Klukshu Environmental Study Follow-up and Wolf Creek Snow Chemistry Study – Final Report

Prepared for:

Champagne - Aishihik Enterprises
100 - 304 Jarvis Street
Whitehorse, Yukon
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Burlington, ON
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Executive Summary

An investigation of the extent of dioxin/furan contaminants in the vicinity of Klukshu Camp on Klukshu Lake has been undertaken to assess the extent of contamination and the possible exposure pathways to the environment and the local population. This study included sampling and analysis of fish tissue, lake sediments, terrestrial mammals and air and smoke. In addition, this study reviewed earlier data for soils and fish tissue and fish organs. The driving force behind this study is the concern that the use of dioxin contaminated herbicides along the Haines-Fairbanks pipeline, through the Canadian section, may have contaminated the soil and vegetation and may be entering the environment and ultimately, contaminating traditional foods and ultimately, humans.

The main conclusions of this study are:

- The tell-tale 2,3,7,8-T_4CDD, which would suggest a direct link to the use of dioxin contaminated herbicides in the area, was not detected in the lake sediments and thus there does not seem to be measurable contamination of the lake sediments by dioxin/furan runoff from contaminated soils
- The terrestrial mammals do not have high levels of dioxin/furans although the voles did show the presence of 2,3,7,8-T_4CDD, suggesting a direct link between the food of this species and the contaminated soils.
- A comparison of the available fish tissue data indicate that the presence of dioxin/furans in fish are very low and less than concentrations in fish from a limited number of other northern lakes for which data are available. Only Lake Trout revealed detectable levels of 2,3,7,8-T_4CDD. Fish tissue concentrations are below the published guidelines.
- Wood chips have high concentrations of dioxin/furans but again the marker compound, 2,3,7,8-T_4CDD, is not detectable.
- The wood smoke data are equivocal. The air blank indicates measurable concentrations of dioxin/furans in the village but 2,3,7,8-T_4CDD is absent. As well, both of the smoke samples released dioxin/furans but there is no indication that the application of dioxin contaminated herbicides has contaminated the wood.
- Surprisingly, background air samples at Klukshu (inside of the smoke/drying house) are higher than background air samples in Hamilton, Ontario and comparable to the air quality at Windsor, Ontario. True background air quality during the winter time (i.e. outside of the smokehouse) is likely better than Hamilton but this was not determined.
- The smoke in the smoke house is producing dioxin/furans, as do most combustion sources, but these are low in comparison to other combustion sources where dioxin/furan emissions have been measured.
- The soils along the pipeline right of way are the only media sampled with significant levels of dioxin/furans. Notably, 2,3,7,8-T_4CDD is dominant in the soils suggesting that the source is the application of contaminated herbicides. Clearly, dioxin/furans are not degrading very quickly in these soils. Nevertheless, the TEQ concentrations of the soil are an order of

magnitude less than the CCME soil criteria for residential soils. They do exceed the CCME guideline for agricultural soils although this guideline does not seem relevant to this site.

As a result of this study and the conclusions outlined above, the only follow-up work that is justified for this site is a community awareness and education program to encourage avoidance of the pipeline right of way. In addition to minimizing potential exposure, this will encourage natural re-vegetation. In addition, we recommend a continued watch of this site relative to the evolving dioxin/furan knowledge base. If future work identifies more stringent dioxin/furan soil residue guidelines, then reassessment of the site may be required.

A second component of this study was to analyse and summarize available snow chemistry and surface water quality data for the Wolf Creek basin. This watershed is an important research basin in the Yukon and these data provide additional information regarding atmospheric deposition of trace organic contaminants and the quality of the runoff water. Snow samples were collected in a large area snow collector during the winter of 1997/98 while the surface water samples were collected in the summer of 1994.

The chemistry of the snow in the Wolf Creek basin is generally typical of that seen elsewhere in the north. Over the 100 days that were represented by these snow samples, an estimated 57 ng/m^2 of Sum PCB was deposited. This is approximately one order of magnitude less than previous estimates. It can not be determined whether this is a trend or the result of an abnormally short accumulation season. The distribution of PCB congeners is indicative of northern atmospheric deposition as it is dominated by the lower chlorinated PCBs.

The dominant organochlorine compound in the snow is the pesticide HCH of which approximately 65% consists of the active ingredient lindane (γ-HCH). The seasonal deposition of Sum HCH of 18 ng/m^2/season is also an order of magnitude less than has been previously observed in the Whitehorse area. Similarly Sum DDT is as much as 2 orders of magnitude lower than previous estimates. These data alone should not be interpreted as evidence of a reduction of atmospheric deposition of contaminants in the Yukon.

The limit of three samples for surface water trace organic chemistry of Wolf Creek precludes extensive interpretation. The predominance of α-HCH in the runoff water is consistent with previous studies that have shown preferential volatilization of lindane and degradation of lindane to HCH. The chlorobenzenes are the dominant trace organics in the runoff water.

The PCB congener distribution for the three samples is entirely comparable to that for the snow supporting the conclusion that the primary, if not only source, of PCBs in the watershed is atmospheric deposition.

As Wolf Creek has been designated as a research basin, it is appropriate that further investigation of the loadings and fate of trace organic contaminants to the basin be undertaken. The present data, while a good start, is too limited to assess trends and to model contaminant fate. Accordingly, we recommend further work be undertaken within the basin to provide a better understanding of the deposition and fate of trace organic contaminants in this northern basin.

Introduction

In October, 1997, the Champagne-Aishik First Nations, in association with Indian and Northern Affairs – Yukon, contracted with MDA Consulting Limited to undertake an environmental investigation at Klukshu Lake. The purpose of this first component of the project was to complete sampling and analysis of various components of the ecosystem and to analyze selected samples for the presence of polychlorinated dibenzo-dioxins and furans (PCDD/F). These new data were to be synthesized along with historical data and other available information on the Klukshu Camp and general area of Klukshu Lake in order to assess the risk to human activities on the site. This component, the main element of this project, will be reported in Part I.

The second component of this project was to summarize the available snow and water chemistry data for trace organics for the Wolf Creek study basin. Samples for this study had been collected by Environment Canada and staff of Indian and Northern Affairs Canada (INAC) over several years and had been analysed by Environment Canada, Burlington. The report on this component of the study will be presented in Part II.

PART I

Klukshu Environmental Study Follow Up

Background

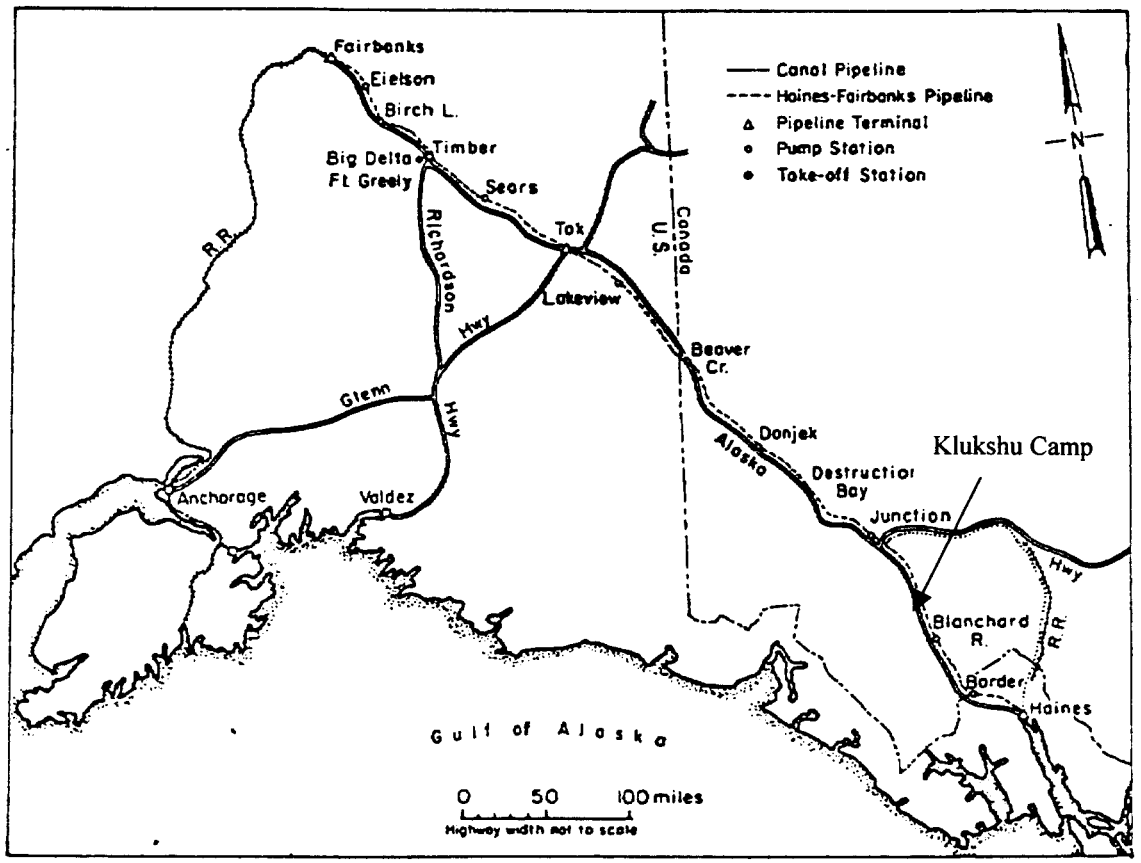
The History of the Haines-Fairbanks Pipeline

Largely due to the Korean War, the U.S. Military required larger volumes of petroleum products in Alaska than were available following World War II. The existing four-inch Canol pipeline could not cover the increased demand for petroleum products. As a result, a pipeline was constructed in 1955 from Haines Alaska through British Columbia and the Yukon Territory back into Alaska, ending at Fairbanks. The pipeline was a joint project of the U.S. Military and the Canadian Government. The U.S. owned the physical assets of the pipeline, but Canada retained title for the portion of the pipeline that went through Canada. A Canadian Press release article stated that when the line is not required for military use it will be available for civilian needs (Hudson, 1994).

Six hundred and twenty-five miles (1006 km) of eight-inch pipe was laid aboveground and underground. Two hundred and ninety-five miles of the pipeline ran through Canada with 45 miles in British Columbia (72 km) and 250 miles in the Yukon Territory (402 km) (see Figure 1). The pipeline right of way is 50 feet wide. Fluor Corporation of Los Angeles designed the pipeline during the years 1950 to 1952. The field construction started in early 1954 and the pipeline was operational by October 12, 1955. The pipeline construction cost was estimated to be $40 million dollars (Hudson, 1994). The Haines-Fairbanks section of the pipeline was primarily an aboveground pipeline with only 148 (238 km) of its 625 miles (1006 km) burried. Areas such as river crossings and road crossings required pipeline burial.

The pipeline route runs through rugged terrain where the elevation varies from 30 feet (9.1 m) above sea level to 3,750 feet (1143 m) above sea level at Haines Junction. Besides the variation in elevation, the pipeline route went through areas of dense

Figure 1: Outline map of the Haines-Fairbanks pipeline



vegetation, poorly drained areas and erosion prone areas. The area of interest for the purposes of this report is the Klukshu reserve, located in the southwest corner of the Yukon Territory. Klukshu village, which is essentially a summer-time camp, is about 400 yards (366 m) away from the pipeline corridor, bordering Klukshu Lake. The Klukshu village has approximately 3 to 4 permanent residents (Gray, 1994). During the fishing season (June to September) a base of about 50 people come to the village area to fish (Gray, 1994).

The quality of the pipe used for the pipeline through Canada was of a lesser quality than the pipe running through the U.S. The pipe laid through Alaska was a seamless pipe with a maximum working stress of 21,600 lbs/square inch (1,518 kg/cm^2). Canada used a

British pipe that had a stress rating between 1,387 to 1,613 lbs/square inch (97.5 to 113.3 kg/cm^2) (Hudson, 1994). The maximum storage capacity of the pipeline was 210,000 barrels (US) (25,040,400 L). The pipeline's normal flow rate was 18,000 barrels (2,146,320 L) per day with a maximum flow rate of 28,000 barrels (3,338,720 L) per day (Bisset, 1995).

The Haines-Fairbanks pipeline was a multi-products pipeline that transported the following products (Hudson, 1995, pg. 7):

1. Diesel fuel, grade DFA;
2. Aircraft turbine and jet engine fuel, grade JP4;
3. Aviation combat gasoline, grade1/4/115.

The Haines-Fairbanks pipeline encountered many leaks and breaches during its history. As stated earlier, the Canadian section was constructed with a lower grade of pipe than the pipe that ran through Alaska. Most of the pipeline was aboveground which caused temperature variations. Variations in temperature caused pressure variations which resulted in the need for pump stations to run at maximum capacity in order to prevent laminar flow (Richard & Denke, 1972). Bullet holes and corrosion were common problems along the Canadian portion of pipeline. The U.S. military used aerial inspections to determine the integrity of the pipeline. Herbicides were used to clear vegetation within the pipeline right of way so that the pipeline could be inspected from the air.

Another problem associated with the pipeline near the Klukshu village was the replacement of a 12 mile (19 km) section of pipeline from the Klukshu River to Dezadeash Lake during the 1970's because of corrosion and bullet holes (Hudson, 1994).

In 1971, the pipeline was shutdown due to decreased demand by the U.S. Military for petroleum products and because the pipeline wasn't operating efficiently or safely. The demand for petroleum products in Alaska decreased as the Korean War ended and the solid fuel MinuteMan Missiles replaced the constantly fuel consuming B-52 Bombers. The pipeline encountered many leakage problems throughout its operation and became obsolete because of its small size relative to more modern pipelines. The Haines-

Fairbanks pipeline was cleared of petroleum products in 1971 by employing a two-phased approach. First, alcohol and water displaced the petroleum. Secondly, the water was displaced by using a "displacement pig" propelled by compressed air. This process reduced the relative humidity inside the pipe, preventing rust formation on the pipe. It was estimated in the late 1970's that it would cost $96,000,000 to repair the pipeline up to safe operating standards (Bissett, 1995).

On January 12, 1979, the Canadian Government gave notice to the Government of the United States of its intention to terminate the Haines-Fairbanks Pipeline Agreement of June 30, 1953. The U.S. had another two years from the date of termination of the agreement to remove the pipeline and restore the right of way. No action was taken within those two years, subsequently, the Canadian Government took the position that the pipeline and related facilities are now under Canadian ownership (Gray, 1994). In 1972, the Canadian Government studied removal and rehabilitation options for the pipeline. The recommendations basically stated that all pipe lying aboveground that would not damage the environment could be removed but pipe located underground or in areas where the pipe has subsided into the wet right of way should be left (Bissett, 1995). All associated pump station structures and equipment as well as sign posts should be salvaged or removed (Bissett, 1995). Most of the salvage and removal of the pipeline and associated materials was conducted in 1980.

Application of Herbicides

As a result of the numerous leaks along the Canadian section of the pipeline, it was decided to maintain a fifty foot (15 m) wide right of way free of vegetation. This would allow weekly aerial inspections of the above-ground portion of the pipeline.

A review of literature on the Haines-Fairbanks pipeline generally indicates some confusion with respect to the application of herbicides. Our best understanding of the information that was reviewed at the offices of Indian and Northern Affairs Canada, Whitehorse, is as follows:

- Aerial application of herbicides apparently occurred approximately four times between 1955 and 1965 with the product believed to be Tordon 101.
- There were also ground level applications of a granular product for vegetation control (probably Tordon) as well as ground level spraying.
- Permission was given to spray Esteron by hand methods in 1965 due to a shortage of 2,4-D and 2,4,5-T.
- In 1968, Esteron was no longer available due to heavy usage in Vietnam so permission was given to use Fenuron.
- Permission to spray Tordon 101 along the Canadian portion of the pipeline was requested in 1968. Evidently, permission was granted and spraying did occur.

There were three primary herbicides sprayed along the Haines-Fairbanks pipeline right of way, they are:

(a) Esteron Brush Killer Herbicide, contained 2, 4-D & 2, 4, 5–T until 1965;
(b) Fenuron Weed & Brush Killer, contained 25% 3-phenyl – 1, 1-dimethylurea and 75% inert ingredients;
(c) Tordon 101, contained 2,4-D and picloram (Hudson, 1994).

2,4-D and 2,4,5-T are chlorinated phenoxy acids, and each is effective against a wide array of broadleaf plant species (Kriebel *et al.*, 1997). They persist in soil only a few weeks. Picloram is more mobile than 2,4-D and therefore better able to penetrate the plant's roots and be transported throughout the plant's tissue. Unlike the phenoxy herbicides, picloram is extremely persistent in soils.

