Danish Ministry of Foreign Affairs

DANIDA

DR. L.W. DWERNYCHUK

Final Report

Preliminary Assessment of Environmental Contamination in Gio Linh, Quang Tri, Viet Nam

Viet Nam

This report contains restricted information and is for official use only.

HATFIELD CONSULTANTS LTD.
Suite 201 - 1571 Bellevue Avenue
West Vancouver, BC, Canada
V7V 1A6

Tel: (604) 926.3261 Fax: (604) 926.5389

Email: hcl@hatfieldgroup.com

Ref. No. 104.Vie.1.MIKA.5

MAY 2000

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

In this document, a variety of terms and abbreviations will be used to simplify presentation; the following is a listing of the more common terms/phrases that will appear:

- PCDD - polychlorinated dibenzo-*p*-dioxin;
- PCDF - polychlorinated dibenzofuran;
- T4CDD - 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (T4CDD), the dioxin congener that was a contaminant in the 2,4,5-T portion of the 50/50 mixture which constituted Agent Orange (2,4-D was the remaining 50% of the mixture);
- TEF - toxic equivalency factor, which is the multiplication factor applied to each concentration of dioxin/furan congener determined in a sample in order to normalize the concentration level to the level of toxicity that would be produced by an equivalent amount of 2,3,7,8-T4CDD (the most toxic dioxin congener) (NATO 1998 a,b,c);
- T-TEQ - total toxic equivalence, which is a normalized level of toxicity when the TEFs are applied to the PCDD/PCDF congeners in a given sample; if a ND (non-detect) or NDR (peak detected during laboratory analysis that did not meet laboratory quantification criteria) is reported, one-half of the detection level (Startin 1994, WHO/EURO 1989) for that congener was used in the calculation of T-TEQ; and
- Agent Orange dioxin (AO dioxin) - T4CDD; the PCDD congener characteristically found in Agent Orange (Schecter 1994).

ACKNOWLEDGEMENTS

The team would like to express its thanks to all officials and individuals met for the kind support and valuable information which the team received during its stay in Viet Nam and which highly facilitated the work of the team. The project team gratefully acknowledges the financial contribution of the Danish government and the in-kind support from Vietnamese agencies involved in the study. Without these contributions, the work could not have been carried out.

In particular, we would like to thank the following individuals:

- Ms. Astrid Danielsen — First Secretary, Danish Embassy, Hanoi, Viet Nam;
- Mr. Dao Nhat Dinh — Program Officer, Danish Embassy, Hanoi, Viet Nam;
- Mr. Tran Khanh Phoi — Programme Co-ordinator, Mines Advisory Group, Viet Nam;
- Mr. Nick Proudman — Programme Co-ordinator, Mines Advisory Group, Viet Nam;
- Mr. Mark Thompson — Senior Technical Advisor, Mines Advisory Group, Viet Nam;
- Mr. David Denman — Technical Advisor, Mines Advisory Group, Viet Nam;
- Mr. Hoang Dang Mai — Director, External Relations Department of Quang Tri Province, Viet Nam; and
- Mr. Nguyen Truong Khoa — Director, Department of Science, Technology and Environment, Quang Tri Province, Viet Nam.

PREFACE

This report provides a summary of work completed on the Short Term Agreement on Supply of Consultancy Services (Ref. No. 104.vie.1.MIKA.5) provided to Hatfield Consultants Ltd. (HCL) by the Royal Danish Embassy, Hanoi on September 1, 1999. HCL was contracted to assess the current levels of dioxins and furans in soils currently being cleared for landmines and UXO by the Mines Advisory Group (MAG) team in Gio Linh District, Quang Tri Province, central Viet Nam.

This report contains the views of the team which do not necessarily correspond to the views of Danida (or the Government of Viet Nam). All proposals are subject to approval by the two governments.

1.0 INTRODUCTION

1.1 Background and Project Objectives

In September 1999, Hatfield Consultants Ltd. (HCL) was contracted by the Royal Danish Embassy, Hanoi, to assess the current levels of dioxins and furans in soils currently being cleared for landmines and UXO in Gio Linh District, Quang Tri Province, central Viet Nam. The Mines Advisory Group (MAG) is implementing a mine and UXO clearance project in Gio Linh District, also funded by Danida, which will assist rural development plans for the region. The MAG/Danida demining program is the first large-scale demining program in Viet Nam, and will likely set the standard for other groups to follow in the future.

The possible presence of dioxins and furans in local soils, a remnant of Agent Orange spraying in the area during the American War (Figure 1), could have an impact on future land-use plans for Gio Linh District. The poorest segments of the population, who directly utilize the natural resources in this area, have the highest health risk associated with residual environmental contamination. The results of this environmental sampling program in Gio Linh will help future development planning, given that precautionary measures may be implemented early in the project to minimize potential chemical contamination to future residents of the area.

An additional benefit of this project is the increased awareness of deminers to potential chemical contamination in soils; this issue will also need to be addressed in future demining or development programs in war-affected areas of Viet Nam. The project also addresses Viet Nam's National Plan for Environment and Sustainable Development Number 1 priority under Environmental Management: "Environmental Impact Assessment of Development projects, with particular emphasis on safeguards to minimize environmental deterioration and control of potentially toxic chemicals and hazardous waste".

An understanding of potential chemical contamination in the environment of Gio Linh District is important in order to:

1. Assist in planning of rural development programs in areas where war-related environmental impacts are particularly severe, such as the former Charlie 1 Firebase in Gio Linh District. Impacts of concern include chemical contamination from Agent Orange dioxin and other herbicides which were known to have been used in the area; and

2. Protect the health of deminers from potential exposure to toxic compounds. The Charlie 1 Firebase area is suspected to be contaminated by several residual war related chemicals, including Agent Orange. Landmine and UXO clearance in contaminated soils increases the potential for exposure to residual toxic chemicals that are present in soils. Through the removal of vegetation, surface soil fragmentation, soil compaction and soil erosion, residual

chemical constituents can be transported into new areas which may directly threaten public health.

The objective of this study was to address the above two issues, through sampling and analysis of soils and sediments in Gio Linh District in Quang Tri Province, Central Viet Nam. Recommendations on minimizing potential exposure to dioxins and other residual chemicals in the environment in this region are also presented.

1.2 Study Area

Gio Linh District has been severely impacted by war; the problems are clearly evident today (Monan 1997). Given its location only 4 km south of the former Demilitarized Zone (DMZ), the area was subject to intense war activity, and was the site of several key battles in the later stages of the war (Turley 1985). The area was of great strategic importance to both the US and north Vietnamese army moving into southern Viet Nam; considerable American efforts were spent to limit the flow of personnel and materiel through this region. To limit the ability of northern troops to move under cover, the area was heavily bombed and sprayed with herbicides between 1965 and 1970 (Figure 1).

A key feature in Gio Linh District is the former US Charlie 1 Firebase, an area which was heavily bombed, mined and sprayed with Agent Orange and other herbicides during the American War. Landmines and UXO are common in the area, and pose a persistent threat to villagers and livestock in the region; it is this area where the MAG demining efforts are concentrated (see Plates section of this report). The area being cleared of landmines and UXO consists of 120 hectares of bare land, scrub vegetation and plantations, and is slated for future development of residential housing, agriculture and other rural development programs (Figure 2). The area is dominated by bare land (cleared grassland and brushland) with some agricultural land, pastureland, plantations and fish pond cultivation. The soil consists primarily of sand, with little clay, silt or other organic material.

Although exact figures are difficult to establish, pre-war forest cover in Gio Linh was probably >80% with high species diversity; the forest types were originally dominated by evergreen, broadleaf species. FIPI (1991) reported that most forest cover in the nearby Aluoi Valley in Thua Thien Hue Province was destroyed by herbicides, with slow restoration observed after 18 years; they speculated that over 100 years would be needed for full reforestation. FIPI (1991) concluded that the quickest way to rehabilitate sprayed areas was through active reforestation.

1.3 Agent Orange Herbicide Applications in Viet Nam

The Agent Orange spraying program by the US Air Force ("Operation Ranch Hand") began in 1961 in a modest manner, but developed into an extensive operation which lasted until 1971. Large C-123 cargo planes were used, each with a capacity of one thousand US gallons of Agent Orange. Normally, the payload was dispensed in a single continuous spray pattern approximately 14 km in length for a run duration of approximately 4½ minutes (Cecil 1986).

More than 6,500 aerial spray missions are recorded in the HERBS data base maintained by the Chemical Operations Division, US Military Assistance Command, Viet Nam, for the period of August, 1965 to February, 1971 (US Institute of Medicine [IOM] 1994). This database contains dates, flight coordinates, amounts and types of herbicides sprayed, including the Dong Ha area (Figures 1 and 3).

Previous studies in Viet Nam indicate that soils in the vicinity of former US military installations in Viet Nam may be contaminated with dioxin (2,3,7,8-T4CDD) if these facilities experienced any activities related to the Agent Orange spraying program (Hatfield Consultants Ltd. and 10-80 Committee 1998). Our review of the HERBS tapes for the Charlie 1 Firebase area indicates several repeat sprayings of Agent Orange in the area west of Highway 1 (Figures 1 and 3). It is also likely that ground spraying of Agent Orange occurred at the site, particularly in the northern, southern and western perimeters of the Firebase, which is also the area which was most heavily mined during the war (no confirmation of this is available).

Agent Orange was a mixture of 2,4-D (2,4-Dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-Trichlorophenoxyacetic acid). 2,3,7,8-Tetrachlorodibenzo-para-dioxin was found to be a contaminant present in the herbicide mixture. According to one of the manufacturers of Agent Orange, Dow Chemical, levels of dioxin varied from <0.05 ppm to ~50 ppm (IOM 1994). According to Gough (1986), ~90% of all Agent Orange was sprayed on jungle, ~8% on food crops and ~2% was used by other branches of the military for special purposes. The ultimate receptacle for 2,3,7,8-T4CDD moving through the local environment is human beings.

The main chemicals used as defoliants and for crop destruction in Viet Nam are listed below.

Major herbicides used in Operation Ranch Hand (from IOM 1994, Table 3-4, p. 89).

Herbicide	Formulation	Purpose	Litres Sprayed ($x10^6$)	Period of Use
Agent Orange, Orange II	2,4-D; 2,4,5-T	General defoliation	42.62	1965-1970
Agent Purple	2,4-D; 2,4,5-T	General defoliation	0.55	1962-1964
Agent Blue (Phytar 560G)	Cacodylic acid	Rapid defoliation, grassy plant control, rice destruction	4.25	1962-1971
Agent Pink	2,4,5-T	Defoliation	0.46	1962-1964
Agent Green	2,4,5-T	Crop destruction	0.03	1962-1964
Agent White (Tordon 101)	2,4-D; picloram	Forest defoliation, long-term control	19.85	1965-1971

Note: Text under the heading "Military Herbicides" (IOM 1994) describes chemical make up and proportions.

Dioxin concentrations in Agent Orange stocks remaining after the war ranged from 0.05 ppm to ~50 ppm and averaged 1.98 ppm to 2.99 ppm for two sets of samples that were analyzed (IOM 1994). Applying an average dioxin concentration of 4.0 ppm for the 72 million litre volume estimate (from the HERBS database), results in an approximate pure dioxin loading to Viet Nam

of ~170 kg, as reflected in the popular literature (Westing 1984). Bengtsson (1976) provided a higher estimate of the average dioxin content of herbicides used in Viet Nam at ~16 ppm.

Agents Pink, Green and Purple contained dioxin at mean concentrations estimated to be 65.6 ppm, 65.6 ppm and 32.8 ppm, respectively (IOM 1994). None were used after 1965.

1.4 Structure of Dioxins and Furans

Polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF) consist of a series of almost planar tricyclic aromatic compounds that can be chlorinated in a variety of positions. Dioxins and furans can be substituted with one to eight chlorine atoms. This gives rise to 75 different chlorinated dioxins and 135 different chlorinated furans. The toxicity of PCDD and PCDF is dependent on the degree of halogenation, and on the location of the halogen atoms. The most toxic dioxin (the one commonly called "dioxin" by the popular press) is substituted with four chlorine atoms attached at the 2,3,7,8 positions, and is therefore referred to as 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin or 2,3,7,8-T4CDD (often it is abbreviated further to T4CDD or TCDD). It is considered to be less toxic to humans compared to a number of other animal species o(CADAS 1994).

1.5 Ecosystem and Human Health Effects of Dioxins and Furans

Studies have investigated the impacts of herbicide applications on individual Vietnamese ecosystem components such as soils. There is little information on the fate and effects of dioxin moving through different ecosystem components, or estimations of bioaccumulation in ascending trophic levels. Understanding these relationships would permit improved estimates of persistence and accumulation of dioxins in the environment and food chains leading to people. The Vietnamese government recognizes that it is necessary to do an integrated environmental evaluation of dioxin contamination, especially since the food chain is perceived as a probable vector for dioxin contamination of the human population in Viet Nam (Quynh *et al.* 1994).

However, the relationship between dioxin and human health remains controversial; researchers also tend to agree that more studies are required in order to generate a clearer understanding of the effects of T4CDD on humans (see Hatfield Consultants Ltd. and 10-80 Committee 2000 and 1998, for a review of this topic).

2.0 PROJECT TEAM

The following organizations and individuals were involved in program:

Royal Danish Embassy, Hanoi

- Astrid Danielsen — First Secretary
- Dao Nhat Dinh — Program Officer

Hatfield Consultants Ltd. (HCL)

- Wayne Dwernychuk, Ph.D. — Exotic Chemical and Heavy Metal Specialist
- Thomas Boivin, M.Sc. — Senior Environmental Specialist and Project Manager
- Garth Taylor, B.Sc. — Field Sampling Specialist
- Susan Cho, M.Sc. — GIS and CAD Specialist

10-80 Committee

- Hoang Dinh Cau, M.D. — 10-80 Committee Project Director
- Phung Tri Dung, M.D. — Project Manager

3.0 METHODOLOGY

3.1 Study Approach

Three basic approaches were undertaken during the study:

- literature review related to herbicide applications and Viet Nam war activities in the vicinity of the Charlie 1 Firebase and DMZ;
- examination of available topographic maps, satellite remote-sensing imagery (including RADARSAT and CORONA imagery), and other environmental data for the area surveyed; and
- a dioxin contamination assessment of the study area, including collection and analysis of soil samples from the Charlie 1 Firebase region and surrounding areas of Gio Linh District.

3.2 Sampling Design and Methods

Sampling methods used in this study were developed and applied during previous dioxin/furan monitoring programs conducted by Hatfield Consultants Ltd. in Viet Nam (Hatfield Consultants and 10-80 Committee 2000; 1998) and for the pulp and paper industry in British Columbia (see references by Dwernychuk, and Dwernychuk *et al.* 1989-1998 cited in Hatfield Consultants Ltd. and 10-80 Committee 1998). Field personnel for this program consisted of Mr. Thomas Boivin (HCL), Mr. Garth Taylor (HCL), and Dr. Phung Tri Dung (10-80 Committee) all of whom have previous experience in dioxin sampling studies in the Aluoi Valley (Thua Thien Hue Province, Viet Nam).

Topographic maps and satellite imagery (CORONA and RADARSAT) available for Quang Tri Province were reviewed and analyzed prior to commencing the field program in order to determine local topography, environmental conditions and other features in the area to be surveyed. A review of existing reports on dioxin contamination in the environment of Viet Nam (Hatfield Consultants Ltd. and 10-80 Committee 2000, 1998; Hatfield Consultants Ltd. 1998a; 1998b; IOM 1994) was performed in order to assess the potential extent of residual contamination of Agent Orange in the Quang Tri area. Other environmental reports relevant to demining and development in Quang Tri were also reviewed (Monan 1997; Peel 1995; Prokosch 1995).

Field supplies transported from Canada included all stainless steel sampling equipment (core samplers, pans, dissecting equipment, etc.), pre-cleaned glass jars with Teflon lids, heat-treated foil, electronic balances (+/- 0.1 g), a Garmin hand-held global positioning system (GPS), pre-numbered labels, data sheets and other items. Acetone and hexane were obtained in Hanoi (HCL maintains a supply in Viet Nam), since it was not possible to transport these with the sampling equipment from Canada.

At the start of the program, the study team met with representatives of the Danish Embassy in Hanoi, including Mines Advisory Group (MAG) personnel in Quang Tri to arrange project logistics. Additional meetings with Provincial, District, and other local government leaders were also arranged. At each meeting, HCL explained the purpose of our program to obtain permission and permits to collect and export samples. A local contact was designated by MAG (David Denman) to provide assistance in the form of transportation, work facilities, on-site logistics and liaison with the local communes. A summary of project work completed during the program is provided in Table 1.

Prior to commencing field sampling, HCL personnel conducted pre-field planning/ reconnaissance with the MAG team; this included familiarization of HCL personnel with the site location and logistics, including MAG operations and field procedures. Site layouts, herbicide spray data and other remote sensing information available for the site (Hatfield Consultants Ltd. 1998b) were reviewed, and a detailed sampling design for the sampling area was prepared. Field data and sample collection commenced during the second day of the field program, following completion of the detailed study design.

The original goal was to collect a minimum of 25 soil samples for dioxin analysis from the MAG project area in Gio Linh District of Quang Tri Province (Table 2; Figure 2). This target number of samples was reached and exceeded (see Section 3.4). Sampling locations were determined from examination of existing topographic maps for the area, MAG site layouts, including RADARSAT remote sensing information (Figure 3). All sampling areas were checked for presence of landmines and UXO by MAG personnel before samples were collected. HCL/10-80 personnel followed the direction and advice of MAG personnel regarding safe locations for sample collection.

Each soil sample consisted of a composite of ten replicates. Samples were collected using a hand-held, stainless steel core sampler. The sampler contains a stainless steel sleeve which was thoroughly cleaned with hexane and acetone between sampling sites. Soil samples were collected from a depth of 0-10 cm, and 10-30 cm, in order to determine variations in dioxin concentration with depth of soils. Surface soils (from 0 cm to 10 cm depth) constituted the majority of analyses, as this soil fraction was found to contain the highest dioxin concentrations in previous Viet Nam dioxin studies (Hatfield Consultants and 10-80 Committee 2000 and 1998). Fish pond sediment samples consisted of single grab samples collected 60-75 cm below the water surface.

At each site, soil samples were placed into a stainless steel tray for compositing. Composites were thoroughly mixed and placed into appropriately labeled hexane/acetone washed and heat-treated jars with Teflon-lined lids. All samples were placed in coolers for storage and transportation.

All samples collected were split into two batches, one for archiving in Viet Nam, and one for transportation to Canada for analysis and archiving. On occasion, random duplicate samples were collected as part of the quality assurance/quality control (QA/QC) program (see Section 3.3 below). Samples were kept in coolers subsequent to collection and kept cool in refrigerators in

Quang Tri. Samples were kept in freezer facilities in the 10-80 Committee laboratory in Hanoi prior to export to Canada. Appropriate arrangements were made to ensure samples remained cool/frozen during transport to Canada.

3.3 Quality Assurance (QA) and Quality Control (QC) Plan

Important components of the study included ensuring standard QA/QC procedures were followed during all sample collection activities, in addition to training of Vietnamese scientists in ultra-trace contaminant sampling. The field team worked closely with the Vietnamese counterparts in the environmental sampling, and outlined the importance of minimizing potential contamination of samples. Some important QA/QC considerations are described below:

- disposable latex gloves were used to handle all samples and specimens, and were dipped in hexane prior to sample collection and/or dissection; gloves were changed between samples and specimens;
- stainless steel trays and tools (spoons, forceps, etc.) were rinsed in ambient water, then acetone and hexane, before each use and between sample collections;
- sample jars were pre-cleaned by our Canadian dioxin analytical laboratory prior to shipment to Viet Nam;
- duplicate samples were collected at all sampling stations;
- all samples were placed in 250 mL heat-treated, wide-mouth glass jars and sealed with lids lined with heat-treated aluminum foil. Samples were appropriately labeled, stored in a cool/dark area, and transported to refrigerator facilities within three hours of collection;
- the location of each sampling station was recorded using a hand-held GPS, as well as still photography and video, to ensure repeatability in future sampling programs;
- detailed records were kept of the name of the owners of local farms, farmer's fields and fish ponds sampled;
- smoking was not permitted in the vicinity of sampling activities; and
- all samples were secured with adhesive tape and were given individual markings to prevent tampering during transport and storage in Viet Nam.

