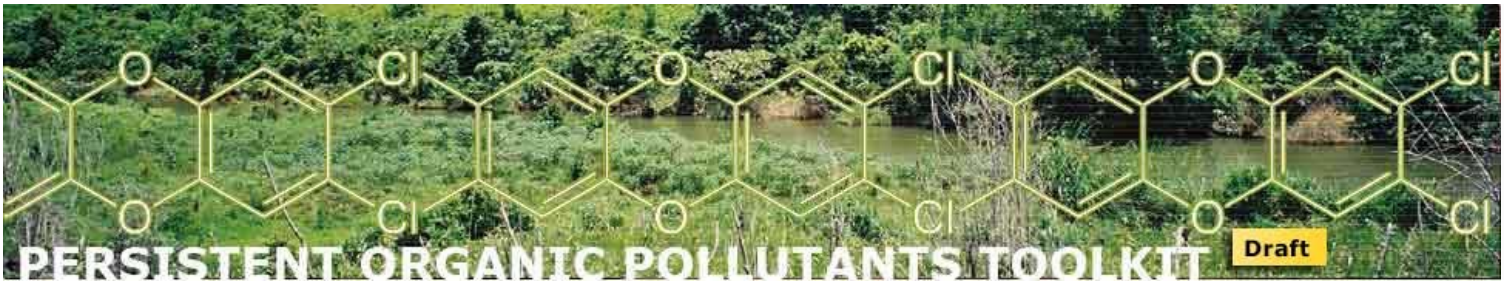


Environmental Quality Guidelines

Collected Biological Samples
Source: Hatfield Consultants
(click to enlarge)

Environmental Quality Guidelines are concentration limits for contaminants or environmental quality characteristics (such as dissolved oxygen or pH) that if exceeded, may affect humans or the environment (CCME 2006). For the POPs program, the CCME Environmental Quality Guidelines for the protection of human health have been recommended as the principle guidelines for ***screening*** purposes.

Like many environmental quality guidelines, the CCME Guidelines are generally based on scientific studies in which animals were exposed to the contaminant in question at various concentrations until a toxic effect was observed. If an animal study is used to represent potential effects to humans, a scaling factor accounting for difference in body weight is used. In addition, safety factors are applied to account for uncertainty, such as the relative sensitivity of animals and humans to a contaminant (CCME 2006).

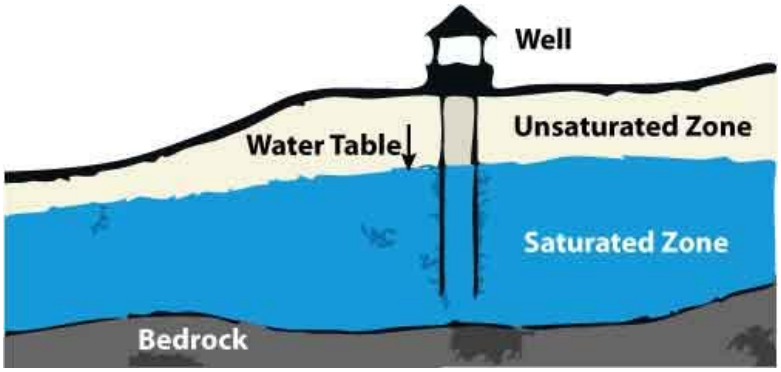
In the case of guidelines protective of human health, once scaling and safety factors have been taken into consideration, the guideline is calculated from **the toxicological reference value** (**TRV**). This is the highest total daily dose or concentration of a given chemical that is considered to not cause a toxic effect in humans when exposed over a lifetime. Guidelines are back calculated from the TRV, by making a number of assumptions about possible exposure scenarios and uptake efficiencies (CCME 2006).

The CCME guidelines provide guidelines addressing most potential exposure scenarios. However CCME does not provide guidelines specific to potential contaminated ***groundwater exposure***.

Groundwater

For contaminants in groundwater, the following screening approaches are recommended, depending on the potential exposure route:

- If the groundwater may be used for drinking water purposes, the Health Canada Guidelines for Canadian Drinking Water Quality (http://www.hc-sc.gc.ca/hecs-sesc/water/index.htm) should be used for screening of COPCs.
- If the groundwater is not used for drinking but may be used for other purposes, then the CCME water quality guidelines that best matches the intended purpose (e.g., livestock watering or to protect aquatic life etc.) should be used (Water Quality Guidelines CCME 2006).
- If the groundwater flows into a stream, lake or pond, it is often assumed that the groundwater will undergo a 10x dilution before discharging. Therefore for screening purposes, it is reasonable to screen groundwater concentrations in this scenario against CCME water quality criteria (for the protection of aquatic life) which have been multiplied by 10.



Additional Documentation and Data

For soil samples, the depth at which samples were collected should be indicated. A map of sampling locations is often helpful to determine if the collected samples reflect the distribution of contaminants across the entire property or just specific areas (Health Canada 2004).

For groundwater, the depth of the water table, flow direction, and travel time are useful data to document.

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Receptors

Receptors are the living organisms (humans, animals and plants) that may be affected by exposure to a chemical hazard. Receptors are unique for a given contaminated site and exposure scenario. It is the receptor that is affected by the risk that is being assessed.

Receptors are the living organisms that may be affected by exposure to chemical hazards
Source: Hatfield Consultants
(click to enlarge)

Humans as Receptors

Humans are often subdivided on the basis of age group (Health Canada 2004). Typical age groups are as follows:

- infants (0 to 6 months),
- toddlers (7 months to 4 years),
- child (5 years to 11 years),
- teen (12 – 19 years) and
- adults (20+ years).

Age groups are assessed separately because many of the factors determining the degree of exposure are different. In addition, certain age groups are more susceptible to chemically mediated effects (i.e., infants, toddlers and pregnant woman are often the most sensitive to chemical exposure)(Health Canada 2004).

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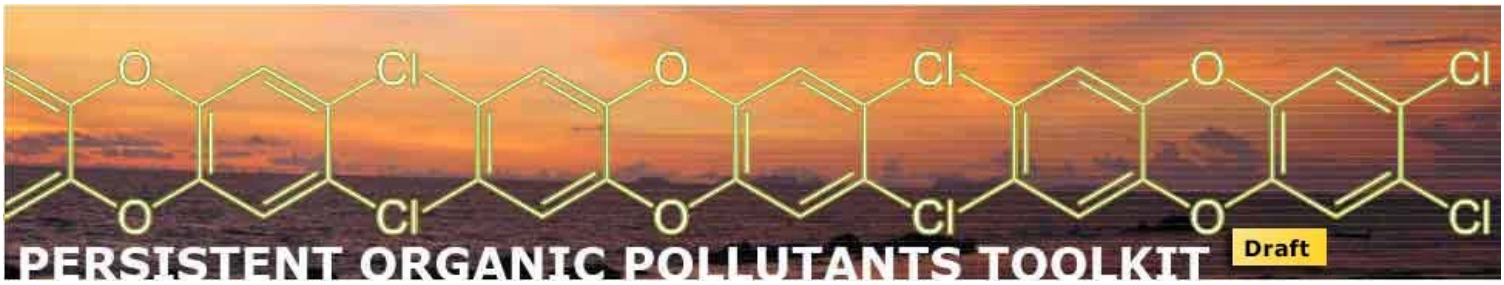

Exposure Pathways

An exposure pathway is the route a chemical ***hazard*** takes to reach (and potentially affect) a ***receptor*** (Environment Canada 2003, Health Canada 2004). Exposure pathways include:

- ***Physical Mechanisms*** – e.g. contaminated soil being washed into a nearby creek and potentially affecting sediment dwelling organisms.
- ***Human Behavior*** – e.g. contaminated material moved by people from one location to another; contaminated soil on a truck's tires or people bring PCB containing oils home to be burned in cooking fires.
- ***Biological Mechanisms*** – e.g. dermal contact with contaminated soil, ingestion of contaminated food, inhalation of dust, etc.

An exposure pathway is the route a chemical hazard takes to reach a receptor
Source: Hatfield Consultants
(click to enlarge)

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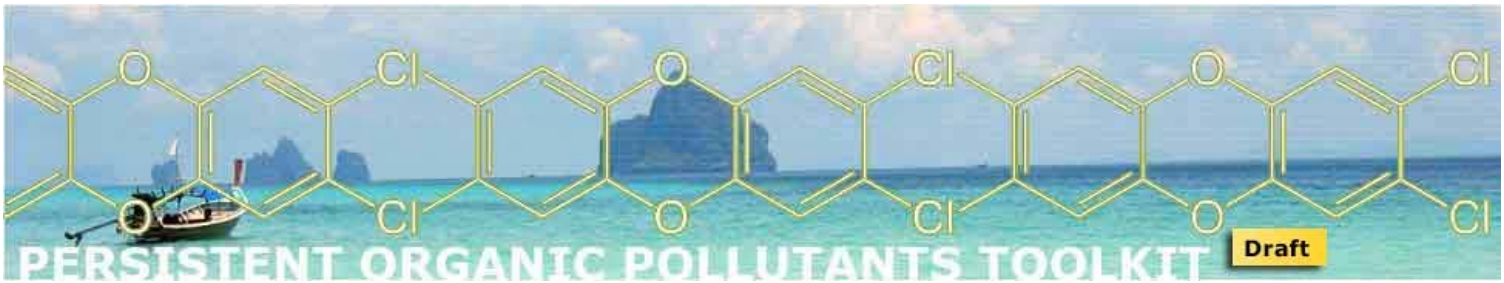
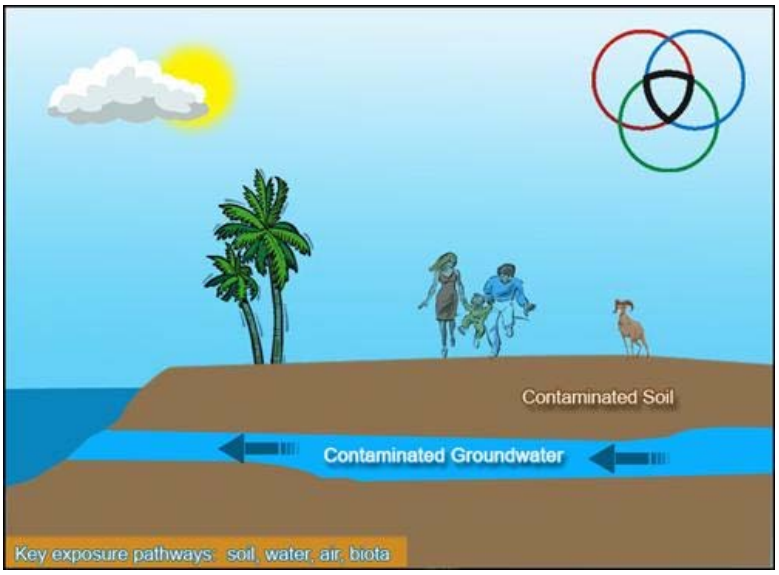


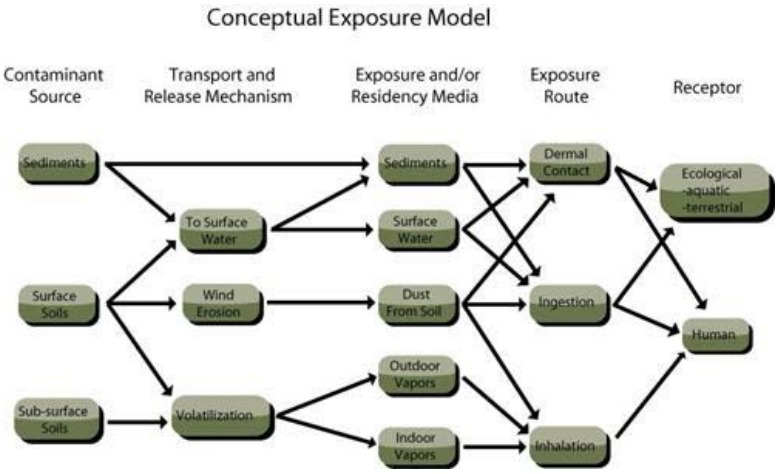
Conceptual Site Exposure Model

A conceptual site exposure model should be created to illustrate and explain how the contaminant sources, exposure pathways and receptors are linked together to form the potential for health risk. This step should involve a simple diagram and short description of these interrelationships. The conceptual exposure model provides the basis for developing the mathematical exposure model and estimation of health risks.

Example 1: schematic picture of conceptual exposure model.



Example 2: schematic flow diagram of conceptual exposure model.



Exposure Analysis

The exposure assessment attempts to quantify the contaminant intake rate for a given pathway. The intake of a contaminant via individual pathways can then be summed to estimate the total daily intake (Health Canada 2004).

Exposure via individual exposure pathways can be calculated by considering contaminant concentrations in **environmental samples**, human behavior information from **exposure surveys** and **standard exposure parameters**.

Alternatively, total exposure (for POPs) can be estimated by collecting **human tissue samples** for direct chemical analysis (i.e., blood and breast milk samples).

Health Canada's Preliminary Quantitative Risk Assessment (**PQRA**) guidance, provides an Excel spreadsheet-based **model** which calculates the total daily intake (Health Canada 2004). A simpler model has been incorporated into the POPs Toolkit (view the Problem Formulation Tool). The equations used to calculate exposure are provided and discussed later in this module.

Cocunut husks soaked in transformer oil for domestic use
Source: Hatfield Consultants
(click to enlarge)

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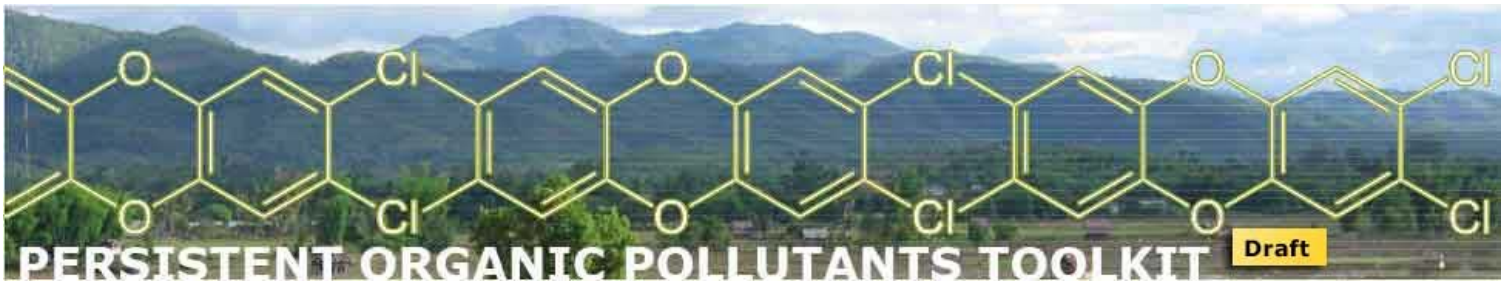

Standard Exposure Parameters

Calculating exposure requires information about several exposure variables. Some of these variables can be derived from the human exposure survey; however, many may not be easily available. Health Canada (2004) provides a **table of standard exposure values** that can be used in the absence of information collected at the site, but they may not be representative of the area being surveyed because they reflect Canadian conditions/characteristics. Risk assessors are encouraged, as much as possible, to use values that are reflective of their country (i.e., average body weight, average lifetime etc.).

The Health Canada standard exposure values can be viewed online here (pdf file).

Other sources of Standard Exposure Parameters include: Richardson (1997) and U.S. EPA Exposure Factors Manual (U.S. EPA, 1997).

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Exposure Equations

For each human exposure pathway, there exists a unique equation for calculating the total daily intake of contaminants. These equations include:

- Accidental ingestion of contaminated soils;
- Inhalation of contaminated soil particles (dust);
- Ingestion of contaminated drinking water;
- Dermal contact with contaminated soil; and
- Ingestion of contaminated vegetables, fruit or meat.

➪ These equations can be found in the risk calculation tool of this website.

Additional equations may also be necessary in cases where a pathway is not sufficiently described by one of the above equations.

Dermal exposures are generally added to the ingested dose, once adjustments are made accounting for differences in absorption
Source: Hatfield Consultants
(click to enlarge)

Inhalation of Dust

The inhalation of dust is usually insignificant relative to direct ingestion of soil and water, and to dermal absorption. However, in some cases the inhalation pathway can become important.

In most cases, the concentration of a contaminant in the respirable airborne dust can be assumed to be equal to the concentration in surface soil (maximum or average). The average airborne concentration of respirable (≤ 10 µm aerodynamic diameter) particulate matter can be assumed to be 0.76 µg/m3 (based on U.S. EPA, 1992).

For situations where vehicle traffic on contaminated unpaved roads can be a significant concern, a reasonable dust level created by vehicle traffic on unpaved roads is 250 µg/m3 (down-wind side of the road; Claiborn et al., 1995).

Dermal Exposure

Toxicological reference values (**TRVs**) for the dermal exposure pathway are not commonly available. Therefore, dermal exposures are generally added to the ingested dose, once adjustments are made accounting for differences in absorption (see Relative Absorption Factors below).

Exposure via Multiple Pathways

In many cases the intake rates for oral, dermal and inhalation exposures are combined and a single TRV is used to evaluate the risks. For example, in cases where only an oral TRV is available, exposures by all routes (oral, dermal, inhalation) should be summed for comparison to the oral TRV.

In cases where TRVs for oral and inhalation exposures are intake rates, calculations for these pathways should be calculated separately.

Relative Absorption Factors (RAFs)

For more refined risk estimates it is desirable to apply **relative absorption factors (RAFs)** in exposure calculations. For PQRAs, oral exposures are typically assumed to have a relative absorption of 100% (RAF = 1); but if evidence suggests a lower bioavailability, this may be modified with justification. Where inhalation exposures are being summed with oral exposures, the inhalation RAF will generally default to 1 unless there is a

good reason for respiratory absorption to be significantly less that 100%.