There was no formal procedure for acquiring herbicides. The application of herbicides on a local basis was totally at the discretion of the Canadian Station foreman (Hudson, 1994). Application methods for spraying herbicides included aerial spraying, hand pumps, and fire trucks. Esteron (Agent Orange) used on the Haines-Fairbanks pipeline was of a weaker concentration than the Esteron used in Vietnam (Bissett, 1995). In a letter to G.R. Cameron, the Commissioner of the Yukon Territory, Lieutenant-Colonel R.P. Rugani, mentions that Agent Orange is unavailable due to the war in Vietnam.

Based on the letter by Lieutenant-Colonel Rugani, it could be assumed with some confidence that Esteron (Agent Orange) was used along the Haines-Fairbanks pipeline only in a limited way. Hudson (1994) concludes that "herbicides containing 2, 4, 5-T were most likely applied from the summer of 1955 to the summer of 1967".

Information that was reviewed as part of this project did not reveal detailed or even qualitative estimates of the quantity of pesticide used. The records did provide one copy of the Technical Provisions for aerial spray application of herbicides between milepost 42.5 and 337.5. No year was specified for this work but the herbicides included Picloram and 2,4-D. Based on an application rate of the mixed solution of 15 gals per acre (168 L/ha) with one part herbicide and 5 parts water, we have estimated that the total application for this job would be of the order of 19,920 gallons (90,556 L) of mix solution or 3,984 gals (18,111 L) of herbicide solution.

In order to provide some estimate of the possible worst case for herbicide usage we have assumed that this amount was used every year from 1955 to 1967 (reportedly the last year of applications) for a total herbicide usage over 13 years of 51,792 gals (235,446 L). This calculation has been made solely for the purpose of comparing possible, worst case, herbicide usage along the pipeline to that of Vietnam. By comparison, the US military began herbicide spraying in Vietnam in 1962 , reached a peak in 1967 and halted spraying in 1971. It has been estimated that 72 million litres of herbicides were used over this time with approximately 60% consisting of Agent Orange (website information, Hatfield Consultants Ltd, {hcl@hatfieldgroup.com}). Agent Orange was a mixture of 2,4-D (2,4 dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid). This calculation suggests that, even at what was clearly a worst case estimate, the application of herbicides along the pipeline right of way in Canada amounts to something less than 0.3% of the usage in Vietnam.

While the quantity of herbicide used can only be estimated, the actual compound in use also can only be guessed. Esteron Brush Killer Herbicide is the only herbicide that contained the critical chlorphenolic mixture of 2,4-D and 2,4,5-T that was contaminated with Dioxins. It seems likely that between 1955 and 1965, that Tordon 101 was

preferentially used. The active ingredient in Tordon is Picloram (*4-Amino-3,5,6-trichloro-2-pyridinecarboxylic acid; 4-amino-3,5,6-trichloropicolinic acid*) which comes as a crystal which would concur with the reported ground level application of a granular product. A review of records provided by INAC-Whitehorse, addresses only the changes in herbicide usage during the mid-1960s. A letter of April 1963 (Appendix 2) indicates that Esteron Brush Killer Herbicide was not available and that permission was requested to substitute a mixture of Fenuron Weed and Brush Killer and Tordon 101 Brush Killer (Picloram). Fenuron (N,N-Dimethyl-N-phenylurea) was manufactured by Monsanto. In February, 1965, permission was sought to again use Esteron and approval for hand sprayer application was given in March (Appendix 2). In November, 1968, permission was again sought to use Tordon 101. This was approved by the Department of Fisheries in December, 1968; but in June, 1968, it appears that approval was being sought for Fenuron. Although the Yukon Game Branch was preferring 2,4-D, it would accept Fenuron. The order for aerial spraying for 1969 indicated that Tordon 101 was to be used. However, correspondence dated February 5, 1969 indicated that non-standard herbicide application consisting of picloram (Tordon) plus 2,4-D was being proposed.

Clearly, a complete record of herbicide usage is not available at present. However, it is clear that the use of Esteron Brush Killer Herbicide, which was contaminated with Dioxins, was not heavily used at least during the last few years of spraying when it was in such high demand in Vietnam. Thus, while total potential application along the Canadian right of way is minor relative to the use in Vietnam, the actual use of the contaminated herbicide appears to be only a small fraction of the total pesticide use. Unfortunately, quantification of contaminated herbicide usage can not be further refined at this time.

Environmental and Human Health Concerns with Herbicides

The construction of the pipeline and the spraying of herbicides along the pipeline right of way disrupted the way of life for the Klukshu people. Klukshu residents began to hunt in other areas once the pipeline was constructed because the animals moved away from the area. Many people would not hunt or collect berries in areas where herbicides were

sprayed because they felt the chemicals contaminated their source of food (Hudson, 1994). It was reported that airplanes applying herbicides along the pipeline right of way accidentally sprayed two people (Hudson, 1994). Dead wood found along the pipeline was routinely used for firewood, construction of house and for smoking (drying) of meat and fish. "Many documented cases of cancer among Klukshu residents and ecological indicators raise questions as to the lasting impacts imposed upon the Reserve and its inhabitants" (Hudson, 1995, pg. 5).

Agent Orange is a defoliant that was widely used by the U.S. military during the Vietnam War. It was given the name "Agent Orange" because of the orange band used to mark the barrels. Agent Orange is mixture of 2,4 – D (2,4 dichlorophenoxyacetic acid) and 2,4, 5 – T (2, 4, 5 – trichlorophenoxyacetic acid). Polychlorinated dibenzodioxin and dibenzofuran, commonly referred to as Dioxin or PCDD/F were an unintended by-product of Agent Orange during the manufacturing process. According to Dow Chemical, the levels of dioxin and furan found in Agent Orange ranged from 0.05 parts per million (ppm) to 47 ppm (website information, Hatfield Consultants Ltd, {hcl@hatfieldgroup.com}). Dow Chemical manufactured Agent Orange under the trade name of "Esteron Brush Killer Herbicide".

The spraying of herbicides along the Haines-Fairbanks pipeline raised concerns of persistent environmental contamination due to the possibility of use of Esteron. Dioxins and Furans are persistent contaminants that have a half-life measured in the decades.

There are 75 individual compounds comprising the PCDDs, depending on the positioning of the chlorine(s) and 135 different PCDFs. Each is referred to as a congener. The term Toxic Equivalents (TEQs) is frequently used with respect to PCDD/F. Total TEQs are the sum of the products of concentrations of individual dioxin-like compounds in a complex environmental mixture times the corresponding 2,3,7,8-TCDD toxicity equivalence factor (TEF) for that compound. The TEFs for congeners and isomers of PCDD and PCDF are as follows (CCME, 1991):

Congener/Isomer	TEF
2,3,7,8-T_4CDD	1.0
1,2,3,7,8-P_5CDD	0.5
1,2.3,4,7,8-H_6CDD	0.1
1,2,3,7,8,9-H_6CDD	0.1
1,2,3,6,7,8-H_6CDD	0.1
1,2,3,4,6,7,8-H_7CDD	0.1
O_8CDD	0.001
2,3,7,8-T_4CDF	0.1
2,3,4,7,8-P_5CDF	0.5
1,2,3,7,8-P_5CDF	0.05
1,2,3,4,7,8-H_6CDF	0.1
1,2,3,7,8,9-H_6CDF	0.1
1,2,3,6,7,8-H_6CDF	0.1
2,3,4,6,7,8-H_6CDF	0.1
1,2,3,4,6,7,8-H_7CDF	0.1
1,2,3,4,7,8,9-H_7CDF	0.01
O_8CDF	0.001

Chloracne and associated dermatologic changes are widely recognized response to PCDD/F and other dioxin-like compounds in humans. Chloracne is a severe acne-like condition that develops within months of first exposure to high levels of dioxin. The duration of this condition is on the order of 25 years although cases of chloracne persisting over 40 years have been noted (CINE, no date). However, as noted by Kriebel *et al.* (1997), results from studies indicate that chloracne is neither a sensitive nor exclusive indicator. The on-set of chloracne may not occur in as many as 50% of adults affected at similar levels and a wide range of chemical compounds can cause chloracne or chloracne-like conditions besides PCDD/F.

There has been considerable study of the epidemiology of PCDD/F. Studies indicate that PCDD/Fs probably increase cancer mortality of several types. There is also the potential

for dioxins to cause reproductive and developmental toxicity, based on laboratory studies. The immune system can also be targeted by PCDD/Fs (CINE, no date). An extensive discussion of the human health and ecological effects of dioxin/furans is provided in AMAP (1998) {see in particular pp. 207 – 211}.

Objective

There has been a long standing concern among members of the Champagne-Aishihik First Nation regarding environmental and human health concerns resulting from the use of herbicides along the pipeline right of way. A series of investigations have preceded this study. These earlier studies included soils testing as well as fish tissue analyses. The current study was intended to address a number of information gaps that remained as a result of this earlier work and was intended to include a thorough synthesis of all of the available information and to assist in determining whether or not a risk assessment was required.

The specific objectives of the sampling programs have been:

i. to determine if the current levels of contaminants pose a threat to occupants utilising the natural resources of the area; and,

ii. if such levels of contaminants are found are there any remediation actions or changes in life styles required.

Workplan- Klukshu

Four areas of concern still exist in the Klukshu area as a result of the operation of the pipeline. The concerns are all tied to the use of pesticides for foliage control. The four areas of concern and proposed sampling and related work, as outlined in the statement of work (Appendix 1) are:

i) Salmon:

A total of 3 king salmon and 3 sockeye salmon from the Klukshu River were collected as part of the traditional harvest. The fish were provided to MDA by INAC and were prepared and analysed for dioxin consistent with previous fish body burden studies undertaken in the Yukon. The intent will be to look at levels of contaminants in the flesh of the fish. AXYS Analytical Services Ltd. in Victoria, B.C. prepared and analysed all samples in order that the analytical results would be consistent with all previous work. Analysis will include homogenization, the determination of lipids and the determination of a suite of dioxins and furans by HRGC-HRMS. Results were provided to MDA by the laboratory and following acceptance, were provided to the client for inspection as interim data.

ii) Sediments in Klukshu Lake:

In the fall of 1997, MDA staff, in association with INAC staff and a representative of the Champagne and Aishihik First Nations, undertook a quick survey of the lake to locate the deep sedimentary basin of the lake prior to freeze-up. Depth sounding and GPS were used to pinpoint the sampling location to permit rapid and precise deployment for sampling through the ice in the winter season.

Also in the fall, MDA staff investigated the trout spawning area as identified by the community representative to determine the nature of the sediment at this location. According to Mr. Jim Dobsen who accompanied us on this trip, this area is located at the delta of the stream that enters via Dribble's Gulch. Visual inspection and a grab sample were collected in this area. It was MDA's opinion at that time that the actual trout spawning area is likely to contain only coarse grained sediment which will be totally inappropriate for sampling as the material will lack the surface area and organic carbon to bond the hydrophobic contaminants (see Figures 2 and 3). Consequently, further sampling at this location was not recommended.

Also at this time, MDA assessed the appropriateness of the boat launch area (Figure 4) with respect to sampling the sediments for Dioxins . The material in the boat launch area

was also relatively coarse grained and thus not highly appropriate for sampling. More importantly, the sediments are frequently disturbed and mixed by outboard motors and thus a representative sample would be difficult to collect. Thus it was determined that the emphasis in all sediment sampling on this project should be on the deep basin core. This is comparable to the approach being taken by other researchers in the Yukon.

Figure 2: The delta at Gribble's Gulch showing the cobbles on the shoreline which indicated that any fine grained contaminated sediment would be moved beyond the delta

In March of 1998, MDA staff accompanied by INAC-Whitehorse personnel and Mr. Currie Kane of the Champagne and Aishihik First Nations visited Klukshu and collected two sediment cores from the deep basin of the lake at the point identified the previous fall. The water depth was 31.5 m. These cores were excellent, containing over 60 cm of sediment and showed the presence of the surface sediment indicating minimal loss. Both

cores showed some evidence of layering, which may be annual. Also, the cores were quite soft and much longer than had been anticipated.

Figure 3: Close-up view of the gravel and cobbles comprising the spawning area about the delta at Gribble's Gulch

iii) Terrestrial Mammals:

Small rodents were collected in the fall of 1997. These included a chipmunk, 2 redback voles, 1 meadow vole and 5 deer mice. All of these were collected from along the pipeline right of way and are considered resident. Similar studies have indicated that small animals living on the right of way are the best indicator organisms of contaminants for the terrestrial environment. These rodents have a very limited territory thereby indicating the potential direct uptake of contaminants from vegetation and soil. These species also serve as the base of the terrestrial food chain and could indicate contaminant accumulation in predators if the rodents are contaminated. Sample homogenization and

lipid determination and analyses of dioxins was undertaken by AXYS. The chipmunk was one sample, the voles were combined and the mice were combined as single samples.

Figure 4: Boat launch area at Klukshu Lake showing the shallowness of the water which would result in sediment mixing by boats in this area

iv) Wood Smoke:

A concern has been expressed that wood from along the pipeline right of way may be contaminated and produce excessive levels of Dioxin and Furans. This wood was used for the drying of fish in the smoke houses at Klukshu as well as for construction in the past. It should be noted that all wood combustion will produce some level of these contaminants in the smoke apparently due to the natural levels of chlorine in the wood. Therefore, in order to determine whether or not wood from along the right of way produces a higher level of contaminants than other wood from the area, it was necessary to have a background sample as well. Thus, in March of 1998, MDA undertook a wood

burning and wood smoke sampling project at Klukshu. Following an air blank from inside the smoking/drying house, wood from outside of the pipeline right of way was burnt to provide a wood smoke blank. Subsequently, wood from along the right of way was collected and burned to provide the sample. While normally replicate samples would be desirable for this work, the budget limited this to one sample for each situation. It is important to note that to the extent possible, this burning was undertaken in a manner consistent with that used in the drying of fish.

The contaminants were collected on a filter and on polyurethane foam plugs inside of the air sampler. The filter and foam plugs were then submitted to AXYS for dioxin analyses.

Reporting

MDA will prepare a full and final report summarizing all of the relevant data for the Klukshu study when the analytical information is received from the various laboratories. Data will be provided to INAC and the Client upon receipt from the laboratories prior to interpretation.

If any of the analytical results suggest that there may be a significant health risk, experts at the Centre for Indigenous Nutrition and Environment (CINE), McGill University will be consulted for advice and opinion. The cost of this assessment was to be covered directly by INAC, not as part of this contract.

Methods

Fish Tissue

A total of 3 king salmon and 3 sockeye salmon from the Klukshu River were collected as part of the traditional harvest. These samples were wrapped in pre-cleaned foil and stored at – 40°C by INAC-Whitehorse until the samples were forwarded to AXYS. AXYS homogenized the samples, determined the lipid content and prepared the sample

for PCDD/F analyses by Gas Chromatograph with High Resolution Mass Spectrometry (GC-HRMS). Full details on sample preparation and analytical methodology can be obtained from AXYS Analytical Services Ltd., P.O. Box 2219, Sidney, B.C., V8L 3S8. The method number used in the analysis can be obtained from the analytical reports provided in the appendices.

Small Mammals

Peter Zurachenko, under contract to MDA Consulting Limited undertook the sampling of small mamals at the Klukshu site in late September, 1997. The trapping of the animals occurred along the pipeline right of way. A total of 32 traps were set on September 24th and retrieved on September 25th. The following were retrieved from the traps:

- 1 chipmunk (*Eutamias*)
- 2 redback voles (*Clethrionomys*)
- 1 meadow vole (*Microtus*)
- 5 deer mice (*Peromycus*)

Upon capture, the animals were sealed individually in pre-cleaned aluminum foil and placed inside of zip-lock bags. Upon return to Whitehorse, they were stored in INAC's low temperature freezer until shipped to the analytical laboratory.

Full details on sample preparation and analytical methodology can be obtained from AXYS Analytical Services Ltd., P.O. Box 2219, Sidney, B.C., V8L 3S8. The method number used in the analysis can be obtained from the analytical reports provided in the appendices.

While these animals were collected along the pipeline right of way, they potentially travel long distances, particularly during a peak in the population cycle. This range could extend to as much as a kilometre; thus, their diet may not be highly reflective of the vegetation along the pipeline. There may also be seasonal movements between summer and winter habitats. The extent of movement in this area is not known. However, Mr.

Zurachenko did note that there were latrine piles near the dens which suggests that over-wintering had occurred in the trap area. The animals were not aged or sexed.