3.4 Samples Collected for Dioxin and Furan Analysis

A total of 69 samples were collected as part of the program (Table 2); 38 were collected for export to Canada, and 31 remained in Viet Nam at the 10-80 Committee laboratory as reference samples. The 38 samples collected for export to Canada included six duplicate samples and one field blank, which were collected for laboratory QA/QC. A total of 26 samples were analyzed for dioxins and furans, including 24 soils and two fish pond sediments.

Samples were collected throughout the MAG project area to provide data on general dioxin contamination levels in the Gio Linh area (Table 2; Figure 2). In the vicinity of the Charlie 1 Firebase, a total of 11 samples were collected in a grid-like pattern, covering a relatively even distribution of the Firebase area. South and east of the Firebase, samples were collected from farmer's fields, rice paddies, fish ponds, plantation forest areas, quarries, and other areas proposed for development following mine/UXO clearance activities.

The project team ensured that a relatively even distribution of soil types and land uses were sampled, including lands which are proposed for future residential and garden development. Soil types ranged from primarily sand (south-east end of sampling area) to those with higher silt and organic content (forest near the MAG field office; *Eucalyptus* plantation area in the south). To the east of the project area, both cultivated and uncultivated fields were sampled, as well as soils near households between the MAG field office and Highway 1. Please refer to the Plates section of this report for representative photos of the sampling areas.

Reference (control) areas sampled in January 1996 in Con Cuong and Chi Khe, Nhge An Province, northern Viet Nam were used to provide comparative data from an area which was not sprayed with herbicides during the war (Hatfield Consultants Ltd. and 10-80 Committee 1998). Additional samples collected by Hatfield at the Dong Ha airbase in Quang Tri Province in 1996 were also be used for comparison, including samples from Thua Thien Hue Province (Hatfield Consultants Ltd. and 10-80 Committee 2000 and 1998).

3.5 Laboratory Analyses Conducted

The following is a brief topical itemization of laboratory methods applied during this investigation. Appendix 1 provides additional information on laboratory procedures involving:

- sample handling;
- extraction;
- chromatographic cleanup (i.e., silica gel column, alumina column, carbon/celite column, alumina column [from the carbon/celite column], and preparation for GC/MS analyses);
- high resolution GC/MS analyses (gas chromatograph/mass spectrometry);
- quantitation protocols;
- GC/ECD analyses (gas chromatograph/electron capture);
- quality assurance/quality control (QA/QC);
- procedural blanks;
- duplicates;
- surrogate standard recoveries;
- laboratory reference samples;

- detection limits;
- calculations; and
- data reporting.

3.5.1 Analytical Methods

Samples arriving from Viet Nam were forwarded to AXYS Analytical Services Ltd. (Victoria, BC, Canada) for dioxin analyses. AXYS Analytical was one of 26 laboratories from around the world that participated in a World Health Organization (W.H.O.) intercalibration study of dioxins/furans analysis; AXYS' results were judged to be among the best of all labs participating. The WHO will be releasing a technical report describing the study and results achieved (*pers. comm.* Dr. C. Hamilton, AXYS Analytical).

The following is a summary of laboratory methods for dioxin and furan analyses performed during this investigation. For more details on methods involving extraction, chromatographic cleanup, high resolution GC/MS analysis and quantitation procedures, please refer to Appendix 1, and Hatfield Consultants and 10-80 Committee (2000 and 1998) and Hatfield Consultants Ltd. (1998a).

A total of 11 dioxins and 14 furans were provided in each sample analysis. Furans are less toxic compounds in the 'dioxin family' of compounds (i.e., they have a slightly different chemical structure, but are similar to dioxins). Furans are automatically determined in conjunction with dioxins during laboratory analyses.

3.5.2 Polychlorinated Dioxins and Furans in Soil Samples

All samples were spiked with ^{13}C-labelled surrogate standards (tetrachlorodioxin, tetrachlorofuran, pentachlorodioxin, pentachlorofuran, hexachlorodioxin, hexachlorofuran, heptachlorodioxin, heptachlorofuran, and octachlorodioxin) prior to analysis. Soil samples were soxhlet extracted. All extracts were subject to a series of chromatographic cleanup steps prior to analysis for polychlorinated dibenzodioxins and dibenzofurans by high resolution gas chromatography with high resolution mass spectrometric detection (HRGC/HRMS).

4.0 RESULTS AND DISCUSSION

4.1 Dioxin and Furan Levels Recorded in Soils and Sediments in Gio Linh

A total of 24 composite soil samples and two individual fish pond sediment samples were analyzed for dioxins and furans during this study (Table 3; Figure 2; Appendix 2). A variety of dioxin and furan congeners were recorded in all samples analyzed, however most were found in low concentrations. The highest levels of contamination were recorded in the West Central area (Site #6), which is located on the western perimeter of the former Charlie 1 Firebase. Low levels of contamination were recorded in areas which have been cleared of mines and UXO by the MAG team, including the two fish ponds sampled in this study.

Dioxin (2,3,7,8-T4CDD) concentrations ranged from ND (not detected; n=6 samples) to 2.1 ppt (West Central Firebase; Site #6). At two sites (South Central East Firebase [Site #9], and Plantation Near Route 1 [Site#26]), dioxins were detected, but not quantified (NDR 0.11 and NDR 01.3, respectively). Furans (2,3,7,8-T4CDF) ranged from 0.11 ppt (Site #16; South Corner of Garden Development) to 19 ppt (West Central Firebase; Site #6). Total TEQ values ranged between 0.217 ppt (Site #18; Cultivated Field) to 36.7 ppt (West Central; Site #6); there was only one other site where Total TEQ values were greater than 10 ppt (North Central East Firebase; Site #3; 10.5 ppt).

In general, highest dioxin levels were recorded in the perimeter area of the former Charlie 1 Firebase, especially in the western portion of the study area (range: 0.18 ppt to 2.1 ppt T4CDD; sampling Sites #1 to #8 inclusive). High levels of octachlorodioxin (O8CDD) were also recorded on the perimeter, especially in the North Central East corner (Site 3; 3,100 ppt) and West Central area (Site 6; 2,200 ppt). An O8CDD value of 1,900 ppt was also recorded in the rice fields behind the MAG office area (Site #24).

Pentachlorodioxins (P5CDD), hexachlorodioxins (H6CDD) and heptachlorodioxins (H7CDD) were also prominent in samples analyzed, especially in the West Central Firebase area (Site #6; 84 ppt, 330 ppt and 800 ppt, respectively). A similar pattern was observed for the various furan congeners (penta-, hexa-, hepta-, and octachlorofuran), with the highest levels observed in the perimeter of the Charlie 1 Firebase, particularly at Site #6 in the West Central area (levels were 130 ppt, 150 ppt, 170 ppt and 79 ppt, respectively for each of the above furan congeners).

Interestingly, dioxin of Agent Orange origin (2,3,7,8 T4CDD) comprised a relatively small proportion of the Total TEQ values recorded in the samples analyzed (Table 3). Only 5.7% of the total TEQ in the sample analyzed from the West Central area (Site #6) may be attributed to Agent Orange dioxin (2,3,7,8 T4CDD). In this case, there was significant contribution of a variety of other less toxic dioxin and furan congeners to the total TEQ. The highest contribution of 2,3,7,8 T4CDD to the Total TEQ was found at Sites #20 (16.6% T4CDD) and #21 (17.0% T4CDD), which were located in the area proposed for the future cemetery and in the rice field in

the south-western corner of the MAG Project Area, respectively. These other dioxin and furan congeners may have originated from chemical materials used at the former Charlie 1 Firebase, including PCBs, wood preservatives and/or fungicides. Conversely, over 95% of the Total TEQ in Aluoi Valley soils was found to be of Agent Orange origin (Hatfield Consultants Ltd. and 10-80 Committee 2000). Comparative data on dioxin levels in other areas of Viet Nam are provided in Tables 4, 5 and 6.

4.2 Implications for Human Health and Deminer Safety

Dioxins in general, and T4CDD in particular, in soils from industrialized countries are expected to be detected at varying concentrations. Given their low water solubility and resistance to rapid degradation, dioxins tend to partition into soil; consequently, this medium serves as a "reservoir" for the contaminant and can result in bioaccumulation in the food chain long after cessation of a contaminating activity and/or process has occurred (Webster and Commoner 1994).

In non-industrialized areas such as central Viet Nam, applications of Agent Orange and other chemicals have resulted in high concentrations of dioxins in the vicinity of former US military installations, such as the former A So Special Forces base in the Aluoi Valley; soil dioxin concentrations in excess of 900 ppt TEQ have been reported at this site (see Tables 4-6, Hatfield Consultants Ltd. and 10-80 Committee 2000). The low dioxin levels reported in this study for the MAG Project Area in Gio Linh suggest that Agent Orange applications may have been less intense in this area relative to Aluoi Valley. Data on dioxin levels from Dong Ha airbase collected in 1996 (1.6 ppt TEQ; Table 4) appear to confirm the low levels reported in this study. Alternatively, the tropical rains may have caused erosion and movement of the contaminant out of the immediate area.

Regulatory agencies concerned with human health protection have employed various protocols to address the issue of dioxin contamination (e.g., in Canada, Health Canada and provincial health ministries and environmental departments; in the US, the Environmental Protection Agency [EPA] and state health agencies).

The following is the British Columbia (Canada) PCDD/PCDF (expressed as T-TEQ) soil standards for agricultural and residential/park soils (source: BC Waste Management Act 1996):

Matrix Numerical Soil Standard (pg/g Total TEQ).

Site-Specific Factor/Receptor	Agricultural Land	Residential/Park Land
Human Health Protection[1]	350	350
Environmental Protection	10	1,000

[1] An adult is used as the critical receptor, and related to intake (ingestion) of contaminated soil.

When addressing the issue of ecological health (environmental protection), the agricultural land and residential/park categories have different levels, 10 pg/g and 1,000 pg/g T-TEQ, respectively.

When addressing human health protection in BC, T-TEQ for agricultural and residential/park soils is 350 pg/g for both categories. This value is calculated on the basis of oral ingestion of soils alone, and does not make provision for dioxins that may be taken into the body through other avenues (e.g., foods, drinking water, exposure to commercial products, etc; BC Environment 1996).

These values focus on adult individuals with an assumed soil ingestion rate of 20 mg/day (BC Environment 1996). The following provides a summation of typical soil ingestion rates for the general population in Canada (source: Angus Environmental 1991, Newhook 1992 and MENVIQ 1992, *cited in* BC Environment 1996):

Typical Average Receptor Characteristic Values for the Canadian General Population.

Age Classes (years)	Soil Intake (mg/day)
0-0.5	20
0.6-4	80
5-11	20
12-19	20
20+	20

It should be noted here that young children are believed to ingest more soil materials and, generally, have greater exposure to soil contaminants relative to adults. Their lower body weight is also a factor. The above table would undoubtedly be magnified for young children in rural Viet Nam, as they are more intimately associated with soil as a result of dress (e.g., they lack footwear) and play habits (particularly the very young living in poor villages who spend time on bare ground), which increase the opportunity to ingest soil. In addition, many houses have dirt floors.

When a given area is to be assessed and categorized as to whether or not it constitutes a contaminated site in BC (Canada), two receptor categories (human health and ecological health, see table on previous page) are always considered. However, if a land category is designated as contaminated by either standard and remediation is contemplated, the BC Waste Management Act (1996) stipulates that the "lowest" matrix numerical soil standard be applied; that is, if a property is to be remediated for agricultural purposes, the 10 pg/g T-TEQ level for PCDDs/PCDFs is the target (remediation measures must reduce the soil contaminate level below 10 pg/g T-TEQ). Similarly, if land is to be remediated solely for the purposes of residential/park use, 350 pg/g T-TEQ is the target criterion.

The rationale for the difference in T-TEQ standards relates to the issues of bioaccumulation and biomagnification. Agricultural areas are used for raising food (crops and livestock); these foods are ultimately consumed by humans, therefore, directly facilitating dioxin bioaccumulation and

biomagnification processes. Since it is important to protect crops, livestock, and human health, a more stringent standard has been designated for ecological health.

Soils in most areas of the Gio Linh study area were below 10 pg/g T-TEQ, and therefore are within the BC standard. The only exception was the 36.7 pg/g T-TEQ in the West Central (Site #6) and 10.5 pg/g TEQ in the North Central East area of the Charlie 1 Firebase (Table 3). Since these two areas are proposed for future orchards and plantation developments (and not agriculture, residential land or fish ponds), potential exposure to future residents of the area is considered low. Deminers working in this area should use additional caution during soil disturbance activities (land clearing, UXO detonation) to avoid direct long-term exposure to potentially contaminated soils. Excavations should be minimized, and food crops/aquaculture ponds should not be developed in this area to avoid the potential for bioaccumulation/ biomagnification of dioxin in the food chain, particularly fish and ducks (Hatfield Consultants Ltd. and 10-80 Committee 2000).

5.0 CONCLUSIONS AND RECOMMENDATIONS

The level of 2,3,7,8-T4CDD contamination (T4CDD; a component of the 2,4,5-T portion of the Agent Orange mixture) was generally found to be low in the MAG Project Area in Gio Linh, Quang Tri, Viet Nam. Based on data to date, there are no immediate concerns regarding dioxin contamination in areas slated for future housing and garden developments, including areas which have previously been cleared of UXO by the MAG team (Figure 2).

Low levels of T4CDD contamination in soils and sediments in Gio Linh suggest a relatively low risk of dioxin contamination from direct exposure to soils or in the food chain. The only areas of possible concern are in the West Central and North Central East areas on the perimeter of the former Firebase. However, since these areas are proposed for future plantation and orchard developments, there appears to be a low risk to the local population. However, extensive digging and fish pond construction in these areas should be discouraged. Detonation of UXO in these areas should be undertaken with caution to avoid extensive air dispersion of soil particles, and potential re-mobilization of dioxins. Information on the Charlie 1 Firebase during its operational existence, especially use of exotic chemicals, would greatly assist in developing a more precise grid to delineate the zone of potential contamination.

Although dioxin levels in the Gio Linh/Charlie 1 Firebase area are low, other former military installations in southern Viet Nam have a high probability of being contaminated with Agent Orange T4CDD. Hatfield Consultants Ltd. and 10-80 Committee (2000) postulated that "hot spots/dioxin reservoirs" could be present near former US and south Vietnamese military installations throughout southern Viet Nam. Evidence from the A So base in Aluoi Valley, including data from other from US bases in Viet Nam (Hatfield Consultants Ltd. and 10-80 Committee 2000) suggest human health risks may be high in these areas.

Development programs in areas which have been severely impacted by war, such as in Gio Linh and other areas of South Viet Nam, should ensure that local residents and aid workers (such as deminers) are not exposed to hazardous chemical contaminants such as dioxin. In areas where contamination is identified or expected, the extent of the problem should be quantified, and mitigation measures implemented to prohibit re-mobilization of dioxins from the soil and entrance of these compounds into the food chain. The measures to be taken will depend on the extent of contamination, but must also be designed to address the basic needs and requirements of the local population (Hatfield Consultants Ltd. and 10-80 Committee 2000).

6.0 REFERENCES

Bengtsson, B. 1976. Ecological effects of chemical warfare and bombing in Viet Nam. A review and possible research priorities. SAREC Report No. 3: 1-23.

BC Environment. 1996. Overview of CSST procedures for the derivation of soil quality matrix standards for contaminated sites. Risk Assessment Unit, Environmental Protection Department, BC Environment. 51 p.

CADAS (Applications Committee of the Academy of Science of France). 1994. Dioxin and its analogues. Paris: Academie des Sciences. 109 p.

Cecil, P.F. 1986. Herbicidal Warfare: the RANCH HAND Project in Viet Nam. New York: Praeger. 290p.

FIPI (Forest Inventory and Planning Institute). 1991. Inventories to assess the impacts of chemical warfare on inland forests - Measures to restore. p. 233-238. In: Research Documents on Forest Inventory and Planning 1961-1991. Ha Noi: FIPI.

Gough, M. 1986. Dioxin, Agent Orange - The facts. New York: Plenum Press. 289 p.

Hatfield Consultants Ltd. and 10-80 Committee. 2000. Development of impact mitigation strategies related to the use of Agent Orange herbicide in the Aluoi Valley, Viet Nam war. Volume 1: Report; Volume 2: Appendices. Hatfield Consultants Ltd., West Vancouver, BC, Canada; 10-80 Committee, Ha Noi, Viet Nam.

Hatfield Consultants Ltd. and 10-80 Committee. 1998. Preliminary assessment of environmental impacts related to spraying of Agent Orange herbicide during the Viet Nam war. Volume 1: Report; Volume 2: Appendices. Hatfield Consultants Ltd., West Vancouver, BC, Canada; 10-80 Committee, Ha Noi, Viet Nam.

Hatfield Consultants Ltd. 1998a. Building Dioxin field Sampling and Laboratory Capacity in Viet Nam. Report for: Viet Nam Short Term Retraining Fund (USTRF), Asia Branch, Canadian International Development Agency and International Environmental Management Initiative (IEMI), Environmental Technology Advancement Directorate, Environment Canada, Hull, PQ.; Hatfield Consultants Ltd., West Vancouver, BC, Canada.

Hatfield Consultants Ltd. 1998b. Using RADARSAT imagery to assess residual environmental effects of the Viet Nam war (1961-1975). Volumes 1 and 2. Report for: RADARSAT User Development Program (RUDP) Coordination Office, Public Works and Government Services Canada, Hull, PQ; Hatfield Consultants Ltd., West Vancouver, BC, Canada.

IOM (Institute of Medicine). 1994. Veterans and Agent Orange - Health Effects of Herbicides used in Viet Nam. Washington, D.C., National Academy Press.

PTI Environmental Services. 1989. Recommended guidelines for measuring organic compounds in Puget Sound sediment and tissue samples. Report prepared for U.S. EPA, Bellevue, Washington, U.S.A.

Monan, J. 1997. Landmines and underdevelopment: a case study of Quang tri Province, Central Viet Nam. The National Political Publishing House, Oxfam, Hong Kong. 28 p.

NATO (North Atlantic Treaty Organization). 1988a. International Toxicity Equivalent Factor (I-TEF) method of risk assessment for complex mixtures of dioxins and related compounds. Pilot study on international information exchange on dioxins and related compounds. Committee on the Challenges of Modern Society. #186.

NATO (North Atlantic Treaty Organization). 1988b. Scientific basis for the development of the International Toxicity Equivalent Factor (I-TEF) method of risk assessment for complex mixtures of dioxins and related compounds. Pilot study on international information exchange on dioxins and related compounds. Committee on the Challenges of Modern Society. #188.

NATO (North Atlantic Treaty Organization). 1988c. Pilot study on information exchange on dioxins and related compounds, Final Report. Committee on the Challenges of Modern Society. #177.

Peel, M. 1995. The occupational health of deminers in Afghanistan. J. Royal Society of Medicine. 88: 683-685.

Prokosch, E. 1995. The technology of killing: a military and political history of antipersonnel weapons. Zed Books Ltd., London.

Quynh, H.T., B.T. Dung, L.B.T. Thuy and M.T. Hoa. 1994. First results on the transfer of 2,3,7,8-T4CDD in nature and its persistence in human body in south Viet Nam. p. 81-91. In: H.D. Cau *et al.* (ed.). Herbicides in War - The Long-term Effects on Man and Nature. 2nd International Symposium, Ha Noi, 1993. Ha Noi: 10-80 Committee, Hanoi Medical School. 476 p.

Schecter, A. (ed.). 1994. Dioxins and health. New York: Plenum Press. 710 p.

Startin, J.R. 1994. Dioxins in food. p. 115-137. In: A. Schecter (ed.). Dioxins and Health. New York: Plenum Press. 710 p.

Turley, G.H. 1985. The Easter offensive: the last American advisors Viet Nam, 1972. Bluejacket Books, Naval Institute Press, Annapolis, Maryland.

Webster T. and B. Commoner. 1994. Overview - the dioxin debate. p. 1-50. In: A. Schecter (ed.). Dioxins and Health. Plenum Press, New York.

Westing, A.W. (ed.). 1984. Herbicides in war: The long-term ecological and human consequences. London: Taylor and Francis.

WHO/EURO. 1989. Levels of PCBs, PCDDS and PCDFs in breast milk: Results of WHO-coordinated interlaboratory quality control studies and analytical field studies (Yrjanhaiki, EJ, ed). Environmental Health Series Report #34. Copenhagen: World Health Organization Regional Office for Europe.

Tables

Table 1. Hatfield/10-80 Committee Project Work Completed October 1999 to May 2000.