Where dermal exposures are being summed with oral exposures, the RAF values presented in Relative Absorption Factors and Exposure via Multiple Pathways table (Excel file) should be applied.

Other sources of RAF values include

- **the Risk Assessment Information System** (RAIS - external link),
- Toxicological Profiles published by **the Agency for Toxic Substances and Disease Registry** (ASTDR - external link)

Toxicity Analysis

The toxicity assessment quantifies the sensitivity of the receptor to the chemical hazard. In a Preliminary Quantitative Risk Assessment, the toxicity assessment typically consists of choosing the correct toxicity reference value (**TRV**) for a given contaminant and exposure uptake route. TRVs generally can be used for multiple routes of exposure (i.e., dietary, inhalation or dermal contact), but for some contaminants, separate TRVs are provided specifically for ingestion and inhalation pathways.

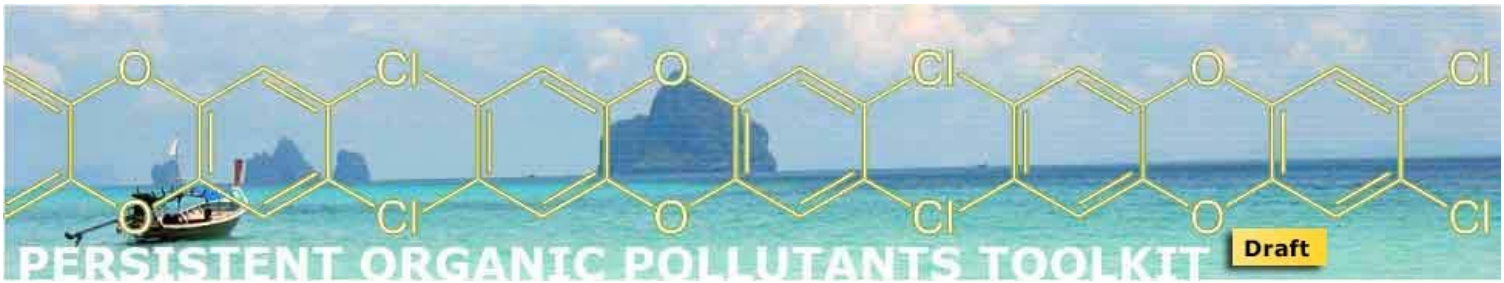
The toxicity assessment quantifies the sensitivity of the receptor to the chemical hazard
Source: Hatfield Consultants
(click to enlarge)

Reference Files:

- Health Canada TRVs (Excel file)
- US EPA RBCs (Excel file)

Toxicity assessments consider the mode of action of the contaminant, the toxic potency as observed in scientific studies, and physiological/biochemical factors which might modify the toxic potency.

Generally, chemicals are considered to have either a **threshold** or **non-threshold** dose or concentration where toxic effects may begin to occur. Each is assessed differently in a human health risk assessment (Health Canada 1994).



Toxicity Reference Values (TRVs)

Health Canada toxicity reference values (TRVs) may be applied where available (Health Canada, 2004). These are referred to as tolerable daily intake (TDI) or reference dose values for non-carcinogens, and slope factors (SF) for carcinogens.

Data without Health Canada TRVs

For substances with no Health Canada TRVs, Reference Doses (**RfD**s), Reference Concentrations (**RfC**s), Acceptable Daily Intakes (**ADI**s), Minimum Risk Levels (**MRL**s) or Cancer Slope Factors (**CSF**s) should be obtained from the following agencies, in order of preference (Health Canada 2004):

- **U.S. EPA Integrated Risk Information System** (IRIS):
- **World Health Organization** (WHO)
- **Netherlands National Institute of Public Health and the Environment** (RIVM):
- **Agency for Toxic Substances and Disease Registry** (ATSDR) (U.S.);

Reference Files:

- Health Canada TRVs (Excel file)
- US EPA RBCs (Excel file)

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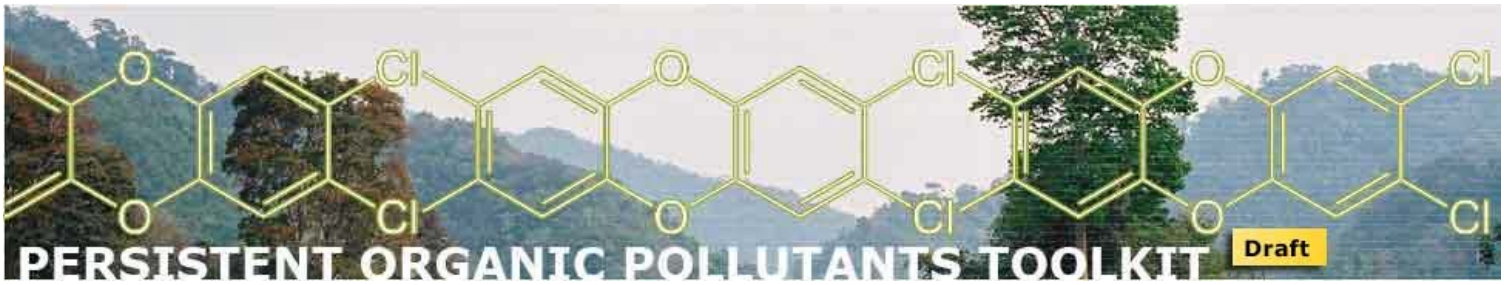
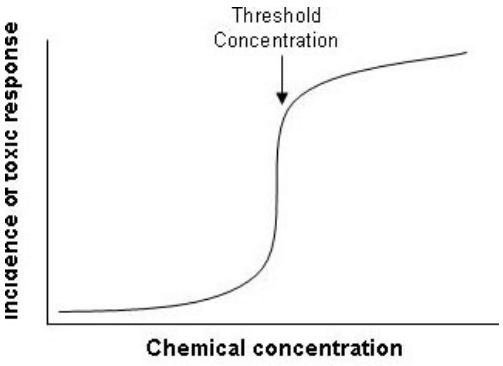


Threshold Contaminants

A threshold response is characterized by a toxic effect occurring above an exposure concentration. Most environmental contaminants are threshold contaminants.



The maximum allowable exposure concentrations, called the **Exposure Limits** (or Toxicity Reference Values) are based on the threshold determined from toxicity experiments. Usually the Exposure Limit incorporates an Uncertainty Factor (or Safety Factor) to account for uncertainties in the estimate. The Exposure Limit for a Threshold Contaminant is generally presented as a Tolerable Daily Intake value (TDI; mg chemical/kg body weight/day) (Health Canada 1994) or a Reference Dose (RfD; US EPA).

You can calculate Hazard Qutotient for a threshold contaminant using the Risk Calculation Tools of the toolkit.

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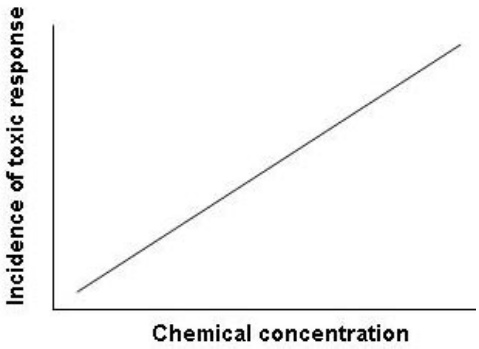
Non-Threshold Contaminants

Non-threshold acting contaminants exhibit affects at virtually all levels of exposure (i.e., any exposure results in some level of risk). Most, but not all carcinogens are generally regarded as non-threshold acting contaminants.



Risk estimation for non-threshold substances is computed differently than for threshold contaminants. The risk estimation is presented as the Incremental Life-time Cancer Risk (ILCR). This is the incremental probability of acquiring cancer over and above the background probability.

The ILCR is calculated by multiplying a chemical concentration by a Slope Factor (SF). In Canada, an acceptable ILCR is generally considered to be 1 in 100,000 (0.00001).

You can calculate an ILCR values using the Risk Calculation Tools.

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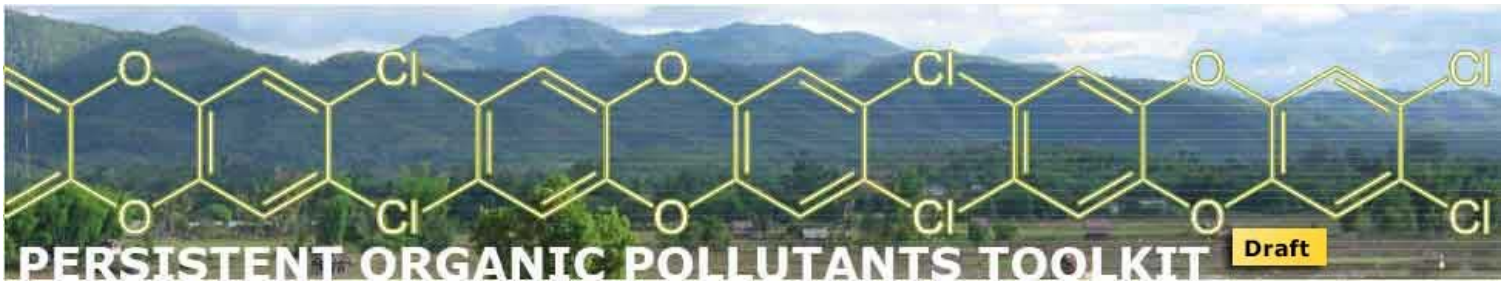

Risk Characterization

The final component of the risk assessment is the risk characterization. The risk characterization integrates the information from the exposure and toxicity analysis to derive a quantitative estimate of human health risk.

This is normally accomplished by calculating an exposure ratio called a **Hazard Quotient (HQ)** for threshold contaminants or an **Incremental Life-time Cancer Risk (ILCR)** for non-threshold contaminants.

If risks are predicted at the risk characterization stage, the risk assessment process is repeated using additional data, refined assumptions and more complex equations and/or risk management measures are taken.

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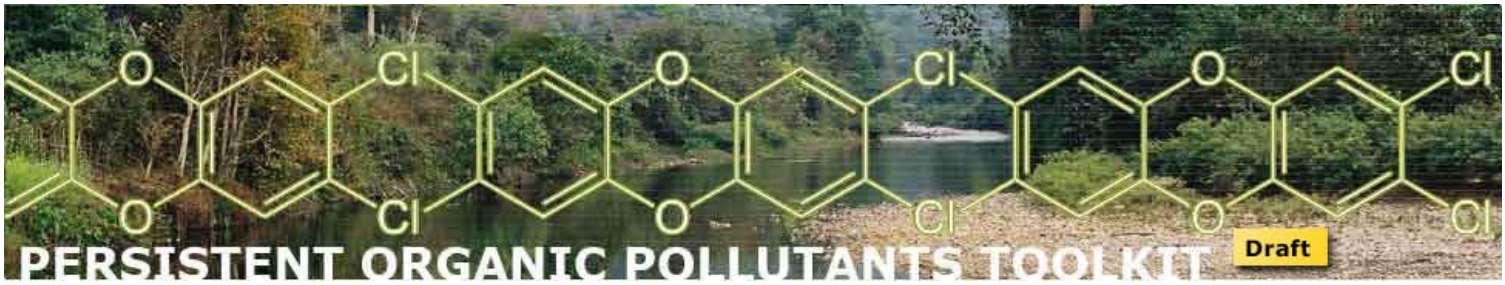

Hazard Quotient

For threshold contaminants, the risk to a human receptor from being exposed to a chemical via a single pathway can be expressed as an Exposure Ratio, commonly called a Hazard Quotient (HQ).

$$HQ = \frac{\text{Dose Rate}}{\text{Reference Dose}} = \frac{\text{Exposure Concentration}}{\text{Reference Concentration}}$$

The reference dose is interpreted as the Tolerable Daily Intake (**TDI**; mg/kg/day).

A Hazard Index (**HI**) is the sum of HQ's for all pathways and similar toxic effects. A HQ of <0.2 for any given pathway is often considered acceptable; while an HI of <1.0 is considered acceptable (Health Canada 2004).

Non-carcinogens: Single-Substance Exposures

For substances presenting risks other than cancer, a Hazard Quotient (HQ; also called an exposure ratio and hazard ratio) will be derived as the ratio of the estimated exposure (for each critical receptor) to the tolerable daily intake (TDI) or tolerable concentration (TC), as follows:

$$\textit{Hazard Quotient} = \frac{\textit{Estimated Dose (µg/kg/day)}}{\textit{Tolerable Daily Intake (µg/kg/day)}}$$

For purposes of preliminary quantitative risk assessment, exposures associated with a HQ = 0.2 will be deemed negligible. This is consistent with the CCME (1996) and the OMEE (1996a), and has become accepted as common practice (Health Canada 2004). If the HQ is greater than 0.2, or the HI is greater than 1, the risk assessment should either be refined and/or risk management measures should be taken.

Online Tool

You can calculate a Hazard Quotient using the Risk Calculation Tools.

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Incremental Lifetime Cancer Risk

For carcinogens, the estimated exposure will be multiplied by the appropriate *Cancer Slope Factor* or *Unit Risk* to derive an estimate of the potential Incremental Lifetime Cancer Risk (ILCR) associated with that exposure (Health Canada 2004). The ILCR is derived as:

ILCR = Exposure (µg/kg/d) x Cancer Slope Factor (µg/kg/day)$^{-1}$

Where pathway-specific slope factors or unit risks exist, the risks via inhalation and the risks via oral + dermal exposure should be estimated separately. In other cases, the cancer risks posed by simultaneous inhalation/dermal/oral exposure will be estimated.

Cancer risks will be considered “essentially negligible” where the estimated ILCR is 1-in-100,000 ($\leq 1 \times 10^{-5}$) (Health Canada 2004).

If the ILCR is greater than 1×10^{-5}, the risk assessment should either be refined and/or risk management measures should be taken.

Online Tool

You can calculate an ILCR value using the Risk Calculation Tools.

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Appendix A8

POPs Issues in Cambodia

POPs Issue in Cambodia and at the Selected POPs Project Case Study Site

Prepared by ROATH Sith, National Consultant
POPs Project Team,
National Training Workshop on Persistent Organic Pollutants Management,
Siem Reap, Cambodia, January 19-21, 2009

Contents

- Background
- POPs pesticides,
- DDT for malaria control,
- Dioxins and Furans,
- PCBs,
- Key Hot-spots,
- POPs management mechanism

Background

- Signed Convention on 23 May 2001;
- Nominated NFP and established TWG for SC;
- October 2003: Start to execute the Enabling Activities for Development of a National Plan for Implementation of the Stockholm Convention;
- November 2004: Conducted POPs inventories (Pesticides, DDT for Malaria Controls; PCBs; and Dioxins and Furans)

Background (cont.)

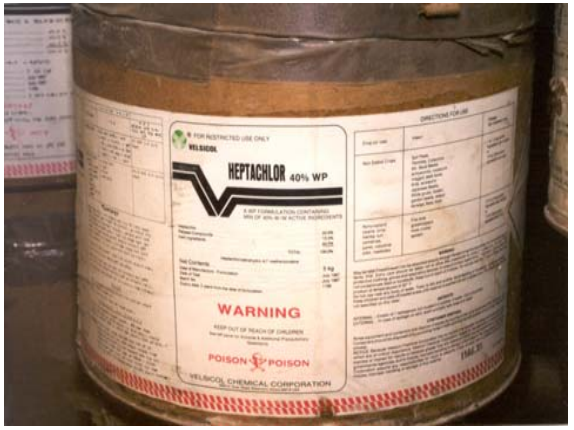
- December 2004: Developed National Profile on Chemicals Management in Cambodia;
- June 2006: Developed National Implementation Plan for the Stockholm Convention;
- Ratification in 25 August 2006;

POPs Pesticides

- There are no production or formulation;
- POPs Pesticides was imported;
- DDT and endrin are the most popular for Cambodia farmers;
- There are no record of amount of imported and use;
- All 9 POPs Pesticides were put in the banned list of Sub-decree No. 69 on “Standards and Management of Agricultural Materials”, 1998;

POPs Pesticides (cont.)

- Some POPs pesticides still found in markets:
  - DDT;
  - Chlordane;
  - Heptachlor



DDT for Malaria Control

- 1953: the first use of DDT in public health, since then continued to use till 1975 but no record available;
- 1975-1979: DDT remained in use during the Khmer Rouge Regime. There was 840 tons of DDT were imported, but no documents to confirm the places of application;
- After Khmer Rouge: remain DDT about 23 tons;

DDT for Malaria Control (cont)

- 1980s: 143 tons of DDT were used (23 tons remain from Khmer Rouge, 120 tons from WHO and Red Cross and/or USA and the former Soviet Union);
- 1980s: there were other uses of DDT at the refugee camps by the United Nations High Commissioner for Refugees (UNHCR) along the Cambodia-Thailand border, but the quantity and exact areas applied remains unknown;

DDT for Malaria Control (cont.)

- Since 1991: the use of DDT in Cambodia was suspended following the advice of WHO and there is no current use of this chemical;
- Future: there is no intention to recommence the use of DDT;

Dioxins and Furans

- Just aware of this chemicals late 1990s;
- Took first and preliminary inventory in 2004;
- Conducted inventory at main sources based on UNEP Toolkit:
  - Waste incineration;
  - Ferrous & non-ferrous metal production;
  - Power generation and heating;
  - Production of mineral products;

Dioxins and Furans (cont.)

- Conducted inventory at main sources based on UNEP Toolkit:
  - Transport;
  - Uncontrolled combustion processes;
  - Production of chemicals & consumer goods;
  - Miscellaneous;
  - Disposal/Landfill;
  - Potential Hot-Spots;
- Result as an estimated figures;

Dioxins and Furans (cont.)