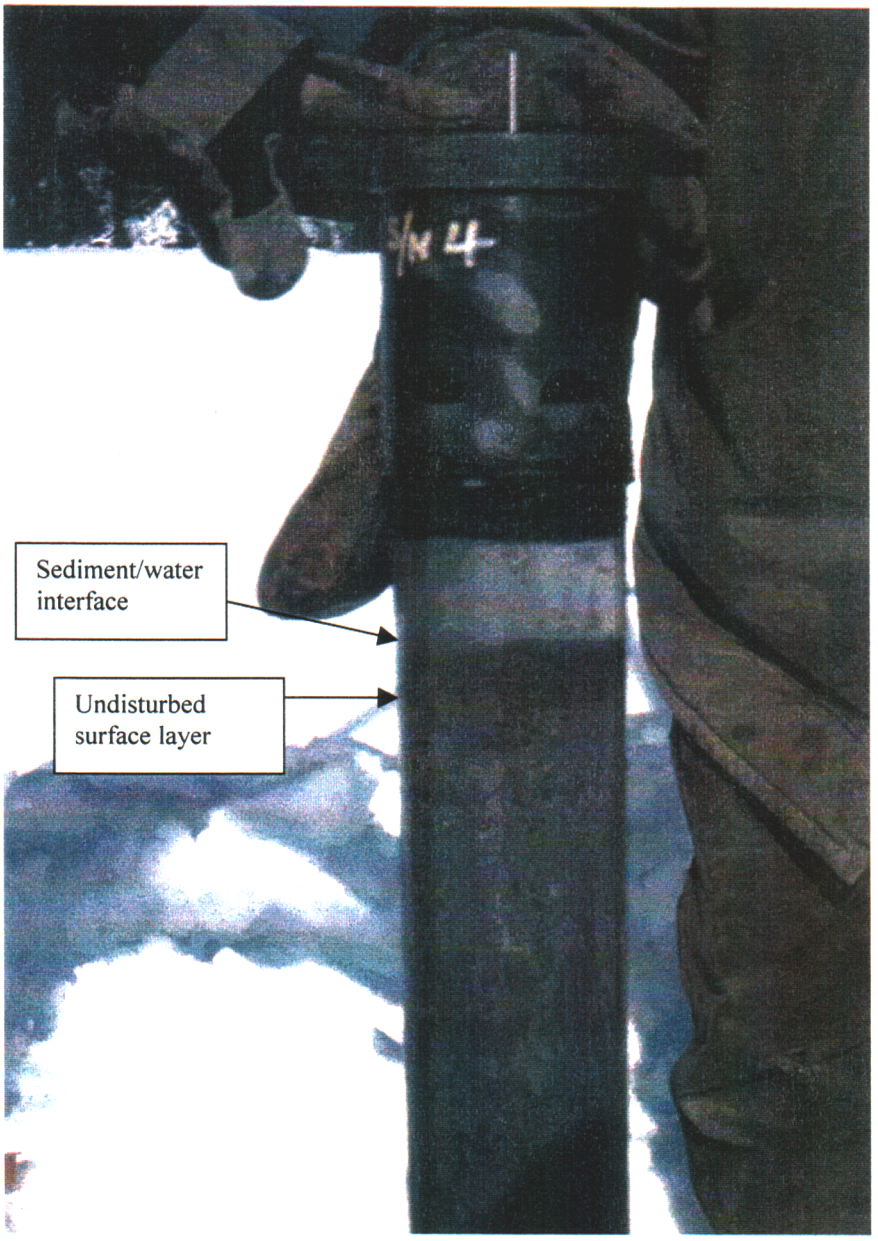
Lake Sediment

In March of 1998, MDA staff accompanied by INAC-Whitehorse personnel and Mr. Currie Kane of the Champagne and Aishihik First Nations visited Klukshu and collected two sediment cores from the deep basin of the lake at the point identified the previous fall (60° 18.777N, 137° 00.745W). The water depth was 31.5 m. These cores were excellent, containing over 60 cm of sediment (Figure 5) and showed the presence of the surface sediment indicating minimal loss (Figure 6). Both cores showed some evidence of layering (see Figures 6 and 7). Also, the cores were quite soft and much longer than had been anticipated.

Figure 5: Sediment core from Klukshu Lake collected from deep portion of lake approximately in line with Gribble's Gulch

One sediment core from the deep depositional zone of Klukshu lake was sectioned at 2 cm intervals. This core was forwarded to Mr. Paul Wilkinson of the Freshwater Institute in Winnipeg. Mr. Wilkinson dated the core and determined the sedimentation rate using ^{137}Cs and ^{210}Pb techniques. Details of the procedure for dating of sediment cores are available in, for example, Muir *et al.* (1995).

Figure 6: Top section of core from Klukshu Lake showing undisturbed brown layer of fresh sediment at surface



The second core was sectioned in the field at two centimetre intervals and was stored frozen at INAC in Whitehorse. As soon as the dates and sedimentation rates were determined, core sections were selected and forwarded to AXYS for analysis for Dioxins.

Additional core sections have been retained frozen until the results from the first samples are received in the event that Dioxin concentrations are high enough to warrant further investigations.

Full details on sample preparation and analytical methodology can be obtained from AXYS Analytical Services Ltd., P.O. Box 2219, Sidney, B.C., V8L 3S8. The method number used in the analysis can be obtained from the analytical reports provided in the appendices.

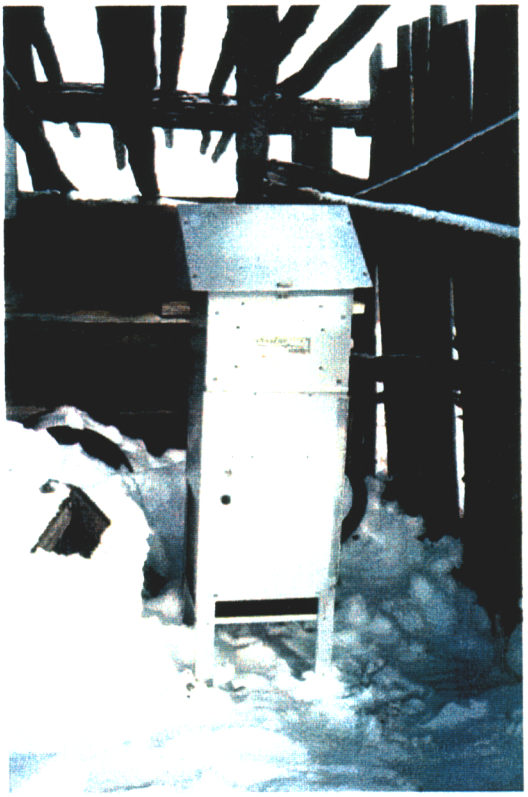
Wood Smoke

The aerosols from the wood burning were collected using a high volume air sampler placed inside the smoke house (Figure 8). Prior to any combustion at the site, the sampler was operated for 21.5 hours as a blank (i.e. no smoke). The flow rate of the sampler has been taken as 0.2 m^3/min, which is the rate when the apparatus is operating at full flow-through. This rate would decrease as the filter became clogged however no adjustment for decreased flow rates has been made. There was no one in residence at the camp at the time of this test and thus sources of PCDD/F should be typical of the air conditions inside the smoke house and in the general area in the absence of any fire. We were careful to avoid disturbing the walls and dirt floor of the site so as to minimize contributions to the blank from previous burning at the site. Power for the sampler was provided by a 4 KW gasoline powered generator, located approximately 30 m from the location of the sampler.

Figure 7: Careful inspection of the core showed laminations but these were not associated with annual layers as derived from ^{210}Pb and ^{137}Cs analysis

As a further precaution, all wood was sawn by hand (Figure 9).

Figure 8: High volume air sampler positioned inside the smoke house prior to lighting of fires and covering with tarpaulins – i.e. background air sample



Normally, during the fish smoking and drying operation, the smoke house is covered by polyethylene tarpaulins to retain the smoke and heat inside the building. For the field blank described above, the covers were not in place but were added for the two wood burn samples (Figure 10). In general, the wood burning tests emulated the traditional methods to the greatest extent possible.

Figure 9: All of the wood used in the burn was cut on-site by hand to avoid contamination

Figure 10: View of the smoke house with tarpaulins in place.

Subsequently, we undertook a 12 hour burn/sampling of dead wood that had been collected from sites several hundred metres from the pipeline right of way (60° 17.552N, 137° 00.993W). This wood was collected under the supervision of Mr. Jim Dobsen (fall, 1997) and Mr. Currie Kane (March, 1998) both of the Champagne and Aishihik First Nations.

The high volume air-sampler was provided by the Atmospheric Environment Service (AES), Environment Canada, Toronto, Ontario. The PUFs (polyurethane foam plugs) used in the sampler were also provided by AES. MDA forwarded the PUFs to AXYS for cleaning and testing prior to use in the sample. The data for the PUF blank are provided in Appendix 3. The filters (1 μ pore size) were pre-cleaned by heating in an oven at 200°C for 8 hours. They were then sealed in acetone and hexane rinsed, air dried

aluminum foil which had been baked at 400°C for eight hours. The filters were not pre-tested by AXYS for PCDD/Fs.

Prior to commencing the sampling, the high volume apparatus was cleaned with ultra-pure acetone and hexane and air dried. Subsequently, acetone and hexane rinsed tweezers were used to remove the two PUF plugs and place them inside the apparatus. Cleaned small tweezers were also used to place the fired filter on the head of the sampler. The sampler head containing the filter and two PUF plugs was then securely attached to the air pump.

Full details on sample preparation and analytical methodology can be obtained from AXYS Analytical Services Ltd., P.O. Box 2219, Sidney, B.C., V8L 3S8. The method number used in the analysis can be obtained from the analytical reports provided in the appendices.

Results

Fish Tissue

Three sockeye samples and two Chinook samples were submitted to AXYS for analysis of PCDD/Fs. These results are provided in Appendix 3. Due to the limited number of detections, the concentrations have not been lipid corrected. Only T_4CDD-Total was quantified above the detection limit in two of the sockeye samples. T_4CDF-Total was quantified in all three of the Sockeye samples and in both of the Chinook samples. One Chinook sample also had P_5CDF-Total quantified at the detection limit. In all cases the 2,3,7,8-TCDF isomer comprised all or most of the T_4CDF-Total

Small Mammals

The project only allowed resources for the analysis of a total of three small mammal, whole tissue samples. As a result, the chipmunk was analysed as a single sample, the 2 redback voles and the meadow vole were composited for a single sample and the 5 deer mice were composited for a total of three samples. As these are not considered food animals for the native community, but were intended to represent the lowest level of the terrestrial food chain, the whole animal was blended for analysis in order to indicate the body burden.

The chipmunk and the two composited samples were submitted to AXYS for analysis of PCDD/Fs. These results are provided in Appendix 3. Due to the limited number of detections, the concentrations have not been lipid corrected. Only the composited vole sample showed detectable concentrations of PCDD/Fs and these were limited to 2,3,4,8 - T_4CDD at 1.4 pg/g and O_8CDD-Total at 1.0 pg/g. None of the samples had concentrations of PCDFs above the detection limits. Despite the limited detections for the composited voles, the TEQ for this sample was the highest for any of the samples analysed due to the high concentration of 2,3,7,8-TCDD.

Lake Sediments

Core Dating

One lake sediment core was used for dating using both ^{210}Pb and ^{137}Cs measured in the core. ^{137}Cs is produced from atmospheric tests of nuclear weapons and the peak period for accumulation of ^{137}Cs is generally taken as 1962. The peak for these samples, which were cut at 2 cm intervals, was approximately 1965 with a spread of 9 years. The ^{210}Pb linear regression model appears more acceptable in this case. The median date for the third slice of the core, based on ^{210}Pb is 1962 with a spread of 18 years. The median years and the range represented by each 2 cm core section (as well as all of the support data) are presented in Table 1. The total period of time represented by the core is estimated at 400 years. In general, the two dating techniques corroborate each other.

Greater precision in the dating could have been achieved with the use of 1 cm thick core sections. However, as this study was not designed to provide a detailed time series of contaminant concentrations for the core, these estimates are entirely appropriate. Based upon these dates, core sections for 0-2 cm, 2-4 cm and 4-6 cm (from the top of the core) were selected for analysis of PCDD/F. These cores represent the time periods of 1997 to 1986, 1986 to 1971 and 1971 to 1953, respectively. Thus all three of these core sections cover the period during and since the construction of the pipeline and during and after the use of herbicides to control vegetation. The single core section from 8 to 10 cm down the core, representing the period from approximately 1932 to 1910, was also analysed to provide a baseline for PCDD/F; that is representative of natural generation in the area prior to the pipeline development.

Table 1: Klukshu Lake sediment core data and results of dating analysis

Layer (cm)	Dry Weight (g)	Dry Weight (g/cm^2)	Por-osity	Per-cent Water	Excess Pb^{210}	Alpha ^{210}Pb Activity (Bq/g)	Alpha ^{210}Pb Activity (±2SD)	^{137}Cs Activity (Bq/g)	^{137}Cs Activity (±2SD)	Linear Regres-sion Model (yrs/slice)	Median Year of Deposit -ion	CRS Mode l (yrs/ slice)	Median Year of Deposit ion
0-2	63.1906	0.7792	0.84	64.5	5.20×10^{-2}	7.60×10^{-2}	2.79×10^{-3}	2.23×10^{-2}	4.45×10^{-3}	11.2	1992	11.2	1992
2-4	87.0715	1.8528	0.81	59.7	3.83×10^{-2}	6.23×10^{-2}	2.38×10^{-3}	2.64×10^{-2}	2.90×10^{-3}	15.4	1979	17.7	1978
4-6	102.3883	3.1153	0.69	43.5	1.09×10^{-2}	3.49×10^{-2}	1.58×10^{-3}	7.02×10^{-1}	4.21×10^{-2}	18.1	1962	9.1	1965
6-8	122.0577	4.6203	0.71	45.4	1.73×10^{-2}	4.13×10^{-2}	1.59×10^{-3}	2.78×10^{-2}	3.89×10^{-3}	21.6	1943	30.9	1945
8-10	120.6948	6.1085	0.71	46.2	7.66×10^{-3}	3.17×10^{-2}	1.66×10^{-3}	7.99×10^{-3}	2.40×10^{-3}	21.3	1921	39.3	1910
10-12	131.9262	7.7353	0.69	43.2	1.99×10^{-3}	2.60×10^{-2}	1.42×10^{-3}	0.00		23.3	1899	36.7	1871
12-14	119.4240	9.2078	0.72	46.9	1.03×10^{-3}	2.50×10^{-2}	1.21×10^{-3}	0.00		21.1	1876		
14-16	165.2368	11.2456	0.66	39.7		2.04×10^{-2}	1.13×10^{-3}	0.00		29.2	1851		
16-18	116.7606	12.6850	0.68	42.6		2.73×10^{-2}	1.28×10^{-3}	0.00		20.7	1826		
18-20	106.4565	13.9976	0.75	50.6		2.08×10^{-2}	9.95×10^{-4}	0.00		18.8	1807		
20-22	92.5225	15.1385	0.75	50.4		2.80×10^{-2}	1.42×10^{-3}	0.00		16.4	1789		
22-24	140.9561	16.8765	0.70	45.1		2.91×10^{-2}	1.38×10^{-3}	0.00		24.9	1768		
24-26	109.4287	18.2258	0.70	45.0		2.47×10^{-2}	1.05×10^{-3}	0.00		19.4	1746		
26-28	132.4278	19.8587	0.69	43.8		2.47×10^{-2}	1.22×10^{-3}	0.00		23.4	1725		
28-30	126.5958	21.4197	0.69	43.6		2.47×10^{-2}	1.08×10^{-3}	0.00		22.4	1702		
30-32	143.6169	23.1906	0.68	41.9		2.24×10^{-2}	1.22×10^{-3}	0.00		25.4	1678		
32-34	133.3562	24.8349	0.65	38.6		2.31×10^{-2}	1.02×10^{-3}	0.00		23.6	1654		
34-36	132.6719	26.4708	0.65	39.0		2.27×10^{-2}	9.16×10^{-4}	0.00		23.5	1630		
36-38	101.7987	27.7260	0.72	47.1		2.27×10^{-2}	7.92×10^{-4}	0.00		18.0	1609		
38-40	109.7623	29.0795	0.72	47.3		2.26×10^{-2}	8.94×10^{-4}	0.00		19.4	1591		

Layer (cm)	Dry Weight (g)	Dry Weight (g/cm^2)	Por-osity	Per-cent Water	Excess Pb^{210}	Alpha ^{210}Pb Activity (Bq/g)	Alpha ^{210}Pb Activity (±2SD)	^{137}Cs Activity (Bq/g)	^{137}Cs Activity (±2SD)	Linear Regres-sion Model (yrs/slice)	Median Year of Deposit-ion	CRS Model (yrs/slice)	Median Year of Deposition
40-42	124.9346	30.6200	0.68	42.7		2.15×10^{-2}	8.86×10^{-4}	0.00					
42-44	172.0374	32.7413	0.61	35.1		1.85×10^{-2}	7.94×10^{-4}	0.00					
44-46	149.3296	34.5826	0.68	42.9		2.17×10^{-2}	9.04×10^{-4}	0.00					
46-48	146.6293	36.3906	0.68	42.6									
48-50	127.9604	37.9684	0.72	47.0									

PCDD/F Results

The deepest core section (sample 812-98-5) which represents sediment from a period of at least 20 years prior to the construction of the pipeline, has consistent non detectable levels of PCDD/F (see Appendix 3). This, in addition to the sample blanks, is convincing evidence of the absence of both laboratory and field contamination. Interestingly, the other three core sections (sample numbers 812-98-1, 812-98-2 and 812-98-3) are also virtually free of PCDD/Fs as well. The only PCDD detected in the surface sample (812-98-1) was O_8CDD – Total at 2.1 pg/g. No Furans were detected in this sample.