Date	Event	Description	Personnel
October 10 -16, 1999	Literature Review and Field Preparations	Compiled existing topographic maps, reports, remote sensing data and other information available on Gio Linh District, Quang Tri. Prepared field equipment and data sheets for transport to Viet Nam. Travel from Canada to Asia.	Thomas Boivin (HCL) Garth Taylor (HCL)
October 17, 1999	Travel from Bangkok to Hanoi	Prepared for meetings in Hanoi with the Danish Embassy and 10-80 Committee	T. Boivin G. Taylor
October 18, 1999	Meetings in Hanoi	Met with the Danish Embassy and 10-80 Committee; discussed our Quang Tri Project, and arranged project field equipment and logistics	T. Boivin, G. Taylor, Mr. Dao Nhat Dinh (Danida), Phung Tri Dung (10-80), Prof. Dr. Hoang Dinh Cau (10-80)
October 19, 1999	Travel to project site and meetings with MAG Team and local authorities	Traveled from Hanoi-Danang-Hue-Dong Ha. Team met by MAG representatives in Hue, and traveled to Dong Ha. Met with Mr. Tran Khanh Phoi, Nick Proudman, Mark Thompson and David Denman. Described project objectives with MAG and arranged field logistics. Also met with the Peoples' Committee of Quang Tri Province to discuss the project and sample exporting permits.	T. Boivin, G. Taylor, P. T. Dung
October 20, 1999	Fieldwork and sample collection	Collection of soil samples at 14 locations in the immediate vicinity of the Charlie 1 Firebase area (sampling sites 1-14; see Table 2 and Figure 2). Meetings with Peoples' Committee representatives.	T. Boivin, G. Taylor, P. T. Dung, D. Denman, MAG demining personnel
October 21, 1999	Fieldwork and sample collection	Collection of soil samples at 7 locations in the area south and west of the Charlie 1 Firebase area (sampling sites 15-21; see Table 2 and Figure 2).	T. Boivin, G. Taylor, P. T. Dung, D. Denman, MAG demining personnel
October 22, 1999	Fieldwork and sample collection	Collection of soil and fish pond sediment samples at 6 locations in the area east of the Charlie 1 Firebase area (sampling sites 22-27; see Table 2 and Figure 2). Meetings with Peoples' Committee representatives.	T. Boivin, G. Taylor, P. T. Dung, D. Denman, MAG demining personnel
October 23 -24, 1999	Travel to Hue	Team traveled to Hue on October 23rd. Dr. Dung departed for Hanoi via train with the team's soil samples. The Canadian team members could not depart Viet Nam until Monday, as the airport was closed due to heavy rains and flooding.	T. Boivin, G. Taylor, P. T. Dung
October 25, 1999	Departure of HCL Personnel	HCL project team return to Canada	T. Boivin, G. Taylor
April 2000	Sample Export and Analysis	Samples were exported from Viet Nam to Canada and were analyzed by AXYS Analytical Services Ltd. in Sidney, B.C., Canada.	AXYS
May, 2000	Report Completion	Final report was prepared following receipt of analytical results. Report submitted to Danish Embassy and MAG in Hanoi on May 31, 2000.	T. Boivin

Table 2 **Soil /Sediment Sampling Sites in Gio Linh District, Quang Tri, Central Viet Nam, October 1999.**

Site Name	Site Type	Site Location	Site #	Sampling Date	Coordinates (GPS 1)		Coordinates (GPS 2)		Sample Type	Soil Depth	Canada ID #	Vietnam ID #
Charlie 1	firebase	central east	1	20-Oct-99	721065	1867779	--	--	Soil	0-10	99VN800	99VN801
Charlie 1	firebase	central west	2	20-Oct-99	720833	1867698	--	--	Soil	0-10	99VN802	99VN803
Charlie 1	firebase	north central east	3	20-Oct-99	720935	1867980	--	--	Soil	0-10	99VN804	99VN805
Charlie 1	firebase	north central west	4	20-Oct-99	720744	1868007	--	--	Soil	0-10	99VN806	99VN808
Charlie 1*	firebase	north central west	4	20-Oct-99	720744	1868007	--	--	Soil	0-10	99VN807	--
Charlie 1	firebase	north west corner	5	20-Oct-99	720697	1867711	--	--	Soil	0-10	99VN809	99VN810
Charlie 1	firebase	west central	6	20-Oct-99	720776	1867650	--	--	Soil	0-10	99VN811	99VN812
Charlie 1	firebase	south west corner	7	20-Oct-99	720809	1867532	--	--	Soil	0-10	99VN813	99VN814
Charlie 1*	firebase	south west corner	7	20-Oct-99	720809	1867532	--	--	Soil	10-30	99VN815	99VN816
Charlie 1	firebase	south central west	8	20-Oct-99	720898	1867597	720871	1867568	Soil	0-10	99VN817	99VN818
Charlie 1	firebase	south central east	9	20-Oct-99	720982	1867519	721006	1867511	Soil	0-10	99VN819	99VN820
Charlie 1	firebase	south east corner	10	20-Oct-99	721170	1867776	721146	1867770	Soil	0-10	99VN821	99VN822
Charlie 1	firebase	north east corner	11	20-Oct-99	721175	1867983	721177	1867992	Soil	0-10	99VN823	99VN824
Future Farmland	cleared area	north east corner	12	20-Oct-99	721256	1868108	721250	1868114	Soil	0-10	99VN825	99VN826
Future Farmland	cleared area	north central area	13	20-Oct-99	721324	1867952	721355	1867865	Soil	0-10	99VN827	99VN828
Future Farmland*	cleared area	north central area	13	20-Oct-99	721324	1867952	721355	1867865	Soil	10-30	99VN829	99VN831
Future Farmland*	cleared area	north central area	13	20-Oct-99	721324	1867952	721355	1867865	Soil	10-30	99VN830	--
Future Farmland	cleared area	south east corner	14	20-Oct-99	721422	1867676	--	--	Soil	0-10	99VN832	99VN833
Garden Development	garden	south east marker	15	21-Oct-99	721482	1867306	721490	1867301	Soil	0-10	99VN834	99VN835
Garden Development	garden	south corner	16	21-Oct-99	721136	1867298	--	--	Soil	0-10	99VN836	99VN837
Uncultivated Field*	field	--	17	21-Oct-99	721018	1867198	721000	1867208	Soil	0-10	99VN838	99VN839
Cultivated Field	field	--	18	21-Oct-99	721093	1867192	721081	1867182	Soil	0-10	99VN840	99VN842
Cultivated Field*	field	--	18	21-Oct-99	721093	1867192	721081	1867182	Soil	0-10	99VN841	--
Cultivated Field*	field	--	18	21-Oct-99	721093	1867192	721081	1867182	Soil	10-30	99VN843	99VN845
Cultivated Field*	field	--	18	21-Oct-99	721093	1867192	721081	1867182	Soil	10-30	99VN844	--
Eucalyptus Plantation	plantation	--	19	21-Oct-99	720901	1867218	720887	1867201	Soil	0-10	99VN846	99VN847
Future Cemetary	quarry	beside quarry	20	21-Oct-99	720643	1867192	720664	1867196	Soil	0-10	99VN848	99VN849

Table 2 Cont'd

Site Name	Site Type	Site Location	Site #	Sampling Date	Coordinates (GPS 1)		Coordinates (GPS 2)		Sample Type	Soil Depth	Canada ID #	Vietnam ID #
MAG Area	field	western border	21	21-Oct-99	720416	1867551	720415	1867550	Soil	0-10	99VN850	99VN851
MAG Area	fish pond	beside MAG office	22	22-Oct-99	721368	1867900	721390	1867904	Fish Pond Seds	--	99VN852	99VN853
MAG Area	fish pond	near RR track	23	22-Oct-99	721431	1867926	721443	1867943	Fish Pond Seds	--	99VN854	99VN855
MAG Area	rice field	behind MAG office	24	22-Oct-99	721454	1867925	721443	1867930	Soil	0-10	99VN856	99VN857
MAG Area	forest	beside MAG office	25	22-Oct-99	721422	1867921	721417	1867915	Soil	0-10	99VN858	99VN860
MAG Area*	forest	beside MAG office	25	22-Oct-99	721422	1867921	721417	1867915	Soil	0-10	99VN859	--
MAG Area*	forest	beside MAG office	25	22-Oct-99	721422	1867921	721417	1867915	Soil	10-30	99VN861	99VN863
MAG Area*	forest	beside MAG office	25	22-Oct-99	721422	1867921	721417	1867915	Soil	10-30	99VN862	--
Near Hwy 1	plantation	north east side	26	22-Oct-99	721606	1868041	721622	1868044	Soil	0-10	99VN864	99VN865
Near Hwy 1	rice field	south east corner	27	22-Oct-99	721613	1867895	721604	1867888	Soil	0-10	99VN866	99VN867
Near Hwy 1*	rice field	south east corner	27	22-Oct-99	721613	1867895	721604	1867888	Field Blank	--	99VN868	--

*Sample not analyzed; sample archived.

Table 3 **Concentrations of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in soil (0-10 cm depth) and fish pond sediments (pg/g [ppt], dry weight), Gio Linh District, Quang Tri, Central Viet Nam, October 1999.**

Site Name, Type and Location	Site #	Sample ID	PCDD Concentration (pg/g)						PCDF Concentration (pg/g)						Total TEQ (pg/g)	% 2,3,7,8 - T4CDD of TEQ
			2,3,7,8 - T4CDD	Total T4CDD	Total P5CDD	Total H6CDD	Total H7CDD	Total O8CDD	2,3,7,8- T4CDF	Total T4CDF	Total P5CDF	Total H6CDF	Total H7CDF	Total O8CDF		
Charlie 1 firebase																
Central east	1	99VN800	**0.20**	0.89	3.1	27	220	870	0.37	2.4	6.4	24	47	23	**3.49**	**5.7%**
Central west	2	99VN802	**0.24**	1.2	3.6	68	580	1700	0.64	2.7	22	81	120	51	**7.69**	**3.1%**
North central east	3	99VN804	**0.33**	2.3	7.5	82	670	3100	0.42	3.2	7.4	75	150	130	**10.5**	**3.1%**
North central west	4	99VN806	**0.18**	1.1	2.7	25	150	620	0.40	2.9	4.7	16	33	23	**3.02**	**6.0%**
North west corner	5	99VN809	**0.34**	0.52	1.4	34	260	1100	NDR (0.31)	1.3	18	55	43	8.1	**5.53**	**6.1%**
West central	6	99VN811	**2.1**	33	84	330	800	2200	19	120	130	150	170	79	**36.7**	**5.7%**
South west corner	7	99VN813	**0.16**	0.69	0.41	8.2	56	280	0.16	2.1	0.65	4.4	10	11	**1.10**	**14.5%**
South central west	8	99VN817	**0.31**	3.3	7.4	74	530	2000	0.75	5.1	22	67	110	63	**8.59**	**3.6%**
South central east	9	99VN819	NDR (0.11)	0.22	0.96	4.3	67	680	0.22	1.7	1.3	4.0	5.7	4.1	**1.39**	**0.0%**
South east corner	10	99VN821	**0.070**	0.20	1.5	8.0	35	270	0.15	1.2	0.79	2.3	4.2	2.7	**0.896**	**7.8%**
North east corner	11	99VN823	**0.064**	0.41	1.4	11	56	200	0.15	0.57	1.6	5.1	7.7	5.0	**0.966**	**6.6%**
Future farmland																
Cleared area, north east corner	12	99VN825	**0.10**	0.79	1.2	5.1	14	44	0.18	2.4	2.0	3.1	2.3	1.5	**0.590**	**16.9%**
Cleared area, north central area	13	99VN827	**0.12**	3.0	2.5	20	100	380	0.55	3.9	4.8	10	16	12	**2.15**	**5.6%**
Cleared area, south east corner	14	99VN832	**ND**	1.6	0.43	2.8	7.0	27	0.17	11	2.0	2.0	1.1	0.79	**0.399**	**0.0%**
Garden development																
South east marker	15	99VN834	**ND**	0.34	0.31	1.3	3.0	8.8	0.078	1.2	0.90	1.4	0.58	0.45	**0.236**	**0.0%**
South corner	16	99VN836	**ND**	0.074	0.18	2.3	8.7	81	0.11	0.36	0.56	1.2	1.0	0.81	**0.391**	**0.0%**
Cultivated field																
--	18	99VN840	**ND**	ND	0.16	1.3	3.4	18	NDR (0.06)	0.40	0.30	0.37	0.47	0.40	**0.217**	**0.0%**
Eucalyptus plantation																
--	19	99VN846	**0.085**	0.21	0.26	3.1	4.7	20	0.13	1.0	0.53	0.63	1.1	0.83	**0.561**	**15.2%**
Future cemetary																
Beside quarry	20	99VN848	**0.050**	0.050	0.12	1.6	4.0	19	0.12	0.50	0.40	0.79	0.97	0.74	**0.302**	**16.6%**
MAG Area																
Field, western border	21	99VN850	**0.23**	0.46	1.2	11	67	270	0.34	6.0	3.1	9.9	16	12	**1.35**	**17.0%**
Fish pond, beside MAG office	22	99VN852	**ND**	0.85	0.83	5.7	23	64	0.25	3.4	1.3	2.6	3.8	2.3	**0.386**	**0.0%**
Fish pond, near RR track	23	99VN854	**0.047**	1.4	1.6	9.8	48	260	0.19	1.5	1.4	4.4	9.3	6.9	**0.897**	**5.2%**
Rice field, behind MAG office	24	99VN856	**0.27**	2.6	9.2	55	390	1900	1.1	6.4	13	47	110	75	**6.97**	**3.9%**
Forest, beside MAG office	25	99VN858	**ND**	0.30	0.43	18	130	450	0.70	4.5	7.0	17	28	20	**1.64**	**0.0%**
Near Hwy 1																
Plantation, north east side	26	99VN864	NDR (0.13)	1.2	5.0	24	120	440	0.35	1.6	4.3	13	29	22	**2.63**	**0.0%**
Rice field, south east corner	27	99VN866	**0.18**	2.4	8.5	40	200	770	0.53	3.7	6.9	24	49	36	**4.06**	**4.4%**

ND = Not detected; for 'Total TEQ' calculations, if ND, ½ detection level was used.

NDR = Peak detected but did not meet quantification criteria; for 'Total TEQ' calculations, NDR was treated as ND.

Table 4 **Concentrations of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in soil, fishpond sediment and animal tissues (pg/g [ppt], dry weight [soils]; pg/g [ppt], wet weight [biological tissues]), central Viet Nam, January 1996 (Source: Hatfield Consultants Ltd. and 10-80 Committee 1998).**

Sample Location and Type	Sample ID	PCDD Concentration (pg/g)						PCDF Concentration (pg/g)						Total TEQ (pg/g)	% 2,3,7,8 - T4CDD of TEQ
		2,3,7,8 - T4CDD	Total T4CDD	Total P5CDD	Total H6CDD	Total H7CDD	Total O8CDD	2,3,7,8- T4CDF	Total T4CDF	Total P5CDF	Total H6CDF	Total H7CDF	Total O8CDF		
A Ngo, Aluoi Valley (Exposed)															
Bomb crater soil (0-10 cm depth)	VN9605	**1.1**	2.0	0.5	3.9	26	830	ND	0.8	0.1	0.5	0.5	1.0	**2.3**	**47.8%**
Bomb crater soil (10-30 cm depth)	VN9613	**0.9**	1.2	ND	3.0	27	950	ND	0.5	0.1	0.2	0.5	0.9	**2.1**	**42.9%**
Fish pond sediment	VN9619	**5.3**	7.7	6.3	9.7	35	880	0.2	0.8	ND	0.3	ND	ND	**6.8**	**77.9%**
Carp liver	VN9618	**1.0**	1.5	0.4	ND	ND	1.0	0.4	2.6	1.3	ND	ND	ND	**1.2**	**83.3%**
Manioc root	VN9603	**ND**	ND	ND	ND	ND	1.1	ND	ND	ND	ND	ND	ND	**0.2**	**0.0%**
Hong Thuong, Aluoi Valley (Exposed)															
Carp liver	VN9620	**1.6**	1.6	ND	ND	ND	1.6	0.7	1.1	0.90	ND	ND	ND	**1.9**	**84.2%**
Manioc root	VN9606	**ND**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.2**	**0.0%**
Hong Ha, Aluoi Valley (Exposed)															
Farmer's field soil (10-30 cm)	VN9615	**1.7**	1.9	ND	2.9	2.7	48	0.2	0.5	0.3	ND	ND	ND	**2.1**	**81.0%**
Fish pond sediment	VN9635	**0.3**	0.3	ND	0.3	1.1	18	ND	ND	ND	ND	0.1	ND	**0.4**	**75.0%**
Carp liver	VN9623	**0.3**	0.6	ND	1.6	3.9	4.0	0.3	1.1	1.6	1.1	0.6	ND	**0.5**	**60.0%**
Hong Van, Aluoi Valley (Exposed)															
Farmer's field soil (10-30 cm)	VN9643	**0.7**	6.9	3.0	16	42	1700	ND	0.4	ND	ND	ND	ND	**2.9**	**24.1%**
Son Thuy, Aluoi Valley (Exposed)															
Pig liver	VN9629	**ND**	ND	ND	0.4	17	300	ND	ND	0.6	3.4	7.2	2.7	**1.3**	**0.0%**
Xa Nham, Aluoi Valley (Exposed)															
Farmer's field soil (10-30 cm)	VN9631	**4.3**	6.5	3.9	6.6	9.9	230	ND	ND	ND	ND	ND	ND	**5.0**	**86.0%**
Carp fat	VN9640	**0.7**	2.3	ND	ND	ND	5.1	1.2	9.2	1.7	ND	ND	ND	**1.5**	**46.7%**
A So, Aluoi Valley (Exposed)															
Former airbase soil (0-10 cm)	VN9642	**110**	120	7.8	13	47	460	3.6	11	8.8	8.4	28	36	**112.6**	**97.7%**
Former airbase soil (10-30 cm)	VN9622	**32**	34	0.2	7.8	23	430	1.1	2.7	2.9	3.7	6.7	7.5	**33.3**	**96.1%**
Fish pond sediment	VN9602	**6.9**	9.5	3.1	9.1	19	460	0.6	1.7	1.4	0.5	0.8	1.2	**7.8**	**88.5%**
A Sap River sediment	VN9650	**0.8**	0.8	ND	0.5	3.6	69	ND	0.40	ND	ND	ND	ND	**1.2**	**66.7%**
Carp fat	VN9646	**51**	59	2.4	ND	ND	ND	6.6	25	12	ND	ND	ND	**53.7**	**95.0%**
Carp liver	VN9614	**2.4**	3.0	0.4	ND	ND	ND	0.4	1.3	0.4	ND	ND	ND	**2.6**	**92.3%**
Duck liver	VN9608	**1.4**	1.4	ND	ND	ND	ND	0.2	0.2	ND	ND	ND	ND	**1.6**	**87.5%**
Dong Ha, Quang Tri province (Exposed)															
Former airbase soil (0-10 cm)	VN9645	**ND**	0.2	ND	9.2	58	290	0.4	1.1	3.5	11	23	26	**1.6**	**0.0%**
Former airbase soil (10-30 cm)	VN9630	**ND**	ND	ND	3.6	13	62	ND	ND	ND	1.3	2.1	3.9	**0.6**	**0.0%**
Chi Khe, Nhge An province (Reference)															
Farmer's field soil (0-10 cm)	VN9636	**ND**	0.2	ND	1.8	1.3	13	0.2	1.1	0.1	0.8	ND	ND	**0.4**	**0.0%**
Farmer's field soil (10-30 cm)	VN9624	**ND**	ND	ND	2.0	1.4	16	ND	0.8	ND	0.6	ND	ND	**0.6**	**0.0%**
Con Cuong, Nhge An province (Reference)															
Carp liver	VN9621	**ND**	0.1	ND	ND	ND	ND	0.2	0.4	0.3	ND	ND	ND	**0.2**	**0.0%**
Duck liver	VN9644	**ND**	ND	ND	ND	ND	ND	0.2	0.4	ND	ND	ND	ND	**0.2**	**0.0%**
Pig liver	VN9641	**ND**	ND	ND	ND	1.2	4.1	ND	ND	ND	ND	ND	ND	**0.2**	**0.0%**

ND = Not detected; for 'Total TEQ' calculations, if ND, ½ detection level was used.
NDR = Peak detected but did not meet quantification criteria; for 'Total TEQ' calculations, NDR was treated as ND.