Category	Source Categories	Annual Releases (g TEQ/a)					
		Air	Water	Land	Product	Residues	Total
1	Waste incineration	40.73	0.00	0.00	0.00	0.781	**41.511**
2	Ferrous & non-ferrous metal production	0.41	0.00	0.00	0.00	1.0	**1.41**
3	Power generation and heating	10.275	0.00	0.00	0.00	1.692	**11.967**
4	Production of mineral products	0.099	0.00	0.00	0.00	0.00	**0.099**
5	Transport	0.005	0.00	0.00	0.00	0.00	**0.005**
6	Uncontrolled combustion processes	217.871	0.00	14.56	0.00	315.60	**548.031**
7	Production of chemicals & consumer goods	0	0	0	0	0	**0**
8	Miscellaneous	3.641	0.00	0.00	0.00	0.00	**3.641**
9	Disposal/Landfill	0	0	0	0	0	**0**
10	Potential Hot-Spots	0	0	0	0	0	**0**
Total		**273.031**	**0.00**	**14.56**	**0.00**	**319.073**	***606.664***

PCBs as dielectric fluid

- Electricity transformer were introduced sine 1906 by French company
- All transformers are imported from
  - Before 1975: France and Japan
  - 1980 -1993: USSR and Eastern Europe1993
  - up to date: France, Korea, Thailand, Japan, Romania and Viet Nam;
- There are no production or formulation;
- There are about 1600 transformers available, of which 1343 recorded;

PCBs (cont.)

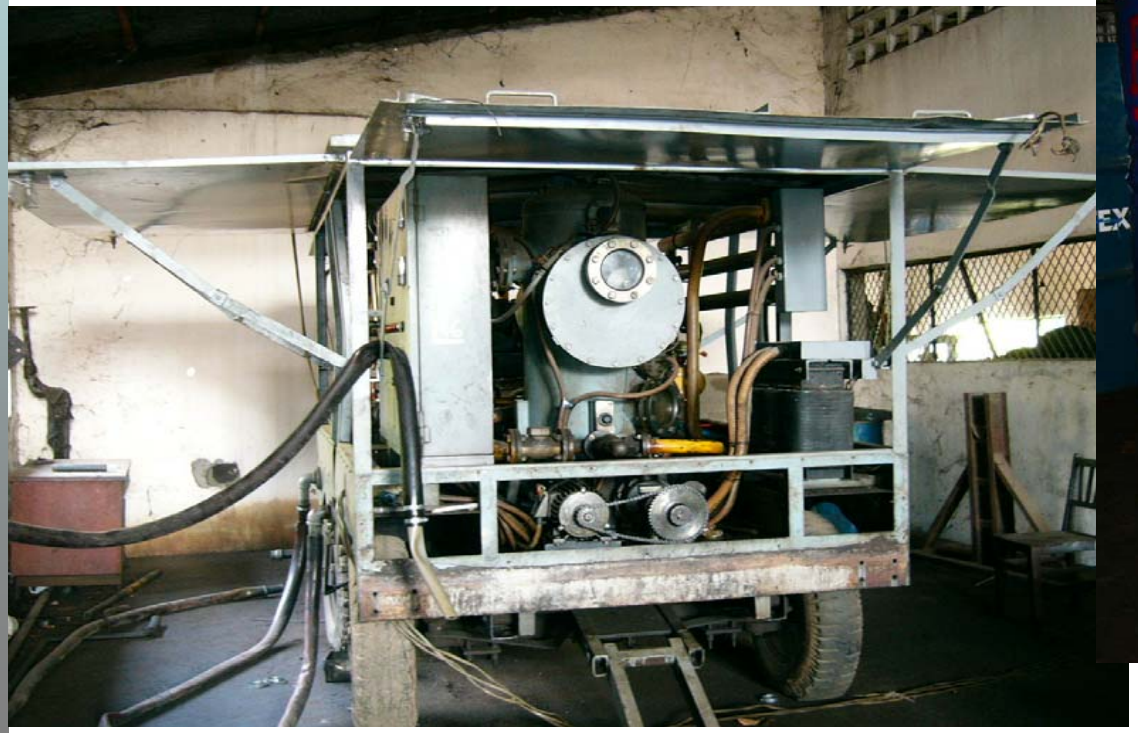
- There are no treatment facilities for PCBs contaminated oil or PCBs containing materials;
- Dielectric oil was reused as retrofilling oil or sold for heating in some small factories, or using as polishing oil and sewing machine as lubricant oil;
- Out of service transformer was sold for metallic recovery;

PCBs (cont.)

- PCBs found: tested by density and test-kits;
- Even ONAN type also found PCBs, as it is imported by private sector;

PCBs (cont.)

- Only one purification machine is use to purify dielectric for retrofilling,
- Great chance for PCBs spread to other equipment



Key hot-spots

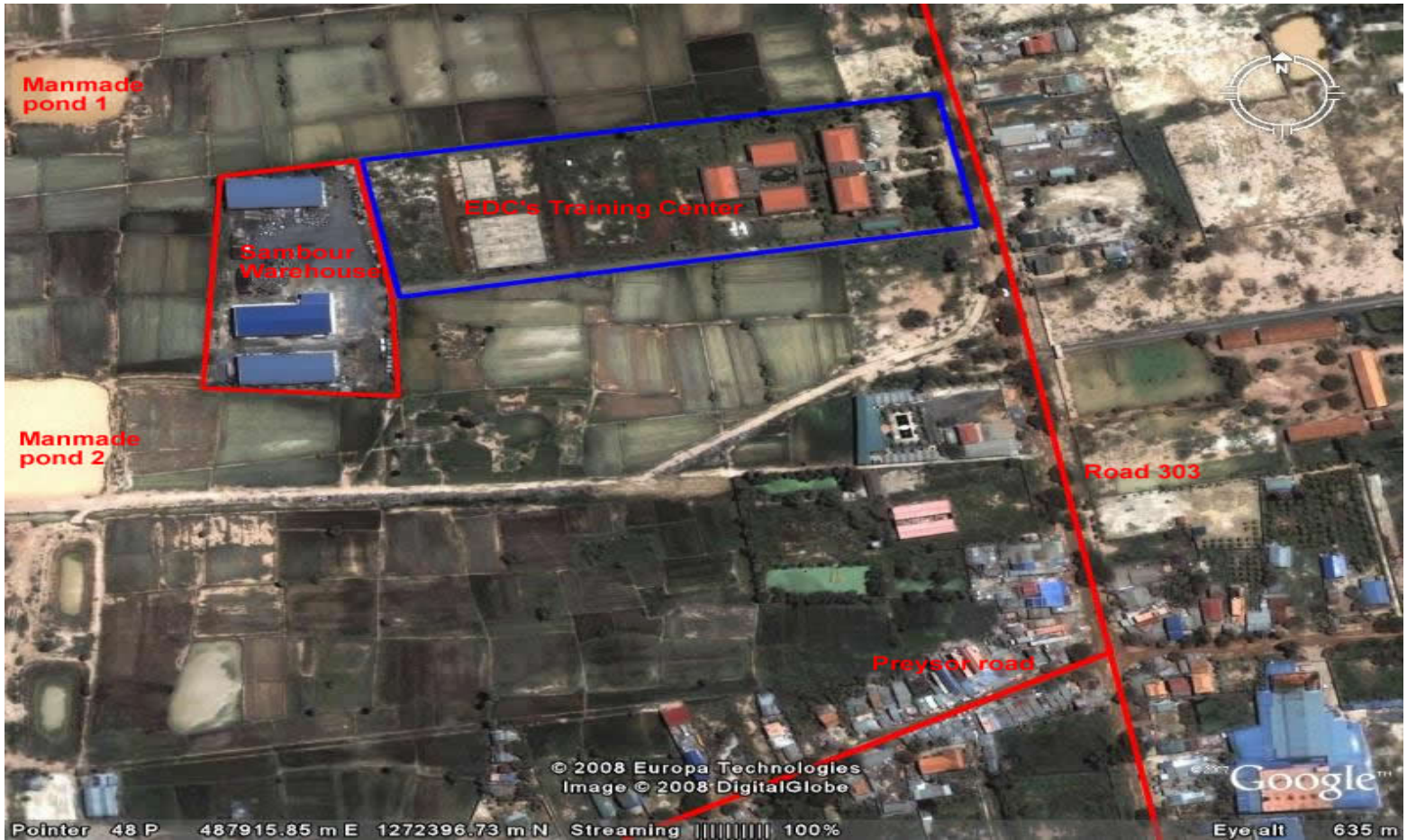
- Five key hotspots has been identified:
  - 1. Transformer workshop
  - 2. Transformer warehouse
  - 3. Pesticide Warehouse
  - 4. Stung Meanchey Dumping Site
  - 5. Kalmet Hospital Incinerator

Hotspots: Transformer Workshop

- The workshop run by EDC. It is located in downtown of Phnom Penh about 50 m from main river
- Soil is contaminated due to PCBs leakages
- Metal drum storing dielectric fluid contaminated with PCBs

Hotspots: Transformer Warehouse

- It is permanent storage located in Sambour district, downtown of Capital



Hotspots: Transformer Warehouse

- Some transformers are broken and have been leaking and no caps;
- The ground of storage are not covered by waterproof or oil prove materials;

Hotspots: Pesticide Warehouse

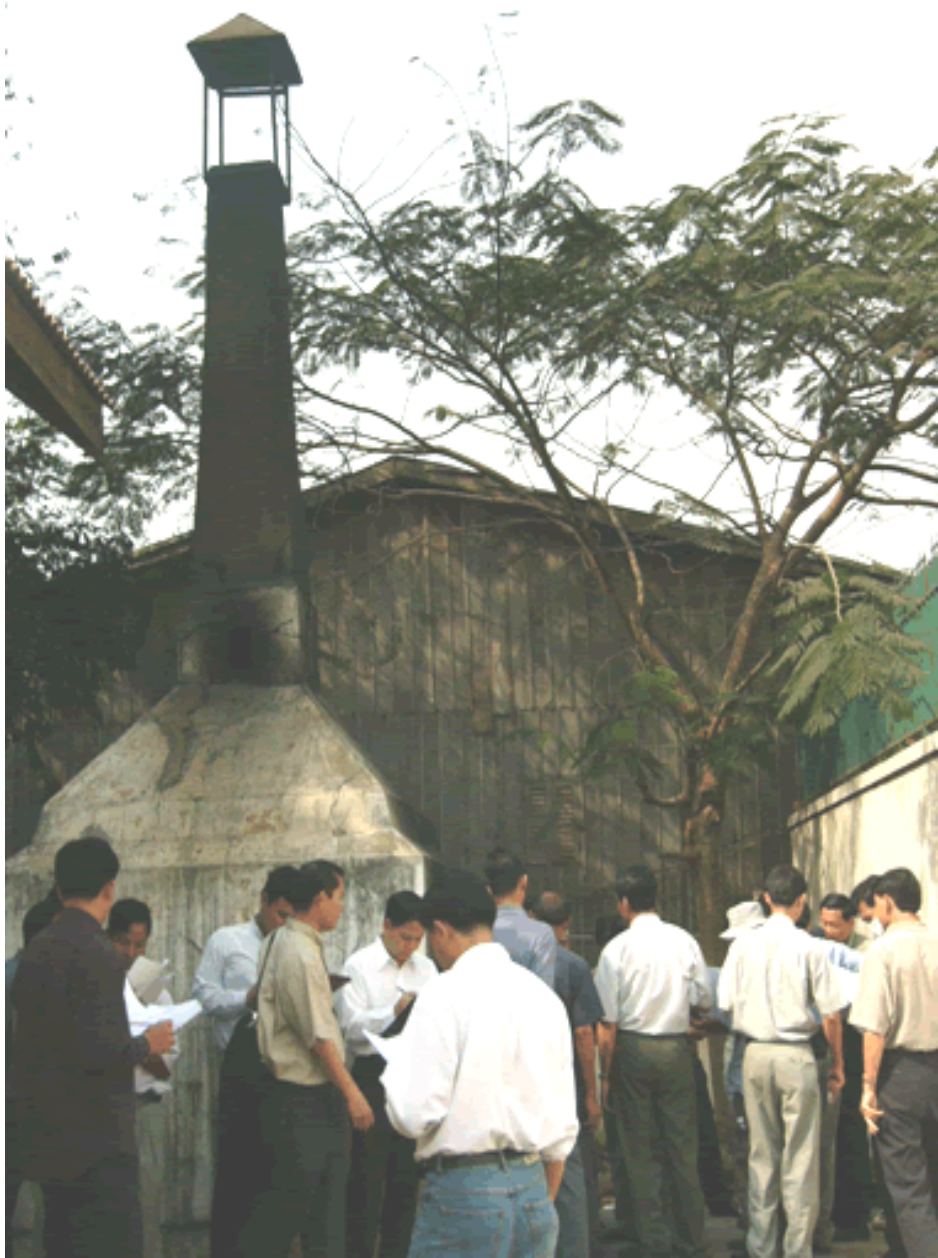
- It’s obsolete pesticide warehouse located in Obek Kaom, Phnom Penh, managed by DAALI, MAFF;
- There are not POPs pesticide;
- It’s located in Phnom Penh;
- It’s involved with the released of Dioxin and Furan from the contaminated soil, sludge and wastes;

Hotspot: Stung Meanchey Dumping Site

- It's located in Phnom Penh;
- It's involved with the released of Dioxin and Furan;

Hotspot: Kalmet Hospital Incinerator

- It's located in Phnom Penh;
- It's involved with the released of Dioxin and Furan



POPs management mechanism

- Legal aspect:
  - Sub-decree No.27 on water pollution control, issued on 6 April 1999.
  - Sub-decree No.36 on solid waste management, issued on 27 April 1999.
  - Sub-decree No.42 on air pollution and noise disturbance, issued on 10 July 2000.
  - Sub-decree No.72 on environmental impact assessment, issued on 11 August 1999.
  - Sub-decree No.72 on environmental impact assessment, issued on 11 August 1999.
  - Law on the management and exploitation of mines resources, adopted on 13 July 2001

POPs management ... (cont.)

- Legal aspect:
  - Law on the management of quality and safety of products and services, adopted on 21 June 2000,
  - Law on pharmaceutical management, adopted on 09 May 1996,
  - Decree law on fisheries management, adopted on 09 March 1987,
  - Sub-decree No.69 on standard and management of agricultural materials, issued on 28 October 1998,
  - Forest Law adopted on 31 August, 2002

POPs management ... (cont.)

- Institutional and technical aspect:
  - Ministry of Environment,
  - Ministry of Agriculture, Forestry and Fisheries,
  - Ministry of Health,
  - Ministry of Industry, Mines and Energy, and
  - Local Authorities (municipality, provinces, and government agencies)
- Public awareness
  - Academia and Civil societies,
  - Governmental ministries and agencies,

Thank you for your attention!

Appendix A9

Case Study of the Sambour EDC Warehouse (SEDCW) Site

Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia Program

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<u>DRAFT</u> RISK ASSESSMENT REPORT - A case study of Sambour EDC Warehouse

Presented by Ken Choviran

National Training Workshop on Human Health Risk Assessment and Management of POPs

Siem Reap, Cambodia, January 19-21, 2009

Canadian International Development Agency | Agence canadienne de développement international | Hatfield Consultants | MOE

Content Outline

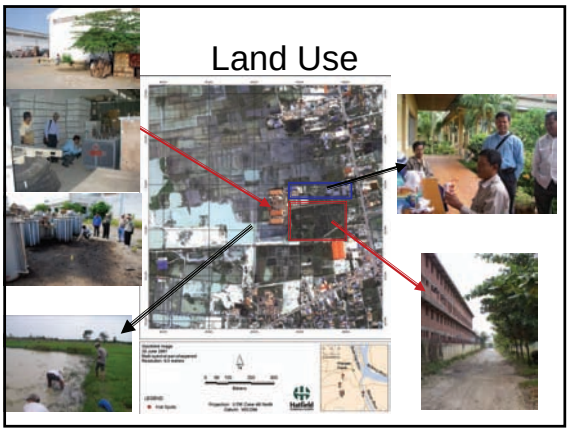
Introduction

- MOE and EDC selected Sambour EDC Warehouse as a case study site.

Site Management

- Since 1997, it has been used for collection & storing electrical equipment, and old transformers.
- Owned by EDC.
- In Sambour Village, Dangkor, Phnom Penh.

Land Use



Suspected POPs

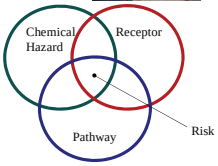
- 2004 Inventory confirmed presence of PCBs.
- Small scale open burning of waste (dioxins/furans).
- No environmental or human tissue data (POPs) available.

Suspected Activities Generating PCBs at SEDCW Site

	Activities	Status
1	Production of PCBs	
2	Production of PCBs containing fluids	
3	**Use of PCB-containing equipment and fluids**	✓
4	**Handling of PCB-containing equipment and fluids**	✓
5	**Storage of PCB containing equipment and fluids**	✓
6	**Leakage of PCB containing equipment**	✓
7	Maintenance and Repair of PCB containing equipment	
8	Retro filling	
9	**Disposal of PCB containing equipment**	✓
10	**Misuse of PCB containing fluids**	✓

Risk Assessment Objectives

- To illustrate the application of the environmental risk assessment process as applied to contaminated sites; and
- To determine if PCBs, dioxins/furans (POPs) and organo-chlorine pesticides (like POPs), and associated health risks are present.



Approach and Process

- Use Health Canada (2004) for Human Health Risk Assessment;
- Preliminary Data Collection - April-May 08;
- 1st Supplementary Field Data Collection - May 08;
- 2nd Data Collection Program (Human tissue) – August 08;
- Samples analysis by CALUX and HR GCMS – Aug – Dec, 08; and
- Risk Assessment with MOE & EDC staff – December 08.