The two core sections that most closely relate to the period of herbicide use on the pipeline (812-98-2 & 3) also show O_8CDD present at 1.8 and 2.0 pg/g. These concentrations are low and are in fact just slightly in excess of the detection limit. These two samples do show T_4CDF – Total present at very low concentrations as well (0.3 and 0.6 pg/g for samples 812-98-2 & 3, respectively).

Given that the sample analyses for sediments included two procedural blanks and two spiked blanks and these showed non-detectable concentrations for the blanks and excellent recoveries for the spiked blanks, we can have a great deal of confidence in these data. Finally, the TEQs for these sediment data indicate very low concentrations and when non-detectable PCDD/Fs are taken as 0, the TEF is 0.0.

Wood Smoke

The PCDD/F results of all air samples from this study are presented in Appendix 3. The PUF (polyurethane foam) procedural blank and the blank run on the PUFs cleaned by AXYS and provided to MDA show residual O_8CDD – Total. While the procedural blank revealed the presence of 1,2,3,4,7,8,9-CDF and O_8CDF – Total above the detection limit, neither of these Furans were detectable in the PUF blank. Thus, it is reasonable to assume that PCDD/Fs in the PUFs and Filters are not a result of contamination in the laboratories or in the PUFs and filters themselves.

MDA commenced sampling with a 21.5 hour run of the air sampler, starting at 11:30 AM on March 11, 1998 and continuing through to 9:00 AM on March 12, 1998. Except for refuelling of the generator, the sampler was run without interruption. No one was resident at the Klukshu Camp during this time and no fires had been started in the smoke house. Also as noted above, great care was taken not to disturb the soot on the walls or dirt and ashes on the floor of the smoke house. Also, the tarpaulins that were placed over the smoke house, in a manner comparable to that used during the drying of fish, were not in place during this test. The sample representing this test was 812-98-P1a & b.

The first wood smoke sample was taken over a period 12 hours on March 12, 1998. The fire was set at 9:45 AM and the air sampler was started at 10:00 AM. The wood used in this burn had been selected, with the help of indigenous personnel, from areas that were well away from the pipeline right of way. The air sampler was subsequently shut off at 10:00 PM. At 5:00 PM the filter was changed due to clogging such that the draw on the sampler was declining significantly. The first filter was placed into a pre-cleaned glass jar. At the end of the test, the filters and PUFs were removed from the apparatus with cleaned tweezers and placed into the sample jars that the cleaned PUFs had been received in from AXYS.

The burn for the wood collected from along the pipeline right of way, commenced at 10:25 PM on March 12, 1998 and was terminated at 10:30 AM on March 13, 1998. The filter was changed on this test at 4:30 AM and placed in a pre-cleaned sample jar. At the end of the test, the PUF plugs and filters were placed inside the original containers using cleaned tweezers and were sealed for delivery to the laboratory.

The field procedural blank (Sample 812-98-P1a&b) showed surprisingly frequent detections of PCDDs and PCDFs. In particular, H_6CDD – Total was detected at 0.001 pg/m^3, H_7CDD – Total was detected at 0.012 pg/m^3 and O_8CDD – Total was detected at 0.037 pg/m^3 for a total PCDD concentration of 0.050 pg/m^3. Furans were more frequently detected but at low concentrations. Detected Furans were T_4CDF – Total at

0.001 pg/m^3, H_6CDF – Total at 0.003 pg/m^3, H_7CDF – Total at 0.007 pg/m^3, and O_8CDF at 0.009 pg/m^3.

The first wood sample (that which should not be contaminated by herbicides) had a number of PCDD/Fs above the detection limit. In fact each isomer total was positive for all Dioxins and Furans. Due to the fact that the field blank had a number of positive congener concentrations, it is reasonable to subtract the values for the field blank from those of the wood smoke as presented in Appendix 3 in the column labeled field blank corrected. The total PCDD and PCDF concentrations for sample 812-98-P2a&b, after applying this correction, were 0.200 and 0.030 pg/m^3, respectively. The most toxic congener, 2,3,7,8-T_4CDD was not detected at 0.3 pg/PUF or approximately 0.001 pg/m^3.

The second wood burning sample, using wood collected from the vicinity of the pipeline, actually had fewer PCDD/F detections than the previous sample. All of the PCDD isomers were positive but only the T_4CDF isomer was detected after field blank correction. This yielded a total PCDD concentration of 0.032 pg/m^3 and a total PCDF concentration of 0.001 pg/m^3. Again, 2,3,7,8- T_4CDD was not detected.

The total concentrations of PCDD/F do not tell the entire story however with respect to these sample. It is necessary to consider the congener make up of the sample. For example, sample 812-98-P2a&b (clean wood) had an H_6CDD-Total concentration of 0.034 pg/m^3; however the three congeners that are factored into the TEQ account for only 0.013 pg/m^3, or only about 38% of the total isomer. This explains why the TEQ for this clean wood sample was approximately the same as for the blank and the dirty wood (812-98-3a&b) sample. This calculation also shows how taking a value equal to one half of the detection limit can be misleading when there are a lot on ND values. Regardless, the TEQs calculated only for positive detections are essentially "0" in all wood smoke samples.

Previous Work

Border Station/Rainy Hollow

The Border Pump Station and Rainy Hollow are adjacent sites in northern B.C. just south of the Yukon border. These sites were constructed as part of the Haines-Fairbanks pipeline. Buried canisters of DDT were found at this site in 1994 and as part of the site assessment and clean-up by Royal Roads University, soils along the pipeline were analysed for PCDD/Fs. The concern here was the possibility of the use of Dioxin contaminated herbicides along the pipeline right of way (Royal Roads University, 1997).

Three soil samples were analyzed for 2,3,7,8-substituted tetra- to octa-chlorinated dibenzo-p-dioxins and dibenzofurans. The conclusion of the report was that "overall the concentrations of dioxins and furans were among the lowest recorded for surface soil samples in the Canadian Arctic, and provide no evidence for either the past application of 2,4,5-T in the vicinity of Border Station or of any risks to humans or wildlife in association with dioxins and furans." None of the 2,3,7,8-substituted congeners that are considered to exhibit toxicity (see Table 2) were detected. The report also notes that the possibility exists that the 2,4,5-T was not used on this portion of the pipeline right of way due to the slow rate of revegetation at this elevation.

Table 2: Dioxin and furan concentrations (pg/g) in soil samples collected in the general vicinity of Rainy Hollow (Royal Roads University, 1997)

Analyte	ROW96-01	ROW96-02	ROW96-03
2,3,7,8-T_4CDD	<0.2	<0.2	<0.1
1,2,3,7,8-P_5CDD	<0.3	<0.2	<0.2
1,2.3,4,7,8-H_6CDD	<0.4	<0.4	<0.3
1,2,3,7,8,9-H_6CDD	<0.4	<0.4	0.3
1,2,3,6,7,8-H_6CDD	<0.4	<0.4	<0.3
1,2,3,4,6,7,8-H_7CDD	<0.6	<0.6	2.9
O_8CDD	6.9	4.3	23
2,3,7,8-T_4CDF	0.2	<0.2	0.8
2,3,4,7,8-P_5CDF	<0.3	<0.2	0.8
1,2,3,7,8-P_5CDF	<0.3	<0.2	0.2
1,2,3,4,7,8-H_6CDF	<0.6	<0.6	<0.5
1,2,3,7,8,9-H_6CDF	<0.6	<0.6	<0.5
1,2,3,6,7,8-H_6CDF	<0.6	<0.6	<0.5
2,3,4,6,7,8-H_6CDF	<0.6	<0.6	<0.5
1,2,3,4,6,7,8-H_7CDF	<0.8	<0.7	0.8
1,2,3,4,7,8,9-H_7CDF	<0.8	<0.7	<0.6
O_8CDF	<1.0	<1.0	1.2

Soil Sampling

In 1993, AXYS Analytical Services Ltd. undertook sampling for soils and berries (Fowler, 1993). Soil samples were collected from six sites on the pipeline right of way. Five of these were from a herbicide treated section and one was close to the Klukshu River in an area that was believed not to have been sprayed. At each location, a shallow trench (approximately 40 cm wide x 50 cm long x 35-40 cm deep) was removed and soil samples were collected close to the surface (1 to 4 cm) and also at a depth of 20 to 25 cm. These five treated area samples were composited to provide a surface and subsurface composite. Unfortunately, it appears that the surface and subsurface samples from the control site were not analysed. The data for the composited soil samples are presented in Table 3.

Table 3: Soil PCDD/F data (pg/g) for composited samples from sprayed areas at Klukshu Camp (Fowler, 1993) and for 1995 soil samples

Analyte	Surface Composite	Surface Composite	Sub-surface Composite	No Growth Area – 1995	Klukshu River Bed - 1995	Road (.5 m from end of pipe) – 1995	Road (.5 m from end of pipe) – 1995
2,3,7,8-T_4CDD	29	30	0.4	9	140	7.2	7.5
1,2,3,7,8-P_5CDD	ND*	ND	ND	ND	0.1	ND	ND
1,2.3,4,7,8-H_6CDD	ND	ND	ND	ND	ND	ND	ND
1,2,3,7,8,9-H_6CDD	ND	ND	ND	ND	0.3	ND	ND
1,2,3,6,7,8-H_6CDD	ND	ND	ND	ND	ND	ND	ND
1,2,3,4,6,7,8-H_7CDD	ND	ND	ND	ND	1.6	0.8	0.9
O_8CDD	2.2	1.7	0.5	2.7	9.6	4.9	6.2
2,3,7,8-T_4CDF	2.2	2.3	ND	1.3	11	0.3	0.3
2,3,4,7,8-P_5CDF	ND	ND	ND	ND	ND	ND	ND
1,2,3,7,8-P_5CDF	ND	ND	ND	ND	0.3	ND	ND
1,2,3,4,7,8-H_6CDF	ND	ND	ND	ND	ND	ND	ND
1,2,3,7,8,9-H_6CDF	ND	ND	ND	ND	ND	ND	ND
1,2,3,6,7,8-H_6CDF	ND	ND	ND	ND	ND	ND	ND
2,3,4,6,7,8-H_6CDF	ND	ND	ND	ND	ND	ND	ND
1,2,3,4,6,7,8-H_7CDF	ND	ND	ND	0.4	7.3	0.3	0.3
1,2,3,4,7,8,9-H_7CDF	ND	ND	ND	ND	5.8	ND	ND
O_8CDF	ND	ND	ND	ND	0.7	ND	ND
TEQ (pg/g)	29.2	30.2	0.4	9.3	141.4	7.4	7.7

* ND = not detected

As stated in a follow-up letter to D. Peerla from Coreen Hamilton of AXYS and dated December 10, 1993, the surface soil composites contain elevated concentrations of 2,3,7,8-T_4CDD and lower concentrations of 2,3,7,8-T_4CDF. Most other dioxin/furan congeners were not detected. Generally, OCDD is predominant in background samples followed by H_7CDD while 2,3,7,8-T_4CDD is not present. Dr. Hamilton concluded that this pattern is consistent with the application of 2,4,5-T (contaminated with 2,3,7,8-T_4CDD) but cautioned that she can not be certain that the application of herbicides is the source for the dioxinf/furan contamination (Appendix 2). This conclusion was supported by Dr. Christopher Rappe of the University of Umea, Sweden (Appendix 2).

As a follow-up to the AXYS study, INAC-Whitehorse undertook some additional soil sampling in 1995. These results are also shown in Table 3. With the exception of the river bed sample, these samples have dioxin/furan TEQ concentrations between the surface and subsurface samples reported by Fowler. The one sample from the river bed shows a relatively high concentration of dioxin/furan TEQ that is entirely due to the high concentration of the 2,3,7,8-T_4CDD.

Fish Tissue Analyses

As part of the 1993 study undertaken by AXYS, fish tissue from Klukshu Lake were analysed for Dioxin/furans (Fowler, 1993). Unlike in the current study, these samples separated target organs and muscle. Subsequent sampling was undertaken in 1995 by INAC and AXYS analysed these. All of the 1993 and 1995 fish tissue data are presented in Table 4.

Also, as part of the 1995 study, fish tissue samples were analysed from a control lake called Big Kalzas Lake. This lake was selected as there is no road access to the site and the pipeline is not located in the vicinity. Thus, the only source for dioxin/furans to this lake is believed to be atmospheric. These data are presented in Table 5.

Table 4: Fish tissue data for samples collected in 1993 and 1995 (pg/g) (not lipid corrected)

Analyte	Burbot Liver Composite	Burbot Liver Composite	Lake Trout Composite – 1995	Lake Trout Composite – 1995	Lake Trout Composite - 1995
2,3,7,8-T_4CDD	ND	ND	ND	ND	ND
1,2,3,7,8-P_5CDD	ND	ND	ND	ND	ND
1,2.3,4,7,8-H_6CDD	ND	ND	ND	ND	ND
1,2,3,7,8,9-H_6CDD	ND	ND	ND	ND	ND
1,2,3,6,7,8-H_6CDD	ND	ND	ND	ND	ND
1,2,3,4,6,7,8-H_7CDD	ND	ND	ND	ND	ND
O_8CDD	ND	ND	ND	ND	ND
2,3,7,8-T_4CDF	5.2	5.3	0.1	0.2	0.1
2,3,4,7,8-P_5CDF	1.4	1.1	ND	ND	ND
1,2,3,7,8-P_5CDF	1.2	1.1	ND	ND	ND
1,2,3,4,7,8-H_6CDF	ND	ND	ND	ND	ND
1,2,3,7,8,9-H_6CDF	ND	ND	ND	ND	ND
1,2,3,6,7,8-H_6CDF	ND	ND	ND	ND	ND
2,3,4,6,7,8-H_6CDF	ND	ND	ND	ND	ND
1,2,3,4,6,7,8-H_7CDF	ND	ND	ND	ND	ND
1,2,3,4,7,8,9-H_7CDF	ND	ND	ND	ND	ND
O_8CDF	ND	ND	ND	ND	ND
TEQ (pg/g)	1.3	1.1	0.3	0.3	0.3

Table 4: Fish tissue data for samples collected in 1993 and 1995 (pg/g) (not lipid corrected) (cont'd.)