Table 5 **Concentrations of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in soil, fishpond sediment, animal tissues and whole human blood, (pg/g [ppt], dry weight [soils], pg/g [ppt], wet weight [biological tissues]), central and southern Viet Nam, November 1997 (Source: Hatfield Consultants Ltd. and 10-80 Committee 1998).**

Sample Location and Type	Sample ID	PCDD Concentration (pg/g)						PCDF Concentration (pg/g)						Total TEQ (pg/g)	% 2,3,7,8 - T4CDD of TEQ
		2,3,7,8 - T4CDD	Total T4CDD	Total P5CDD	Total H6CDD	Total H7CDD	Total O8CDD	2,3,7,8- T4CDF	Total T4CDF	Total P5CDF	Total H6CDF	Total H7CDF	Total O8CDF		
A So, Aluoi Valley, central Viet Nam (Exposed)															
Soil (0 to 10 cm depth)															
Former airbase	97VN051	**897.85**	897.85	7.76	24.35	68.44	563.84	10.46	30.30	23.59	8.19	19.83	16.50	**901.22**	**99.6%**
Former airstrip	97VN057	**88.32**	88.32	7.40	19.83	65.82	697.05	3.08	11.27	6.94	8.94	22.37	30.31	**92.21**	**95.8%**
Manioc field	97VN001	**6.61**	8.26	1.56	8.49	10.92	142.29	0.64	3.17	0.87	0.55	0.92	1.61	**7.01**	**94.3%**
Ploughed field	97VN013	**4.20**	6.49	2.93	10.49	10.88	136.34	0.24	1.66	0.78	ND	0.78	1.95	**4.53**	**92.7%**
Fish pond sediment															
Fish pond #3	97VN009	**8.5**	11	3.3	5.8	9.4	220	0.5	2.2	1.1	0.2	ND	ND	**9.2**	**92.4%**
Fish pond #2	97VN007	**5.4**	7.1	4.5	9.3	7.9	170	0.3	1.5	0.9	0.2	ND	ND	**6.0**	**90.0%**
Fish pond #1	97VN005	**5.2**	9.9	13	10	5.3	64	0.3	2.3	1.1	0.3	ND	ND	**5.9**	**88.1%**
Fish pond #4	97VN011	**1.8**	3.3	2.5	1.5	1.4	23	0.1	0.6	0.4	ND	ND	ND	**2.0**	**90.0%**
Animal tissue															
Grass carp fat (pond#4)	97VN039	**34**	41	9.5	1.8	0.2	0.6	4.4	15	5.3	0.6	0.2	0.1	**35.4**	**96.0%**
Grass carp fat (pond#3)	97VN031	**21**	25	4.0	0.6	0.8	3.3	4.0	15	5.0	ND	0.5	ND	**22.4**	**93.8%**
Grass carp fat (pond#2)	97VN027	**16**	20	4.2	1.4	0.7	1.0	2.4	11	4.0	1.1	0.1	ND	**16.7**	**95.8%**
Grass carp fat (pond#1)	97VN019	**7.9**	10	2.3	1.5	1.6	2.9	2.3	13	3.4	0.5	0.4	NDR	**8.7**	**90.8%**
Duck fat	97VN045	**6.1**	7.0	3.4	0.8	ND	2.2	1.1	2.7	2.1	ND	ND	ND	**7.0**	**87.1%**
Human blood (lipid basis)															
Males, age >25	97VN047	**31**	31	ND	6.9	10	52	ND	ND	3.4	17	ND	NDR	**37.2**	**83.4%**
Females, age >25	97VN048	**11**	11	ND	ND	14	64	ND	ND	ND	ND	ND	NDR	**14.3**	**76.9%**
Males, age 12 to 25	97VN049	**21**	21	ND	ND	10	NDR	ND	ND	ND	14	24	76	**25.5**	**82.4%**
Females, age 12 to 25	97VN050	**12**	12	ND	ND	19	50	ND	ND	ND	ND	12	ND	**15.4**	**78.0%**
Rang Rang, Ma Da forest region, southern Viet Nam (Exposed)															
Soil (0 to 10 cm)															
North of Ma Da River	97VN077	**19.10**	24.88	8.94	26.37	7.54	26.86	2.48	8.98	5.42	1.13	1.44	1.40	**20.33**	**93.9%**
South of former airstrip	97VN075	**7.86**	10.13	1.41	7.22	6.62	16.58	1.03	4.02	1.54	0.51	ND	0.81	**8.44**	**93.1%**
At former airstrip	97VN079	**1.82**	2.46	3.76	7.60	9.58	24.91	0.59	1.15	0.71	ND	1.07	ND	**2.37**	**76.8%**
Sediment															
Fish pond near Ba Hao	97VN073	**7.80**	9.71	ND	ND	5.85	29.51	0.59	0.88	1.07	ND	1.32	1.41	**7.93**	**98.4%**
Ba Hao Reservoir	97VN089	**2.28**	3.34	ND	7.59	10.40	18.76	0.27	2.12	ND	ND	1.01	0.69	**2.64**	**86.4%**

ND = Not detected; for 'Total TEQ' calculations, if ND, ½ detection level was used.

NDR = Peak detected but did not meet quantification criteria; for 'Total TEQ' calculations, NDR was treated as ND.

Table 6 **Concentrations of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in soil (0-10 cm depth) composite samples (pg/g [ppt], dry weight), Aluoi Valley, Viet Nam, March 1999. (Source: Hatfield Consultants Ltd. and 10-80 Committee 2000).**

Site Location	Sample ID	PCDD Concentration (pg/g)						PCDF Concentration (pg/g)						Total TEQ (pg/g)	% 2,3,7,8 - T4CDD of TEQ
		2,3,7,8 - T4CDD	Total T4CDD	Total P5CDD	Total H6CDD	Total H7CDD	Total O8CDD	2,3,7,8- T4CDF	Total T4CDF	Total P5CDF	Total H6CDF	Total H7CDF	Total O8CDF		
A Dot Commune															
Site 1	99VN020	**1.0**	1.0	ND	1.5	11	540	0.3	1.7	ND	ND	0.5	0.7	**1.8**	**55.6%**
Site 1	99VN022	**0.8**	0.8	ND	1.1	8.8	430	0.2	1.7	0.3	ND	0.4	0.7	**1.4**	**57.1%**
Site 2	99VN023	**0.4**	0.6	ND	1.1	3.0	43	0.2	0.9	0.3	ND	0.4	0.4	**0.62**	**64.5%**
A So Special Forces Base															
North West	99VN001	**220**	220	8.7	17	32	330	3.7	11	9.3	7.7	11	11	**220**	**>99%**
North Centre	99VN003	**360**	370	13	16	16	310	11	25	37	3.9	4.2	4.6	**360**	**>99%**
North Centre (dup.)	99VN004	**260**	260	9.2	11	13	280	7.1	17	25	3.1	4.1	3.8	**260**	**>99%**
North East	99VN006	**260**	280	23	22	10	240	20	35	20	4.4	1.5	1.2	**260**	**>99%**
Centre West	99VN008	**24**	36	28	23	7.5	120	2.1	12	9.1	1.7	1.0	0.9	**26**	**92.3%**
Centre	99VN010	**25**	37	31	25	5.2	69	1.6	6.1	5.7	1.4	0.7	0.7	**27**	**92.6%**
Centre East	99VN012	**45**	54	21	21	7.5	130	2.7	11	9	2.3	0.9	0.9	**46**	**97.8%**
South West	99VN014	**15**	20	6.5	7.6	6.8	75	0.9	6	4.8	1.5	0.9	0.8	**16**	**93.8%**
South Centre	99VN016	**5.4**	7.6	3.6	4.4	5.1	77	0.4	2.3	1.6	0.6	0.5	0.6	**5.7**	**94.7%**
South East	99VN018	**4.2**	5.1	2.5	6	9.2	240	0.4	2.4	1.0	0.3	0.9	1.0	**4.9**	**85.7%**
Huong Lam Commune															
Site 1	99VN025	**0.4**	0.6	ND	0.9	3.2	68	ND	0.3	ND	ND	0.4	0.6	**0.6**	**66.7%**
Site 2	99VN027	**ND**	0.4	0.3	3.9	32	180	0.2	0.6	0.2	2.7	6.6	6.0	**0.6**	**-**
Huong Phong Commune															
Site 1	99VN029	**1.6**	2.3	0.3	1.9	7.0	270	0.2	1.3	0.5	0.5	0.8	0.8	**2.1**	**76.2%**
Site 2	99VN031	**6.7**	8.4	2.0	4.4	14	210	0.4	2.6	2.1	1.1	1.2	1.2	**7.3**	**91.8%**
Phu Vinh Commune															
Site 1	99VN035	**3.0**	3.7	0.7	2.4	11	540	0.3	1.1	0.6	0.8	0.6	1.2	**3.8**	**78.9%**
Site 2	99VN037	**3.1**	3.7	1.0	3.2	13	610	0.5	2.6	2.4	0.7	1.3	1.5	**4.1**	**75.6%**
Hong Thuong Commune															
Site 1	99VN039	**5.1**	6.8	1.5	6.1	30	2200	0.3	1.3	1.5	0.7	0.9	1.1	**7.7**	**66.2%**
Ta Bat Special Forces Base															
North West	99VN057	**11**	16	7.7	9.6	21	880	0.7	5.7	2.8	1.0	1.6	1.6	**13**	**84.6%**
North Centre	99VN055	**9.2**	12	2.5	8.0	28	820	0.6	3.2	2.8	3.5	4.9	3.8	**11**	**83.6%**
North East	99VN053	**9.4**	15	7.8	8.5	13	520	1.4	11	11	2.4	2.3	2.1	**11**	**85.5%**
Centre West	99VN059	**35**	40	7.0	8.9	18	800	1.0	5.3	2.5	1.0	1.2	1.3	**37**	**94.6%**
Centre	99VN061	**5.9**	10	6.7	8.0	10	400	0.8	6.5	6.8	0.7	0.9	1.0	**7.1**	**83.1%**
Centre East	99VN063	**4.3**	8.8	1.4	5.7	18	750	0.3	2.7	1.0	0.3	0.6	0.6	**5.5**	**78.2%**
South West	99VN069	**18**	27	5.2	12	19	520	0.4	4.5	2.1	3.0	4.5	3.2	**19**	**94.7%**

ND = Not detected; for 'Total TEQ' calculations, if ND, ½ detection level was used.

NDR = Peak detected but did not meet qualification criteria; for 'Total TEQ' calculations, NDR was treated as ND.

Table 6 Cont'd.

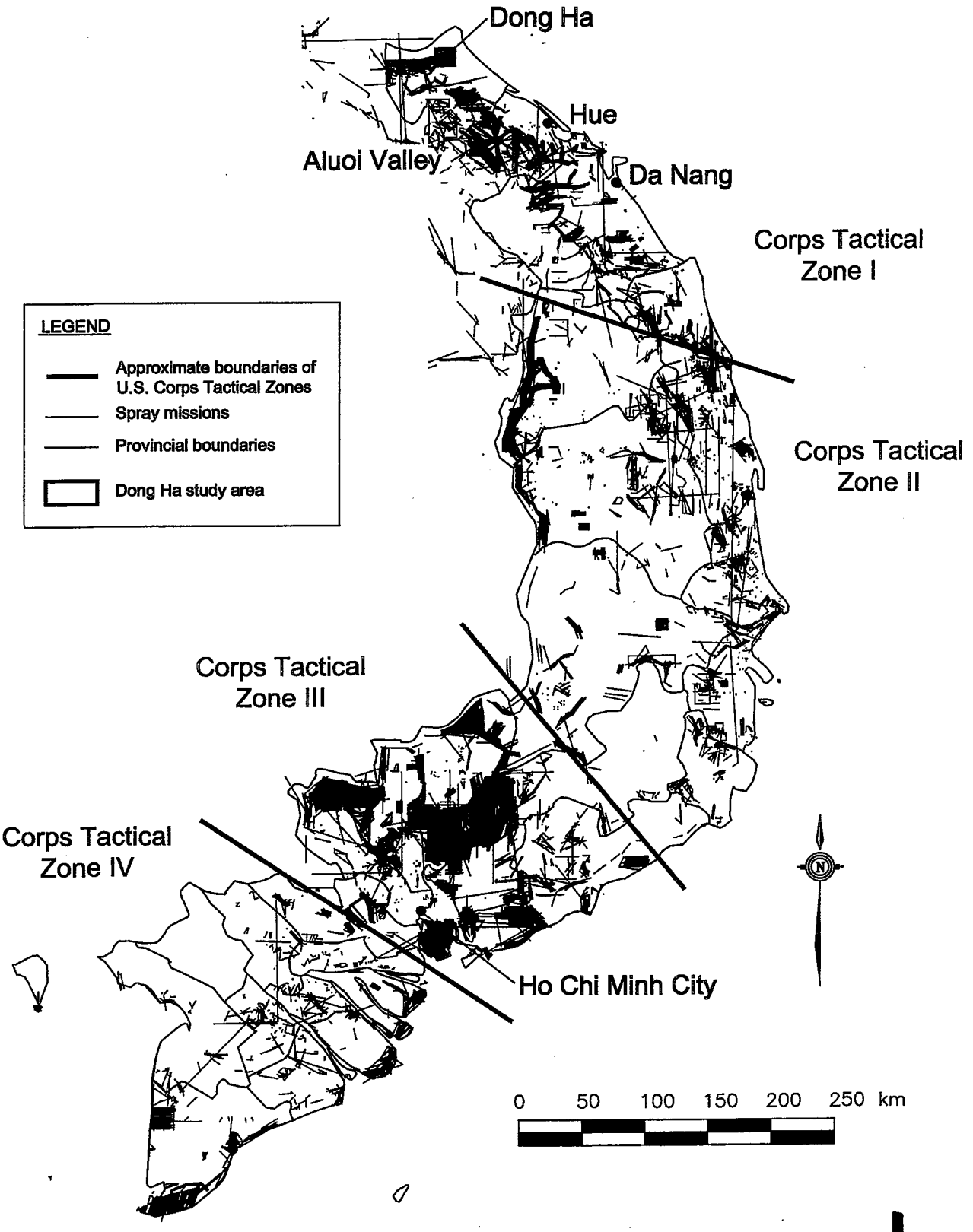
Site Location	Sample ID	PCDD Concentration (pg/g)						PCDF Concentration (pg/g)						Total TEQ (pg/g)	% 2,3,7,8 - T4CDD of TEQ
		2,3,7,8 - T4CDD	Total T4CDD	Total P5CDD	Total H6CDD	Total H7CDD	Total O8CDD	2,3,7,8- T4CDF	Total T4CDF	Total P5CDF	Total H6CDF	Total H7CDF	Total O8CDF		
South Centre	99VN065	**8.4**	16	5.4	10	16	1100	0.5	4.1	2.1	0.8	1.0	1.2	**10**	**84.0%**
South East	99VN067	**7.7**	12	3.1	10	17	530	0.6	4.4	2.8	1.0	1.4	1.5	**9.0**	**85.6%**
Bo Dot Market															
Site 1	99VN033	**4.6**	6.8	7.8	20	150	1100	3.2	16	15	26	34	19	**9.1**	**50.5%**
Son Thuy Commune															
Site 1	99VN041	**3.1**	4.3	5.7	29	230	1800	0.4	2.1	4.1	19	44	36	**7.6**	**40.8%**
Site 2	99VN043	**3.4**	6.6	4.5	9.2	30	1100	NDR	1	1.3	1.1	1.7	2.0	**5.1**	**66.7%**
Hong Quang Commune															
Site 1	99VN051	**7.9**	8.9	2	5.4	4.3	67	0.4	1.1	1.9	1.5	0.9	0.6	**8.3**	**95.2%**
Aluoi Commune															
Site 1	99VN073	**2.1**	3.1	1.9	8.5	4.1	28	0.2	1.3	0.7	0.4	0.4	0.5	**2.7**	**77.8%**
Aluoi Market															
Site 1	99VN071	**15**	21	9.5	11	19	770	0.8	7.9	4.0	0.8	0.4	0.6	**17**	**88.2%**
Aluoi Special Forces Base															
North West	99VN079	**11**	15	6.7	13	7.0	74	0.6	3	2.1	1.0	11.8	1.3	**12**	**91.7%**
North Centre	99VN077	**12**	15	4.9	11	6.1	76	0.6	2.1	1.5	0.9	1.8	1.7	**13**	**92.3%**
North East	99VN075	**5.0**	7.3	7.5	10	9.7	140	0.4	1.6	1.0	0.9	1.7	1.7	**5.7**	**87.7%**
Centre West	99VN083	**12**	15	3.9	9.5	8.0	340	0.5	2.2	1.1	0.6	0.7	0.7	**13**	**92.3%**
Centre	99VN081	**5.7**	6.9	1.7	5.7	6.7	210	0.5	1.7	0.9	0.8	1.0	0.6	**6.3**	**90.5%**
Centre East	99VN085	**19**	24	7.4	16	11	370	0.9	5.8	3.1	1.7	1.3	1.2	**20**	**95.0%**
South West	99VN091	**11**	16	13	11	6.6	260	0.5	2.7	1.6	0.6	0.4	0.6	**12**	**91.7%**
South Centre	99VN087	**19**	26	18	16	7.0	320	0.7	3.4	2.1	1.1	0.8	0.8	**20**	**95.0%**
South East	99VN089	**10**	14	8.8	11	7.3	250	0.6	3.6	2.4	1.0	0.9	0.7	**11**	**90.9%**
Hong Kim Commune															
Site 1	99VN049	**3.7**	4.7	0.8	3.6	3.7	74	0.2	0.9	0.3	ND	0.4	0.5	**4.1**	**90.2%**
Hong Van Commune															
Site 1	99VN045	**0.4**	0.8	1.0	5.0	6.3	130	0.1	0.5	ND	0.4	1.1	0.8	**1.1**	**36.4%**
Site 2	99VN047	**0.3**	1.0	ND	1.4	3.5	64	0.1	0.9	0.3	0.2	0.4	0.5	**0.6**	**50.0%**

ND = Not detected; for 'Total TEQ' calculations, if ND, ½ detection level was used.

NDR = Peak detected but did not meet qualification criteria; for 'Total TEQ' calculations, NDR was treated as ND.

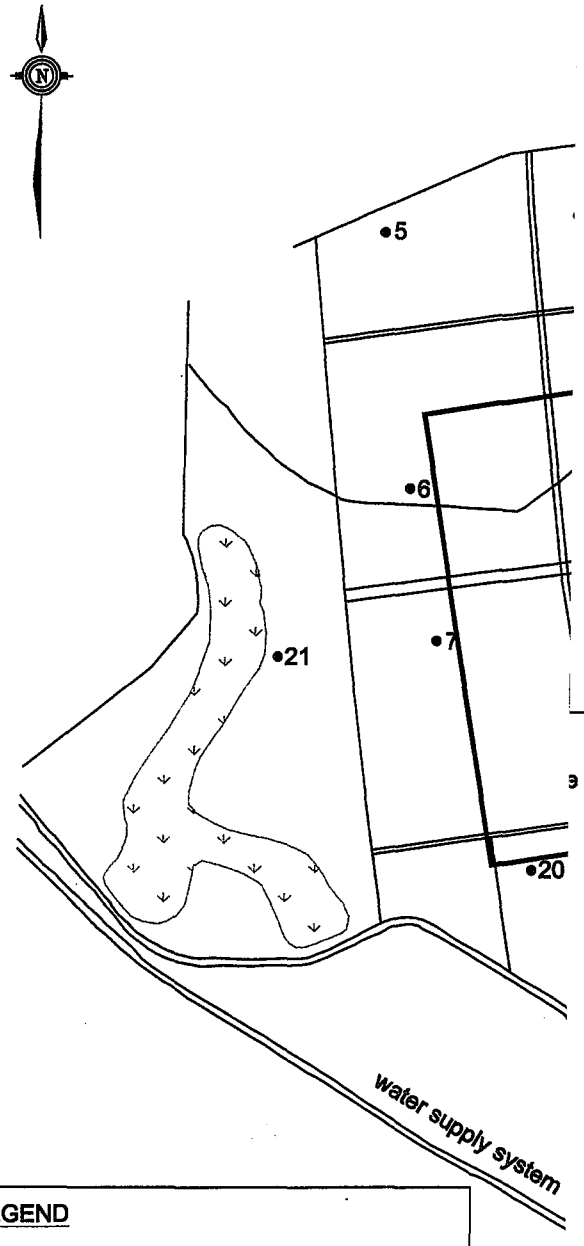
Figures

Figure 1 Aerial herbicide spray missions in southern Viet Nam, 1965-1971, and location of study area in Dong Ha, Quang Tri Province (Source: US Dept. of the Army).