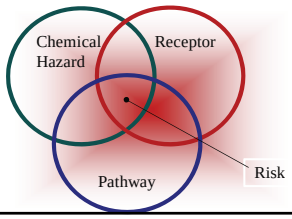
List of Samples Collected, SEDCW, Phnom Penh, Cambodia.

Location	Site Name	May 20 - 24, 2008				August 5 - 6, 2008
		Soil	Sediment	Biota	QA/QC	Blood
Phnom Penh, Cambodia	Sambour EDC Warehouse	23	3	6	2	14

Detailed list of samples collected and analyzed is provided as **Appendix A1**.

Problem Formulation

- All the components required for a human health risk were present: chemical hazards, receptors and pathways linking the hazards and receptors.



Problem Formulation – Chemical Hazards (1)

- The chemical hazards identified were PCBs and dioxin/furans.
- Screening the maximum concentrations for PCDD/Fs and dioxin-like PCBs resulted in exceedance factors of 2.6 (floor dust) and 9.7 (stained soil in transformer storage yard), respectively (using WHO 2006 TEF).
- Both PCDD/Fs and dioxin-like PCBs were considered contaminants of potential concern (COPC).

Problem Formulation – Receptors (2)

- Receptors are the living organisms (humans, animals and plants) that may be affected by exposure to a chemical hazard.

Potential Human receptors related to the SEDCW site (within 1 km radius) may include.

Sambour Site, Phnom Penh, Cambodia

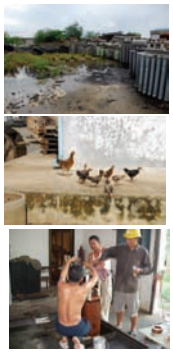
Types of Potentially exposed	Estimated numbers
Sambour village residents Within 1 km radius	1,286
Full time staff of warehouse	22
Full time policemen	3
Full time EDC training center staff	25
Full time security staff of Center	7
Students (short-term training courses)	65-110
Shift workers and visitors	25
Total	1,438

(Source: Sith, 2008)

ID of Receptors

Problem Formulation – Pathway (3)

- How a chemical ***hazard*** reaches & potentially affects a ***receptor:***
  - ***Physical Mechanisms*** – contaminant transported into environment.
  - ***Human Behavior*** –moved by people, means of transport.
  - ***Biological Mechanisms of Chemical Intake*** – dermal and/or eye contact, ingestion of contaminated food and/or soils, and inhalation of dust.



Pathway

From human exposure survey May 2008, the pathway included:

1) ingestion,
2) inhalation of indoor and outdoor dust; and
3) dermal contact.

- Exposure scenario involving soil contact, ingestion, chicken and other food ingestion and off-site dust inhalation.

Risk Characterization

- Potential human health risk associated with exposure to PCBs & dioxin/furans in transformer oils, contaminated sediments and crab tissue is present.
- The results of the PCB exposure model was confirmed by measured concentrations of PCBs in the blood of some workers/staff.

Risk Estimates

- Hazard Quotients: Scenarios ranged from 0.002 to **2.6** (local resident - child)
- Incremental Lifetime Cancer Risk: Scenarios ranged from 2E-07 to **3.8E-04** (local resident – child).
- Blood PCBs Levels – Generally not different from other background measurements; exception **one worker potentially elevated**

Path Forward to Risk Management

- From the risk assessment, the site can be placed into one of five categories of risk management priority, namely:
  - Level A – action is required;
  - **Level B - action likely required**;
  - Level C - action may potentially be required;
  - Level N - remedial action not needed; and
  - Level I - insufficient data.

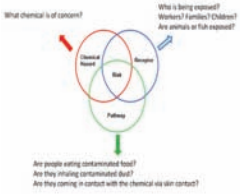
Human Health Risk & Other Concerns

- The potential risks to human health and ecology (from the results of the risk assessment);
- Responsibility/liability that it may pose to:
  - the owners (e.g. cost of remediation, reputation and relation), and
  - affected parties – workers/staff, nearby property owners.
- Currently no specific measures to mitigate the potential PCBs exposures

Setting Risk Reduction Strategy for the Site

- Goals, Objectives and Indicators ➔ need to address three elements of risk.

1) Reduction in health risk to potentially exposed people; and
2) Avoiding, or minimizing uncontrolled release of PCBs & Dioxin/Furans.



Proposed Goals, Sub-goals and Indicators (1)

Goal 1	Sub goals	Indicator
To reduce health risks to sensitive groups of people arising from PCB contamination	1.1To minimize health risks of residents living adjacent to the SEDCW site.	By year 2015, reduce daily exposure to PCBs to the lowest acceptable level (i.e., HQ<0.2).
	1.2To minimize health risks of workers and trainers working elsewhere on the EDC compound.	By year 2015, reduce daily exposure to PCBs to the lowest acceptable level (i.e. HQ <0.2)
	1.3To minimize health risk of workers working in the SEDCW site	By 2015, reduce daily exposure to PCBs to the lowest acceptable level (i.e., HQ<0.2)

Proposed Goals, Sub-goals and Indicators (2)

Goal 2	Sub goals	Indicator
To avoid or, when avoidance is not feasible, minimize uncontrolled releases of PCB hazardous materials or accidents (including explosion and fire) during their handling, storage and use.	2.1 To establish hazardous materials management action plans to address potential chemical hazards, exposure pathways and potential receptors identified through human health risk assessment.	By year 2015, the national hazardous materials management priorities plan is in place and effectively enforced.
	2.2 Where practicable, to avoid or minimize the use of hazardous materials (for example, replacing PCBs in electrical equipment by non-PCB substitutes).	By year 2015, PCB oil or PCB contaminated oils are no longer in use in all transformers and capacitors.
	2.3 To prevent uncontrolled releases of PCBs and other hazardous chemicals to the environment or uncontrolled reactions that might result in fire or explosion.	By 2015, proper containment facilities are in place and properly operated and maintained.
	2.4 To Implement management controls (procedures, inspections, communications, training, and drills) to address residual risks that have not been (or cannot be) prevented or controlled through appropriate risk management measures.	By 2015, management control activities – procedures, inspections, communication, training and drills – are conducted regularly.

Proposed Management Measures

- Numerous technical approaches and other instruments.
- Combination of various measures ➔ more effective outcomes in risk reduction.
- Identified/pre-screened options/measures were further screened against balancing factors: i) effectiveness ii) Long-term reliability iii) Implementability iv) Implementation risk; v) cost (construction, operation & maintenance).

Recommended RA Options: 1) Measures for Controlling PCB Hazard

- Containment facility;
- Test-based inventory of contaminated equipment;
- Store contaminated equipment in containment facility;
- Area signage and enforce access restriction;
- Label equipment, containers and piping systems.

Recommended RA Options: 2) Spill Control, Prevention & Mitigation

- Spill Control & Countermeasure Plan and SOPs;
- Engineering measures to control release;
- Training staff on release prevention and mitigation;
- Monitoring and Inspection Program;
- Enforce use of Personal Protection Gear.

Recommended RA Options: 3) Excavating & Capping of Hot Spot.

- Excavating and recapping critical area promptly;
- Cleaning up of potentially contaminated channels and ditches;
- Capturing sediments from run-off from site during rain; and
- Preventing contaminated soil removed by truck or wind.

Recommended RA Options: 4) Occupational Health & Safety Plan at Work Place

- Job safety analysis;
- Prevention and protective measures:
  - Remove high exposure activities from work process;
  - Minimize hazards through institutional, administrative & engineering controls; and
  - Enforce use of protection equipment.
- Integrity of workplace facilities/structure.

Recommended RA Options: Control site Access & change in human behavior

5. Define & enforce "restricted entry" without proper personal protection equipment;
6. Control on consumption of contaminated foods – discourage or educate on safe eating of suspected contaminated food.
7. Stop workers/staff from bringing contaminated oil and products home
8. Monitor & verify effectiveness of RA plan;
9. Risk Communication & Training; and
10. Labeling

Next Steps

- Risk Communication:
  - Community concerned; and
  - Decision makers.

- Sensitizing/channeling POPs RA/RM into decision/policy agenda ➔ commitment.
- Implementation Plan/Program and Support.

Conclusion

- All three element of risk are presents:
  - POPs – PCBs & dioxin/furan → exceedance factors of 2.6 and 10.2 respectively.
  - Pathway – on-site and off-site exposure (dermal contact, ingestion, and inhalation);
  - Receptors – human and ecological.
- Slightly higher than background level of PCB concentration found in blood of selected staff from both Warehouse and Training Center.
- Ingestion of contaminated food is the predominant route of exposure.

Conclusion (2)

- Potential human health risk associated with PCBs exposure & dioxin/furans.
- SEDCW site is categorized as Level B – actions likely required.
- There is neither past nor existing mitigation plan in place.
- Short-list of cost-effective RA options are proposed to address: 1) hazard; 2) pathway; and 3) receptors.
- Risk communication, implementation plan, and monitoring and evaluation measures are important for the success in risk reduction.

Thank You

For further information contact:

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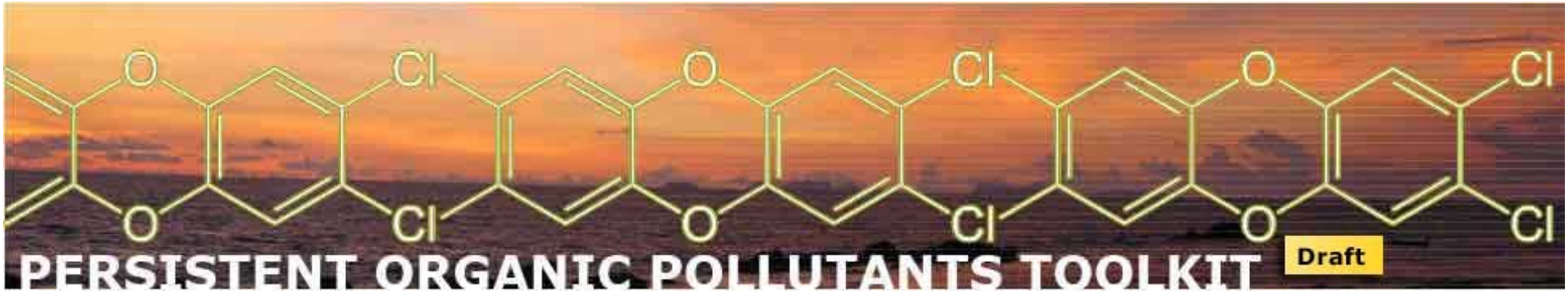
Appendix A10

Preliminary Quantitative Risk Assessment (PQRA)



Risk Calculation Tools

Several risk tools that use a simple model, have been provided to estimate Human Health Risks. The tool calculates exposure (i.e., dose) via ingestion, inhalation and dermal contact. Calculated doses are then used to calculate expressions of human health risk:

- Hazard Quotients (HQs) for non-carcinogens
- Incremental Lifetime Cancer Risk (ILCRs) for carcinogens

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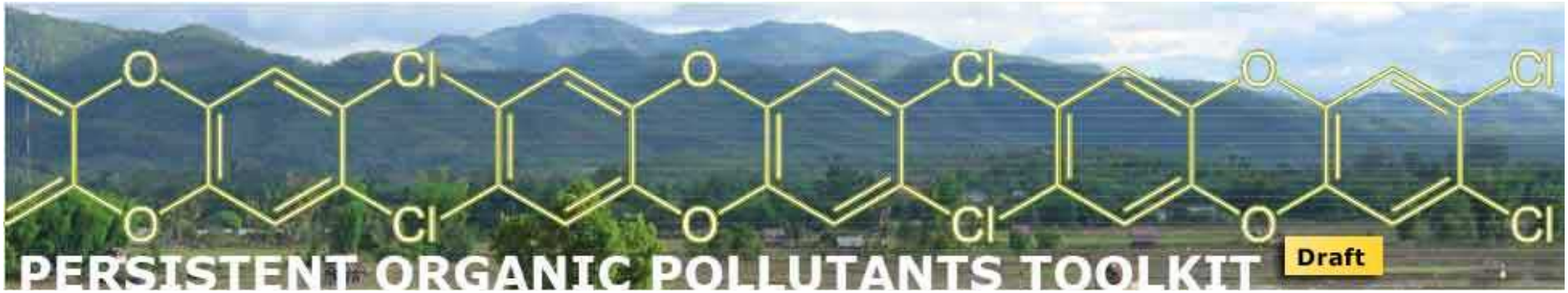


Risk Calculation Tool for a Non-Carcinogen (Threshold) Contaminant

Use this tool to calculate the Hazard Quotient (HQ) for a threshold contaminant (see training material for more information).
If a Hazard Quotient greater than 0.2 is calculated, a risk to human health potentially exists.

Accidental Soil Ingestion Dose Calculation (hide)

$$Dose_{SoilIngestion} = \frac{(C_s \times IR_s \times AF_{GIT} \times D_{Hours} \times D_{Days} \times D_{Weeks} \times D_{Years})}{BW \times 16 \times 365 \times LE} = \_\_\_\_$$

C_s =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
IR_s =		kg/day	Accidental soil ingestion rate for adult (see Table: Receptor Characteristics)
AF_{GIT} =		(unitless)	Absorption Factor for the gastrointestinal tract. **Use a value of 1** for a preliminary risk assessment (as recommended by Health Canada, 2004)
D_{Hours} =		# of hours	Hours per-day with exposure (0 - 16) *(16 is the maximum assumed awake hours per day)*
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =	N/A	years	Number of years of exposure (not used for non-carcinogens)

BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)
LE =	N/A	years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Note: dusts can be trapped by the nose and later ingested, soils can also be ingested from hands if hands are not regulary washed or if dusts deposit on foods eaten at the site.

Water Ingestion Dose Calculation (hide)

$$Dose_{WaterIngestion} = \frac{(C_W \times IR_W \times AF_{GIT} \times D_{Days} \times D_{Weeks} \times D_{Years})}{BW \times 365 \times LE} =$$

C_W =		mg/kg	Concentration of contaminant in drinking water, usually 90th percentile or maximum.
IR_W =		L/day	Water ingestion rate for adult (see Table: Receptor Characteristics - adapted from Health Canada, 2004)
AF_{GIT} =		(unitless)	Absorption Factor for the gastrointestinal tract. **Use a value of 1 for a preliminary risk assessment** (as recommended by Health Canada, 2004)
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =	N/A	years	Number of years of exposure (not used for non-carcinogens)
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)
LE =	N/A	years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Food Ingestion Dose Calculation (hide)

$$Dose_{FoodIngestion} = \frac{(C_{food} \times IR_{food} \times AF_{GIT} \times D_{Days} \times D_{Years})}{BW \times 365 \times LE} =$$

C_{food} =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
IR_{food} =		kg/day	Food ingestion rate (see Table: Receptor Characteristics)
AF_{GIT} =		(unitless)	Absorption Factor for the gastrointestinal tract. **Use a value of 1 for a preliminary risk assessment** (as recommended by Health Canada, 2004)
D_{Days} =		# of days in a year food item is ingested	Number of days in a year food from the site is ingested (0 - 365)
D_{Years} =	N/A	years	Number of years of exposure (not used for non-carcinogens)
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)

LE =	N/A	years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Note: If multiple animals are consumed from the site (i.e., crabs, chickens, snakes, snails etc.), the dose from eating these items should be calculated separately using the same formula.

Inhalation of contaminated particles Dose Calculation (hide)

$$Dose_{ParticleInhalation} = \frac{(C_s \times P_{Air} \times IR_A \times AF_{Inh} \times D_{Hours} \times D_{Days} \times D_{Weeks} \times D_{Years})}{BW \times 365 \times LE \times 10e^{-9}} =$$

C_s =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
P_{Air} =		$\mu g/m^3$	Concentration of particles in the air. **Use 0.76µg/m^3** for typical conditions as per USEPA (1992)
IR_A =		m^3/hour	Inhalation rate (see Table: Receptor Characteristics)
AF_{Inh} =		(unitless)	Absorption Factor for the lungs. **Use a value of 1** for a preliminary risk assessment (as recommended by Health Canada, 2004)
D_{Hours} =		# of hours in a day	Hours of a day with exposure (0 - 24)
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =	N/A	years	Number of years of exposure (not used for non-carcinogens)
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)
LE =	N/A	years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Note: the concentration of respirable dust may be much higher in certain circumstances. Examples would include locations next to dirt roads and inside workshops or storage facilities.

Dermal contact with contaminated soil Dose Calculation (hide)

$$Dose_{DermalContact} = \frac{(C_s \times SA_H \times SL_H \times AF_{Skin} \times EF \times D_{Days} \times D_{Weeks} \times D_{Years})}{BW \times 365 \times LE} =$$

C_s =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
SA_H =		cm^2	Surface area of hands (assumes only hands are exposed, see Table: Receptor Characteristics)

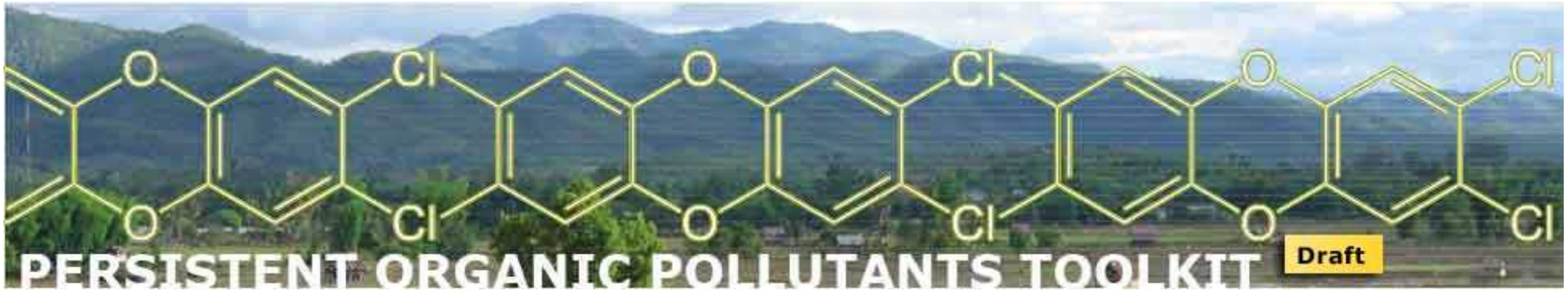
SL_H =		kg/cm^2 - event	Soil loading to exposed skin (see Table: Receptor Characteristics). For a given area of skin, hands will be exposed to a greater mass of contaminated soil than skin on other parts of the body. Health Canada (2004) give hands a 10x greater loading (SLH) than other skin covered portions of the body.
AF_{Skin} =		(unitless)	Absorption Factor for the skin (see Table: Relative Dermal Absorption Factors)
EF =		events/day	number of dermal exposures per day
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =	N/A	years	Number of years of exposure (not used for non-carcinogens)
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)
LE =	N/A	years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Note: For a given area of skin, hands will be exposed to a greater mass of contaminated soil than skin on other parts of the body. Health Canada (2004) give hands a 10x greater loading (SLH) than other skin covered partions of the body. Please refer to Exposure Table.