Analyte	White Fish Composite – 1995	White Fish Composite – 1995	White Fish Composite – 1995
2,3,7,8-T_4CDD	ND	ND	ND
1,2,3,7,8-P_5CDD	ND	ND	ND
1,2.3,4,7,8-H_6CDD	ND	ND	ND
1,2,3,7,8,9-H_6CDD	ND	ND	ND
1,2,3,6,7,8-H_6CDD	ND	ND	ND
1,2,3,4,6,7,8-H_7CDD	ND	ND	ND
O_8CDD	ND	ND	ND
2,3,7,8-T_4CDF	ND	ND	ND
2,3,4,7,8-P_5CDF	ND	ND	ND
1,2,3,7,8-P_5CDF	ND	ND	ND
1,2,3,4,7,8-H_6CDF	ND	ND	ND
1,2,3,7,8,9-H_6CDF	ND	ND	ND
1,2,3,6,7,8-H_6CDF	ND	ND	ND
2,3,4,6,7,8-H_6CDF	ND	ND	ND
1,2,3,4,6,7,8-H_7CDF	ND	ND	ND
1,2,3,4,7,8,9-H_7CDF	ND	ND	ND
O_8CDF	ND	ND	ND
TEQ (pg/g)	0.5	0.2	0.3

Table 5: Fish tissue data for samples collected in 1995 (pg/g) (not lipid corrected) from Big Kalzas Lake

Analyte	Lake Trout Composite	Lake Trout Composite	Lake Trout Composite	Lake Trout Composite	White Fish Sample 5069	White Fish Sample 5067	White Fish Sample 5065
2,3,7,8-T_4CDD	ND	ND	ND	ND	ND	ND	ND
1,2,3,7,8-P_5CDD	ND	ND	ND	ND	ND	ND	ND
1,2.3,4,7,8-H_6CDD	ND	ND	ND	ND	ND	ND	ND
1,2,3,7,8,9-H_6CDD	ND	ND	ND	ND	ND	ND	ND
1,2,3,6,7,8-H_6CDD	ND	ND	ND	ND	ND	ND	ND
1,2,3,4,6,7,8-H_7CDD	ND	ND	ND	ND	ND	ND	ND
O_8CDD	ND	ND	ND	ND	ND	ND	ND
2,3,7,8-T_4CDF	ND	0.2	0.2	0.2	ND	ND	ND
2,3,4,7,8-P_5CDF	ND	ND	ND	ND	ND	ND	ND
1,2,3,7,8-P_5CDF	ND	ND	ND	ND	ND	ND	ND
1,2,3,4,7,8-H_6CDF	ND	ND	ND	ND	ND	ND	ND
1,2,3,7,8,9-H_6CDF	ND	ND	ND	D	ND	ND	ND
1,2,3,6,7,8-H_6CDF	ND	ND	ND	ND	ND	ND	ND
2,3,4,6,7,8-H_6CDF	ND	ND	ND	ND	ND	ND	ND
1,2,3,4,6,7,8-H_7CDF	ND	ND	ND	ND	ND	ND	ND
1,2,3,4,7,8,9-H_7CDF	ND	ND	ND	ND	ND	ND	ND
O_8CDF	ND	ND	ND	ND	ND	ND	ND
TEQ (pg/g)	0.4	0.3	0.3	0.3	0.2	0.4	0.5

Wood Chips

Wood chips were collected from the timbers used in the construction of the smoke house at Klukshu Camp in 1995. These were analysed by AXYS for dioxin/furans in January, 1996. The results of this analysis are presented in Table 6. Also note that copies of all of

the laboratory reports for the Fowler (1993) study and the 1995 samples provided by INAC are presented in Appendix 4.

Table 6: Summary data for the 1995 wood chip sample from the smoke house at Klukshu Camp

Analyte	Lake Trout Composite
2,3,7,8-T_4CDD	ND
1,2,3,7,8-P_5CDD	7.6
1,2.3,4,7,8-H_6CDD	6.3
1,2,3,7,8,9-H_6CDD	17
1,2,3,6,7,8-H_6CDD	19
1,2,3,4,6,7,8-H_7CDD	160
O_8CDD	410
2,3,7,8-T_4CDF	9.3
2,3,4,7,8-P_5CDF	2.9
1,2,3,7,8-P_5CDF	4.0
1,2,3,4,7,8-H_6CDF	8.1
1,2,3,7,8,9-H_6CDF	ND
1,2,3,6,7,8-H_6CDF	8.0
2,3,4,6,7,8-H_6CDF	8.0
1,2,3,4,6,7,8-H_7CDF	71
1,2,3,4,7,8,9-H_7CDF	3.6
O_8CDF	32
TEQ (pg/g)	16.8

Discussion of Results

Introduction

A large amount of data has been produced since 1993 relevant to the presence and distribution of dioxins/furans in the vicinty of the Klukshu Camp. While the current project has focused on small mammals, lake sediments, fish tissue and wood smoke, it is essential to consider all of the data in a logical and step by step progression. As a result, the discussion here will commence with the soils, proceed to the small mammals in the vicinity of the pipeline, then to the lake sediments, all of the fish data and finally consider the wood chips and wood smoke data. Wherever possible, the Klukshu data will be put in context by comparisons with present guidelines and results from other studies.

Soils

The soil and river bed data for Klukshu had TEQ concentrations ranging from 0.4 to 141.4 pg/g. Characteristically, the subsurface samples had the lowest concentrations confirming the relative immobility of the dioxins/furans within the soil column (MOE, 1997). Nevertheless, it is clear that the surface soils in the vicinity of the pipeline have received an input of dioxins/furans. The dominance of the 2,3,7,8-T_4CDD congener strongly supports the probable source as the application of Esteron herbicide contaminated with dioxin. It is also evident that the dioxin/furans remain in the soil at measurable concentrations nearly 30 years after their application. As there are no preceding data, we can not estimate degradation rates at this site and thus, we cannot predict when these compounds will decrease to less that the current detection limit.

Although it is clear that dioxin/furans are present in the soils, the concentrations are well within acceptable CCME criteria for residential soil which is set at a TEQ of 1000 pg/g (CCME, 1991). The CCME remediation criterion for agricultural lands is 10 pg/g. This would not seem to be an appropriate criterion to apply to this site.

A total of 25 soil samples were analysed in the vicinity of the Plastimet Inc. fire in Hamilton, Ontario. This fire burned for approximately 3 days in mid-July, 1997 (July 9-12). It consumed a large warehouse in the industrial core of Hamilton which was being used to store large quantities of polyvinyl chloride (PVC) plastic (MOE, 1997). TEQ concentrations in soils sampled as part of this fire ranged from 4.0 to 84 pg/g. The highest concentration, collected as a surface sample sometime between July 12th and 14th was from a small parkette immediately west of the fire site. In Ontario, in the absence of a known point source of dioxin emissions, soil dioxin concentrations in urban communities similar to Hamilton range from less than 1 pg/g to more than 100 pg/g TEQ.

It is unfortunate that a true background sample (i.e. from a location well away from the pipeline and from other possible sources of contamination except background atmospheric) was not collected and analysed for this site. However, the soil samples from Rainy Hollow (Table 2) could be considered to be representative of soil background concentrations. It is noteworthy that the Rainy Hollow soil samples have non-detectable concentrations of 2,3,7,8-T_4CDD while O_8CDD is the dominant homologue while at Klukshu the 2,3,7,8-T_4CDD isomer is dominant in all samples except for one. Even with the limited sampling at Klukshu, it is noteworthy that the concentrations of dioxin/furans in the soil along the pipeline are as high as background concentrations for urban centres of southern Ontario. The concentrations are well below the health based standard for residential soils, suggesting that they do not pose a direct health risk. Nevertheless, some efforts to minimize human contact may be appropriate.

Small Mammals

The intent in sampling small mammals from the pipeline right of way was to assess the extent of dioxin/furan uptake by biota essentially resident in the contaminated zone. Only the composite vole sample showed measurable concentrations of 2,3,7,8-T_4CDD and O_8CDD. These concentrations are barely above the detection limits and the TEQs are very low in all cases.

MDA has not been successful in locating comparable data for other sites and there are no guidelines established for small mammals. The only thing that can be concluded from these data is that voles are probably feeding off of vegetation with higher concentrations of dioxins/furans (e.g. roots) and/or ingesting more soil than the mice and chipmunk which probably tend to have a diet predominantly of leafy vegetation and seeds. MOE (1997) has shown that while vegetation in the vicinity of the Plastimet fire had elevated concentrations of dioxins/furans, these quickly declined to background following precipitation. Leafy vegetables and lawn grass from the vicinity of the fire all showed very low concentrations indicating, among other things, that there was little evidence of uptake of the contaminants by vegetation.

Lake Sediments

Although only limited data are available, the four lake sediment samples indicate very low concentrations of dioxin/furans with only O_8CDD and T_4CDF-Total present, at very low concentrations. While these concentrations are at or just above the detection limits, they are only just above the concentrations of the deep core sample, which represents an approximate time period of 1910 to 1932. Clearly this is well before the construction of the pipeline or the use of any herbicides on the right of way. Also noteworthy is the absence of the 2,3,7,8-T_4CDD isomer, which, if present, would suggest a direct linkage between the contaminated soils of the pipeline and the sediments of the lake. The predominance of O_8CDD would suggest that these very low concentrations are typical of background concentrations within the sediments.

Comparative published data for northern lakes is limited to Great Slave Lake and three Finnish Lakes (AMAP, 1998). Only Great Slave Lake will be considered here. The two cores for Great Slave Lake show a maximum of Total PCDD/Fs in about the mid-1950s. These rose sharply from the concentrations of the 1930s and 1940s and have subsequently declined. It is indicated that the appearance of elevated levels of PCDD/Fs in these cores coincides with the start up of two chlorine-bleached kraft pulp mills within the drainage basin and the use of pentachlorophenol and PCDD/F containing herbicides

within the basin. Maximum concentrations in these cores were of the order of 40 to 85 pg/g for Total PCDD/Fs or approximately 40 times more than in the sediments of Klukshu Lake. For all intents and purposes, the concentrations of PCDD/Fs in Klukshu Lake sediments can be considered as negligible.

Fish Tissue

Fish tissue has been analysed more than any other matrix. This is a direct result of the importance of fish to the diet of the Champagne and Aishihik First Nations. Two of the three Sockeye tissue samples from the current study had detectable concentrations of T_4CDD but this was not 2,3,7,8-T_4CDD. 2,3,7,8-T_4CDF was present in all of the sockeye and chinook samples analysed here. Regardless, the 2,3,7,8-T_4CDD toxic equivalents for the fish tissue were very low at less than 0.29 pg TEQ/g (ND values were taken at ½ the detection limit). Previous analyses of composite samples of Burbot liver and Lake Trout and Whitefish composites showed only detectable concentrations of 2,3,7,8-T_4CDF in the Burbot liver and the Lake Trout composites. Not surprisingly, the concentrations were highest in the Burbot liver, where these contaminants would tend to concentrate. 2,3,4,7,8- and 1,2,3,7,8-P_5CDF were also detected in the Burbot liver.

The control fish tissue samples from Big Kalzas Lake revealed detectable levels of 2,3,7,8-T_4CDF in three Lake Trout composite samples at just above the detection limit. All other dioxin/furans were not detectable.

Burbot liver from other lakes in Canada were comparable in that T_4CDD was not detected and T_4CDF concentrations were ranged from <1.3 – 28.3 pg/g (wet wt) (AMAP, 1998). The highest concentrations were from Lake Laberge. Thus, Burbot livers from Klukshu are slightly elevated relative to other Canadian Arctic lakes but are not as high as observed for Lake Laberge.

Muscle and skin have been analysed for Lake Trout from Kusawa and Laberge Lakes in the Yukon. T_4CDD was not detectable while T_4CDF was detected only in Lake Laberge

at 3.3 pg/g (AMAP, 1998). Given that the detection limit for the Kusawa fish was <2 pg/g, it is reasonable to assume that the concentrations observed for Klukshu Lake Trout (detection limit = 0.1 pg/g) are actually less than observed at Kusawa. Whitefish muscel and skin from Great Slave Lake had concentrations of 0.1 and 0.7 pg/g for T_4CDD and T_4CDF, respectively. The Whitefish samples from Klukshu did not have detectable concentrations of any of the dioxin/furans analysed.

Several agencies have established criteria, action levels or guidelines for 2,3,7,8-T_4CDD in the environment. The US Food and Drug Administration has set 25 pg TCDD/g in edible portions of fish as the level at which action must be taken regarding interstate commerce. Draft Canadian Environmental Quality Guidelines (Environment Canada, 1996) established 1.1 pg/g to protect animals that consume aquatic biota. The USEPA (1995) established 0.5 pg/g as the guideline value for assessment of hazards to fish eating wildlife.

In general, the fish from Klukshu Lake have very low concentrations of dioxins/furans and there is little evidence of significant contamination from the use of dioxin contaminated herbicides along the pipeline right of way. Based on the above guidelines, even the Lake Trout, the only species in which 2,3,7,8-T_4CDD was detected, are well below the most stringent guideline established by the USEPA. Dried fish tissue from the smoke house could be analysed to determine the level of dioxin/furans added through this process. However, this should not be considered a high priority as the process has been used for generations and the only way to avoid this source would be to terminate this tradition.

Wood Chips and Wood Smoke

A wood chip sample was collected by INAC in 1995. The analysis of this sample showed relatively high concentrations of dioxin/furans (16.8 pg TEQ/g). Notably, 2,3,7,8-T_4CDD is absent and the dioxins are dominated by O_8CDD. Together, this distribution suggests that contaminated herbicides are not the source as seen for the soil

samples. This distribution suggests a production of dioxin/furans from normal low temperature combustion. There are no data for comparison and no standards established for wood.

The results of the wood smoke survey are equivocal. This is in part due to the limited number of samples which the budget allowed for. Specifically, it would have been desirable to have analysed a full filter and PUF blank which had been exposed to the Klukshu air and sampling equipment only for the time it took to install the PUF and filter and remove it again. This field method blank would have identified any contamination that was occurring as part of the field procedures, storage and shipping. Second, a true ambient air quality blank (i.e. open air as opposed to within the smoke house would have been useful. This would have resolved the source of PCDD/Fs in the current field blank. In addition, it would have been highly desirable to replicate all samples; however this would greatly increase the analytical costs.

The field blank, which was collected by operating the high-volume air sampler 24 hours in the smoke house prior to any fires or disturbance of the sample site did contain measurable concentrations of dioxins/furans. Interestingly, the all important 2,3,7,8-T_4CDD congener, which would indicate air-borne concentrations of the dioxin contaminant of Esteron, was not present. This indicates, that, at least during the winter months with snow cover, the 2,3,7,8-T_4CDD is not escaping from the soil. Due to the presence of PCDD/Fs in this field blank sample, it was necessary to correct the actual wood smoke samples by subtracting the concentrations in the blank from those of the wood smoke samples.

A great deal of care was taken to ensure that there was no mixing of the wood that was collected from areas that should not have been affected by herbicide spraying with the wood that was directly from the right of way. Thus we have no definitive explanation for why the PCDD/F concentrations from the "clean" wood smoke exceed those of the smoke from the wood from the pipeline. The PCDDs for the clean wood are an order of magnitude higher than for the wood from the pipeline and the PCDFs are almost non-

detectable in the pipeline wood. It is possible that the difference can be explained by the nature of the wood that was used. All of the wood for the clean burn was from standing or recently fallen dead stock along the roadway into Klukshu Camp. In contrast, the wood from the right of way was collected from standing dead wood immediately adjacent to the right of way or from debris piles that apparently had been created when the right of way was last cleared. Thus the right of way wood was likely older than the clean wood and had been dead for some time, possibly of the order of 30 years. We have no way of determining if this is a plausible explanation and there is an absence of data in the literature to help understand how the nature of the wood that was burnt would affect dioxin/furan emissions.

Although the concentrations of PCDD/Fs in the wood smoke are measurable they remain very low. This is in part due to the limited uptake of PCDD/Fs by vegetation, probably as a result of their hydrophobic nature. This has been demonstrated by MOE (1997) for non-woody vegetation including grass and leafy vegetables. Comparable PCDD/F TEQs for air from different sources are listed in Table 7.

Table 7: Dioxin/furan concentrations (pg TEQ/m^3) in air from previous studies (Note: all information is from MOE, 1997)

Medium	Location/Situation	Concentrations (pg TEQ/m^3)
Air	Plastimet Fire, Hamilton (July 9-18, 1997)	0.59 – 19
Air	Wood stoves (sampled in chimney)	19 – 214
Air	Large public bonfires in UK, sampler approximately 200 m away	0.6 –16
Air	Large open landfill fires (Finland)	51 – 427
Air	Tobacco smoke (main stream) (Germany and Japan)	108 - 2143
Air (background)	Windsor (1989 – 1992)	0.012 – 1.73 mean = 0.23
Air (background)	Hamilton (1991 – 1995)	0.013 – 0.194 mean = 0.079
Air (background)	Klukshu Camp (this study)	0.33
Air	Klukshu Camp (clean wood smoke inside smoke house)	0.22
Air	Klukshu Camp (pipeline wood smoke inside smoke house)	0.31

The TEQs for the Klukshu samples are very similar and this is a result of the large number of non-detect values in these samples. In this TEQ calculation, the non-detectable concentrations are taken to be equal to one half of the detection limit. Thus, when the TEQ calculations are made, a sample with very few detectable values, such as the background air sample for Klukshu can have a TEQ equal to or greater than that of a sample with more detectable concentrations. In all cases, the presence of 2,3,7,8-T_4CDD largely determines the TEQ due to the use of unity for the multiplier for this congener.