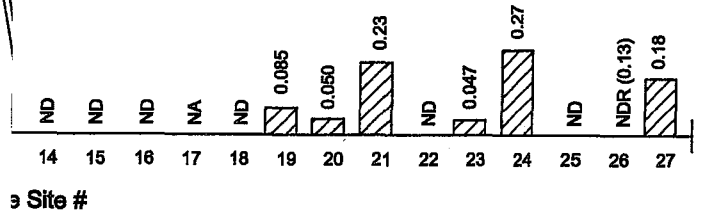


RDE884: UDEP2.DWG

Figure 2 Soil sampling locations and , October 1999.



NA	Not analyzed
ND	Not detected
NDR	During lab testing, an analytical peak was detected but did not meet qualifications criteria; NDR was considered as ND for Total TEQ calculations.



LEGEND

- • ## Soil / sediment sampling sites
- Existing housing
- Proposed housing and garden plot areas
- Present UXO detonation area
- Approximate boundary of original Charlie 1 US Firebase (pre-1972)
- Rice fields
- Forest areas

RDE884: CHART7.DWG

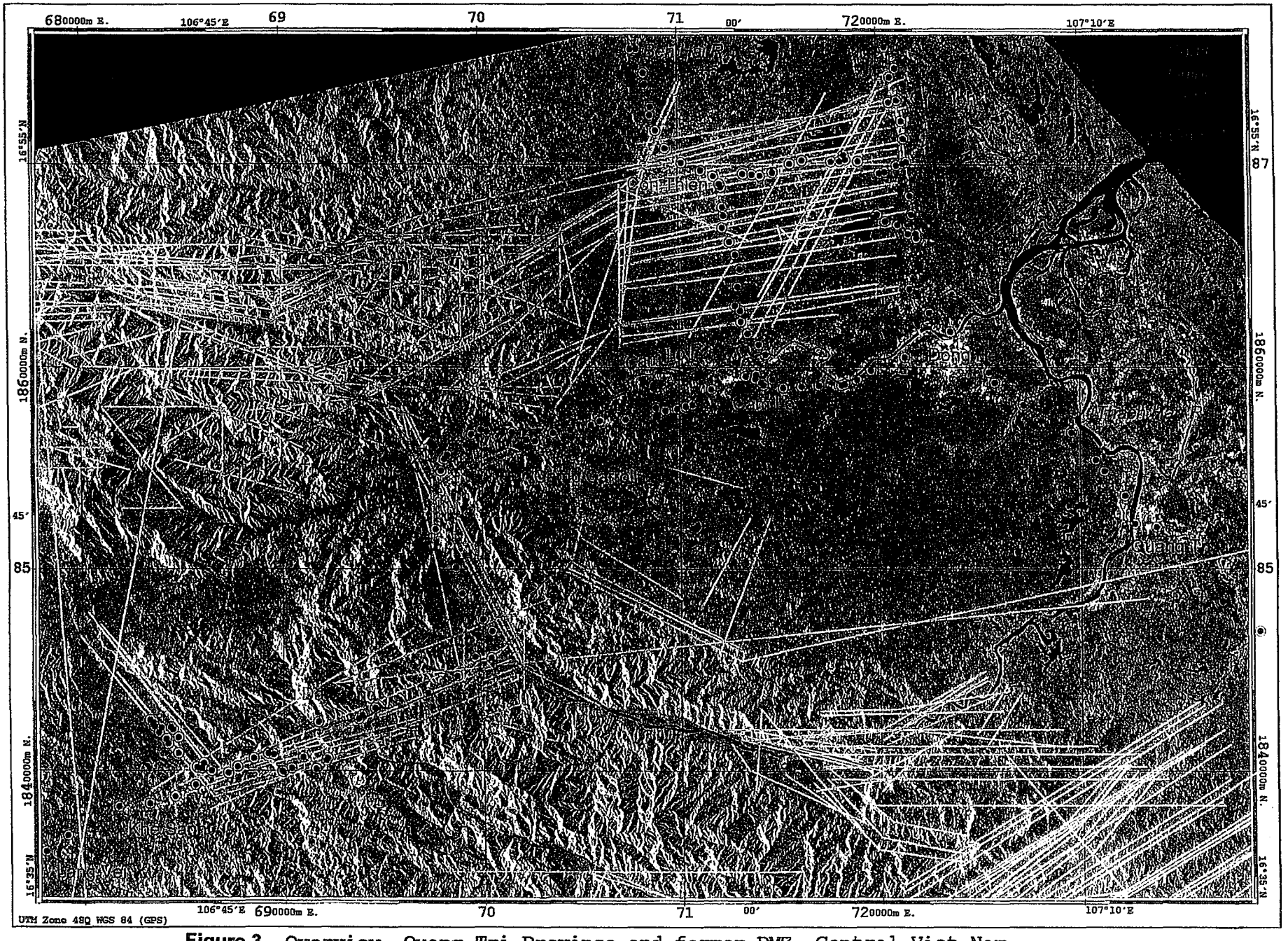


Figure 3 Overview, Quang Tri Province and former DMZ, Central Viet Nam

RADARSAT STANDARD MODE (S7), 13-January-1997

1:250 000 Scale

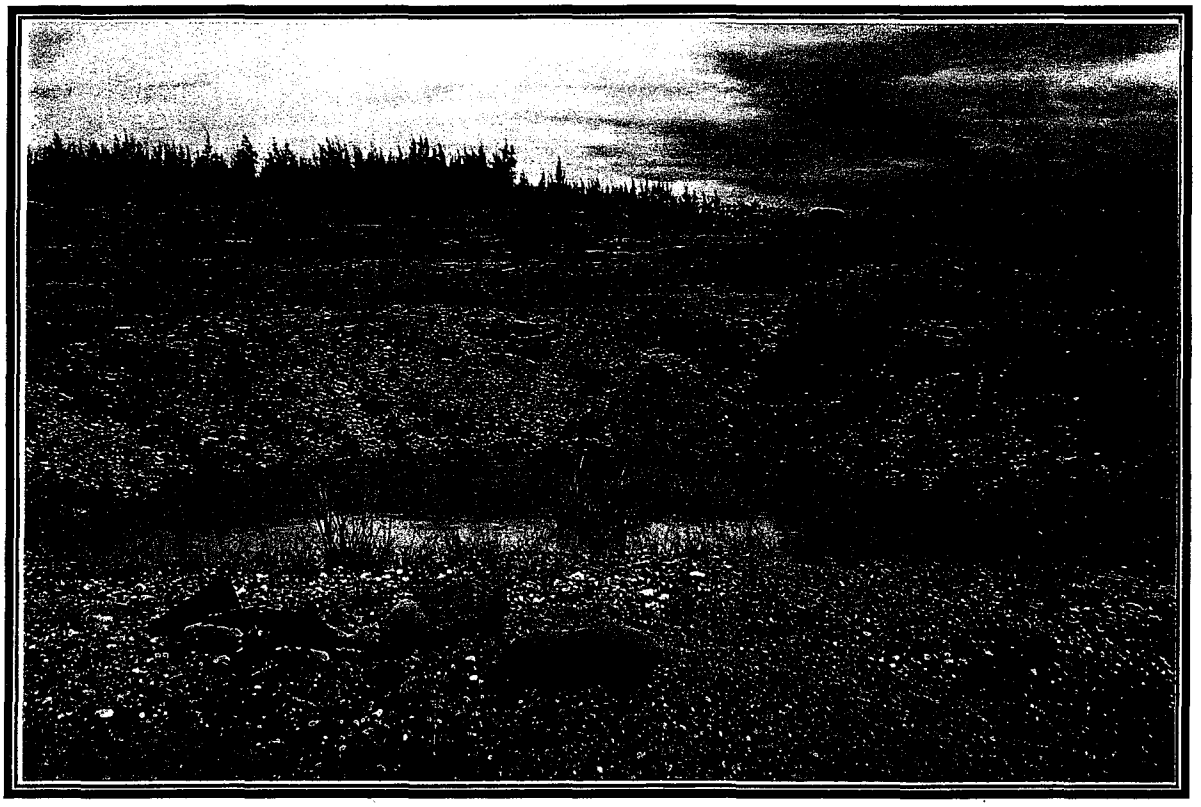
Kilometres 10 0 10

Miles 10 0 10

Plates

Hatfield Consultants Ltd.

Plate 1: Entrance to MAG project area, and former Charlie 1 US Firebase.



Hatfield Consultants Ltd.

Plate 2: Central portion of MAG project area, near sampling sites #1, 2, 8 and 9.

Hatfield Consultants Ltd.

Plate 3: Soil sample collection with stainless steel core.

Hatfield Consultants Ltd.

Plate 4: Compositing a soil sample.

Hatfield Consultants Ltd.

Plate 5: West central area of Charlie 1 Firebase (sampling site #6). Highest dioxin levels were recorded in this region.

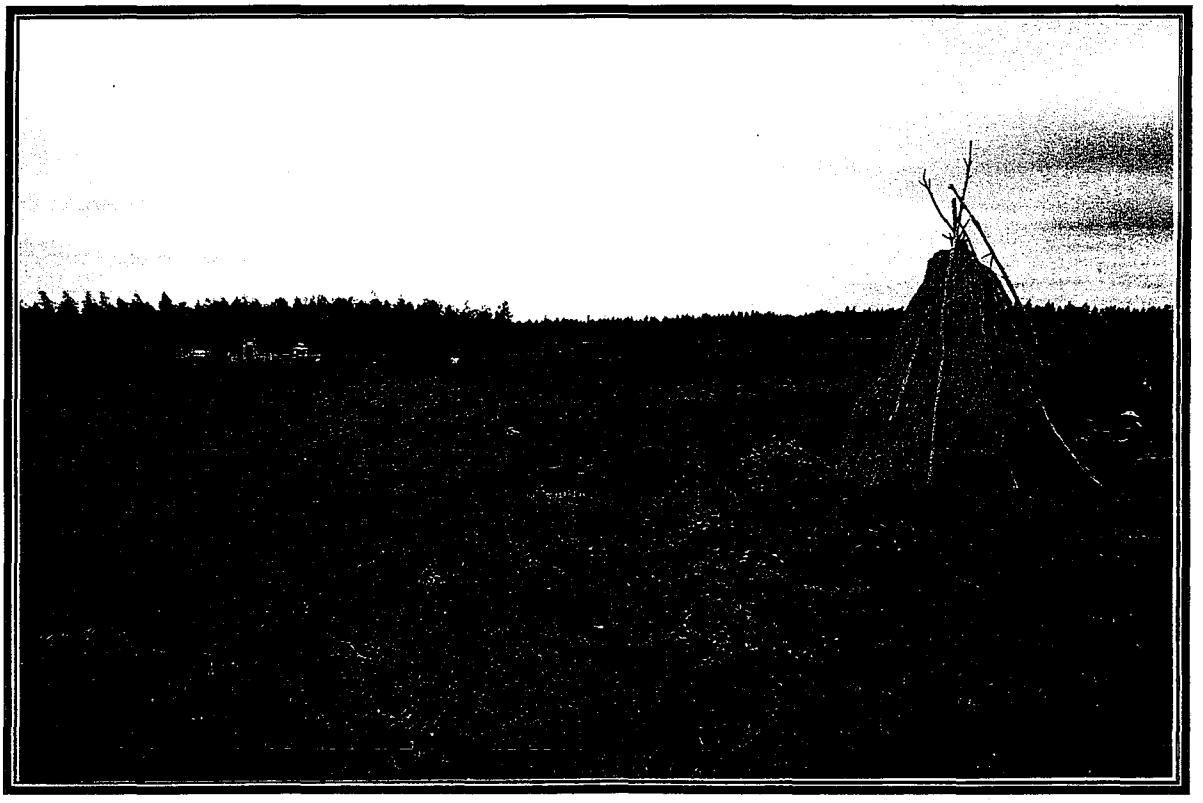
Hatfield Consultants Ltd.

Plate 6: Soil sample collection at site #12, NE corner of MAG Project Area and site of future farmland.

hcl

Hatfield Consultants Ltd.

Plate 7: Soils in the SE corner of the MAG Project Area (sites #15-16) are predominantly sand.



Hatfield Consultants Ltd.

Plate 8: Farmer's fields, scrub vegetation and *Eucalyptus* plantation (far left) in the south end of the MAG Project Area (sites #17-19).

Hatfield Consultants Ltd.

Plate 9: Collection of fish pond sediment sample at site #22, near MAG Project office.

Hatfield Consultants Ltd.

Plate 10: Local residents collecting firewood on the eastern border of the MAG Project Area.

hcl

Appendices

Appendix 1

AXYS Analytical Services Ltd. Dioxin and Furan Analytical Methodologies and QA/QC

ANALYSIS OF POLYCHLORINATED DIOXINS AND FURANS IN SOIL, TISSUE, HUMAN BLOOD, BREAST MILK AND VACUTAINERS

Summary

All samples were spiked with ^{13}C-labelled surrogate standards (tetrachlorodioxin, tetrachlorofuran, pentachlorodioxin, pentachlorofuran, hexachlorodioxin, hexachlorofuran, heptachlorodioxin, heptachlorofuran, and octachlorodioxin) prior to analysis. Soil samples were soxhlet extracted. Tissue samples were extracted by eluting through a glass chromatographic column with solvent. Blood, milk and vacutainers were solvent extracted. All extracts were subject to a series of chromatographic cleanup steps prior to analysis for polychlorinated dibenzodioxins and dibenzofurans by high-resolution gas chromatography with high-resolution mass spectrometric detection (HRGC/HRMS).

1. EXTRACTION PROCEDURES

Soil Samples (DX-S-01/Ver. 2)

A subsample of soil was dried overnight at 105°C to determine moisture content.

An accurately weighed soil sample was dried by grinding with anhydrous sodium sulphate. The mixture was transferred to a soxhlet thimble and an aliquot of surrogate standard solution added. The soxhlet thimble was allowed to reflux for 16 hours with 80:20 toluene:acetone. The cooled extract was transferred to a separatory funnel and sequentially washed with potassium hydroxide solution, distilled water, concentrated sulphuric acid and distilled water. The organic layer was dried over anhydrous sodium sulphate, the solvent evaporated to dryness and the residue redissolved in hexane. Activated copper was added to the extract to remove sulphur. The extract was ready for chromatographic cleanup procedures.

Tissue Samples (DX-T-03/Ver. 2)

A subsample of tissue was dried overnight at 105°C to determine moisture content.

An accurately weighed tissue sample was dried by grinding with anhydrous sodium sulphate. The mixture was transferred to a glass chromatographic column containing 1:1 dichloromethane:hexane. An aliquot of surrogate standard solution was added to the column. The column was eluted with additional solvent. The eluate was subsampled for gravimetric lipid determination. The remaining extract was concentrated and eluted through a gel permeation column (to remove lipids and high molecular weight interferences) with 1:1 dichloromethane:hexane. The 150 - 300 mL fraction was collected and concentrated. The extract was ready for chromatographic cleanup procedures.

Blood Samples (DX-B-06/Ver. 1)

An accurately weighed blood sample was extracted by shaking for 30 minutes with a mixture of ethanol, hexane and saturated ammonium sulphate. The extraction step was repeated

AXYS ANALYTICAL SERVICES LTD P.O. BOX 2219, 2045 MILLS RD. WEST, SIDNEY, B.C., CANADA V8L 3S8 TEL (250) 656-0881 FAX (250) 656-4511

using hexane. The organic layers were combined and washed twice with distilled water. The hexane extract was dried over anhydrous sodium sulphate, filtered, and the solvent evaporated to just dryness. The extract was redissolved in 1:1 dichloromethane:hexane and subsampled for gravimetric lipid determination. The remaining extract was concentrated and eluted through a gel permeation column (to remove lipids and high molecular weight interferences) with 1:1 dichloromethane:hexane. The 150 - 300 mL fraction was collected and concentrated. The extract was ready for chromatographic cleanup procedures.

Breast Milk Samples (DX-M-04/Ver. 3)

An accurately weighed breast milk sample was added to 2:1 acetone:hexane in a separatory funnel. An aliquot of surrogate standard was added and the mixture shaken. The extraction step was repeated by shaking with hexane. The organic layers were combined and washed with distilled water. The extract was dried over anhydrous sodium sulphate and concentrated. The extract was subsampled for gravimetric determination. The remaining extract was concentrated and eluted through a gel permeation column (to remove lipids and high molecular weight interferences) with 1:1 dichloromethane:hexane. The 150 - 300 mL fraction was collected and concentrated. The extract was ready for chromatographic cleanup procedures.

Vacutainer Proof (SOP LAB-2/Ver. 2607)

Dilute sodium chloride solution and a corn oil were added to 25 vacutainers. The containers were frozen, mixed by vortexing, and refrozen overnight. The solutions were combined and extracted three times with dichloromethane. The extract was dried over anhydrous sodium sulphate and an aliquot of surrogate standard solution added. The extract was concentrated.

The extract was eluted through a gel permeation column (to remove lipids and high molecular weight interferences) with 1:1 dichloromethane:hexane. The 150 - 300 mL fraction was collected and concentrated.

The extract was loaded onto a basic alumina column. The first fraction, eluted with hexane was discarded. The second fraction, eluted with 1:1 dichloromethane:hexane, was retained and concentrated. The extract was transferred to an autosampler vial, evaporated just to dryness and aliquots of recovery standards (^{13}C-labelled 1,2,3,4-tetrachlorodibenzodioxin and 1,2,3,7,8,9-hexachlorodibenzodioxin) were added. The extract was ready for analysis by HRGC/MS.

2. CHROMATOGRAPHIC CLEANUP PROCEDURES

a) Silica Gel Column

Soil Extracts

The extract was transferred to a layered silica gel column (layers: $AgNO_3$ on silica, neutral, basic, neutral, acidic, neutral). Extracts were eluted with 2% dichloromethane:hexane. The eluate was concentrated. Activated copper was added to the extract to remove sulphur.

AXYS ANALYTICAL SERVICES LTD P.O. BOX 2219, 2045 MILLS RD. WEST, SIDNEY, B.C., CANADA V8L 3S8 TEL (250) 656-0881 FAX (250) 656-4511

Tissue, Blood and Milk Extracts
The extract was transferred to a layered silica gel column (layers: neutral, basic, neutral, acidic, acidic). The column was eluted with 1:1 dichloromethane:hexane. The eluate was concentrated.

b) Alumina Column

The extract from the silica gel column was loaded onto a basic alumina column. The first fraction, eluted with hexane was discarded. The second fraction, eluted with 1:1 dichloromethane:hexane, was retained and concentrated.

c) Carbon/Celite Column

The extract from the alumina column was loaded onto a 4.5% carbon/Celite column. The column was eluted with 1:1 cyclohexane:dichloromethane (discard) followed by 1:1 ethylacetate:toluene (discard). The column was inverted and eluted with toluene (collected). The fraction was evaporated to near dryness and redissolved in hexane.

d) Alumina Column

The extract from the carbon/Celite column was loaded onto a basic alumina column. The first fraction, eluted with hexane was discarded. The second fraction eluted with 1:1 dichloromethane:hexane was retained and concentrated.

e) Preparation for GC/MS Analysis

The extract was transferred to an autosampler vial, evaporated just to dryness and aliquots of recovery standards (^{13}C-labelled 1,2,3,4-tetrachlorodibenzodioxin and 1,2,3,7,8,9-hexachlorodibenzodioxin) were added. The extract was ready for analysis by HRGC/MS.

3. HIGH RESOLUTION GC/MS ANALYSIS

Polychlorinated dibenzodioxins (PCDD) and dibenzofurans (PCDF) were analyzed on an Ultima Autospec mass spectrometer equipped with a Hewlett Packard 5890 gas chromatograph, a DB-5 capillary chromatography column (60 m, 0.25 mm i.d. x 0.1 µm film thickness), a CTC autosampler and an Alpha workstation. The mass spectrometer was tuned daily to have a static mass resolution of 10,000 or greater. Data were acquired in the voltage selected ion recording mode (SIR) to enhance sensitivity. At least two ions were used to monitor each of the target analytes and ^{13}C-labelled surrogate standards. Five additional ions were monitored to check for interference from chlorinated diphenyl ethers. The masses of the ions monitored for target analytes and surrogate standards are presented in Table 1.

4. QUANTITATION PROCEDURES

Concentrations of target analytes were calculated using the isotope dilution method of quantitation. PCDDs and PCDFs were quantified by comparing the area of the quantification

AXYS ANALYTICAL SERVICES LTD P.O. BOX 2219, 2045 MILLS RD. WEST, SIDNEY, B.C., CANADA V8L 3S8 TEL (250) 656-0881 FAX (250) 656-4511

ion to that of the corresponding ^{13}C-labelled surrogate standard and correcting for response factors. Response factors were determined daily using authentic PCDDS and PCDFs.