Calculation of Hazard Quotient:

$$HQ = \frac{(Dose_{SoilIngestion} + Dose_{WaterIngestion} + Dose_{FoodIngestion} + Dose_{ParticleInhalation} + Dose_{DermalContact})}{TDI} = \quad$$

TDI =		mg/kg - day	Tolerable daily intake (TDI) (see Table: Health Canada's TDIs, or US EPA's TDIs).
$Dose_{SoilIngestion}$ =		mg/kg - day	
$Dose_{WaterIngestion}$ =		mg/kg - day	
$Dose_{FoodIngestion}$ =		mg/kg - day	
$Dose_{ParticleInhalation}$ =		mg/kg - day	
$Dose_{DermalContact}$ =		mg/kg - day	
Total Dose =		mg/kg - day	



Risk Calculation Tool for a Carcinogen (Non-Threshold) Contaminant

Use this tool to calculate the Incremental Lifetime Cancer Risk (ILCR) for a non-threshold contaminant (see training material for more information).

If an Incremental Lifetime Cancer Risk greater than 1 x 10^{-5} is calculated, a cancer risk potentially exists.

Accidental Soil Ingestion Dose Calculation (hide)

$$Dose_{SoilIngestion} = \frac{(C_s \times IR_s \times AF_{GIT} \times D_{Hours} \times D_{Days} \times D_{Weeks} \times D_{Years})}{BW \times 16 \times 365 \times LE} = \_\_\_\_$$

C_s =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
IR_s =		kg/day	Accidental soil ingestion rate for adult (see Table: Receptor Characteristics)
AF_{GIT} =		(unitless)	Absorption Factor for the gastrointestinal tract. **Use a value of 1** for a preliminary risk assessment (as recommended by Health Canada, 2004)
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D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =		years	Number of years of exposure

BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics - adapted from Health Canada, 2004)
LE =		years	Life expectancy. The number of year that the person is likely to live.

Note: dusts can be trapped by the nose and later ingested, soils can also be ingested from hands if hands are not regulary washed or if dusts deposit on foods eaten at the site.

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IR_{food} =		kg/day	Food ingestion rate (see Table: Receptor Characteristics)
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D_{Days} =		# of days **in a year** food item is ingested	Number of days in a year food from the site is ingested (0 - 365)
D_{Years} =		years	Number of years of exposure (not used for non-carcinogens)
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics - adapted from Health Canada, 2004)

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C_s =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
SA_H =		cm^2	Surface area of hands (assumes only hands are exposed, see Table: Receptor Characteristics)
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parts of the body. Health Canada (2004) give hands a 10x greater loading (SLH) than other skin covered portions of the body.

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EF =		events/day	number of dermal exposures per day
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
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BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)
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Note: For a given area of skin, hands will be exposed to a greater mass of contaminated soil than skin on other parts of the body. Health Canada (2004) give hands a 10x greater loading (SLH) than other skin covered partions of the body. Please refer to Exposure Table.

Total Calculation of Incremental Lifetime Cancer Risk:

$$ILCR = ((Dose_{SoilIngestion} + Dose_{WaterIngestion} + Dose_{FoodIngestion}) \times SF_{Oral}) + (Dose_{ParticleInhalation} \times SF_{Inhalation}) + (Dose_{DermalContact} \times SF_{Dermal}) =$$

SF_{Oral} =		mg/kg - day	Oral slope factor for contaminant (see Table: Health Canada's Slope Factors, or US EPA's Slope Factors).
$SF_{Inhalation}$ =		mg/kg - day	Oral slope factor for contaminant (see Table: Health Canada's Slope Factors, or US EPA's Slope Factors).
SF_{Dermal} =		mg/kg - day	Dermal slope factor for contaminant (see Table: Health Canada's Slope Factors, or US EPA's Slope Factors). **Where SF_{Dermal} is not available, use the SF_{Oral} value**.
$Dose_{SoilIngestion}$ =		mg/kg - day	
$Dose_{WaterIngestion}$ =		mg/kg - day	
$Dose_{FoodIngestion}$ =		mg/kg - day	
$Dose_{ParticleInhalation}$ =		mg/kg - day	
$Dose_{DermalContact}$ =		mg/kg - day	
Total Dose =		mg/kg - day	

Appendix A11

Economic Valuation of POPs Impacts

Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia Program

Canadian International Development Agency | Agence canadienne de développement international

Hatfield CONSULTANTS

 2/27/2009 SLIDE 1

Economic Valuation of Health Impacts from POPs

by Thomas Boivin

Hatfield Consultants Partnership

Canadian International Development Agency | Agence canadienne de développement international

Hatfield CONSULTANTS

 2/27/2009 SLIDE 2

Why Conduct An Economic Valuation of POPs Impacts? (1)

- Understanding economic costs of POPs is important *for convincing policymakers of the impacts of POPs;*
- However, there are not enough **resources** - financial, human, or technical to deal with these problems;
- Countries need to **prioritize** to make better use of limited resources
- We need to be **strategic** to maximize the use of limited funds;

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 2/27/2009 SLIDE 3

Why Conduct An Economic Valuation of POPs Impacts? (2)

- An economic valuation is not commonly done in countries where strong regulations and enforcement are in place;
- If a site is contaminated, then the government or developer is responsible to clean it up to avoid human health or ecological impacts;
- "Polluter Pays Principle" is common in western countries, but is often not enforced in SE Asian countries;
- Risk Assessment requires a good understanding of the economic costs of different management options;

 2/27/2009 SLIDE 4

Overview of Economic Valuation of Health Impacts from POPs

- Preliminary methodology has been developed for discussion;
- Economic costs will be calculated from the case study sites, and these will be compared with different risk management or remediation measures;
- Limited data exists on the economic costs of POPs in the 4 countries;
- Any estimates of economic impacts from POPs can be modified in future as additional data becomes available.

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 2/27/2009 SLIDE 5

Overview of Economic Valuation of Health Impacts from POPs (2)

- The objectives of the economic valuation of health risk portion of the project are:
  - a) To estimate (in *quantitative* terms) the dollar value of the human health impact of POPs contamination at a designated 'hot spot';
  - b) to compare the estimate with the cost of remediation measures; and
  - c) to describe (in *qualitative* terms) the values of POPs impacts in direct human health and other unquantified costs.

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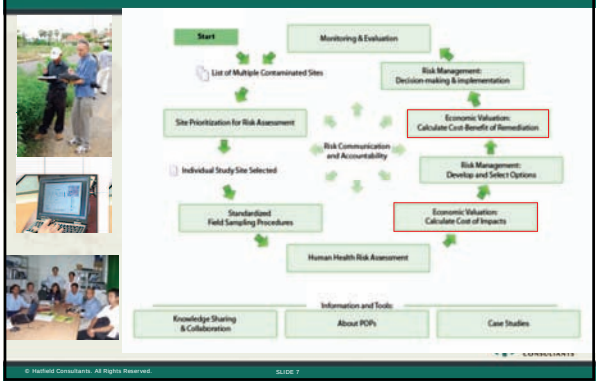
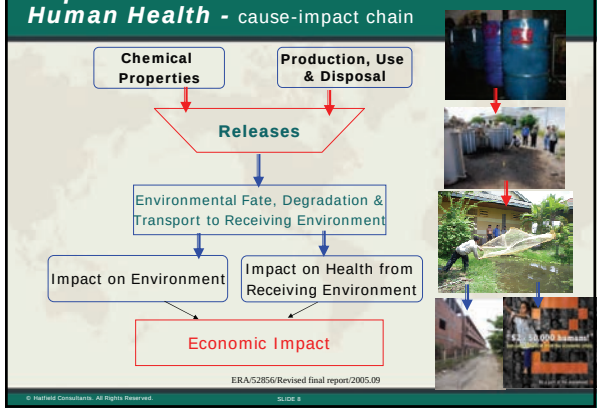
 SLIDE 6

Economic Valuation Within Overall Risk Governance Framework



 SLIDE 7

Impact of Chemicals On Environment And Human Health - cause-impact chain

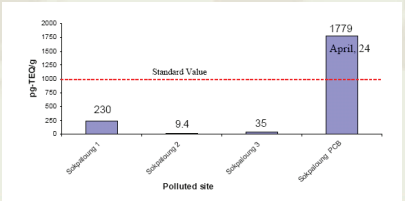


 SLIDE 8

Land Use for SPL Site

Suspected POPs Contaminants

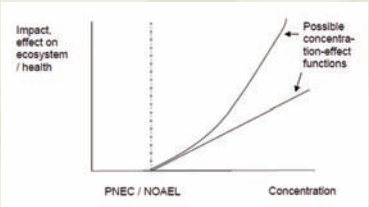
- The site is used to collect, store and repair used transformers from 1982.
- Recycled oil is transferred into 45-gallon drums, and is re-used
- Previously analyzed samples from the site suggested potentially high concentrations of PCBs.



 SLIDE 10

Valuation of Health Risk

- Valuation of human health risks is the most significant and also the most controversial parameter.
- In many cases, we can define the effect concentration, but a dose-response relationship has not been defined to show how types of morbidity and premature mortality respond to the exceedance of the no-effect level.



 SLIDE 11

The Ideal Approach

- The ideal measurement of economic impacts involves four 'end points':
  - **(a) Health effects from exposure to ambient environmental concentrations;**
  - **(b) Health effects from chemicals accumulated in food and water;**
  - **(c) Health effects from exposure to chemicals in the workplace; and**
  - **(d) Loss of ecosystem functioning.**
- **Difficulties in establishing relationships between ecological or health effects and economic costs:**
  - **Limited health dose-response information exists;**
  - **Effects are not known with any precision; and**
  - **Resources are required to conduct "willingness to pay" (WTP) studies and collect other important information.**

 SLIDE 12

Possible Economic Valuation Approaches

- There are several methodologies for establishing a dollar value for adverse human health impacts;
- Each approach requires significant data collection to ensure accuracy of the results.

 SLIDE 13

Disability Adjusted Life Years (DALY) Approach to Economic Valuation

- DALY is originally developed by WHO to quantify the impact of premature death (mortality) and disability (morbidity) on a population by combining them into a common metric.
- One DALY can be thought of as one lost year of "healthy" life.
- DALYs show the relative importance of health problems and can be combined with other data to establish which public health interventions would be most cost-effective.
- For example, 3,300 DALYs would equal 100 infant deaths or 5,500 people aged 50 living one year with blindness. These comparisons are helpful in setting national and global health priorities.

 SLIDE 14

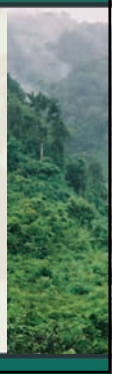
Why the DALY Approach Was Selected

- Given limitations of time and resources, the DALY approach to estimating the physical component of human health impact is judged the best approach because:
  - *Conceptual simplicity*: DALY covers both mortality and morbidity in one number. The equations are straightforward with 5 elements in 2 equations;
  - *Data availability*: WHO has estimated DALY rates per 100,000 population for all countries, not just the four of the POPs study;
  - *Ethically Acceptable*: The DALY approach does not place a value on a human life; rather is places a value on the risk shared by members of an exposed population.

 SLIDE 15

Approach – Limitations of the Analysis

- Human health impacts are not the only impacts at a POPs contaminated site;
- Non-human health impacts such as environmental impacts, decreased land values, and ecological impacts may also be significant;
- However, non-human health impacts can be *qualified* (e.g., described in words).



 SLIDE 16

Key Steps in Economic Valuation using DALY

- **Step 1 - Obtain DALY**
- **Step 2 - Scale DALY to Local Site**
- **Step 3 - Calculate Unit Price per DALY**

} Calculate Cost of Impacts

- **Step 4 - Estimate Site Remediation Costs**
- **Step 5 - Estimate Benefit of Remediation (#DALYs saved per year)**
- **Step 6 - Calculate Cost-Effectiveness of Remediation**

} Calculate Cost of RM Options => Cost-Effective

 SLIDE 17

Step 1 - Obtain DALY

- **Step 1 - Obtain DALY**
- These estimates are found at the WHO website:
  - Go to WHO website http://www.who.int/en/
  - Click on "Data & Statistics" http://www.who.int/research/en/
  - Scroll down to "Data by Categories"
  - Under "Mortality & Health Status", select: ***Causes of Death [xls 3.03 MB]***
  - Download the file. Filename = **bodgbddeathdalyestimates**

 SLIDE 18

DALYs / 100,000 population, 2002. 4 POPs countries

DALYs per 100,000 of population	Cambodia	Lao People's Democratic Republic	Malaysia	Thailand
Population ('000) (e)	13,810	5,529	23,965	62,193
All Causes	**38,451**	**40,324**	**14,626**	**20,508**
I. Communicable, maternal, perinatal and n	23,975	24,340	2,906	6,111
A. Infectious and parasitic diseases	16,191	10,740	1,604	4,563
1. Tuberculosis	1,904	643	281	320
2. STDs excluding HIV	154	417	146	155
3. HIV/AIDS	3,180	28	320	2,221
4. Diarrhoeal diseases	2,801	3,181	117	297
5. Childhood-cluster diseases	1,124	994	68	51
6. Meningitis	1,573	422	70	156
7. Hepatitis B (g)	182	106	48	135
8. Malaria	884	832	28	259
9. Tropical-cluster diseases	85	360	84	84
10. Leprosy	6	9	12	11
11. Dengue	44	112	17	111
12. Japanese encephalitis	32	84	9	8
13. Trachoma	18	17	0	0
14. Intestinal nematode infections	357	317	92	96
B. Respiratory infections	1,799	3,660	357	532
C. Maternal conditions	864	1,371	146	162
D. Perinatal conditions (h)	3,324	6,663	358	463
E. Nutritional deficiencies	1,797	1,906	441	390

 SLIDE 19

DALYs / 100,000 population, 2002. 4 POPs countries

DALYs per 100,000 of population (continued)	Cambodia	Lao People's Democratic Republic	Malaysia	Thailand
II. Noncommunicable diseases	11,847	11,257	10,180	11,673
A. **Malignant neoplasms**	1,125	932	955	1,157
B. Other neoplasms	17	24	11	12
C. Diabetes mellitus	254	157	394	421
D. Endocrine disorders	358	95	113	218
E. Neuropsychiatric conditions	2,968	3,183	2,874	3,222
F. Sense organ diseases	764	795	1,888	2,236
G. Cardiovascular diseases	2,362	2,315	1,545	1,568
H. Respiratory diseases	837	933	649	728
I. Digestive diseases	888	1,093	522	592
J. Genitourinary diseases	440	212	260	330
K. Skin diseases	88	50	104	122
L. Musculoskeletal diseases	429	409	502	575
M. Congenital anomalies	1,171	913	200	310
N. Oral conditions	147	144	164	181
III. Injuries	2,628	4,727	1,540	2,724
A. Unintentional injuries	1,923	3,849	1,071	2,032
2. Poisonings	22	137	15	19
B. Intentional injuries	705	878	469	692

 SLIDE 20

Step 2 - Calculate Unit Price per DALY

- To calculate the dollar value (unit cost) of a DALY, the benefits transfer method is used.
- *Value of 1 DALY*: Using benefit transfer, the calculation of the 2007 US$ value of 1 DALY in **Laos** is made as follows:
  - Start with the value of a DALY in the United Kingdom used in the 2003 "The Social Cost of Chemicals" study: **€ 94,936**;
  - Convert this 2003 Euro value to a 2007 US$ value using historical data on the Euro – US$ exchange rate[1] and UK inflation from 2004 – 2007.[2] That yields a 2007 US$ value of 1 DALY in the UK of **$118,401**;
  - Adjust the UK DALY to local conditions by the ratio of per capita income of the two countries.[3] GNI/capita in the UK is 17.4 times that of Laos in 2007. Divide the UK value of a DALY by that multiple to yield a 2007 US$ value of 1 DALY in Laos of **$6,796**

[1] The average exchange rate for 2003 was US$1.1321 = €1.00. www.oanda.com
[2] Annual inflation in the UK was: 2.6% (2004), 2.2% (2005), 2.4% (2006) & 2.6% (2007). World Bank.
[3] Gross National Income per capita, PPP method: $33,800 (UK); $13,570 (Laos). UK / Laos = 17.4

 SLIDE 21

Step 3 - Estimate Site Remediation Costs

- Cost estimates for different remediation options can be developed;
- Issues which need to be considered, including:
  - Remediation method to be used (e.g., Capping? Incineration?);
  - Costs are site-specific, depending on type of contamination and extent of the problem;
  - Simple solutions can significantly reduce risk, and may be preferable to more costly, high-tech solutions;
  - Social/cultural acceptance of remediation method used; and
  - Government and local priorities.