Comparing the TEQs for the Klukshu samples to other measurements from Table 7 indicates that the background air inside the smoke house at Klukshu is marginally higher than the background air concentrations in both Hamilton and Windsor. Had the sampler been operated entirely in the open for this sample, as opposed to within the smoke house, this background would have likely been much lower. The two samples representing wood burning within the smoke house are both comparable to the mean TEQ for Windsor background air and lower than the minimum concentrations reported for other fire situations.

In conclusion, although the data are limited, there is no evidence that the wood from the pipeline is producing higher air emissions of PCDD/Fs than other wood from the Klukshu area. As well, the air quality, with respect to dioxin/furans, from within the smoke house, is comparable to background conditions at Windsor, Ontario, and slightly worse than background conditions at Hamilton, Ontario. Evidently, the use of herbicides along the pipeline right of way is not influencing the dioxin/furan emissions from the wood. As well, the process of drying the wood in smoke houses using relatively small fires of local dried wood is not producing high TCDD TEQs within the smoke house and thus, the impact on the air in the community is also likely to be negligible.

Conclusions and Recommendations

Based upon this study and our review of previously collected data we have concluded the following:

- The tell-tale 2,3,7,8-T_4CDD, which would suggest a direct link to the use of dioxin contaminated herbicides in the area, was not detected in the lake sediments and thus there does not seem to be extensive contamination of the lake sediments by dioxin/furan runoff from contaminated soils
- The terrestrial mammals do not have high levels of dioxin/furans although the voles did show the presence of 2,3,7,8-T_4CDD, suggesting a direct link between the food of this species and the contaminated soils.
- A comparison of the available fish tissue data indicate that the presence of dioxin/furans in fish are very low and less than concentrations in fish from a limited number of other northern lakes for which data are available. Only Lake Trout revealed detectable levels of 2,3,7,8-T_4CDD. Fish tissue concentrations are below the published guidelines.
- Wood chips have high concentrations of dioxin/furans but again the marker compound, 2,3,7,8-T_4CDD, is not detectable.
- The wood smoke data are equivocal. The air blank indicates measurable concentrations of dioxin/furans in the village but 2,3,7,8-T_4CDD is absent. As well, both of the smoke samples released dioxin/furans but there is no indication that the application of dioxin contaminated herbicides has contaminated the wood.
- Surprisingly, background air samples at Klukshu (inside of the smoke/drying house) are higher than background air samples in Hamilton, Ontario and comparable to the air quality at Windsor, Ontario. True background air quality during the winter time (i.e. outside of the smokehouse) is likely better than Hamilton but this was not determined.

- The smoke in the smoke house is producing dioxin/furans, as do most combustion sources, but these are low in comparison to other combustion sources where dioxin/furan emissions have been measured.
- The soils along the pipeline right of way are the only media sampled with significant levels of dioxin/furans. Notably, 2,3,7,8-T_4CDD is dominant in the soils suggesting that the source is the application of contaminated herbicides. Clearly, dioxin/furans are not degrading very quickly in these soils. Nevertheless, the TEQ concentrations of the soil are an order of magnitude less than the CCME soil criteria for residential soils. They do exceed the CCME guideline for agricultural soils although this is not relevant to this site.

As a result of this study and the conclusions outlined above, we recommend the following:

1. Further analyses of sediments, fish, and terrestrial mammals is not, in our opinion, required.
2. If community concerns arise as a result of the background air quality measurements, additional air quality samples would be justified to measure dioxin/furans in the air during all seasons. We would expect that there would be higher concentrations in the summer when dioxin/furans may be escaping from the soils, and lower concentrations in the winter time when the soil is frozen and covered with snow.
3. Although the voles indicate that 2,3,7,8-T_4CDD is accumulating in these species, it is not in other terrestrial mammals. As voles are not a food source for the natives, this is not an immediate concern. Accumulation at the bottom of the terrestrial food chain is not likely a health risk based upon the dominance of fish in the local diet.
4. The only obvious concern with respect to the dioxin/furan contamination of the Klukshu Camp seems to be the residual concentrations in the soils along the pipeline. It is known that this right of way is used as an important access route for pedestrians as well as for motorized off-road vehicles. Although

data are only available for the Klukshu vicinity, it should be assumed that most soils on the right of way will contain similar PCDD/F residues. Consequently, the exposure of people, especially children, to the dust and soil itself should be limited. A health risk assessment of this exposure pathway may be desirable. Clearly, it would be appropriate to undertake an awareness and education program for aboriginals and others to make them aware of this possible pathway and to recommend avoidance of the right of way. Minimizing vehicular and pedestrian use of the right of way would encourage natural revegetation which would reduce the mobility of the residues as well as avoiding direct human exposure. In particular, children should not be allowed to play on the right of way.

5. Finally, while avoidance of the right of way is an effective and immediate means to reduce exposure, the PCDD/F concentrations do not exceed current relevant CCME guidelines. We do recommend that these guidelines and the scientific basis for their development be reviewed periodically. If in light of new information, the present residues indicate exposure risks, then a reassessment with additional field monitoring would be appropriate.

PART II

Wolf Creek Snow Contaminant Study

Introduction

The Wolf Creek drainage basin was chosen for research because it's conveniently close to Whitehorse and because of the variety of terrain if offers. The stream drains almost two hundred square kilometres of land area with a change in elevation of 1300 metres, ranging from rugged mountain top to thick boreal forest. Three meteorological stations were established in 1993 within the three different ecological zones in the drainage basin. These consist of boreal forest, subalpine shrubland (which makes up more than half of the basin), and alpine tundra. Each of the stations records air temperature, rainfall, snowfall, wind speed, humidity, solar radiation, snow depth, blowing snow, soil temperature and soil heat flux.

The project began as part of Canada's Arctic Environmental Strategy undertaken by Indian and Northern Affairs Canada, in partnership with Environment Canada's National Hydrology Research Institute. The project was designed to improve knowledge of Yukon waters. The information gained at Wolf Creek about how water moves through a drainage basin can be used in other parts of the Yukon for purposes like flood forecasting, environmental impact assessments, and water license reviews. As part of the multi-disciplinary research at this site, an assessment of snow and water chemistry has been undertaken. This portion of the report briefly summarizes the available data on this site.

Wolf Creek – Snow Samples

The Wolf Creek Basin study has been ongoing for several years primarily as a hydrologic study. Some environmental chemistry samples have been collected and analysed by NWRI, Environment Canada. These included snowmelt runoff samples. It was proposed here to round out this study by sampling fresh fallen snow in a large area snow collector

custom designed for sampling snowfall for trace organic contaminants. These samples were analysed by Environment Canada (EC). It was appropriate to have EC undertake the analysis for comparability with previous samples.

The sampler was set up by MDA and INAC personnel in October, 1997 and was operated for the 1997/98 winter period by INAC-Whitehorse staff. Snow samples were collected on a weekly basis into pre-cleaned aluminum cases designed for the purpose. These cases were stored in sub-zero freezers and periodically, the samples were thawed and composited to provide sufficient sample volume for analyses. A total of seven samples were collected during the winter of 1997 and 1998. Samples were shipped by INAC to EC in Burlington, Ontario for analyses in pre-cleaned "pepsi-can" containers.

Results

Snow Samples

A total of seven snow samples were analysed by the National Laboratory for Environmental Testing of Environment Canada, Burlington, Ontario. Samples were handled in the field and analysed in a manner consistent with that reported by Gregor *et al.*, 1996). The sample volumes ranged from 9.7 L to 18.5 L while the period of time represented by the samples ranged from 7 days to 20 days for a total sampling season of 100 days. This season was unusually short due to the relatively warm weather in November and early December and an early spring, with the last sample being removed on April 13, 1998. The data are presented in Appendix 5 and summarized in Tables 8 and 9 for Sum PCBs and organochlorines, respectively.

Table 8: Summary Sum-PCB (sum of 109 individual and co-eluting congeners) data for snow samples from Wolf Creek, 1997-98

Sample #	97-1	97-2	97-3	98-1	98-2	98-3	98-4	Total
Period	12/04/97-	12/22/97-	12/29/97-	01/14/98-	01/26/98-	02/13/98-	03/04/98-	for Winter
Sampled	12/22/97	12/29/97	01/14/98	01/26/98	02/13/98	03/04/98	04/13/98	Season
Volume (L)	17	15.7	10.9	9.7	10.4	11.1	18.5	
Sum PCB (ng/L)	2.3316	2.4231	3.2207	2.9786	3.3363	3.0780	2.4267	
Deposition (ng/m2)	8.8	8.5	7.8	6.4	7.7	7.6	10.0	**56.8 ng/m^2/ season**
Number of Days	18	7	16	12	18	20	9	**100**
Flux (ng/m2/day)	0.5	1.2	0.5	0.5	0.4	0.4	1.1	
						Weighted winter	Mean for season	**0.57 ng/m^2/day**

Internal standards were used in the samples to assess the quality of the analysis. For these samples, 1,3-DBB, 1,3,5-TBB, 1,2,4,5-TBB, δ-HCH, endrin/ketone, PCB # 30, and PCB # 204 were used. The mean reported recoveries for each compound were:

- 1,3-DBB 81.8%
- 1,3,5-TBB 32.6%
- 1,2,4,5-TBB 32.4%
- δ-HCH 76.6%
- endrin/ketone 22.6%
- PCB # 30 98.5%
- PCB # 204 99.5%

These recoveries are highly consistent between the samples and the low recoveries for 1,3,5-TBB, 1,2,4,5-TBB and endrin/ketone are not unusual in large volume samples. It can be concluded that we can have confidence in these data and they have been reported here with no corrections for recoveries.

The concentrations of PCBs ranged from 2.332 to 3.336 ng/L. As demonstrated in Figure 11, the PCBs are dominated by the lower chlorinated PCBs, generally with fewer than six chlorines. This is consistent with the absence of a local PCB source and indicates that the PCBs are transported long distances in the atmosphere.

The large surface area of the snow collector (4.5 m^2) allows a direct calculation of the flux of PCBs to the site. For the seven sampling periods, the daily flux ranged from 0.4 to 1.2 ng/m^2/day (see Figure 12). The weighted (by the number of days that each sample represented) for the winter season was 0.56 ng/m^2/day. The seasonal deposition (~ 56 ng/m^2) is an order of magnitude less than has been previously estimated for the Whitehorse area (200 – 430 ng/m^2 for 1993/94 and 1992/93, respectively) (AMAP, 1998). Whether this is an ongoing trend, a result of a year with relatively low snowfall and thus reduced scavenging, or is typical of PCB deposition in the Wolf Creek basin can not be determined at this time. It would be appropriate to correct the snow collected in the large area collector by the actual measured snow fall for the site and re-calculate the annual deposition.

Table 9: Summary of blank corrected organochlorine concentrations and seasonal depositions to the large area snow collector at Wolf Creek, 1997-98

Sample No.	97-1	97-2	97-3	98-1	98-2	98-3	98-4	Volume Weighted Mean	Seasonal Deposition
Period Sampled	12/04/97-12/22/97	12/22/97-12/29/97	12/30/97-01/14/98	01/14/98-01/26/98	01/26/98-02/13/98	02/13/98-03/04/98	03/04/98-04/13/98		
Volume (L)	17 ng/L	15.7 ng/L	10.9 ng/L	9.7 ng/L	10.4 ng/L	11.1 ng/L	18.5 ng/L	(ng/L)	(ng/m2/ season)
1,3-DCB	0.0358	0.0862	0.0867	0.2092	0.1843	0.0670	0.0627	0.0939	1.95
1,4-DCB	0.2349	6.7326		15.1838				2.7543	**57.11**
1,2-DCB	0.0327	0.1965	0.1402	0.4647	0.2998	0.1836		0.1590	3.30
1,3,5-TCB				0.0057	0.0086			0.0016	0.03
1,2,4-TCB	0.0296	0.1714	0.1922	0.1684	0.3414	0.1140	0.0607	0.1379	2.86
1,2,3-TCB	0.0191	0.0619	0.1036	0.0919	0.1570	0.0587	0.0462	0.0692	1.43
1,2,3,4-TTCB	0.0113	0.0251	0.0235	0.0295	0.0410	0.0317	0.0139	0.0232	0.48
PECB	0.0630	0.0804	0.0228	0.0199	0.0851	0.0978	0.0294	0.0567	1.18
a-HCH	0.2022	0.3010	1.1760	1.7393	0.5737	0.3573	0.5657	0.6243	12.94
HCB			0.0347	0.0176	0.1652	0.0218	0.0053	0.0279	0.58
g-HCH (Lindane)	0.1330	0.3356	0.7637	1.0237	0.4108	0.2187	0.2903	0.4057	8.41
Sum HCH	0.3352	0.6365	1.9397	2.7630	0.9845	0.5760		0.8603	17.84
Heptachlor									
Aldrin									
Heptachlor Epoxide	0.0145	0.0080	0.0178	0.0284	0.0315	0.0221	0.0389	0.0229	0.47
g-Chlordane	0.0150	0.0070	0.0261	0.1694	0.0364	0.0223	0.0029	0.0319	0.66
a-Endosulfan	0.1922	0.1287	0.2224	0.2973	0.2276	0.2897	0.5066	0.2739	5.68
a-Chlordane	0.0084	0.0035	0.0257	0.1814	0.0264	0.0166	0.0034	0.0296	0.61
Dieldrin	0.0342	0.0164	0.0450	0.2529	0.0839	0.0501	0.0214	0.0601	1.25
p,p-DDE	0.0078	0.0154	0.0082	0.0044	0.0026	0.0077		0.0066	0.14
Endrin		0.0739	0.0980	0.0285	0.0420	0.0726	0.0831	0.0567	1.17
b-Endosulfan	0.0034				0.0077		0.0047	0.0024	0.05
p,p-DDD	0.0171	0.0045	0.0040	0.0299		0.0100	0.0106	0.0107	0.22
o,p-DDT	0.0220	0.0092		0.0080	0.0195	0.0349		0.0127	0.26
p,p-DDT	0.0431							0.0078	0.16
Methoxychlor									
Mirex		0.0029	0.0051					0.0011	0.02

Figure 11: Volume weighted PCB congener concentration of snow samples collected at Wolf Creek, 1997-98