Concentrations of analytes were corrected based on the percent recovery of surrogate standards. Concentrations are reported in pg/g dry weight for soils and pg/g wet weight for tissues, and in pg/g wet weight and lipid weight for blood and milk samples.

Sample detection limits are reported for each target analyte, based on a minimum detectable area for that compound in the chromatogram.

A summary of the surrogates standards and the relative response factors (RRF) used in the quantitation procedure is presented in Table 1.

The instrumental conditions, analyte identification and quantification protocols for PCDDs/PCDFs, as described in Environment Canada Report EPS 1/RM/19, February 1992[1] were strictly adhered to.

REFERENCES

1. Environment Canada Reference Method EPS 1/RM/19, *Reference Method for the Determination of Polychlorinated Dibenzo-para-dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) in Pulp and Paper Mill Effluents,* February 1992.

AXYS ANALYTICAL SERVICES LTD P.O. BOX 2219, 2045 MILLS RD. WEST, SIDNEY, B.C., CANADA V8L 3S8 TEL (250) 656-0881 FAX (250) 656-4511

Table 1. Analyte Ions Monitored, Surrogates Used and RRF Determination for Dioxins/Furans by High Resolution GC/MS

ANALYTE	Quantitation Ion (m/z)	Confirmation Ions (m/z)	SURROGATE	RRF Determined From
2,3,7,8 T4CDD	320	322	2,3,7,8 ^{13}C-T4CDD	2,3,7,8 T4CDD
1,2,3,7,8 P5CDD	354	356	1,2,3,7,8 ^{13}C-P5CDD	1,2,3,7,8 P5CDD
1,2,3,4,7,8 H6CDD	390	392	1,2,3,6,7,8 ^{13}C-H6CDD	1,2,3,4,7,8 H6CDD
1,2,3,6,7,8 H6CDD	390	392	1,2,3,6,7,8 ^{13}C-H6CDD	1,2,3,6,7,8 H6CDD
1,2,3,7,8,9 H6CDD	390	392	1,2,3,6,7,8 ^{13}C-H6CDD	1,2,3,7,8,9 H6CDD
1,2,3,4,6,7,8 H7CDD	424	426	1,2,3,4,6,7,8 ^{13}C-H7CDD	1,2,3,4,6,7,8 H7CDD
O8CDD	458	460	^{13}C-O8CDD	O8CDD
2,3,7,8 T4CDF	304	306	2,3,7,8 ^{13}C-T4CDF	2,3,7,8 T4CDF
1,2,3,7,8 P5CDF	340	342	1,2,3,7,8 ^{13}C-P5CDF	1,2,3,7,8 P5CDF
2,3,4,7,8 P5CDF	340	342	1,2,3,7,8 ^{13}C-P5CDF	2,3,4,7,8 P5CDF
1,2,3,4,7,8 H6CDF	374	376	1,2,3,4,7,8 ^{13}C-H6DCF	1,2,3,4,7,8 H6CDF
1,2,3,6,7,8 H6CDF	374	376	1,2,3,4,7,8 ^{13}C-H6DCF	1,2,3,6,7,8 H6CDF
2,3,4,6,7,8 H6CDF	374	376	1,2,3,4,7,8 ^{13}C-H6DCF	2,3,4,6,7,8 H6CDF
1,2,3,7,8,9 H6CDF	374	376	1,2,3,4,7,8 ^{13}C-H6DCF	1,2,3,7,8,9 H6CDF
1,2,3,4,6,7,8 H7CDF	408	410	1,2,3,4,6,7,8 ^{13}C-H7CDF	1,2,3,4,6,7,8 H7CDF
1,2,3,4,7,8,9 H7CDF	408	410	1,2,3,4,6,7,8 ^{13}C-H7CDF	1,2,3,4,7,8,9 H7CDF
O8CDF	442	444	^{13}C-O8CDD	O8CDF
LABELLED SURROGATE	**Quantitation Ion (m/z)**	**Confirmation Ions (m/z)**	**SURROGATE**	
2,3,7,8 ^{13}C-T4CDF	316	318	1,2,3,4 ^{13}C-TCDD	
2,3,7,8 ^{13}C-T4CDD	332	334	1,2,3,4 ^{13}C-TCDD	
1,2,3,7,8 ^{13}C-P5CDF	352	354	1,2,3,4 ^{13}C-TCDD	
1,2,3,7,8 ^{13}C-P5CDD	366	368	1,2,3,4 ^{13}C-TCDD	
1,2,3,4,7,8 ^{13}C-H6CDF	384	386	1,2,3,7,8,9 ^{13}C-H6CDD	
1,2,3,6,7,8 ^{13}C-H6CDD	402	404	1,2,3,7, 8,9 ^{13}C-H6CDD	
1,2,3,4,6,7,8 ^{13}C-H7CDF	418	420	1,2,3,7,8,9 ^{13}C-H6CDD	
1,2,3,4,6,7,8 ^{13}C-H7CDD	436	438	1,2,3,7,8,9 ^{13}C-H6CDD	
^{13}C-O8CDD	470	472	1,2,3,7,8,9 ^{13}C-H6CDD	
RECOVERY STANDARDS				
1,2,3,4 ^{13}C-T4CDD	332	334		
1,2,3,7,8,9 ^{13}C-H6CDD	402	404		

AXYS ANALYTICAL SERVICES LTD.
QUALITY ASSURANCE/QUALITY CONTROL SUMMARY

AXYS' QA/QC procedures are formally documented in a quality manual, "QA/QC Policies and Procedures Manual, Revision 5, June, 1999". This document describes quality assurance policies and procedures related to sample receiving, sample analysis and data reporting as well as quality control measures and procedures for review of QA/QC procedures and specifications, ensuring continued excellence in the analyses conducted by Axys.

All staff is thoroughly instructed in AXYS' overall QA/QC policies with emphasis on aspects directly related to their particular speciality. The staff work as an integrated team to ensure quality analytical results with key individuals responsible for review of the accumulated QA/QC information pertaining to each sample.

The basis of Axys' QA/QC plan is the batch method. Each workup batch is analyzed with quality control samples such as procedural blanks, reference materials, spiked matrices and duplicate samples. The batch goes from sample workup through instrumentation as a unit, and then on to data interpretation and formal report generation. The sample results are reviewed and evaluated in relation to the QA/QC samples worked up with the batch.

A summary of the key points of AXYS' QA/QC protocols is presented below.

1. QA/QC Samples

Batch Size - Analyses are carried out in batches. Each batch consists of a maximum of nine samples plus QC samples (usually a spiked sample or reference material, one duplicate and a procedural blank).

Blanks - One procedural blank is analyzed with each batch of samples.

Duplicates – When specified by the analytical method, samples (10%) are analyzed in duplicate at no extra cost to the client. Results for duplicates are presented along with the analysis results.

Reference Samples- Certified reference materials or spiked samples are analyzed with each batch and are relied on to demonstrate the accuracy of the data. Reported results must agree with expected results to within acceptable limits.

Surrogates - Chemically labelled analogues of the target compound are added to each sample prior to analysis. Whenever possible, a complete suite of labelled targets is employed.

AXYS ANALYTICAL SERVICES LTD P.O. BOX 2219, 2045 MILLS RD. WEST, SIDNEY, B.C., CANADA V8L 3S8 TEL (250) 656-0881 FAX (250) 656-4511

2. Instrumental Analysis

Instrument Linearity - Quantification linearity of the analytical instruments (GC/MS, HRGC/MS, GC/ECD) is periodically verified by a multi-point calibration.

Daily Calibration - Instrument mass range is regularly calibrated. Relative response factors (RRFs) (native/surrogate) are determined by a single point calibration every twelve hours (beginning and end of run). RRFs determined at beginning and end of the analysis of a sample suite must agree to within 15% (RSD).

Column Carryover - A solvent blank is run after each calibration standard or more often as needed to ensure that there is no carry over from one GC/MS run to another.

Window Standard - For some analyses a cocktail or "window-defining" mixture is run periodically to define the window during which a group of compounds is expected.

3. Data Reporting

Surrogate Recoveries – The percent recoveries of surrogate or internal standards are reported with each sample result and are required to meet the acceptance criteria established for the method. Percent recoveries are usually well within the acceptable range. If recoveries are outside the range, the analysis is repeated.

Concentrations - Concentrations of target analytes are calculated using the internal standard method of quantification and are corrected based on the percent recovery of surrogate standards.

Detection Limits - Detection Limits are monitored and reported on a sample-specific basis. The detection limit is calculated as the concentration corresponding to the area reject. The area reject, determined from the ion chromatogram is the area of a peak with height three times the maximum height of the noise. Only peaks with responses greater than three times the background noise level are quantified.

AXYS ANALYTICAL SERVICES LTD P.O. BOX 2219, 2045 MILLS RD. WEST, SIDNEY, B.C., CANADA V8L 3S8 TEL (250) 656-0881 FAX (250) 656-4511

Appendix 2

Dioxin and Furan Analytical Results
Soils and Fish Pond Sediments

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN800**	**AXYS FILE:**	**L2436-1**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
SAMPLE SIZE:	**9.17 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**13**	**CONCENTRATION IN:**	**pg/g**

Charlie 1 Firebase
(Central east)
Site #1

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.89	0.050	T4CDF - Total	2.4	0.050
2,3,7,8	0.20	0.050	2,3,7,8	0.37	0.050
P5CDD - Total	3.1	0.060	P5CDF - Total	6.4	0.050
1,2,3,7,8	0.60	0.060	1,2,3,7,8	0.38	0.050
			2,3,4,7,8	0.51	0.050
H6CDD - Total	27	0.060	H6CDF - Total	24	0.080
1,2,3,4,7,8	0.95	0.060	1,2,3,4,7,8	2.3	0.080
1,2,3,6,7,8	4.1	0.060	1,2,3,6,7,8	0.81	0.080
1,2,3,7,8,9	3.0	0.060	2,3,4,6,7,8	0.82	0.080
			1,2,3,7,8,9	0.30	0.080
H7CDD - Total	220	0.56	H7CDF - Total	47	0.20
1,2,3,4,6,7,8	92	0.56	1,2,3,4,6,7,8	13	0.20
			1,2,3,4,7,8,9	0.99	0.20
O8CDD	870	23	O8CDF	23	0.12

Surrogate Standards	% Recovery
13C-T4CDF	87
13C-T4CDD	110
13C-P5CDF	110
13C-P5CDD	90
13C-H6CDF	100
13C-H6CDD	100
13C-H7CDF	75
13C-H7CDD	68
13C-O8CDD	100

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	3.49	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	3.49	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Kenneale
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	**99VN802**	**AXYS FILE:**	**L2436-2**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Charlie 1 Firebase (Central west) Site #2		
SAMPLE SIZE:	**10.1 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**7.2**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	1.2	0.050	**T4CDF - Total**	2.7	0.050
2,3,7,8	0.24	0.050	**2,3,7,8**	0.64	0.050
P5CDD - Total	3.6	0.050	**P5CDF - Total**	22	0.050
1,2,3,7,8	0.84	0.050	**1,2,3,7,8**	0.95	0.050
			2,3,4,7,8	2.1	0.050
H6CDD - Total	68	0.060	**H6CDF - Total**	81	0.090
1,2,3,4,7,8	1.5	0.060	**1,2,3,4,7,8**	5.9	0.090
1,2,3,6,7,8	11	0.060	**1,2,3,6,7,8**	1.9	0.090
1,2,3,7,8,9	4.6	0.060	**2,3,4,6,7,8**	2.2	0.090
			1,2,3,7,8,9	0.35	0.090
H7CDD - Total	580	0.43	**H7CDF - Total**	120	0.24
1,2,3,4,6,7,8	220	0.43	**1,2,3,4,6,7,8**	34	0.24
			1,2,3,4,7,8,9	1.8	0.24
O8CDD	1700	0.89	**O8CDF**	51	0.070

Surrogate Standards	% Recovery
13C-T4CDF	72
13C-T4CDD	73
13C-P5CDF	75
13C-P5CDD	150
13C-H6CDF	81
13C-H6CDD	84
13C-H7CDF	74
13C-H7CDD	73
13C-O8CDD	86

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	7.69	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	7.69	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lysniak
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN804**	**AXYS FILE:**	**L2436-3**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Charlie 1 Firebase (North central east) Site #3		
SAMPLE SIZE:	**9.21 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**10**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	2.3	0.050	**T4CDF - Total**	3.2	0.050
2,3,7,8	0.33	0.050	**2,3,7,8**	0.42	0.050
P5CDD - Total	7.5	0.050	**P5CDF - Total**	7.4	0.060
1,2,3,7,8	1.7	0.050	**1,2,3,7,8**	0.65	0.060
			2,3,4,7,8	1.0	0.060
H6CDD - Total	82	0.070	**H6CDF - Total**	75	0.15
1,2,3,4,7,8	3.2	0.070	**1,2,3,4,7,8**	5.5	0.15
1,2,3,6,7,8	14	0.070	**1,2,3,6,7,8**	2.2	0.15
1,2,3,7,8,9	8.4	0.070	**2,3,4,6,7,8**	2.6	0.15
			1,2,3,7,8,9	NDR(0.15)	0.15
H7CDD - Total	670	1.3	**H7CDF - Total**	150	0.57
1,2,3,4,6,7,8	340	1.3	**1,2,3,4,6,7,8**	55	0.57
			1,2,3,4,7,8,9	3	0.57
O8CDD	3100	1.6	**O8CDF**	130	0.23

Surrogate Standards	% Recovery
13C-T4CDF	88
13C-T4CDD	92
13C-P5CDF	100
13C-P5CDD	160
13C-H6CDF	96
13C-H6CDD	94
13C-H7CDF	82
13C-H7CDD	74
13C-O8CDD	90

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	10.5	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	10.4	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	**99VN806**	**AXYS FILE:**	**L2436-4**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
SAMPLE SIZE:	**9.52 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**10**	**CONCENTRATION IN:**	**pg/g**

Charlie 1 Firebase
(North central west)
Site #4

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.92	0.090	**T4CDF - Total**	3.2	0.050
2,3,7,8	NDR(0.17)	0.090	**2,3,7,8**	0.45	0.050
P5CDD - Total	3.3	0.050	**P5CDF - Total**	4.5	0.060
1,2,3,7,8	0.71	0.050	**1,2,3,7,8**	0.26	0.060
			2,3,4,7,8	0.35	0.060
H6CDD - Total	24	0.070	**H6CDF - Total**	16	0.14
1,2,3,4,7,8	1.0	0.070	**1,2,3,4,7,8**	1.2	0.14
1,2,3,6,7,8	3.5	0.070	**1,2,3,6,7,8**	0.61	0.14
1,2,3,7,8,9	2.7	0.070	**2,3,4,6,7,8**	0.66	0.14
			1,2,3,7,8,9	0.16	0.14
H7CDD - Total	160	0.35	**H7CDF - Total**	35	0.16
1,2,3,4,6,7,8	78	0.35	**1,2,3,4,6,7,8**	11	0.16
			1,2,3,4,7,8,9	0.69	0.16
O8CDD	710	0.69	**O8CDF**	27	0.13

Surrogate Standards	% Recovery
13C-T4CDF	76
13C-T4CDD	72
13C-P5CDF	78
13C-P5CDD	130
13C-H6CDF	84
13C-H6CDD	83
13C-H7CDF	72
13C-H7CDD	62
13C-O8CDD	58

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	2.94	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	2.89	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Kungvale
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	99VN806 (DUPLICATE)	AXYS FILE:	WG2826-103 (DUP. L2436-4)
CLIENT:	Hatfield Consultants Ltd.	DATE:	06-May-2000
CLIENT NO.:	2607		
SAMPLE TYPE:	Sediment	METHOD NO.:	DX-S-01/Ver.3
SAMPLE SIZE:	9.21 g (dry)	INSTRUMENT:	GC-HRMS
% MOISTURE:	10	CONCENTRATION IN:	pg/g

Charlie 1 Firebase
(North central west)
Site #4 (Dupl.)

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	1.1	0.050	T4CDF - Total	2.9	0.050
2,3,7,8	0.18	0.050	2,3,7,8	0.40	0.050
P5CDD - Total	2.7	0.050	P5CDF - Total	4.7	0.050
1,2,3,7,8	0.68	0.050	1,2,3,7,8	0.23	0.050
			2,3,4,7,8	0.39	0.050
H6CDD - Total	25	0.060	H6CDF - Total	16	0.12
1,2,3,4,7,8	0.97	0.060	1,2,3,4,7,8	1.3	0.12
1,2,3,6,7,8	3.3	0.060	1,2,3,6,7,8	0.58	0.12
1,2,3,7,8,9	3.0	0.060	2,3,4,6,7,8	0.55	0.12
			1,2,3,7,8,9	0.20	0.12
H7CDD - Total	150	0.31	H7CDF - Total	33	0.20
1,2,3,4,6,7,8	75	0.31	1,2,3,4,6,7,8	11	0.20
			1,2,3,4,7,8,9	0.71	0.20
O8CDD	620	0.63	O8CDF	23	0.10

Surrogate Standards	% Recovery
13C-T4CDF	79
13C-T4CDD	79
13C-P5CDF	89
13C-P5CDD	150
13C-H6CDF	110
13C-H6CDD	89
13C-H7CDF	91
13C-H7CDD	82
13C-O8CDD	88

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	3.02	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	3.02	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lungmaik
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	**99VN809**	**AXYS FILE:**	**L2436-5**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Charlie 1 Firebase (North west corner) Site #5		
SAMPLE SIZE:	**10.1 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**10**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.52	0.050	T4CDF - Total	1.3	0.050
2,3,7,8	0.34	0.050	2,3,7,8	NDR(0.31)	0.050
P5CDD - Total	1.4	0.050	P5CDF - Total	18	0.050
1,2,3,7,8	0.46	0.050	1,2,3,7,8	0.85	0.050
			2,3,4,7,8	1.9	0.050
H6CDD - Total	34	0.070	H6CDF - Total	55	0.12
1,2,3,4,7,8	1.0	0.070	1,2,3,4,7,8	6.3	0.12
1,2,3,6,7,8	8.1	0.070	1,2,3,6,7,8	1.5	0.12
1,2,3,7,8,9	2.7	0.070	2,3,4,6,7,8	1.4	0.12
			1,2,3,7,8,9	0.28	0.12
H7CDD - Total	260	0.44	H7CDF - Total	43	0.29
1,2,3,4,6,7,8	130	0.44	1,2,3,4,6,7,8	17	0.29
			1,2,3,4,7,8,9	0.66	0.29
O8CDD	1100	0.89	O8CDF	8.1	0.090

Surrogate Standards	% Recovery
13C-T4CDF	92
13C-T4CDD	100
13C-P5CDF	110
13C-P5CDD	170
13C-H6CDF	96
13C-H6CDD	100
13C-H7CDF	99
13C-H7CDD	91
13C-O8CDD	110

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	5.53	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	5.52	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN813**	**AXYS FILE:**	**L2436-7**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Charlie 1 Firebase (South west corner) Site #7		
SAMPLE SIZE:	**9.83 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**11**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.69	0.050	**T4CDF - Total**	2.1	0.050
2,3,7,8	0.16	0.050	**2,3,7,8**	0.16	0.050
P5CDD - Total	0.41	0.060	**P5CDF - Total**	0.65	0.050
1,2,3,7,8	0.23	0.060	**1,2,3,7,8**	NDR(0.11)	0.050
			2,3,4,7,8	NDR(0.11)	0.050
H6CDD - Total	8.2	0.060	**H6CDF - Total**	4.4	0.080
1,2,3,4,7,8	0.35	0.060	**1,2,3,4,7,8**	0.28	0.080
1,2,3,6,7,8	1.1	0.060	**1,2,3,6,7,8**	0.17	0.080
1,2,3,7,8,9	1.2	0.060	**2,3,4,6,7,8**	0.24	0.080
			1,2,3,7,8,9	0.11	0.080
H7CDD - Total	56	0.080	**H7CDF - Total**	10	0.12
1,2,3,4,6,7,8	28	0.080	**1,2,3,4,6,7,8**	3.6	0.12
			1,2,3,4,7,8,9	NDR(0.2)	0.12
O8CDD	280	0.34	**O8CDF**	11	0.080

Surrogate Standards	% Recovery
13C-T4CDF	84
13C-T4CDD	100
13C-P5CDF	92
13C-P5CDD	160
13C-H6CDF	96
13C-H6CDD	91
13C-H7CDF	98
13C-H7CDD	91
13C-O8CDD	97