 SLIDE 22

Step 4 - Calculate Cost-Effectiveness of Remediation

- The economic analysis must include an estimation of benefit over time, and needs to consider the following questions:
  - How much money can we save in future by investing in environmental protection today?
  - How much money would we lose (or how many people will be impacted) if we do **not** invest in environmental protection, and end up with a bigger problem in the future?

 SLIDE 23

Step 5 - Relate Site Remediation Costs to Number of DALYs Saved

Therefore:

$$\text{\# DALYs Saved Per Year} = \frac{\text{Site Remediation Costs Over Time}}{\text{Average Price Per DALY}}$$

- The above simple calculation can be used to compare the #DALYs saved as part of decision-making process;
- For example:
  - Site remediation costs (Option A) = $100,000;
  - Average price per DALY (Laos) = $6,796
  - Therefore: #DALYs Saved Per Year = $100,000/$6,976
    = 14.7 DALYs/Year

 SLIDE 24

Conclusions (1)

- Understanding economic costs of POPs is important *for convincing policymakers of the impacts of POPs;*
- Helps to **prioritize sites** which may require remediation;
- Can also prioritize across different sectors/investments (e.g., how does the costs of a clean-up project compare to the investment required for other civil projects (clean water project, etc.?);
- In most developed countries, there is a well developed legislative framework, strict enforcement and sanctions against violators. As such, an economic valuation is not normally performed.

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 SLIDE 25

Conclusions (2)

Key Questions and Assumptions:

- How do we place a value on health impacts, and how do we link health problems to POPs?
- Use of the DALY approach requires certain assumptions and professional judgment to be applied, and accordingly may generate uncertainties in final economic estimates.
- Costing remediation measures also requires a number of assumptions, as these vary between different sites and between countries.

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 SLIDE 26

Conclusions (3)

- The POPs Project Economic Analysis will develop a simple method which can help prioritize risk management and remediation activities;
- Methodology developed is still a draft for discussion;
- Comments from workshop participants, local public health officials and economists would be appreciated;
- Risk Management Discussion session will include discussion of costs for remediation at the Case Study Site;
- Final draft reports for review– early March 2009.

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 SLIDE 27

Please Send Your Comments to World Bank and Hatfield!

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 2/27/2009 SLIDE 28

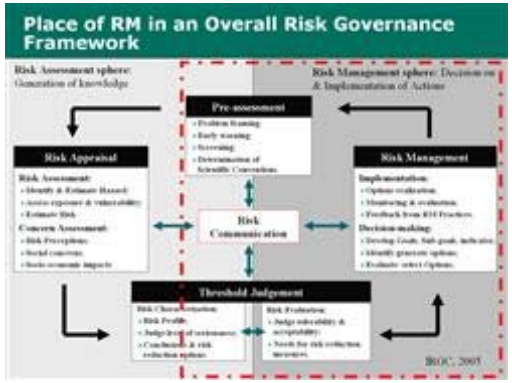
Appendix A12

Risk Management Decision Making Process

Introduction to Risk Management

Risk Assessment results feed directly into the Risk Management phase. Risk Assessments evaluate the probability and magnitude of contaminant-related effects, while Risk Management is a process used to:

- Decide whether a level of risk is acceptable in a larger context (socially, economically and politically); and/or,
- Select risk reduction options (i.e., either technical or policy-based solutions), and assess cost-benefit of the options.



Place of Risk Management in Overall Risk Governance Framework
Source: Hatfield Consultants
(click to enlarge)

Characteristics of Effective Risk Management Strategies

Experience from industrialized countries show that certain characteristics are likely to promote an effective and successful risk management decision-making process:

***Current**:* Risk reduction strategies need to remain up to date with evolving national policies and priorities, new scientific findings or technological developments, and they need to take into account the effectiveness of existing strategies.

***Participatory**:* Numerous stakeholders play a role in the development of an effective Risk Management strategy. Consequently, effective risk communication and dialogue must be apparent in all Risk Management activities.

***Informed**:* Risk management decision-making requires various types of information such as statistical data, probability studies, information about local customs and practices, knowledge about the nature of past and present exposure, economic analyses, information about regulatory and other control options, etc.

***Contextual**:* Risk reduction strategies should be adapted to the political, cultural and socio-economic context as well as local realities.

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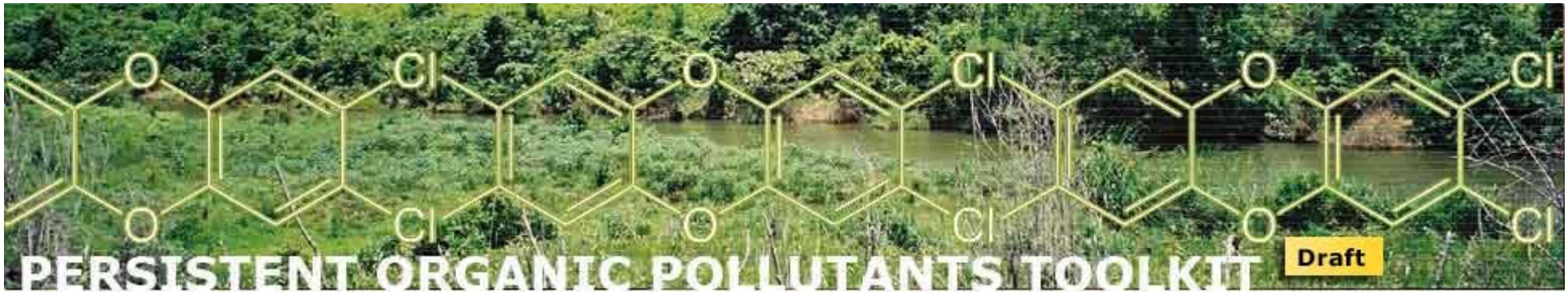
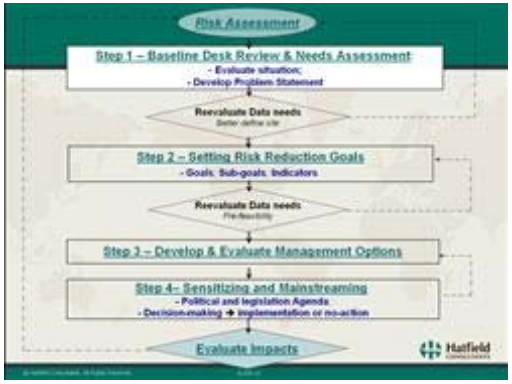


Five Step Process for Risk Management

The Five Step Risk Management Process used in the POPs Toolkit can be used for planning risk management activities on either a site-specific or a nation-wide basis.

The Risk Management process must be carried out within the context of the unique institutional mechanisms and circumstances of each country. Therefore, the guidance and broad suggestions presented in this module should be used and applied in a flexible manner.



The Five Step Process for Risk Management
Source: Hatfield Consultants
(click to enlarge)

Step 1 - Baseline Review

The Baseline Review provides the framework for the Risk Management process. It defines and describes the following:

- The exposure scenarios resulting in risks that need to be managed;
- The types of economic information needed to estimate the costs related to chemical contamination (i.e., health care, lost wages, reduction in property value, loss of property usage);
- Information related to local and national conditions;
- Communications strategy and approach; and
- The basis for the collaborative development of national priorities for health risk management.

For Risk Management programs addressing human health risks on a country-wide basis and/or site specific, it is helpful to divide the Baseline Review into a Situation Statement and a Problem Statement.

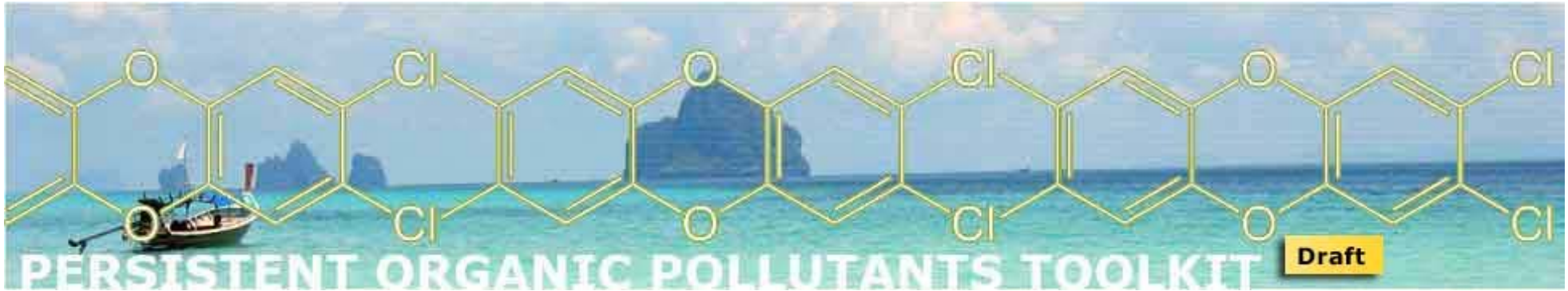
Baseline Desk Review & Needs Assessment follows directly from Risk Assessment data and results
Source: Hatfield Consultants
(click to enlarge)

Step 2 - Setting Risk Reduction Goals

The process of setting risk reduction goals involves clearly defining the goals for the protection of human health and the environment from POPs-related risks. These goals provide the framework for developing and evaluating Risk Management Options in Step 3.

The expected output from this step is a concise statement and table of the main risk reduction goals which includes goal setting for the overall goals, sub-goals and indicators.

Step 2 follows from Baseline Desk Review & Needs Assessment phase
Source: Hatfield Consultants
(click to enlarge)



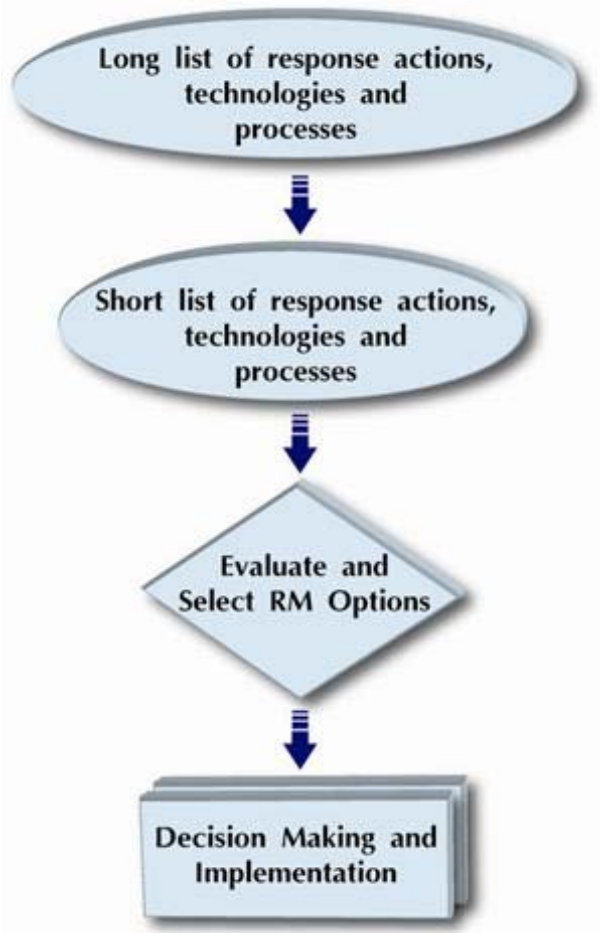
Step 3 - Developing and Evaluating Management Options

Step 3 builds upon the results from Step 1 (Baseline Review), and Step 2 (Goal Setting). The development and evaluation of risk management options can be accomplished by:

- Developing a list of possible response actions, technologies and process;
- Preliminary screening of the list;
- Qualitative screening of the list; and
- Semi-quantitative evaluation of selected approaches on the list.

The suggested output is an evaluation of the advantages and drawbacks of possible risk reduction options that could be used to prevent, or reduce, the risk of concern. The last step (iv) ties into the policy making process.

Clearning up a contaminated storage building
Source: FAO
(click to enlarge)



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General Risk Reduction Considerations

Use a Multi-pronged Approach

In most cases, there will be more than one way to achieve a particular risk reduction goal. A combination of regulatory and voluntary risk management approaches should be considered when dealing with unacceptable risks at contaminated sites.

Conducting a multi-pronged approach requires a large amount of communication (Thailand)
Source: Hatfield Consultants
(click to enlarge)

Communication

The development of risk management options requires communication and participation between government agencies and other stakeholder groups to focus on:

- Existing national and local risk management approaches;
- Lesson learned from other countries that have risk managed POPs contaminated sites;
- New and innovative risk management measures; and
- Resources available.

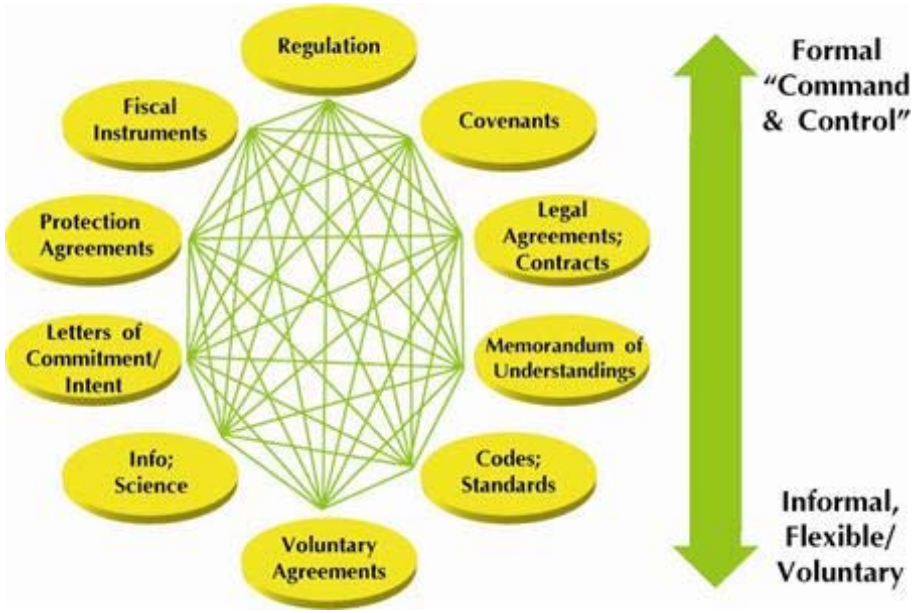
Use Existing Tools

When considering possible actions, it may also be useful to consider how *existing* tools and measures can be made more effective. For example, a lack

of active enforcement of existing regulations, or lack of awareness, may be contributing to observed risks.

Continuum of Risk Management Approaches

Each category of risk reduction measures can be placed in a range of flexibility, between formal command and control measures to informal, voluntary measures. The figure below shows the categories of risk reduction on this range.



Example Risk Management Options

This page provides a list of risk management approaches. Most were presented in National Implementation Plans (NIPs); however, some additional approaches are also provided.

A GeoMembrane Cap in Vancouver, BC
Source: Mike Rankin
(click to enlarge)

Chemical Hazard:

Risk management approaches addressing the chemical hazard usually involve the removal of the contaminants from soil, sediments or groundwater.

Example approaches include:

- Excavation of contaminated soils followed by off-site disposal,
- Solidification or stabilization,
- Removal (excavation),
- Disposal (off-site),
- Removal of contamination by treating soils with microbes,
- Phytoremediation ,
- Chemical degradation,
- Proper segregation,
- Research and development.,
- Mandatory screening for POPs contamination,
- Cap contaminated soils,

- Establish guidelines and limits for acceptable values of residual chemical products or equipment,
- Redesign process, change substance/material used,
- Include BAT in relevant industrial activities related to waste incineration and disposal, metallurgical industry, chemical industry and transportation sector,
- Natural attenuation, or
- Volatalization.

Pathway:

Risk Management approaches addressing the pathway usually involve placing a barrier between the contamination and the receptor.

Example approaches include:

- The use of personal protective equipment,
- Local bans on hunting/fishing,
- Limit occupation & accidental exposure,
- Drainage and dust erosion controls,
- Loading and unloading control (transport),
- Access restriction,
- Activity restriction,
- Compulsory use of personal protection equipment,
- Public awareness information and education - school curriculum,
- Monitoring & maintenance of equipment,
- Biological and medical monitoring of workers,
- Awareness of the value of protective equipment and going home from work with clean clothes/hands/shoes,
- Rules and enforced demobilization and decontamination after work,
- Sanitation and cleanliness,
- Capping or covering contaminated soils with clean soils, asphalt etc., or
- Using vegetation, wind fences and dust suppressants to control dust levels.

Receptor:

Risk Management approaches addressing the receptor usually involve restricting receptor access to the site.

Example approaches include:

- Use of walls or fences to keep people out of the contaminated area,
- Containment,
- Control on storage,
- Develop national guidelines (inventory and identification /labeling contaminated equipment),
- Land use restrictions,
- Provide free alternatives to behaviours resulting in risk,
- Public awareness information and education - school curriculum,
- Warning signs and labels, and
- Land use restrictions on contaminated sites.