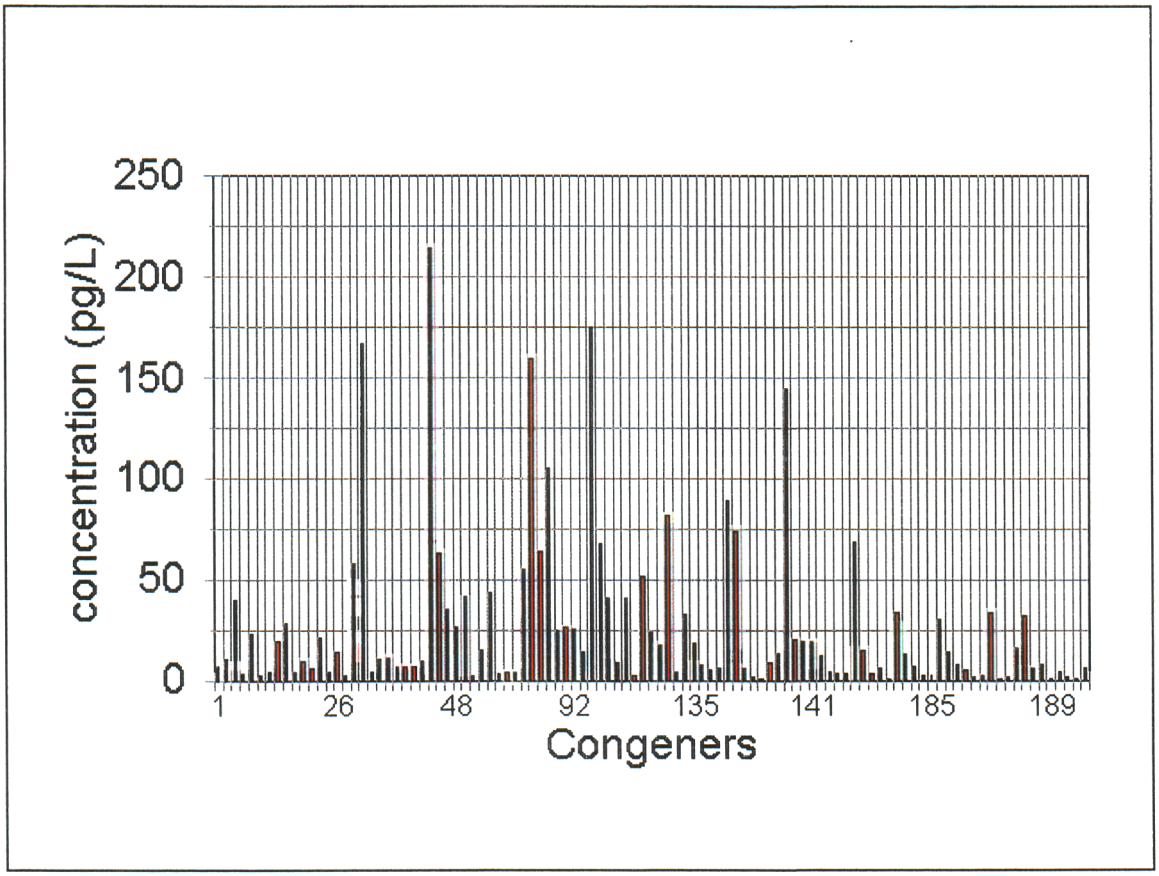
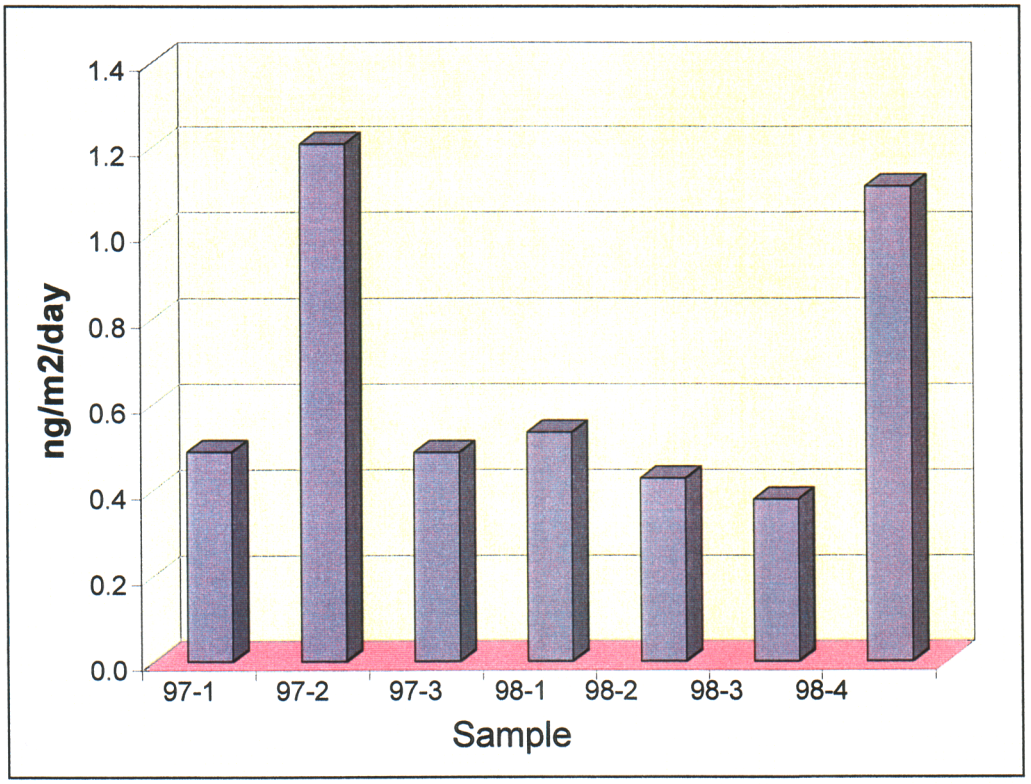


Figure 12: Comparison of Sum PCB flux in snow over the winter at Wolf Creek – 1997 - 1998



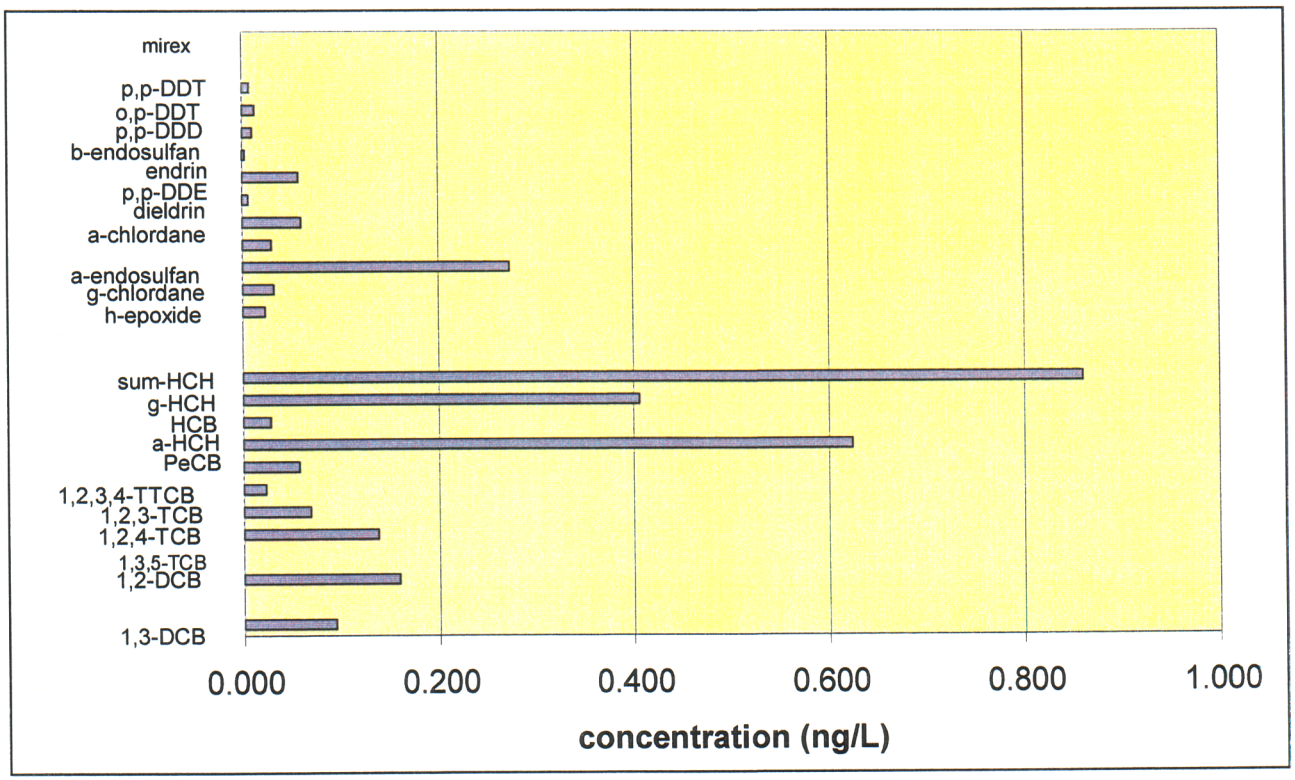
The organochlorine data are consistent with previous studies of snow chemistry in the Yukon. One item in Table 9 deserves mention; specifically, it appears that there may have been contamination of some of the samples by 1,4-dichlorobenzene. This is the only explanation that we can provide for the very high concentrations of this compound in some of the samples. It seems to be a field problem (possibly storage) due to the fact that the samples have been blank corrected.

The dominant organochlorine is the pesticide HCH reported here as the sum of the α-HCH and γ-HCH isomers (see Figure 13). Approximately 65% of the total HCH deposition of approximately 18 ng/m^2/season is comprised of γ-HCH (lindane). This distribution between the two isomers is comparable to other snow samples from across the Arctic. The 1997/98 seasonal deposition of Sum-HCH is again less than has been

previously observed in the Whitehorse area (70 – 120 ng/m^2/season for 1992/93 and 1993/94, respectively). This decrease could be a result of the need to correct the snow collector data for collection efficiency or is confirmation of the general trend that has been observed for decreased concentrations of HCHs in the north (AMAP, 1998) or a combination of both factors.

DDT concentrations are low as is the seasonal deposition for Sum-DDT. The estimated 1997/98 deposition of Sum-DDT is approximately 0.8 ng/m^2/season. In contrast, the deposition for the Whitehorse area was estimated at 50 and 20 ng/m^2/season for 1992/93 and 1993/94 ng/m^2/season, respectively (AMAP, 1998). Again, whether this is indicative of a trend or poor calibration of the snow collector needs to be investigated further.

Figure 13: Weighted mean concentrations of organochlorine pesticides in snow from Wolf Creek, 1997-98



Wolf Creek Water Chemistry

Large volume water quality samples were collected at Wolf Creek, upstream of the Alaska Highway bridge on June 24, July 6 and July 21, 1994. These samples were analysed for organochlorine pesticides and 105 PCB congeners. The analysis were undertaken by the National Water Research Institute, Environment Canada, Burl;ington, Ontario and are considered to be reasonably comparable to the snow chemistry analytical procedures.

As illustrated in Figures 14 and 15, there is no obvious trend in the concentrations of these compounds over the season. Note that the data have not been presented in chronological order in these figures to minimize masking. Also, the grouping of compounds in each figure is based on the collective range of concentrations. 1,2,4-TCB has been excluded in this figure although it was detected (see Appendix 6). Heptachlor, aldrin, trans-nonachlor, mirex, δ-chlordane, 2,4- DDE, endosulfan 1, endosulfan 2,

Figure 14: Concentrations of selected pesticides in the Wolf Creek surface water

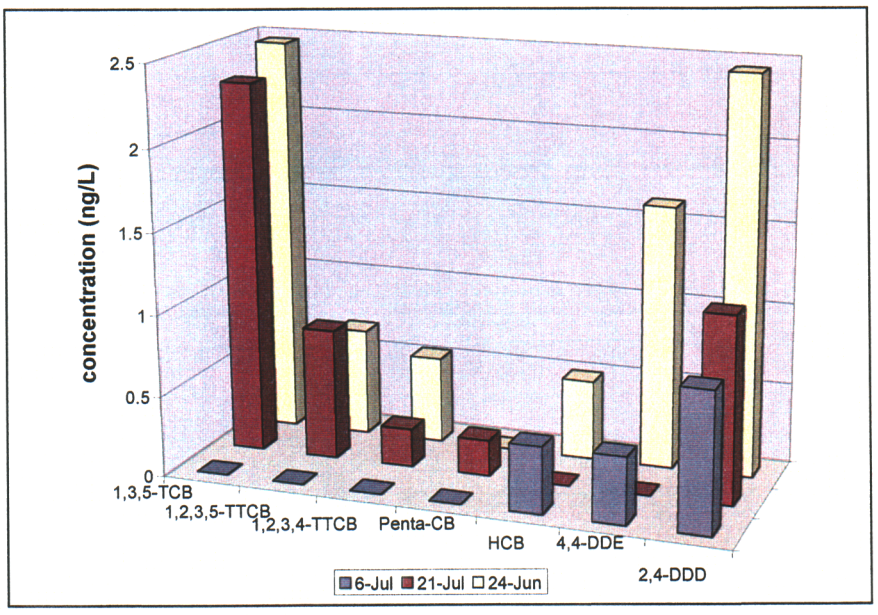
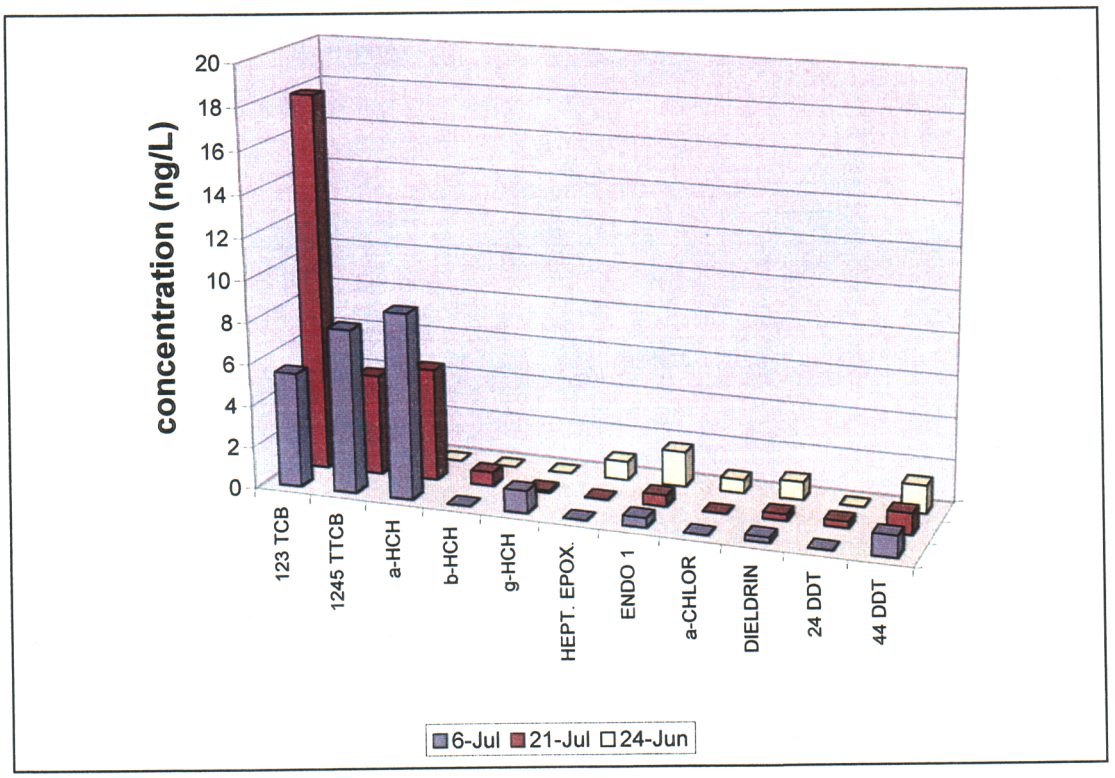


Figure 15: Concentrations of selected pesticides in the Wolf Creek surface water

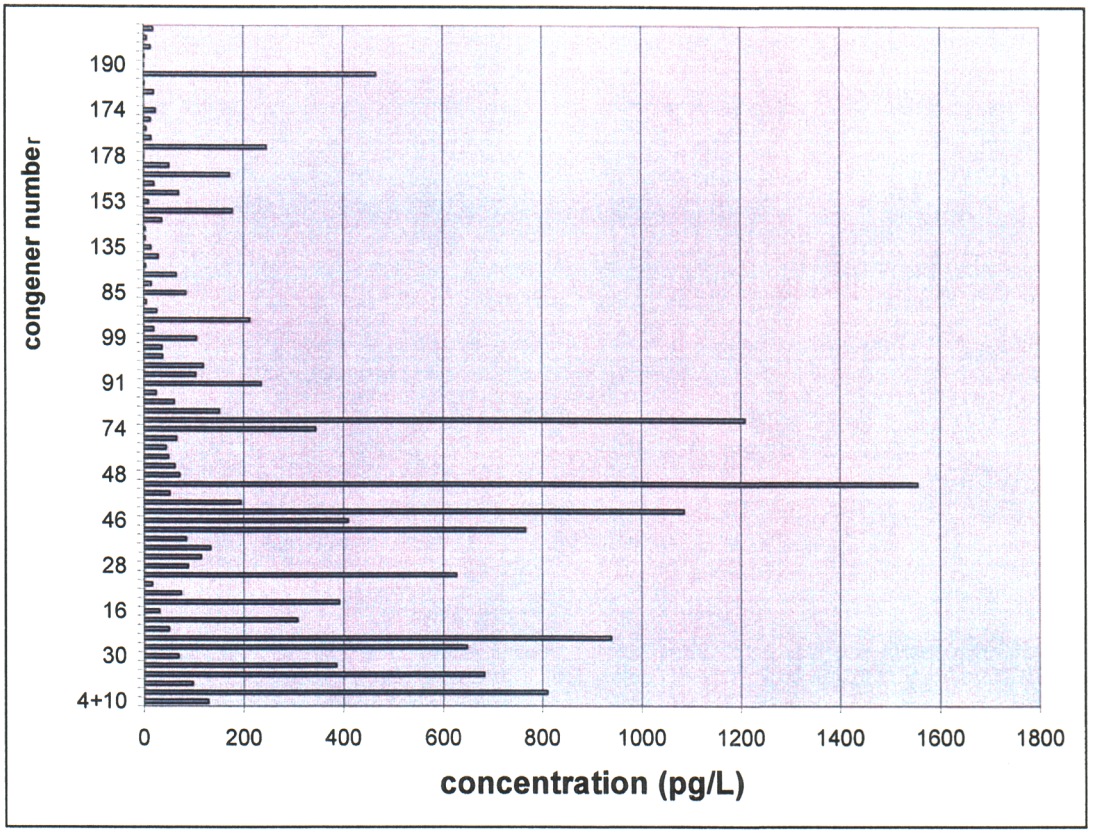


4,4-DDD, and methoxychlor were not detected. Perhaps further understanding could be achieved by calculating fluxes for these dates (i.e incorporating flow rates during the time of sampling).