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	1.10	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	1.08	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lamprecht
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	**99VN819**	**AXYS FILE:**	**L2436-9**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Charlie 1 Firebase (South central east) Site #9		
SAMPLE SIZE:	**6.86 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**32**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.22	0.080	**T4CDF - Total**	1.7	0.050
2,3,7,8	NDR(0.11)	0.080	**2,3,7,8**	0.22	0.050
P5CDD - Total	0.96	0.060	**P5CDF - Total**	1.3	0.070
1,2,3,7,8	0.36	0.060	**1,2,3,7,8**	0.18	0.070
			2,3,4,7,8	0.18	0.070
H6CDD - Total	4.3	0.16	**H6CDF - Total**	4.0	0.060
1,2,3,4,7,8	0.71	0.16	**1,2,3,4,7,8**	0.35	0.060
1,2,3,6,7,8	1.2	0.16	**1,2,3,6,7,8**	0.26	0.060
1,2,3,7,8,9	1.5	0.16	**2,3,4,6,7,8**	0.24	0.060
			1,2,3,7,8,9	0.49	0.060
H7CDD - Total	67	0.16	**H7CDF - Total**	5.7	0.10
1,2,3,4,6,7,8	30	0.16	**1,2,3,4,6,7,8**	2.4	0.10
			1,2,3,4,7,8,9	NDR(0.19)	0.10
O8CDD	680	0.67	**O8CDF**	4.1	0.080

Surrogate Standards	% Recovery
13C-T4CDF	82
13C-T4CDD	99
13C-P5CDF	96
13C-P5CDD	180
13C-H6CDF	94
13C-H6CDD	95
13C-H7CDF	98
13C-H7CDD	95
13C-O8CDD	99

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	1.39	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	1.35	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lungrake
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	**99VN823**	**AXYS FILE:**	**L2436-11**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**04-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Charlie 1 Firebase (North east corner) Site #11		
SAMPLE SIZE:	**9.46 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**6.8**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.41	0.050	T4CDF - Total	0.57	0.050
2,3,7,8	0.064	0.050	2,3,7,8	0.15	0.050
P5CDD - Total	1.4	0.050	P5CDF - Total	1.6	0.050
1,2,3,7,8	NDR(0.37)	0.050	1,2,3,7,8	0.14	0.050
			2,3,4,7,8	0.15	0.050
H6CDD - Total	11	0.050	H6CDF - Total	5.1	0.050
1,2,3,4,7,8	0.46	0.050	1,2,3,4,7,8	0.40	0.050
1,2,3,6,7,8	1.5	0.050	1,2,3,6,7,8	0.25	0.050
1,2,3,7,8,9	1.5	0.050	2,3,4,6,7,8	0.27	0.050
			1,2,3,7,8,9	0.26	0.050
H7CDD - Total	56	0.060	H7CDF - Total	7.7	0.050
1,2,3,4,6,7,8	26	0.060	1,2,3,4,6,7,8	3.4	0.050
			1,2,3,4,7,8,9	0.25	0.050
O8CDD	200	0.23	O8CDF	5.0	0.050

Surrogate Standards	% Recovery
13C-T4CDF	71
13C-T4CDD	73
13C-P5CDF	68
13C-P5CDD	68
13C-H6CDF	81
13C-H6CDD	82
13C-H7CDF	75
13C-H7CDD	78
13C-O8CDD	82

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	0.966	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	0.941	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lungmak
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN825**	**AXYS FILE:**	**L2436-12**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**04-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Future Farmland Cleared area (North east corner) Site #12		
SAMPLE SIZE:	**8.64 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**17**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.79	0.050	T4CDF - Total	2.4	0.050
2,3,7,8	0.10	0.050	2,3,7,8	0.18	0.050
P5CDD - Total	1.2	0.050	P5CDF - Total	2.0	0.050
1,2,3,7,8	NDR(0.24)	0.050	1,2,3,7,8	0.44	0.050
			2,3,4,7,8	0.094	0.050
H6CDD - Total	5.1	0.050	H6CDF - Total	3.1	0.050
1,2,3,4,7,8	0.19	0.050	1,2,3,4,7,8	0.25	0.050
1,2,3,6,7,8	0.54	0.050	1,2,3,6,7,8	0.17	0.050
1,2,3,7,8,9	0.59	0.050	2,3,4,6,7,8	NDR(0.12)	0.050
			1,2,3,7,8,9	1.1	0.050
H7CDD - Total	14	0.050	H7CDF - Total	2.3	0.050
1,2,3,4,6,7,8	7.0	0.050	1,2,3,4,6,7,8	1.2	0.050
			1,2,3,4,7,8,9	NDR(0.16)	0.050
O8CDD	44	0.11	O8CDF	1.5	0.050

Surrogate Standards	% Recovery
13C-T4CDF	71
13C-T4CDD	68
13C-P5CDF	65
13C-P5CDD	69
13C-H6CDF	81
13C-H6CDD	80
13C-H7CDF	77
13C-H7CDD	74
13C-O8CDD	79

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	0.590	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	0.563	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	**99VN832**	**AXYS FILE:**	**L2436-14**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**04-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Future Farmland Cleared area (South east corner) Site #14		
SAMPLE SIZE:	**8.19 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**19**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	1.6	0.070	**T4CDF - Total**	11	0.050
2,3,7,8	ND	0.070	**2,3,7,8**	0.17	0.050
P5CDD - Total	0.43	0.060	**P5CDF - Total**	2.0	0.050
1,2,3,7,8	0.086	0.060	**1,2,3,7,8**	0.34	0.050
			2,3,4,7,8	0.070	0.050
H6CDD - Total	2.8	0.050	**H6CDF - Total**	2.0	0.060
1,2,3,4,7,8	0.11	0.050	**1,2,3,4,7,8**	0.22	0.060
1,2,3,6,7,8	NDR(0.27)	0.050	**1,2,3,6,7,8**	0.12	0.060
1,2,3,7,8,9	0.42	0.050	**2,3,4,6,7,8**	0.091	0.060
			1,2,3,7,8,9	0.69	0.060
H7CDD - Total	7.0	0.070	**H7CDF - Total**	1.1	0.070
1,2,3,4,6,7,8	3.2	0.070	**1,2,3,4,6,7,8**	0.58	0.070
			1,2,3,4,7,8,9	0.15	0.070
O8CDD	27	0.16	**O8CDF**	0.79	0.060

Surrogate Standards	% Recovery
13C-T4CDF	51
13C-T4CDD	47
13C-P5CDF	51
13C-P5CDD	54
13C-H6CDF	62
13C-H6CDD	60
13C-H7CDF	58
13C-H7CDD	55
13C-O8CDD	61

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	0.399	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	0.362	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lazowski
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN836**	**AXYS FILE:**	**L2436-16**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**04-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Garden Development (South corner) Site #16		
SAMPLE SIZE:	**8.99 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**10**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.074	0.060	**T4CDF - Total**	0.36	0.050
2,3,7,8	ND	0.060	**2,3,7,8**	0.11	0.050
P5CDD - Total	0.18	0.070	**P5CDF - Total**	0.56	0.050
1,2,3,7,8	0.11	0.070	**1,2,3,7,8**	0.10	0.050
			2,3,4,7,8	0.058	0.050
H6CDD - Total	2.3	0.050	**H6CDF - Total**	1.2	0.050
1,2,3,4,7,8	0.12	0.050	**1,2,3,4,7,8**	0.13	0.050
1,2,3,6,7,8	0.43	0.050	**1,2,3,6,7,8**	0.13	0.050
1,2,3,7,8,9	0.47	0.050	**2,3,4,6,7,8**	0.10	0.050
			1,2,3,7,8,9	0.15	0.050
H7CDD - Total	8.7	0.050	**H7CDF - Total**	1.0	0.050
1,2,3,4,6,7,8	4.1	0.050	**1,2,3,4,6,7,8**	0.67	0.050
			1,2,3,4,7,8,9	NDR(0.079)	0.050
O8CDD	81	0.14	**O8CDF**	0.81	0.050

Surrogate Standards	% Recovery
13C-T4CDF	63
13C-T4CDD	64
13C-P5CDF	59
13C-P5CDD	60
13C-H6CDF	71
13C-H6CDD	72
13C-H7CDF	72
13C-H7CDD	70
13C-O8CDD	75

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.391 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.360 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lungmah
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN836 (DUPLICATE)**	**AXYS FILE:**	**WG2827-103 (DUP L2436-16)**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**04-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment** Garden Development (South corner)	**METHOD NO.:**	**DX-S-01/Ver.3**
SAMPLE SIZE:	**9.60 g (dry)** Site #16 (Dupl.)	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**10**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.075	0.050	**T4CDF - Total**	0.57	0.050
2,3,7,8	ND	0.050	**2,3,7,8**	0.11	0.050
P5CDD - Total	0.37	0.050	**P5CDF - Total**	0.46	0.050
1,2,3,7,8	0.099	0.050	**1,2,3,7,8**	0.077	0.050
			2,3,4,7,8	0.080	0.050
H6CDD - Total	2.3	0.050	**H6CDF - Total**	0.76	0.050
1,2,3,4,7,8	NDR(0.11)	0.050	**1,2,3,4,7,8**	0.16	0.050
1,2,3,6,7,8	0.42	0.050	**1,2,3,6,7,8**	0.13	0.050
1,2,3,7,8,9	0.48	0.050	**2,3,4,6,7,8**	0.10	0.050
			1,2,3,7,8,9	NDR(0.14)	0.050
H7CDD - Total	8.5	0.050	**H7CDF - Total**	1.0	0.050
1,2,3,4,6,7,8	4.0	0.050	**1,2,3,4,6,7,8**	0.67	0.050
			1,2,3,4,7,8,9	NDR(0.09)	0.050
O8CDD	82	0.10	**O8CDF**	0.80	0.050

Surrogate Standards	% Recovery
13C-T4CDF	76
13C-T4CDD	72
13C-P5CDF	69
13C-P5CDD	73
13C-H6CDF	84
13C-H6CDD	85
13C-H7CDF	80
13C-H7CDD	81
13C-O8CDD	85

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	0.369	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	0.339	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN840**	**AXYS FILE:**	**L2436-17**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**04-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Cultivated Field		
SAMPLE SIZE:	**8.28 g (dry)** Site #18	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**18**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.060	**T4CDF - Total**	0.40	0.050
2,3,7,8	ND	0.060	**2,3,7,8**	NDR(0.06)	0.050
P5CDD - Total	0.16	0.050	**P5CDF - Total**	0.30	0.050
1,2,3,7,8	0.085	0.050	**1,2,3,7,8**	NDR(0.074)	0.050
			2,3,4,7,8	ND	0.050
H6CDD - Total	1.3	0.050	**H6CDF - Total**	0.37	0.050
1,2,3,4,7,8	NDR(0.071)	0.050	**1,2,3,4,7,8**	0.12	0.050
1,2,3,6,7,8	NDR(0.27)	0.050	**1,2,3,6,7,8**	0.061	0.050
1,2,3,7,8,9	0.36	0.050	**2,3,4,6,7,8**	NDR(0.075)	0.050
			1,2,3,7,8,9	NDR(0.094)	0.050
H7CDD - Total	3.4	0.050	**H7CDF - Total**	0.47	0.050
1,2,3,4,6,7,8	1.6	0.050	**1,2,3,4,6,7,8**	0.36	0.050
			1,2,3,4,7,8,9	ND	0.050
O8CDD	18	0.090	**O8CDF**	0.40	0.060

Surrogate Standards	% Recovery
13C-T4CDF	60
13C-T4CDD	62
13C-P5CDF	62
13C-P5CDD	67
13C-H6CDF	66
13C-H6CDD	67
13C-H7CDF	62
13C-H7CDD	63
13C-O8CDD	71

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.217 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.161 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lungrale
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN846**	**AXYS FILE:**	**L2436-18**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**04-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Eucalyptus Plantation		
SAMPLE SIZE:	**8.80 g (dry)** Site #19	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**12**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.21	0.050	T4CDF - Total	1.0	0.050
2,3,7,8	0.085	0.050	2,3,7,8	0.13	0.050
P5CDD - Total	0.26	0.050	P5CDF - Total	0.53	0.060
1,2,3,7,8	0.17	0.050	1,2,3,7,8	NDR(0.12)	0.060
			2,3,4,7,8	NDR(0.062)	0.060
H6CDD - Total	3.1	0.080	H6CDF - Total	0.63	0.050
1,2,3,4,7,8	ND	0.080	1,2,3,4,7,8	0.14	0.050
1,2,3,6,7,8	0.90	0.080	1,2,3,6,7,8	0.15	0.050
1,2,3,7,8,9	0.89	0.080	2,3,4,6,7,8	NDR(0.11)	0.050
			1,2,3,7,8,9	0.33	0.050
H7CDD - Total	4.7	0.070	H7CDF - Total	1.1	0.080
1,2,3,4,6,7,8	2.2	0.070	1,2,3,4,6,7,8	0.73	0.080
			1,2,3,4,7,8,9	0.092	0.080
O8CDD	20	0.090	O8CDF	0.83	0.070

Surrogate Standards	% Recovery
13C-T4CDF	44
13C-T4CDD	42
13C-P5CDF	47
13C-P5CDD	50
13C-H6CDF	57
13C-H6CDD	55
13C-H7CDF	51
13C-H7CDD	47
13C-O8CDD	50

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.561 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.538 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN848**	**AXYS FILE:**	**L2436-19**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Future cemetary (Beside quarry) Site #20		
SAMPLE SIZE:	**8.44 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**21**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.050	0.050	**T4CDF - Total**	0.50	0.050
2,3,7,8	0.050	0.050	**2,3,7,8**	0.12	0.050
P5CDD - Total	0.12	0.050	**P5CDF - Total**	0.40	0.050
1,2,3,7,8	0.074	0.050	**1,2,3,7,8**	NDR(0.09)	0.050
			2,3,4,7,8	0.069	0.050
H6CDD - Total	1.6	0.050	**H6CDF - Total**	0.79	0.050
1,2,3,4,7,8	NDR(0.081)	0.050	**1,2,3,4,7,8**	0.14	0.050
1,2,3,6,7,8	0.27	0.050	**1,2,3,6,7,8**	0.11	0.050
1,2,3,7,8,9	0.36	0.050	**2,3,4,6,7,8**	0.12	0.050
			1,2,3,7,8,9	NDR(0.16)	0.050
H7CDD - Total	4.0	0.050	**H7CDF - Total**	0.97	0.050
1,2,3,4,6,7,8	1.6	0.050	**1,2,3,4,6,7,8**	0.66	0.050
			1,2,3,4,7,8,9	NDR(0.11)	0.050
O8CDD	19	0.070	**O8CDF**	0.74	0.050

Surrogate Standards	% Recovery
13C-T4CDF	74
13C-T4CDD	71
13C-P5CDF	71
13C-P5CDD	75
13C-H6CDF	82
13C-H6CDD	78
13C-H7CDF	71
13C-H7CDD	67
13C-O8CDD	75

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	0.302	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	0.295	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lamb

Approved

ANALYSIS REPORT

DX001B

POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	**99VN850**	**AXYS FILE:**	**L2436-20**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	MAG Area Field (Western border) Site #21		
SAMPLE SIZE:	**8.90 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**17**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.46	0.050	**T4CDF - Total**	6.0	0.060
2,3,7,8	0.23	0.050	**2,3,7,8**	0.34	0.060
P5CDD - Total	1.2	0.050	**P5CDF - Total**	3.1	0.050
1,2,3,7,8	NDR(0.31)	0.050	**1,2,3,7,8**	NDR(0.2)	0.050
			2,3,4,7,8	0.28	0.050
H6CDD - Total	11	0.050	**H6CDF - Total**	9.9	0.050
1,2,3,4,7,8	0.50	0.050	**1,2,3,4,7,8**	0.66	0.050
1,2,3,6,7,8	1.6	0.050	**1,2,3,6,7,8**	0.43	0.050
1,2,3,7,8,9	1.2	0.050	**2,3,4,6,7,8**	0.42	0.050
			1,2,3,7,8,9	0.19	0.050
H7CDD - Total	67	0.050	**H7CDF - Total**	16	0.050
1,2,3,4,6,7,8	32	0.050	**1,2,3,4,6,7,8**	5.8	0.050
			1,2,3,4,7,8,9	0.35	0.050
O8CDD	270	0.29	**O8CDF**	12	0.050

Surrogate Standards	% Recovery
13C-T4CDF	72
13C-T4CDD	70
13C-P5CDF	72
13C-P5CDD	77
13C-H6CDF	85
13C-H6CDD	81
13C-H7CDF	73
13C-H7CDD	61
13C-O8CDD	64

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	1.35	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	1.32	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN852**		**AXYS FILE:**	**L2436-21**
CLIENT:	**Hatfield Consultants Ltd.**		**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**			
SAMPLE TYPE:	**Sediment**	MAG Area Fish pond (Beside MAG office) Site #22	**METHOD NO.:**	**DX-S-01/Ver.3**
SAMPLE SIZE:	**9.61 g (dry)**		**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**23**		**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.85	0.050	**T4CDF - Total**	3.4	0.060
2,3,7,8	ND	0.050	**2,3,7,8**	0.25	0.060
P5CDD - Total	0.83	0.050	**P5CDF - Total**	1.3	0.050
1,2,3,7,8	NDR(0.16)	0.050	**1,2,3,7,8**	NDR(0.2)	0.050
			2,3,4,7,8	NDR(0.14)	0.050
H6CDD - Total	5.7	0.050	**H6CDF - Total**	2.6	0.050
1,2,3,4,7,8	NDR(0.22)	0.050	**1,2,3,4,7,8**	0.30	0.050
1,2,3,6,7,8	0.45	0.050	**1,2,3,6,7,8**	0.19	0.050
1,2,3,7,8,9	0.64	0.050	**2,3,4,6,7,8**	0.20	0.050
			1,2,3,7,8,9	NDR(0.14)	0.050
H7CDD - Total	23	0.050	**H7CDF - Total**	3.8	0.050
1,2,3,4,6,7,8	9.1	0.050	**1,2,3,4,6,7,8**	1.7	0.050
			1,2,3,4,7,8,9	NDR(0.18)	0.050
O8CDD	64	0.13	**O8CDF**	2.3	0.050

Surrogate Standards	% Recovery
13C-T4CDF	80
13C-T4CDD	84
13C-P5CDF	85
13C-P5CDD	91
13C-H6CDF	93
13C-H6CDD	93
13C-H7CDF	81
13C-H7CDD	80
13C-O8CDD	87

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	0.386	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	0.317	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Kuzmiak
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	**99VN854**	**AXYS FILE:**	**L2436-22**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment** (MAG Area Fish pond (Near RR track) Site #23)	**METHOD NO.:**	**DX-S-01/Ver.3**
SAMPLE SIZE:	**8.69 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**21**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	1.4	0.040	**T4CDF - Total**	1.5	0.050
2,3,7,8	0.047	0.040	**2,3,7,8**	0.19	0.050
P5CDD - Total	1.6	0.050	**P5CDF - Total**	1.4	0.050
1,2,3,7,8	0.23	0.050	**1,2,3,7,8**	0.11	0.050
			2,3,4,7,8	NDR(0.11)	0.050
H6CDD - Total	9.8	0.050	**H6CDF - Total**	4.4	0.050
1,2,3,4,7,8	0.29	0.050	**1,2,3,4,7,8**	0.36	0.050
1,2,3,6,7,8	0.81	0.050	**1,2,3,6,7,8**	0.21	0.050
1,2,3,7,8,9	1.3	0.050	**2,3,4,6,7,8**	0.20	0.050
			1,2,3,7,8,9	ND	0.050
H7CDD - Total	48	0.050	**H7CDF - Total**	9.3	0.050
1,2,3,4,6,7,8	21	0.050	**1,2,3,4,6,7,8**	3.0	0.050
			1,2,3,4,7,8,9	NDR(0.29)	0.050
O8CDD	260	0.15	**O8CDF**	6.9	0.050

Surrogate Standards	% Recovery
13C-T4CDF	77
13C-T4CDD	84
13C-P5CDF	81
13C-P5CDD	84
13C-H6CDF	90
13C-H6CDD	90
13C-H7CDF	80
13C-H7CDD	76
13C-O8CDD	79