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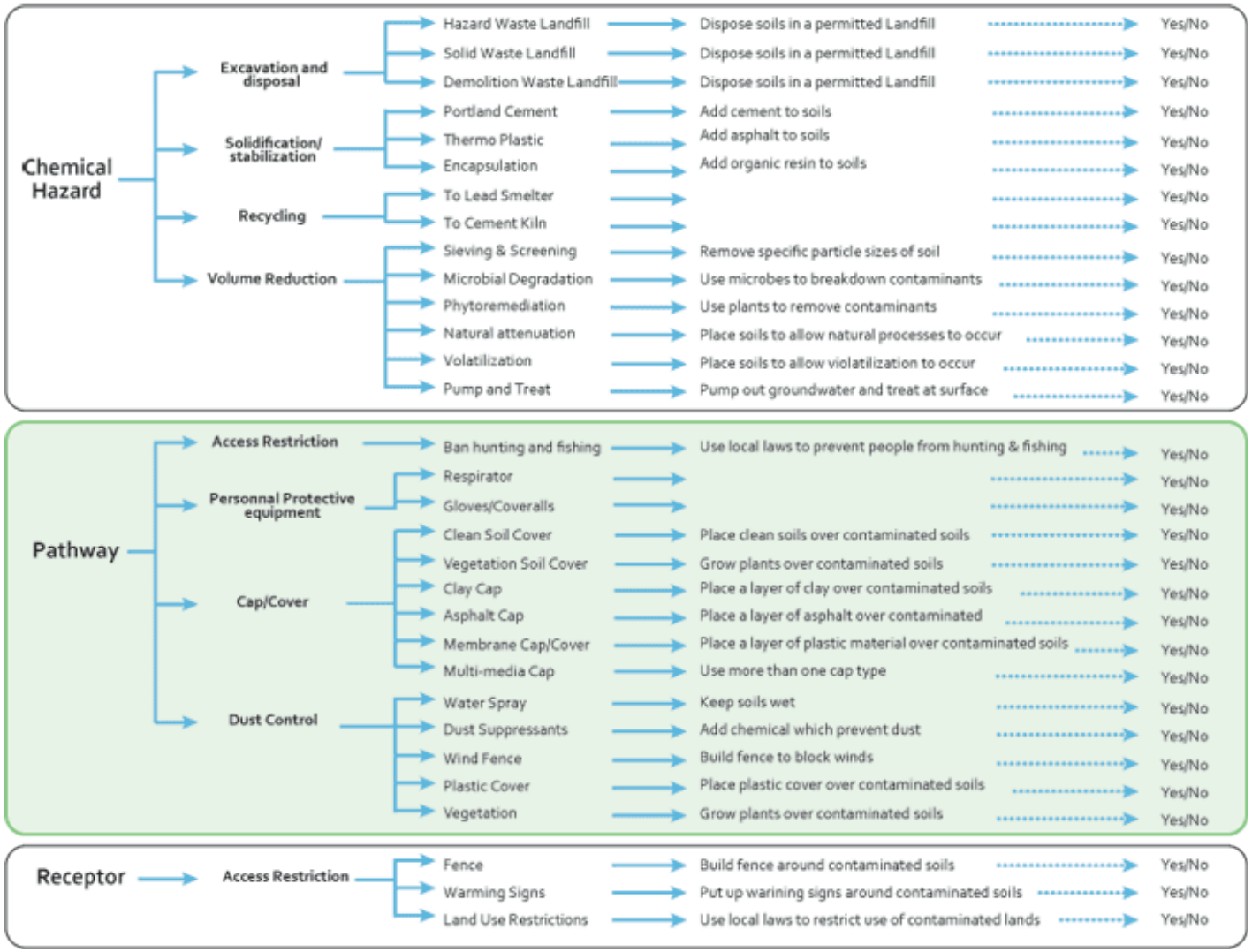
Preliminary Screening

The preliminary screening step can be simplified by expanding general approaches ("response actions") into Technologies and Process Options. This is best done using either a table or a flow diagram (as shown below). Reviewing this table/flow diagram, it assists with the selection of approaches which are unlikely to be effective.

The table/flow diagram is developed from the long list of potential risk management options and is therefore site-specific. Consequently, a new table/flow diagram will have to be created for each new site.



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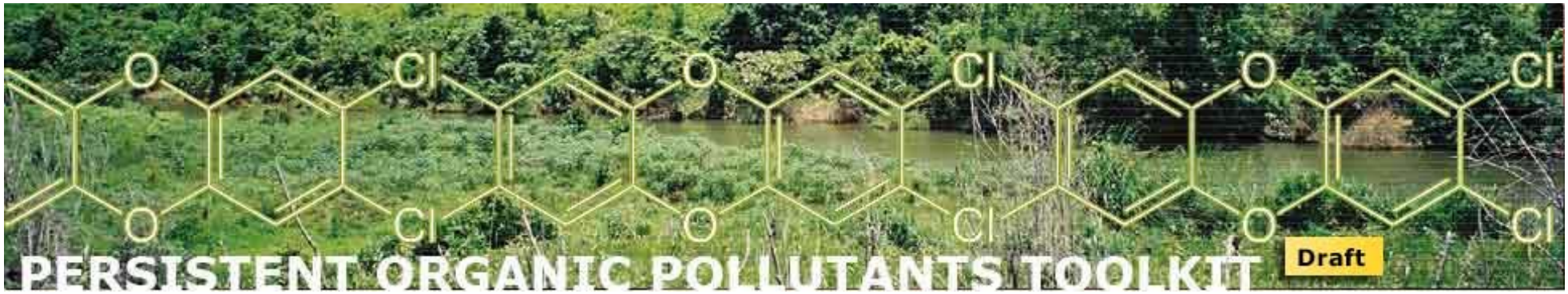


Qualitative Screening

Risk Management Options retained from the preliminary screening are evaluated in the qualitative screening.

Balancing Factors

During the qualitative screening, each management option is weighed against various **balancing factors**. Balancing factors may include:

- Effectiveness
- Long term Reliability
- Ease of Implementation
- Implementation risk
- Cost:
  - cost for implementation
  - cost for operation and maintenance

Risk management options should be weighed against each other using balancing factors
Source: Araleya
(click to enlarge)

Recommending Management Alternatives

Once all technologies and implementation options have been weighed, the concerned officials will recommend risk management alternatives from those developed and evaluated in the risk management decision process.

Recommending management options is a balancing act
Source: Hatfield Consultants
(click to enlarge)

Criteria for Recommendations

The person who proposes **a list of recommended management alternatives** is responsible for demonstrating to decision-makers that the recommended actions **meet the following criteria**:

- They are protective of present and future public health, safety and welfare and of the environment;
- Are based on balancing different key factors;
- Treat hot spots of contamination to the extent feasible; and
- Take into consideration the concerns of stakeholders.

As a rule, **the least expensive, more protective alternative is preferred**, unless the additional cost of a more expensive alternative is justified by proportionately greater benefits within one or more of the weighting factors.

Implementation Planning

The detailed Risk Management action plan must include implementation plans by addressing:

- **How** – under what legal mandate will the activity(ies) be undertaken and with what resources?
- **When** – realistic timeframe for the actions; and key milestones?
- **By whom** – ministry, agency, or stakeholder groups to be involved?

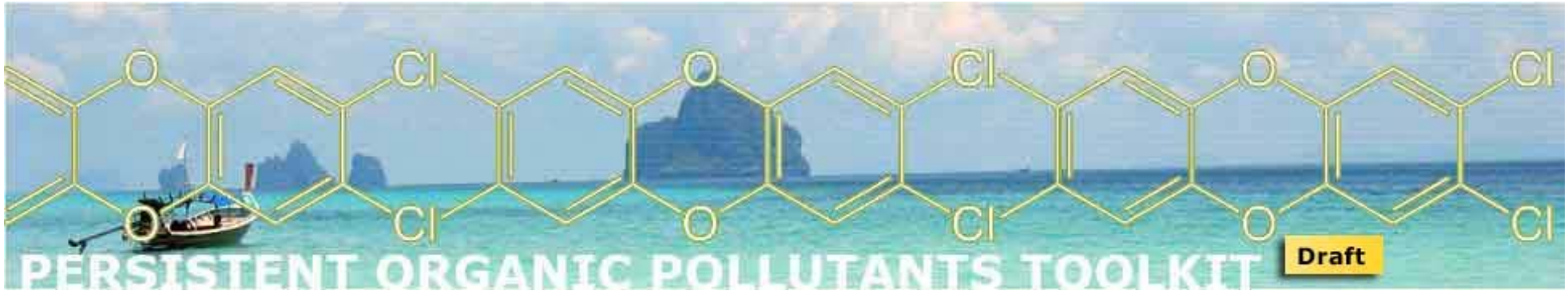
For more discussion on stakeholder identification and planing, please read here.

Stakeholders should be consulted in implementation planning
Source: Hatfield Consultants
(click to enlarge)

Assigning Responsibilities

Risk management responsibilities may be shared between different ministries depending upon the complexity of the risk situation – multi-media, multi-source, or multi-chemical in context.

The Responsibility Assignment Matrix (RAM) can be used as a tool to help organize responsibilities, organizations involved, expertise and experience; appropriate level of decision making authority, etc.



Step 4 - Risk Communication and Policy Making

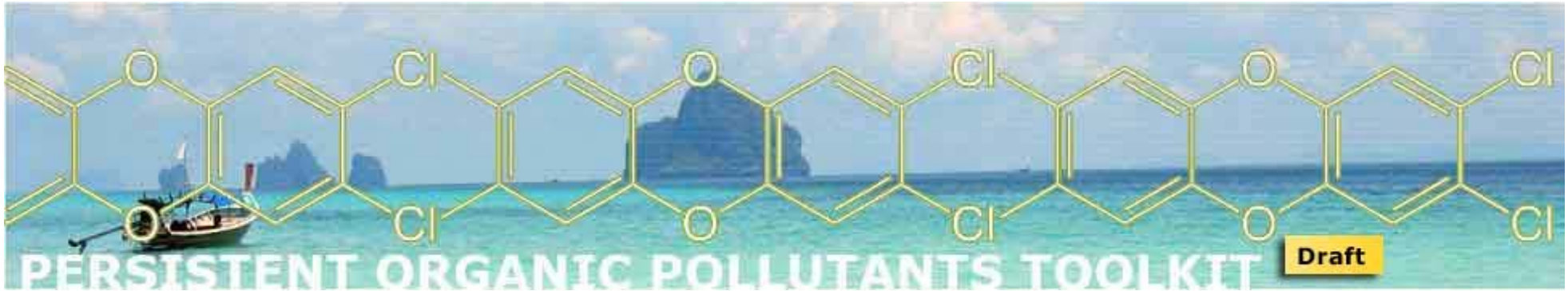
Step 4 - Risk Communication and Policy Making - focuses on:

- **Risk Communication** and creating a risk awareness culture;
- **Communicating** with decision-makers; and
- the **Policy Process**.

The main purpose of this step is to discuss Risk Management strategies and means for:

- Sensitizing and mainstreaming identified POPs health risk management (RM) options into national political agenda and national development planning;
- Fostering national political and securing financial commitments to ensure their effectiveness and sustainability.

Grand Palace, Bangkok
Source: Hatfield Consultants
(click to enlarge)



Step 5- Monitoring and Evaluation of Risk Management Programmes

Step 5 of the risk management training module will introduce you to the key steps and approaches to monitor and evaluate the adopted risk management options.

Monitoring and evaluation are integral parts of the risk management decision-making process. However, in most developing countries, it is often the weakest link in the whole risk management process.

Risk management is only as good as its weakest link – every step from risk characterization to monitoring and evaluation is important.

Monitoring and evaluation is an integral part of the risk management decision-making process
Source: Hatfield Consultants
(click to enlarge)

Objectives and Expected Outcomes of Step 5

Objective: To evaluate the progress and impact of the risk management options and determine whether adaptive action is required.

Suggested outcomes: An evaluation of the risk management effectiveness as measured against the baseline situation and in light of the risk reduction goal. Also determine whether the current options should be continued, and if not, recommendations for adaptations. Any results from monitoring and evaluation should be communicated to stakeholders as part of a public accountability process.

References:

Adapted from Monitoring & Evaluation – some Tools, Methods & Approaches, Operations Evaluation Department (pdf file) - World Bank, 2004

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Appendix A13

Group Discussion Composition

Apppendix A 13

Group Discussion
January 21, 2009

Group Blue:

No	Name	Designation
1	Dr. HEAN Vanhan	
2	Ms. SEM Tola Sreypeou	
3	Mr. YIN Samray	
4	Dr. PHOK Chansorphea	
5	Mr. THONG Sokvongsa	
6	Phnom Penh Municipality	
7	Royal Agriculture University	
8	Mr. SOK Pounlork	
9	Mr. Heng Sorethy	
10	Mr. CHEA Kimsien	

Group Pink:

No	Name	Designation
1	Dr. PRAK Piseth Raingsey	
2	Mr. Sith Roath	
3	Mr. CHIN Sothun	
4	Mr. PHAN Oun	
5	Ms. TEA Channy	
6	Faculty of Medicine	
7	Mr. SIV Kung	
8	Mr. TY Keang	
9	Ms. MEN Sary	

Group Yellow:

No	Name	Designation
1	Ms. CHAN Somaly	
2	Mr. SOU Virak	
3	Mr. KANG Sareth	
4	Mr. MOK Yarann	
5	Mr. SOURN Punlork	
6	Mr. NGIM Veng	
7	Mr. SAROEUN Kessara	
8	Mr. KANG Sareth	
9	Mr. MOY Vathana	

International Group

No.	Name	Designation
1	Mr. Rogelio M. Magat	
2	Ms. Li Xin	
3	Ms. Tian Yajing	
4	Ms. Amelia Rachmatunisa	
5	Ms. Dewi Ratnaningsih	
6	Ms. Emmanuelita Mendoza	
7	Mr. Ho Kien Trung	
8	Ms. Pham Thi Nguyet Nga	

Appendix A14

Debriefing Note for Group Discussion

Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia Program

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 2/27/2009 SLIDE 1

"Debriefing Note for Group Discussion

Session 9: Risk Management Development &Selection "

National Training Workshop

Siem Reap, Cambodia, January 21, 2009

Canadian International Development Agency | Agence canadienne de développement international | Hatfield CONSULTANTS

 2/27/2009 SLIDE 2

Background

- The training workshop is to facilitate improved communication and coordination between key Ministries in the areas of risk assessment and management, compliance monitoring and enforcement;
- Collaborative tools for risk management.
- The objective of the RM component =➔ to enhance the capacity to apply the RA results to set RM and identify priority interventions to reduce risks to an acceptable level.

(i) developing strategies for the management of these risks at the selected site; and,

(ii) Developing cost and benefits of alternatives.

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 SLIDE 3

Assignments for Group Discussion

- 4 or 5 discussion groups chaired by one designated member (selected by the group), and facilitated by the project team. The discussion group topics are:
  - Setting Risk Reduction Goals for the Site;
  - Reviewing Proposed Management Measures; and
  - Costing Preferred RM Options.

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 2/27/2009 SLIDE 4

Setting Risk Reduction Goals for the Site

- Please review draft Risk Assessment Report pp. 41 - 44.
- Pay special attention to Table 6.1 Goals, Sub-goals and Indicators for the SEDCW Study Site, Phnom Penh, Cambodia, and let the workshop know your view:
  - Are they appropriate for the site;
  - Are they going to work; and
  - Areas for improvement.
- Your group has 20 minutes to work on this question.

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 SLIDE 5

Reviewing Proposed Management Measures

- Please spend 20 minutes to review the proposed risk management measures presented on pp. 45-49 in the Case Study Report for the SEDCW Site.
  - Identify the options that make existing measures more effective and outlined new initiatives.
  - Consider whether all the options listed will achieve the required risk reduction goal, bearing in mind risk factors.
  - Obtain stakeholder agreement on which decision-criteria to use in order to select management options.
  - On the basis of the decision-criteria, evaluat strengths & weaknesses of each option (Table 6.2).

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 SLIDE 6

Costing your Preferred RM Options

- Please spend 30 minutes to prepare rough cost estimates of your group's preferred risk management options by using the cost calculating spreadsheet attached (file name: cost estimates for SEDC v2).
- Costs have to be developed on a case-by-case basis to a large degree, since they will be greatly influenced by site-specific issues, the nature of the waste materials, costs for services, and by project scale, duration, etc.

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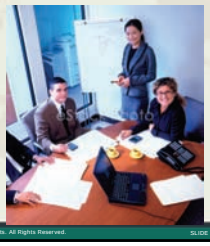
 SLIDE 7

Special Notes

- Please kindly assign one team member to take notes from the discussion and present the outcomes to the plenary session.
- Hatfield and World Bank Project Team members will join the discussion groups, to provide technical support if required.



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 SLIDE 8

Thank You

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 2/27/2009 SLIDE 9

Appendix A15

Group Discussion Results on Risk Management for Sambour EDC Warehouse Site

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Appendix A15-1
Blue Group

REGIONAL CAPACITY BUILDING PROGRAM FOR RISK MANAGEMENT OF POPS IN SOUTH EAST ASIA

National Training Workshop on Human Health Risk Assessment and Management of POPs

Group's proposed changes to the Risk Reduction Goals for the Site are highlighted:

Give priority to address health of the workers, then the resident;

Focus more on addressing the hazard pathway;

Cost-efficient risk management options are preferred.

Time frame shortened from 2015 to 2012 for most of the indicators.

Table 6.1 Goals, Sub-goals and Indicators for the SEDCW Study Site, Phnom Penh, Cambodia.

Goal 1	Sub goals	Indicator
To reduce health risks to sensitive groups of people arising from PCB contamination	1.1 To minimize health risk of workers working in the SEDCW site	By 2012, reduce daily exposure to PCBs to the lowest acceptable level (i.e., HQ<0.2) or monitor success of implementing specific risk management approaches (to be determined).
	1.2 To minimize health risks of residents living adjacent to the SEDCW site.	By year 2012, reduce daily exposure to PCBs to the lowest acceptable level (i.e., HQ<0.2) or monitor success of implementing specific risk management approaches (to be determined).
	1.3. To minimize health risks of workers and trainers working elsewhere on the EDC compound.	

Goal 2	Sub goals	Indicator
To avoid or, when avoidance is not feasible, minimize uncontrolled releases of PCB hazardous materials or accidents	2.1. To establish hazardous materials management action plans to address potential chemical hazards, exposure pathways and potential receptors identified through human health risk assessment.	By year 2012, the National Hazardous Materials Management Priorities Plan is in place and effectively enforced.