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	0.897	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	0.882	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	**99VN856**	**AXYS FILE:**	**L2436-23**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	MAG Area Rice field (Behind MAG office) Site #24		
SAMPLE SIZE:	**10.8 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**18**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	2.6	0.050	**T4CDF - Total**	6.4	0.050
2,3,7,8	0.27	0.050	**2,3,7,8**	1.1	0.050
P5CDD - Total	9.2	0.050	**P5CDF - Total**	13	0.050
1,2,3,7,8	1.3	0.050	**1,2,3,7,8**	0.71	0.050
			2,3,4,7,8	0.76	0.050
H6CDD - Total	55	0.060	**H6CDF - Total**	47	0.12
1,2,3,4,7,8	1.9	0.060	**1,2,3,4,7,8**	3.5	0.12
1,2,3,6,7,8	8.9	0.060	**1,2,3,6,7,8**	1.3	0.12
1,2,3,7,8,9	5.8	0.060	**2,3,4,6,7,8**	2.0	0.12
			1,2,3,7,8,9	0.21	0.12
H7CDD - Total	390	0.49	**H7CDF - Total**	110	0.25
1,2,3,4,6,7,8	200	0.49	**1,2,3,4,6,7,8**	31	0.25
			1,2,3,4,7,8,9	2.6	0.25
O8CDD	1900	3.1	**O8CDF**	75	0.56

Surrogate Standards	% Recovery
13C-T4CDF	72
13C-T4CDD	75
13C-P5CDF	75
13C-P5CDD	78
13C-H6CDF	80
13C-H6CDD	81
13C-H7CDF	74
13C-H7CDD	76
13C-O8CDD	89

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	6.97	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	6.97	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lunjak
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN858**	**AXYS FILE:**	**L2436-24**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	MAG Area Forest (Beside MAG office) Site #25		
SAMPLE SIZE:	**10.8 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**6.4**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.30	0.050	**T4CDF - Total**	4.5	0.050
2,3,7,8	ND	0.050	**2,3,7,8**	0.70	0.050
P5CDD - Total	0.43	0.050	**P5CDF - Total**	7.0	0.070
1,2,3,7,8	NDR(0.31)	0.050	**1,2,3,7,8**	0.56	0.070
			2,3,4,7,8	NDR(0.65)	0.070
H6CDD - Total	18	0.050	**H6CDF - Total**	17	0.050
1,2,3,4,7,8	NDR(0.6)	0.050	**1,2,3,4,7,8**	1.6	0.050
1,2,3,6,7,8	2.3	0.050	**1,2,3,6,7,8**	0.87	0.050
1,2,3,7,8,9	1.7	0.050	**2,3,4,6,7,8**	0.91	0.050
			1,2,3,7,8,9	0.44	0.050
H7CDD - Total	130	0.20	**H7CDF - Total**	28	0.070
1,2,3,4,6,7,8	52	0.20	**1,2,3,4,6,7,8**	10	0.070
			1,2,3,4,7,8,9	0.85	0.070
O8CDD	450	3.3	**O8CDF**	20	0.15

Surrogate Standards	% Recovery
13C-T4CDF	72
13C-T4CDD	76
13C-P5CDF	70
13C-P5CDD	140
13C-H6CDF	82
13C-H6CDD	84
13C-H7CDF	72
13C-H7CDD	69
13C-O8CDD	76

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	1.64	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	1.57	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lucyniak
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN864**	**AXYS FILE:**	**L2436-25**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
	Near Hwy 1 Plantation (North east side) Site #26		
SAMPLE SIZE:	**9.03 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**13**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	1.2	0.050	**T4CDF - Total**	1.6	0.050
2,3,7,8	NDR(0.13)	0.050	**2,3,7,8**	0.35	0.050
P5CDD - Total	5.0	0.050	**P5CDF - Total**	4.3	0.050
1,2,3,7,8	0.78	0.050	**1,2,3,7,8**	0.23	0.050
			2,3,4,7,8	0.33	0.050
H6CDD - Total	24	0.050	**H6CDF - Total**	13	0.10
1,2,3,4,7,8	1.1	0.050	**1,2,3,4,7,8**	1.0	0.10
1,2,3,6,7,8	3.0	0.050	**1,2,3,6,7,8**	0.55	0.10
1,2,3,7,8,9	2.7	0.050	**2,3,4,6,7,8**	0.62	0.10
			1,2,3,7,8,9	NDR(0.11)	0.10
H7CDD - Total	120	0.14	**H7CDF - Total**	29	0.050
1,2,3,4,6,7,8	56	0.14	**1,2,3,4,6,7,8**	10	0.050
			1,2,3,4,7,8,9	0.61	0.050
O8CDD	440	2.6	**O8CDF**	22	0.12

Surrogate Standards	% Recovery
13C-T4CDF	79
13C-T4CDD	86
13C-P5CDF	79
13C-P5CDD	81
13C-H6CDF	94
13C-H6CDD	96
13C-H7CDF	81
13C-H7CDD	78
13C-O8CDD	89

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	2.63	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	2.60	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lungreen
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	99VN864 (DUPLICATE)		AXYS FILE:	WG2832-103 (DUP. L2436-25)
CLIENT:	Hatfield Consultants Ltd.		DATE:	06-May-2000
CLIENT NO.:	2607			
SAMPLE TYPE:	Sediment	Near Hwy 1 Plantation (North east side) Site #26 (Dupl.)	METHOD NO.:	DX-S-01/Ver.3
SAMPLE SIZE:	10.1 g (dry)		INSTRUMENT:	GC-HRMS
% MOISTURE:	11		CONCENTRATION IN:	pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	1.1	0.070	T4CDF - Total	1.5	0.080
2,3,7,8	NDR(0.17)	0.070	2,3,7,8	ND	0.080
P5CDD - Total	5.7	0.060	P5CDF - Total	3.5	0.070
1,2,3,7,8	NDR(0.87)	0.060	1,2,3,7,8	NDR(0.28)	0.070
			2,3,4,7,8	0.29	0.070
H6CDD - Total	27	0.060	H6CDF - Total	13	0.21
1,2,3,4,7,8	1.2	0.060	1,2,3,4,7,8	1.1	0.21
1,2,3,6,7,8	3.3	0.060	1,2,3,6,7,8	0.56	0.21
1,2,3,7,8,9	3.3	0.060	2,3,4,6,7,8	0.80	0.21
			1,2,3,7,8,9	ND	0.21
H7CDD - Total	110	0.15	H7CDF - Total	27	0.080
1,2,3,4,6,7,8	56	0.15	1,2,3,4,6,7,8	10	0.080
			1,2,3,4,7,8,9	NDR(0.65)	0.080
O8CDD	430	1.8	O8CDF	22	0.12

Surrogate Standards	% Recovery
13C-T4CDF	35
13C-T4CDD	37
13C-P5CDF	37
13C-P5CDD	39
13C-H6CDF	46
13C-H6CDD	44
13C-H7CDF	38
13C-H7CDD	38
13C-O8CDD	40

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	1.96	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	1.88	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**99VN866**		**AXYS FILE:**	**L2436-26**
CLIENT:	**Hatfield Consultants Ltd.**		**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**			
SAMPLE TYPE:	**Sediment**	Near Hwy 1 Rice field	**METHOD NO.:**	**DX-S-01/Ver.3**
SAMPLE SIZE:	**8.13 g (dry)**	(South east corner) Site #27	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**19**		**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	2.4	0.050	**T4CDF - Total**	3.7	0.090
2,3,7,8	0.18	0.050	**2,3,7,8**	0.53	0.090
P5CDD - Total	8.5	0.050	**P5CDF - Total**	6.9	0.050
1,2,3,7,8	1.1	0.050	**1,2,3,7,8**	ND	0.050
			2,3,4,7,8	NDR(0.45)	0.050
H6CDD - Total	40	0.050	**H6CDF - Total**	24	0.050
1,2,3,4,7,8	1.6	0.050	**1,2,3,4,7,8**	2.0	0.050
1,2,3,6,7,8	4.4	0.050	**1,2,3,6,7,8**	0.99	0.050
1,2,3,7,8,9	4.5	0.050	**2,3,4,6,7,8**	1.2	0.050
			1,2,3,7,8,9	0.53	0.050
H7CDD - Total	200	0.16	**H7CDF - Total**	49	0.11
1,2,3,4,6,7,8	92	0.16	**1,2,3,4,6,7,8**	18	0.11
			1,2,3,4,7,8,9	1.2	0.11
O8CDD	770	3.3	**O8CDF**	36	0.12

Surrogate Standards	% Recovery
13C-T4CDF	63
13C-T4CDD	64
13C-P5CDF	65
13C-P5CDD	69
13C-H6CDF	74
13C-H6CDD	72
13C-H7CDF	66
13C-H7CDD	69
13C-O8CDD	79

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	4.06	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	4.05	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lazmak
Approved

Appendix 3

AXYS Analytical Services Ltd.
Quality Control Results:
- Batch Summary Sheets
- Procedural Blanks
- Spiked Matrix

BATCH SUMMARY

Batch ID:	DXWG2826	***Date:***	06-May-2000
Analysis Type:	Dioxin & Furan	***Matrix Type:***	Sediment

BATCH MAKEUP

Contract: 2607 ***Samples:*** L2436 -1
-2
-3
-4
-5
-6
-7
-8
-9

Blank:
WG2826-101

Reference or Spike:
WG2826-102

Duplicate:
WG2826-103

Comments:

1.

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	**LAB BLANK**	**AXYS FILE:**	**WG2826-101**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**N/A**	**METHOD NO.:**	**DX-S-01/Ver.3**
SAMPLE SIZE:	**10.0 g**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**N/A**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.050	T4CDF - Total	ND	0.050
2,3,7,8	ND	0.050	2,3,7,8	ND	0.050
P5CDD - Total	ND	0.060	P5CDF - Total	ND	0.050
1,2,3,7,8	ND	0.060	1,2,3,7,8	ND	0.050
			2,3,4,7,8	ND	0.050
H6CDD - Total	ND	0.050	H6CDF - Total	ND	0.050
1,2,3,4,7,8	ND	0.050	1,2,3,4,7,8	ND	0.050
1,2,3,6,7,8	ND	0.050	1,2,3,6,7,8	ND	0.050
1,2,3,7,8,9	ND	0.050	2,3,4,6,7,8	ND	0.050
			1,2,3,7,8,9	ND	0.050
H7CDD - Total	ND	0.050	H7CDF - Total	0.059	0.050
1,2,3,4,6,7,8	ND	0.050	1,2,3,4,6,7,8	0.059	0.050
			1,2,3,4,7,8,9	ND	0.050
O8CDD	0.24	0.060	O8CDF	NDR(0.11)	0.050

Surrogate Standards	% Recovery
13C-T4CDF	91
13C-T4CDD	110
13C-P5CDF	70
13C-P5CDD	64
13C-H6CDF	100
13C-H6CDD	94
13C-H7CDF	78
13C-H7CDD	75
13C-O8CDD	94

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	0.090	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	0.001	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lynvale
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	**Spiked Matrix**	**AXYS FILE:**	**WG2826-102**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**Sediment**	**METHOD NO.:**	**DX-S-01/Ver.3**
SAMPLE SIZE:	**10.0 g**	**INSTRUMENT:**	**GC-HRMS**
		CONCENTRATION IN:	**pg/g**

Dioxins	Determined	Expected	% Recovery	Furans	Determined	Expected	% Recovery
T4CDD - Total				**T4CDF - Total**			
2,3,7,8	2.2	1.8	122	**2,3,7,8**	2.2	1.9	116
P5CDD - Total				**P5CDF - Total**			
1,2,3,7,8	6.4	5.0	128	**1,2,3,7,8**	5.6	4.6	122
				2,3,4,7,8	5.7	4.6	124
H6CDD - Total				**H6CDF - Total**			
1,2,3,4,7,8	7.2	5.4	133	**1,2,3,4,7,8**	5.9	4.6	128
1,2,3,6,7,8	5.6	5.0	112	**1,2,3,6,7,8**	5.7	4.6	124
1,2,3,7,8,9	6.0	5.2	115	**2,3,4,6,7,8**	5.3	4.6	115
				1,2,3,7,8,9	4.9	4.6	107
H7CDD - Total				**H7CDF - Total**			
1,2,3,4,6,7,8	4.9	4.5	109	**1,2,3,4,6,7,8**	5.7	4.6	124
				1,2,3,4,7,8,9	5.4	4.6	117
O8CDD	8.7	8.3	105	**O8CDF**	7.7	7.5	103

Surrogate Standards	% Recovery
13C-T4CDF	62
13C-T4CDD	74
13C-P5CDF	84
13C-P5CDD	85
13C-H6CDF	75
13C-H6CDD	80
13C-H7CDF	78
13C-H7CDD	68
13C-O8CDD	77

1. Concentrations are recovery corrected.

Approved

BATCH SUMMARY

Batch ID:	DXWG2827	***Date:***	04-May-2000
Analysis Type:	Dioxin/Furan	***Matrix Type:***	Sediment

BATCH MAKEUP

Contract:	2607	***Samples:***	L2426 -10 -11 -12 -13 -14 -15 -16 -17 -18

Blank:

WG2827-101

Reference or Spike:

WG2827-102

Duplicate:

WG2827-103

Comments:

1.

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

DX001B

CLIENT SAMPLE I.D.:	**LAB BLANK**	**AXYS FILE:**	**WG2827-101**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**04-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**N/A**	**METHOD NO.:**	**DX-S-01/Ver.3**
SAMPLE SIZE:	**10.0 g (dry)**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**N/A**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.050	T4CDF - Total	ND	0.050
2,3,7,8	ND	0.050	2,3,7,8	ND	0.050
P5CDD - Total	ND	0.050	P5CDF - Total	ND	0.050
1,2,3,7,8	ND	0.050	1,2,3,7,8	ND	0.050
			2,3,4,7,8	ND	0.050
H6CDD - Total	ND	0.050	H6CDF - Total	ND	0.050
1,2,3,4,7,8	ND	0.050	1,2,3,4,7,8	ND	0.050
1,2,3,6,7,8	ND	0.050	1,2,3,6,7,8	ND	0.050
1,2,3,7,8,9	ND	0.050	2,3,4,6,7,8	ND	0.050
			1,2,3,7,8,9	ND	0.050
H7CDD - Total	0.064	0.050	H7CDF - Total	0.053	0.050
1,2,3,4,6,7,8	0.064	0.050	1,2,3,4,6,7,8	0.053	0.050
			1,2,3,4,7,8,9	NDR(0.053)	0.050
O8CDD	0.28	0.050	O8CDF	0.16	0.050

Surrogate Standards	% Recovery
13C-T4CDF	75
13C-T4CDD	76
13C-P5CDF	72
13C-P5CDD	72
13C-H6CDF	83
13C-H6CDD	85
13C-H7CDF	74
13C-H7CDD	68
13C-O8CDD	69

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	0.085	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	0.001	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	Spiked Matrix	AXYS FILE:	WG2827-102
CLIENT:	2607	DATE:	04-May-2000
CLIENT NO.:	Hatfield Consultants Ltd.		
SAMPLE TYPE:	Sediment	METHOD NO.:	DX-S-01/Ver.3
SAMPLE SIZE:	10.0 g	INSTRUMENT:	GC-HRMS
		CONCENTRATION IN:	pg/g

Dioxins	Determined	Expected	% Recovery	Furans	Determined	Expected	% Recovery
T4CDD - Total				T4CDF - Total			
2,3,7,8	2.1	1.8	117	2,3,7,8	1.9	1.9	100
P5CDD - Total				P5CDF - Total			
1,2,3,7,8	6.0	5.0	120	1,2,3,7,8	5.0	4.6	109
				2,3,4,7,8	5.2	4.6	113
H6CDD - Total				H6CDF - Total			
1,2,3,4,7,8	5.3	5.4	98	1,2,3,4,7,8	5.4	4.6	117
1,2,3,6,7,8	5.1	5.0	102	1,2,3,6,7,8	5.3	4.6	115
1,2,3,7,8,9	5.1	5.2	98	2,3,4,6,7,8	4.7	4.6	102
				1,2,3,7,8,9	4.5	4.6	98
H7CDD - Total				H7CDF - Total			
1,2,3,4,6,7,8	4.3	4.5	96	1,2,3,4,6,7,8	5.0	4.6	109
				1,2,3,4,7,8,9	5.0	4.6	109
O8CDD	7.3	8.3	88	O8CDF	7.2	7.5	96

Surrogate Standards	% Recovery
13C-T4CDF	58
13C-T4CDD	56
13C-P5CDF	56
13C-P5CDD	61
13C-H6CDF	71
13C-H6CDD	74
13C-H7CDF	69
13C-H7CDD	66
13C-O8CDD	68

1. Concentrations are recovery corrected.

Approved

BATCH SUMMARY

Batch ID:	DXWG2832	***Date:***	06-May-2000
Analysis Type:	Dioxin & Furan	***Matrix Type:***	Sediment

BATCH MAKEUP

Contract:	2607	***Samples:***	L2436 -19 -20 -21 -22 -23 -24 -25 -26

Blank: WG2832-101

Reference or Spike: WG2832-102

Duplicate: WG2832-103

Comments:

1.

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	**LAB BLANK**	**AXYS FILE:**	**WG2832-101**
CLIENT:	**Hatfield Consultants Ltd.**	**DATE:**	**06-May-2000**
CLIENT NO.:	**2607**		
SAMPLE TYPE:	**N/A**	**METHOD NO.:**	**DX-S-01/Ver.3**
SAMPLE SIZE:	**10.0 g**	**INSTRUMENT:**	**GC-HRMS**
% MOISTURE:	**N/A**	**CONCENTRATION IN:**	**pg/g**

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.040	**T4CDF - Total**	ND	0.050
2,3,7,8	ND	0.040	**2,3,7,8**	ND	0.050
P5CDD - Total	ND	0.050	**P5CDF - Total**	ND	0.050
1,2,3,7,8	ND	0.050	**1,2,3,7,8**	ND	0.050
			2,3,4,7,8	ND	0.050
H6CDD - Total	0.44	0.050	**H6CDF - Total**	ND	0.050
1,2,3,4,7,8	ND	0.050	**1,2,3,4,7,8**	NDR(0.1)	0.050
1,2,3,6,7,8	NDR(0.077)	0.050	**1,2,3,6,7,8**	NDR(0.075)	0.050
1,2,3,7,8,9	0.15	0.050	**2,3,4,6,7,8**	NDR(0.1)	0.050
			1,2,3,7,8,9	ND	0.050
H7CDD - Total	0.52	0.050	**H7CDF - Total**	0.45	0.050
1,2,3,4,6,7,8	NDR(0.68)	0.050	**1,2,3,4,6,7,8**	0.32	0.050
			1,2,3,4,7,8,9	0.060	0.050
O8CDD	1.4	0.050	**O8CDF**	NDR(0.18)	0.050

Surrogate Standards	% Recovery
13C-T4CDF	69
13C-T4CDD	70
13C-P5CDF	75
13C-P5CDD	80
13C-H6CDF	90
13C-H6CDD	87
13C-H7CDF	75
13C-H7CDD	67
13C-O8CDD	67

2,3,7,8 - TCDD TEQs (Using WHO 1998 TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	0.096	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	0.019	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

D Lupniak
Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.:	Spiked Matrix	AXYS FILE:	WG2832-102
CLIENT:	Hatfield Consultants Ltd.	DATE:	06-May-2000
CLIENT NO.:	2607		
SAMPLE TYPE:	Sediment	METHOD NO.:	DX-S-01/Ver.3
SAMPLE SIZE:	10.0 g	INSTRUMENT:	GC-HRMS
		CONCENTRATION IN:	pg/g

Dioxins	Determined	Expected	% Recovery	Furans	Determined	Expected	% Recovery
T4CDD - Total				T4CDF - Total			
2,3,7,8	2.0	1.8	111	2,3,7,8	1.9	1.9	100
P5CDD - Total				P5CDF - Total			
1,2,3,7,8	5.9	5.0	118	1,2,3,7,8	5.0	4.6	109
				2,3,4,7,8	5.1	4.6	111
H6CDD - Total				H6CDF - Total			
1,2,3,4,7,8	5.4	5.4	100	1,2,3,4,7,8	5.0	4.6	109
1,2,3,6,7,8	5.0	5.0	100	1,2,3,6,7,8	5.0	4.6	109
1,2,3,7,8,9	3.9	5.2	75	2,3,4,6,7,8	4.0	4.6	87
				1,2,3,7,8,9	3.3	4.6	72
H7CDD - Total				H7CDF - Total			
1,2,3,4,6,7,8	4.5	4.5	100	1,2,3,4,6,7,8	5.0	4.6	109
				1,2,3,4,7,8,9	4.7	4.6	102
O8CDD	8.2	8.3	99	O8CDF	8.4	7.5	112

Surrogate Standards	% Recovery
13C-T4CDF	74
13C-T4CDD	69
13C-P5CDF	69
13C-P5CDD	69
13C-H6CDF	76
13C-H6CDD	72
13C-H7CDF	57
13C-H7CDD	52
13C-O8CDD	38

1. Concentrations are recovery corrected.

Approved