(including explosion and fire) during their handling, storage and use.	Be aware of it's partway and try to minimize the partway. Ex. wear difference boot and cloth in the site and change when you go out.	
	2.2. Where practicable, to avoid or minimize the use of hazardous materials (for example, replacing PCBs in electrical equipment by non-PCB substitutes).	By year 2012, PCB oil or PCB contaminated oils are no longer in use in all transformers and capacitors.
	2.3. To prevent uncontrolled releases of PCBs and other hazardous chemicals to the environment or uncontrolled reactions that might result in fire or explosion.	By 2012, proper containment facilities are in place and properly operated and maintained.
	2.4. To implement management controls (procedures, inspections, communications, training, and drills) to address residual risks that have not been (or cannot be) prevented or controlled through appropriate risk management measures.	By 2012, management control activities – procedures, inspections, communication, training and drills – are conducted regularly.

1.1. Reviewing Proposed Management Measures

Please spend 30 minutes to review the proposed risk management measures presented below and in the Case Study Report for the SEDCW Site. Provide us your comments how to improve or revise the proposed risk management measures.

Please score each risk management measure (low, medium, high) and select the preferred risk management options. Please feel free to add other options that you think are preferable or more appropriate.

Table 6.2 Risk Management Options from the Qualitative Screening, SEDCW Site, Phnom Penh, Cambodia.

Intervention types		Balancing Factors				
Technology	**Process Options**	**Effectiveness**	**Long term reliability**	**Implement-ability**	**Associated Risk**	**Cost**
Work place safety regulation	Define & implement permitted maintenance requirements	High	High	Medium	Low	Low
	Provide protection equipment, first aids & sanitary facilities	High	High	Medium	Low	Medium
	Provide proper work environment & shower stations	High	High	Medium	Low	High

Intervention types		Balancing Factors				
Technology	**Process Options**	**Effectiveness**	**Long term reliability**	**Implement-ability**	**Associated Risk**	**Cost**
Control on entries	Define & strictly enforce hot work spaces	High	High	High	Low	Medium
Control hunting	Discourage hunting & fishing in or near hot spot	High	High	Challenging but doable	Low	Low
	Educate on safe cooking & eating habits	High	High	Not really easy	Low	Low
Monitoring	Record & verify effectiveness of safety regulations	High	High	Medium	Low	Medium
	Investigate exposure incidents	High	High	Medium	Low	Medium

Intervention types		Balancing Factors				
Technology	**Process Options**	**Effectiveness**	**Long term reliability**	**Implement-ability**	**Associated Risk**	**Cost**
Training & communication	Prepare staff to recognize and respond to PCB hazards	High	High	High	Low	High
Poster & meeting	Raise awareness about PCB effects, and how to manage them	High	High	Challenging but doable	Low	High
Mass media	Raise awareness	High	High	easy	Low	High
In situ storage	Store PCBs/ transformers in separate containment facilities	Medium reduce chance not contamination	Medium	Easy to implement	Medium	Low
Decontamination	Replace PCB oil by non-PCB substitutes	High	High	Technically Challenging	High	Medium
	Destroy transformers, recycle metallic components	High	High	Very Challenging	High	High
Release prevention	Spill control, prevention & countermeasure procedures	High	High	Moderately easy	Low	Medium
Incineration *ex situ*	PCB oils and waste wrapped, transported and destroyed ex situ	High	High	Very challenging	Medium	Very high
Dust/ run-off control	Capping surface & controlling contaminant from getting into drainage or stream	High	High	Moderately easy	Medium	High
Hazard waste landfill	Dispose soils/waste in permitted landfills	Medium	High	Impossible, due to lack of such facility in country	High	Medium
Solid waste landfill	Dispose soils/waste in permitted landfills	High	High			Medium
Demolition waste in landfill	Dispose soils/waste in permitted landfills	High	High			Low

Costing your Preferred RM Options

No costing was provided due to time limitation and lack of functional parameters about the site and concrete options..

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Appendix A15-2 Pink Group

REGIONAL CAPACITY BUILDING PROGRAM FOR RISK MANAGEMENT OF POPS IN SOUTH EAST ASIA

National Training Workshop on Human Health Risk Assessment and Management of POPs

Setting Risk Reduction Goals for the Site

Change in priority of sub-goals to address the health of the workers first, and then the residents.

Table 6.1 Goals, Sub-goals and Indicators for the SEDCW Study Site, Phnom Penh, Cambodia.

Goal 1	Sub goals	Indicator
To reduce health risks to the most/prioritized sensitive groups of people arising from PCB contamination	1.2. To minimize health risks of residents living adjacent to the SEDCW site.	By year 2015, reduce daily exposure to PCBs to the lowest acceptable level (i.e., HQ<0.2) or monitor success of implementing specific risk management approaches (to be determined).
	1,3, To minimize health risks of workers and trainers working elsewhere on the EDC compound.	
	1.1. To minimize health risk of workers working in the SEDCW site	By 2015, reduce daily exposure to PCBs to the lowest acceptable level (i.e., HQ<0.2) or monitor success of implementing specific risk management approaches (to be determined).

Goal 2	Sub goals	Indicator
To avoid or, when avoidance is not feasible, minimize uncontrolled releases of PCB hazardous materials or accidents	2.1. To establish hazardous materials management action plans to address potential chemical hazards, exposure pathways and potential receptors identified through human health risk assessment.	By year 2015, the National Hazardous Materials Management Priorities Plan is in place and effectively enforced.

(including explosion and fire) during their handling, storage and use.	2.2. Where practicable, to avoid or minimize the use of hazardous materials (for example, replacing PCBs in electrical equipment by non-PCB substitutes).	By year 2015, PCB oil or PCB contaminated oils are no longer in use in all transformers and capacitors.
	2.3. To prevent uncontrolled releases of PCBs and other hazardous chemicals to the environment or uncontrolled reactions that might result in fire or explosion.	By 2015, proper containment facilities are in place and properly operated and maintained.
	2.4. To implement management controls (procedures, inspections, communications, training, and drills) to address residual risks that have not been (or cannot be) prevented or controlled through appropriate risk management measures.	By 2015, management control activities – procedures, inspections, communication, training and drills – are conducted regularly.

1.1. Reviewing Proposed Management Measures

Proposed adding another risk management alternative to support strengthening the coordination mechanism.

Selection of risk management was based on the effectiveness as shown below:

Table 6.2 Risk Management Options from the Qualitative Screening, SEDCW Site, Phnom Penh, Cambodia.

Intervention types		Balancing Factors				
Technology	**Process Options**	**Effectiveness**	**Long term reliability**	**Implement-ability**	**Associated Risk**	**Cost**
Work place safety regulation	Define & implement permitted maintenance requirements	low				
	Provide protection equipment, first aids & sanitary facilities	High				
	Provide proper work environment & shower stations	High				
Control on entries	Define & strictly enforce hot work spaces	High				
Control hunting	Discourage hunting & fishing in or near hot spot	medium				
	Educate on safe cooking & eating habits	medium				
Monitoring	Record & verify effectiveness of safety regulations	high				

Intervention types		Balancing Factors				
Technology	**Process Options**	**Effectiveness**	**Long term reliability**	**Implement-ability**	**Associated Risk**	**Cost**
	Investigate exposure incidents	medium				

Intervention types		Balancing Factors				
Technology	**Process Options**	**Effectiveness**	**Long term reliability**	**Implement-ability**	**Associated Risk**	**Cost**
Training & communication	Prepare staff to recognize and respond to PCB hazards	medium				
Poster & meeting	Raise awareness about PCB effects, and how to manage them	high				
Mass media		high				
In situ storage	Store PCBs/ transformers in separate containment facilities	high				
Decontamination	Replace PCB oil by non-PCB substitutes	medium				
	Destroy transformers, recycle metallic components	low				
Release prevention	Spill control, prevention & countermeasure procedures	high				
Incineration *ex situ*	PCB oils and waste wrapped, transported and destroyed ex situ	low				
Dust/ run-off control	Capping surface & controlling contaminant from getting into drainage or stream	high				
Hazard waste landfill	Dispose soils/waste in permitted landfills	high				
Solid waste landfill	Dispose soils/waste in permitted landfills	high				
Demolition waste in landfill	Dispose soils/waste in permitted landfills	high				
Strengthen and support existing coordination unit to implement NIP		high				

Costing your Preferred RM Options

all totaled $1,200,000

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Appendix A15.3 Yellow Group

REGIONAL CAPACITY BUILDING PROGRAM FOR RISK MANAGEMENT OF POPS IN SOUTH EAST ASIA

National Training Workshop on Human Health Risk Assessment and Management of POPs

Setting Risk Reduction Goals for the Site

Placing special emphasis on reduce risk via food ingestion pathway.

Table 6.1 Goals, Sub-goals and Indicators for the SEDCW Study Site, Phnom Penh, Cambodia.

Goal 1	Sub goals	Indicator
To reduce health risks to sensitive groups of people arising from PCB contamination	1.1. To minimize health risks of residents living adjacent to the SEDCW site. -reduce risk resident esp, **food pathway** by implenentation plan: *knowlegde awareness, and equi*(give awareness to the passive)	By year 2015, reduce daily exposure to PCBs to the lowest acceptable level (i.e., HQ<0.2) <u>or</u> monitor success of implementing specific risk management approaches (to be determined).
	1.2. To minimize health risks of workers and trainers working elsewhere on the EDC compound.	
	1.3. To minimize health risk of workers working in the SEDCW site	By 2015, reduce daily exposure to PCBs to the lowest acceptable level (i.e., HQ<0.2) <u>or</u> monitor success of implementing specific risk management approaches (to be determined).

Goal 2	Sub goals	Indicator
To avoid or, when avoidance is not feasible, minimize uncontrolled releases of PCB hazardous materials or accidents (including explosion and fire) during their	2.1. To establish hazardous materials management action plans to address potential chemical hazards, exposure pathways and potential receptors identified through human health risk assessment. - Equipment: contain equipment that leakaage (indoor)	By year 2015, the National Hazardous Materials Management Priorities Plan is in place and effectively enforced.

handling, storage and use. - reduce uncontrolled release	2.2. Where practicable, to avoid or minimize the use of hazardous materials (for example, replacing PCBs in electrical equipment by non-PCB substitutes). -soil(existing): contain on isolate or remove to prevnet release to environment	By year 2015, PCB oil or PCB contaminated oils are no longer in use in all transformers and capacitors.
	2.3. To prevent uncontrolled releases of PCBs and other hazardous chemicals to the environment or uncontrolled reactions that might result in fire or explosion.	By 2015, proper containment facilities are in place and properly operated and maintained.
	2.4. To implement management controls (procedures, inspections, communications, training, and drills) to address residual risks that have not been (or cannot be) prevented or controlled through appropriate risk management measures.	By 2015, management control activities – procedures, inspections, communication, training and drills – are conducted regularly.

Reviewing Proposed Management Measures

Table 6.2 Risk Management Options from the Qualitative Screening, SEDCW Site, Phnom Penh, Cambodia.

Intervention types		Balancing Factors				
Technology	**Process Options**	**Effectiveness**	**Long term reliability**	**Implement-ability**	**Associated Risk**	**Cost**
Work place safety regulation	Define & implement permitted maintenance requirements	HIgh: **provide trianing, auditing need to be occured**.				
	Provide protection equipment, first aids & sanitary facilities	HIgh: **internal compliant and enforcement of use of personal protection equipment(PPE)**				
	Provide proper work environment & shower stations	HIgh:				
Control on entries	Define & strictly enforce hot work spaces	High: **effectiveness, cautionary sign, and enforcement.**				
Control hunting	Discourage hunting & fishing in or near hot spot	**medium**				
	Educate on safe cooking & eating habits	**medium**				

Intervention types		Balancing Factors				
Technology	**Process Options**	**Effectiveness**	**Long term reliability**	**Implement-ability**	**Associated Risk**	**Cost**
Monitoring	Record & verify effectiveness of safety regulations					
	Investigate exposure incidents					

Intervention types		Balancing Factors				
Technology	**Process Options**	**Effectiveness**	**Long term reliability**	**Implement-ability**	**Associated Risk**	**Cost**
Training & communication	Prepare staff to recognize and respond to PCB hazards					
Poster & meeting	Raise awareness about PCB effects, and how to manage them					
Mass media						
In situ storage	Store PCBs/ transformers in separate containment facilities					
Decontamination	Replace PCB oil by non-PCB substitutes Destroy transformers, recycle metallic components					
Release prevention	Spill control, prevention & countermeasure procedures					
Incineration *ex situ*	PCB oils and waste wrapped, transported and destroyed ex situ					
Dust/ run-off control	Capping surface & controlling contaminant from getting into drainage or stream					
Hazard waste landfill	Dispose soils/waste in permitted landfills					
Solid waste landfill	Dispose soils/waste in permitted landfills					
Demolition waste in landfill	Dispose soils/waste in permitted landfills					

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Appendix A 15.4
International Group

REGIONAL CAPACITY BUILDING PROGRAM FOR RISK MANAGEMENT OF POPS IN SOUTH EAST ASIA

National Training Workshop on Human Health Risk Assessment and Management of POPs

INTERNATIONAL GROUP

Table 6.1 Goals, Sub-goals and Indicators for the SEDCW Study Site, Phnom Penh, Cambodia.

Goal 1	Sub goals	Indicator
To reduce health risks to sensitive groups of people arising from PCB contamination	1.1. To minimize health risks of residents living within 1 Km away from the hotspot site including students in the dormitory and children in the community.	By year 2012, reduce daily exposure to PCBs to the an acceptable level by 70% of the results of the HQ while in 2015 at the lowest acceptable level at HQ<0.2
	1.2. To minimize health risks of workers working in the SEDWC site and its compound.	By 2015, reduce daily exposure to PCBs to the lowest acceptable level (i.e., HQ<0.2)

Goal 2	Sub goals	Indicator
To avoid or, when avoidance is not feasible, minimize uncontrolled releases of PCB hazardous materials or accidents (including explosion and fire) during their handling, storage and use.	2.1. To establish hazardous materials management action plans to address potential chemical hazards, exposure pathways and potential receptors identified through human health risk assessment.	By year 2011, the National Hazardous Materials Management Priorities Plan is in place and effectively enforced.
	2.2. Where practicable, to avoid or minimize the use of hazardous materials (for example, replacing PCBs in electrical equipment by non-PCB substitutes).	By year 2015, PCB oil or PCB contaminated oils are no longer in use in all transformers and capacitors.
	2.3. To prevent uncontrolled releases of PCBs and other hazardous chemicals to the environment or uncontrolled reactions that might result in fire or explosion.	By 2015, proper containment facilities are in place and properly operated and maintained.
	2.4. To implement management controls (procedures, inspections,	By 2015, management control activities – procedures, inspections, communication,

	communications, training, and drills) to address residual risks that have not been (or cannot be) prevented or controlled through appropriate risk management measures.	training and drills – are conducted regularly.
	2.5 Provision of tight security on the equipment	ASAP
Goal 3	**Sub goals**	**Indicator**
To rectify the adverse effects/impacts on health (damage) and employ the necessary mitigating measures to remediate and clean-up the site	2.1. To establish networking and Interagency/Committee with the concerned government agencies, academe, and non-government organizations (NGOs)	By year 3rd Quarter of 2009, the Committee and coordination will set-up mechanisms for the implementation plan in handling issues on POPs *per se*.
	2.2 To provide infrastructure facility to improve (if existing) the health care management services of the community.	By year 2010, provision of health cards for workers and, compensation (if any) to the affected residents thru the political will of the Cambodian Government.
	2.3. To establish a good waste Treatment, Storage, and Disposal (TSD) Facility for PCB equipment, oil, and contaminated soil	By year 2011, PCB oil or PCB contaminated oils that are no longer in use in all transformers and capacitors can stored temporarily while waiting for their treatment.

Table 6.2 Risk Management Options from the Qualitative Screening, SEDCW Site, Phnom Penh, Cambodia.

Intervention types		Balancing Factors				
Technology/ Policy	Process Options	Effectiveness	Long term reliability	Implement-ability	Associated Risk	Cost
Workplace Safety policy and regulation	If no policy yet, then adopt international guidelines	High	High	Doable	Low	Medium
	Provision shower and eye stations.	High	High	Medium	Low	Low
	Provision of PPEs on all exposed workers.	High	High	Doable	Low	Medium
Control on entries	Strictly enforce entry on hot work spaces	High	High	Low	Medium	Low
Control of human behavior / practices	Discourage hunting & fishing in or near hot spot	Medium	Medium	Doable	Low	Low
Monitoring	Record & verify effectiveness of safety regulations	High	High	Challenging	Medium	High
	Compliance monitoring of permits'conidtions					
Training & communication	Prepare staff to recognize and respond to PCB hazards	High	Medium	Easy	Low	high
Information, Education and Communications (IECs)	Raise awareness about PCB effects, and how to manage them through signages, coordination meetings	high	high	Challenging	Low	high
Mass media	Radio and television broadcast/ advertisements, primers, brochures, etc.	High	High	Challenging	Low	medium
In situ storage	Store PCBs/ transformers in separate containment facilities	High	High	High	High	High

Intervention types		Balancing Factors				
Technology/ Policy	Process Options	Effectiveness	Long term reliability	Implement-ability	Associated Risk	Cost
Decontamination	Treatment of transformers, recycle metallic components	High	High	High	High	High
Release prevention	Spill control, prevention & countermeasure procedures	High	High	High	High	High
Installation of regional Incineration and TSD facility *ex situ to serve other countries*	destruction equipment, oil, and soil remediation	High	High	High	High	High
Strengthen government regulations	Review policy regulations in accordance present situation with guidance on international standards and the full enforcement of the law	High	High	Challenging	High	High