Although the HCHs are not dominant in the surface waters, as they tended to be in the snow, they still show relatively high concentrations, especially for α-HCH. The loss of HCHs from snow has been documented in the north (Jensen *et al.*, 1997). Thus it is not surprising to see the concentrations decrease. Also, we know that there is a preferential loss of γ-HCH and photo-degradation of γ-HCH to α-HCH, thus explaining the increase ratios between these two compounds. The α-HCH to γ-HCH ratio in the surface waters were 9:1 and 49:1 on July 6 and July 21, respectively. Surprisingly, HCHs were not detected in the June 24 sample. In contrast, the mean α-HCH to γ-HCH ratio for the snow was 1.5:1.

The volume weighted mean PCB congener concentrations for the three river samples are illustrated in Figure 16. There is considerable similarity between the congener distribution seen in the surface water and the PCB distribution noted in Figure 11 for the Wolf Creek snow samples. This should not be a surprise and demonstrates that the only significant source for PCBs in the Wolf Creek watershed is from atmospheric deposition. Calculation of PCB fluxes from the basin would require a higher level of sampling and the integration with the flow data.

Figure 16: Volume weighted mean PCB concentrations for individual congeners for the Wolf Creek surface water samples



Conclusions and Recommendations

The chemistry of the snow is generally typical of that seen elsewhere in the north with the general tendency for the concentrations of the various contaminants to be lower than what has been determined in the Whitehorse area previously. Over the 100 days that were represented by these samples, an estimated 57 ng/m^2 of Sum PCB was deposited. This is approximately one order of magnitude less than previous estimates. It can not be determined whether this is a trend or the result of a rather short and abnormal accumulation season. The distribution of PCB congeners is indicative of northern atmospheric deposition as it is dominated by the lower chlorinated PCBs.

The dominant organochlorine compound in the snow is the pesticide HCH of which approximately 65% consists of the active ingredient lindane (γ-HCH). The seasonal deposition of Sum HCH of 18 ng/m^2/season is also an order of magnitude less than has been previously observed in the Whitehorse area. Similarly, Sum-DDT is as much as 2 orders of magnitude lower than previous estimates.

The three samples for surface water trace organic chemistry of Wolf Creek limits interpretation. The predominance of α-HCH in the runoff water is consistent with previous studies that have shown preferential volatilization of lindane and degradation of lindane to HCH. The chlorobenzenes are the dominant trace organics in the runoff water.

The PCB congener distribution for the three samples is entirely comparable to that for the snow supporting the conclusion that the primary, if not the only source of PCBs in the watershed, is atmospheric deposition.

As Wolf Creek has been designated as a research basin, it is appropriate that further investigation of the loadings and fate of trace organic contaminants to the basin be undertaken. The present data, while a good start, is too limited to assess trends and to model contaminant fate. We would recommend the following:

- Continuation of the snow collector sampling for several consecutive winter seasons to better quantify the annual deposition and to evaluate trends in deposition. If loadings to the Yukon are decreasing, this would prove to be worthwhile "good news" if it could be supported.
- Further sampling of the outflow would be appropriate but only if there was an expanded sampling program within the basin to allow the development of a contaminant mass balance for the basin. As there are ongoing hydrologic and climatic studies, this would be a relatively low cost addition to the program while providing a unique data set.

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Appendix 1: Statement of Work

STATEMENT OF WORK
Consulting and Professional Services

As per the attached "PROPOSAL" prepared by MDA as of November 11, 1997.

PROPOSAL TITLE: **Klukshu Environmental Study Follow-up and Wolf Creek Snow Chemistry Study**

Prepared for:

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October 3, 1997

APPENDIX - "D"
STATEMENT OF WORK
Consulting and Professional Services
Klukshu Environmental Study Follow-up and Wolf Creek Snow Chemistry Study

Background

Various environmental samples have been collected in the area of the Klukshu Indian Reserve over the past several years. The objectives of the sampling programs have been

i. to determine if the current levels of contaminants pose a threat to occupants utilising the natural resources of the area; and,
ii. if such levels of contaminants are found are there any remediation actions or changes in life styles required.

To date no levels appear to pose any immediate human health concerns. Several areas of potential concerns still exist which have not been investigated.

Objective

The objective of the study is to investigate potential sources of contaminants not yet studied in the Klukshu area and determine if any human health concern exist, giving special consideration to multiple exposures resulting from a traditional life style.

Workplan- Klukshu

Four areas of concern still exist in the Klukshu Area as a result of the operation of the pipeline. The concerns are all tied to the use of pesticides for foliage control. All information will be sent to experts to determine the potential impact on Human health. The four areas of concern and proposed sampling are:

i) Salmon:

Analyses of 3 king salmon and 3 sockeye salmon from the Klukshu River will be undertaken as part of the traditional harvest. The fish will be provided to MDA by INAC and will have been stored and prepared for analyses consistent with previous fish body burden studies undertaken in the Yukon. The intent will be to look at levels of contaminants in the flesh of the fish.

The fish will be provided to AXYS Analytical Services Ltd. in Victoria, B.C. in order that the analytical results can be consistent with all previous work. Analysis will include homogenization, the determination of lipids and the determination of a suite of dioxins and furans by HRGC-HRMS. Results will be provided to MDA by the laboratory and following acceptance, provided to the client as interim data for inspection.

ii) Sediments in Klukshu Lake:

In the fall of 1997, MDA staff in association with INAC staff and a representative of the native community, will undertake a quick survey of the lake to locate the deep sedimentary basin of the lake prior to freeze-up. Depth sounding and GPS will be used to pinpoint the sampling location to permit rapid and precise deployment for sampling through the ice in the winter season.

Also in the fall, MDA staff will investigate the trout spawning area as identified by the community representative to determine the nature of the sediment at this location. It is our opinion at this time that this area is likely to contain only coarse grained sediment which will be totally inappropriate for sampling as the material will lack the surface area and organic carbon to bond the hydrophobic contaminants. A grab sample will be collected at this time to determine the nature of the sediment. If the sediment is fine grained, the position will be noted using GPS and a grab sample or core (dependent upon the site) will be collected through the ice for analyses. If a core is collected, dating will be required but this has not been costed in this proposal due to the fact that the substrate is unlikely to be appropriate for coring.

Also at this time, MDA will determine a position for sampling of the boat launch area in consultation with INAC and the community representative and this position will also be located with GPS. The appropriateness of this sample location will be determined with grab samples. Again this sample will be collected in the winter time through the ice.

It is proposed here that all samples be collected through the ice to minimize mixing and disturbance from open water and to facilitate the processing of the samples. As well, it is more efficient to undertake all sampling at one time and to process all samples at one time for this purpose to minimize the storage time of the samples.

MDA will undertake the collection of 1 sediment core from the deep depositional zone of Klukshu lake in the winter of 1998 (e.g. January, February). This core will be aged using ^{137}Cs. The core will also be sectioned at one or two centimetre intervals (dependent upon the core diameter and length of core) on-site and samples will be stored in appropriate clean containers provided by the analytical laboratory. Sub-samples will be taken for each section for the dating. Based upon the results of the dating, core sections will be selected for analyses by AXYS for dioxins and furans such that the analysed sections coincide with the period of operation of the pipeline. All other samples will be stored frozen until the completion of the project in the event that positive detections of contaminants requires further investigation of the core material. MDA will make every attempt to carefully select the sections for dating in order to minimize the number of samples analysed but still clearly identify the 1954 (onset of deposition) and 1963 (peak deposition) dates using ^{137}Cs. As this is essentially a screening level of analyses, MDA recommends that this method of dating is of sufficient level of detail. However, if full core dating is required, then ^{210}Pb will be required for each core section. Consequently, ^{210}Pb dating costs have not been priced here.

iii) Terrestrial Mammals:

Several (minimum of 3) small rodents will be collected in the fall of 1997 and stored in ultra-low temperature freezers until submitted for analyses with the fish samples. These specimens will be trapped from along the pipeline right of way. Similar studies have indicated that small animals living on the right of way are the best indicator organisms of contaminants for the terrestrial environment. Rodents will be selected that have a very limited territory thereby indicating the potential direct uptake of contaminants from vegetation and soil. These species also serve as the base of the food chain and could indicate contaminant accumulation in predators if the rodents are contaminated. Sample homogenization and lipid determination and analyses will be undertaken by AXYS.

iv) Wood Smoke:

A concern has been expressed that wood from along the pipeline right of way may be contaminated and produce excessive levels of Dioxin and Furans. It should be noted here that all wood combustion will produce some level of these contaminants in the smoke apparently due to the natural levels of chlorine in the wood. Therefore, in order to determine whether or not wood from along the right of way produces a higher level of contaminants than other wood from the area, it will be necessary to have a background sample as well. Thus, MDA proposes to collect wood from along the right of way and burn it in a controlled burn as close as possible to the conditions that would be used for space heating in the community. Two separate samples of wood smoke will be collected from the right of way burn. The location of this burn will have to be away from the community to avoid any health concerns.

The burn for background samples should be undertaken in the identical manner as the for test wood except that this burn will be conducted first and sampled. It is proposed to sample the wood smoke using a high volume air sampler. Both the particulate filter and the first and second foam plugs will be analysed to determine the total concentration of contaminants. Nevertheless, as we will not be sampling 100% of the smoke, we will only be providing a comparison between the contaminant concentrations between the two samples of wood.

Community assistance and involvement in this component will be required to ensure that the conditions are as close as possible to real conditions of the community. Details of the experiment will be established during the fall site visit and the actual sampling will be undertaken in the winter sampling season.

WorkPlan - Wolf Creek

The Wolf Creek Basin study has been ongoing for several years primarily as a hydrologic study. Some environmental chemistry samples have been collected and analysed by NWRI, Environment Canada. These included some snow and snowmelt runoff samples. It is proposed here to round out this study by sampling fresh fallen snow in a large are

snow collector and to have these samples analysed by Environment Canada (EC). It is appropriate to have EC undertake the analysis for comparability with previous samples.

The sampler will be operated for a period of 5 months during which time INAC-Whitehorse staff will collect the samples on a weekly basis into pre-cleaned aluminum cases designed for the purpose. These cases will be stored in sub-zero freezers and periodically, the samples will be thawed and composited to provide sufficient sample volume for analyses. A total of 10 samples have been budgeted for in this project. Samples will be shipped by INAC to EC in Burlington, Ontario for analyses in pre-cleaned "pepsi-can" containers. All of the material and freight costs will be born by INAC.

All analytical data from this and previous studies will be provided to D. Gregor at MDA for review and inspection prior to release to INAC as interim data. MDA will then utilise all data available to prepare a summary report on the environmental chemistry of the Wolf Creek watershed.

Timing

Work will commence immediately upon authorization by the contract authority. Rodent sampling will be undertaken first in an effort to collect samples prior to the first snow fall. If this is not successful, additional sampling will be undertaken in the winter or spring depending upon conditions.

A project planning trip is planned for early October. At this time all final details for the project will be worked out with INAC and the Klukshu community. This will include location of sampling areas, investigation of substrate, determination of wood smoke sampling methods, determination of wood smoke sampling details and locations of wood supply. Also at this time, the snow collector for Wolf Creek will be set up and the sampling program established

The main sampling trip for Klukshu Lake will occur in January or February, 1998. Sediment sampling will be undertaken through the ice and will take approximately one day. Wood smoke sampling will take an estimated 3 days to allow for preparation of the sampler, a consistent burn (i.e. a good bed of coals has been established for each burn) and to allow a sufficient length of time to collect the high volume air sample to provide an appropriate sample volume.

All samples will be submitted to the laboratories immediately upon return from the field. Laboratory analysis will take at least one month however, dioxin analysis can not begin until after the core dating is completed. All analyses will be finished by April 15, 1998. Data review, synthesis and preparation of the reports will be undertaken in April and May and the final draft report will be submitted by May 29, 1998. Revisions and finalization of the report will be undertaken by MDA at no additional cost in June, 1998.

Appendix 2: Selected Correspondence Regarding the Use of Herbicides On the Pipeline Right of Way

DEPARTMENT OF THE ARMY
PETROLEUM DISTRIBUTION OFFICE
[illegible] SUPPORT GROUP
APO 98749

ARCL-F

9 April 1963

1-5-10-c

Mr. G. R. Cameron
Commissioner of the Yukon Territory
P. O. Box 2703
Whitehorse, Yukon Territory, Canada

G2638 Canada

Dear Sir:

Due to the Vietnam situation we are unable to procure 2-4,D, 2-4.5,T Estron Brush Killer Herbicide for brush control on the ~~Haines-Fairbanks~~ Pipeline Right-of-Way and Pump Stations. In lieu of the above herbicide we have substituted for use in Alaska, Fenuron Weed and Brush Killer; Active Ingredient: 25% Fenuron (3-Phenyl-1, 1-Dimethylurea) and 75% Inert Ingredient; and Tordon 101 Mixture, Brush Killer, Active Ingredients: 10.2% of 4-Amio-3,5,6 Trichloropicolinic Acid, 39.6% of 2,4-Dichlorophenoxy-acetic Acid, and 50.2% Inert Ingredient.

It is requested that permission be granted for the use of the above herbicides on the Haines-Fairbanks Pipeline Right-of-Way and Pump Stations within the Yukon Territory.

Providing permission is granted we are planning brush control work early this coming summer.

Sincerely yours,

19-4-63

RAYMOND P. BUCANI
LTC, QMC
Chief, PDO

HEADQUARTERS
UNITED STATES ARMY, ALASKA
SUPPORT COMMAND and FORT RICHARDSON
APO 949, Seattle, Washington

ARCL-E

24 February 1965

Mr. J. B. Fitzgerald
Director
Department of Game
Federal Building
Whitehorse, Y. T.
Canada

Dear Mr. Fitzgerald:

Request permission to use chemical for clearing vegetation along the Haines Fairbanks Pipeline within Canada.

It is proposed that Esteron, manufactured by Dow Chemical Company will be used and applied by hand-generated spray nozzles. The right-of-way will be sprayed to a width of fifty feet and not closer than 500 feet from any stream or lake.

Your early approval of this request will be appreciated.

Yours truly,

W. M. Mantz

W. M. MANTZ
Colonel, QMC
Commanding

TERRITORIAL
GAME DEPARTMENT
MAR 5 1965
WHITEHORSE, Y. T.

MAR - 5 1965

ARCL-E

P.O. Box 2703,
Whitehorse, Yukon Territory.

18, March, 1965.

W.M., Mantz, Colonel, QMC,
Commanding, United States Army,
Alaska Support Command and
Fort Richardson,
APO 949, Seattle, Washington.

Dear Sir:

This will acknowledge your letter of February 24, 1965, in which you request permission to use chemical for clearing vegetation along the Haines Fairbanks Pipeline within Canada.

Authority is herewith given to use Esteron, applied by hand-generated spray nozzles, to spray the pipeline right-of-way, in the Yukon Territory, to a width of fifty feet and not closer than 500 feet from any stream or lake.

I appreciate being advised of the proposed use of such chemical.

Yours truly,

G.R. Cameron,
Commissioner of the Yukon Territory.

JBF/ja

c.c. C.R.

PETROLEUM DISTRIBUTION OFFICE
UNITED STATES ARMY, ALASKA SUPPORT COMMAND
APO 96749

ARCL-F

5 November 1968

Mr. J. B. Fitzgerald
Director
Department of Fish and Game
Federal Building
Whitehorse, Y. T., Canada

Dear Mr. Fitzgerald:

Transmitted herewith are plans and technical specifications for a proposed project providing for control of brush and weeds along that portion of the Haines-Fairbanks petroleum products pipeline right-of-way lying within Canadian borders. Provided contractual arrangements can be made which are mutually agreeable to both the Canadian government and the U. S. Army and subject to your approval of the herbicide selected and method of application, the work would be accomplished in the summer of 1969 between late June and early August.

The herbicide proposed, picloram (Tordon 101), was approved by the United States Federal Committee on Pest Control and by the State of Alaska Fish and Game Department for use in a similar project along the pipeline from the Canadian border north to Fairbanks, Alaska. This work was accomplished in the summer of 1968. Excellent results were obtained in extent of kill of broad-leafed vegetation within the right-of-way. The helicopter aerial spray method of application proved to be entirely satisfactory in that no incident of drift beyond prescribed limits occurred.

It will be greatly appreciated if you will review the project documents inclosed and advise if these meet with your approval. Your cooperation in marking up and returning a set of the drawings (strip maps) to outline areas within which spraying operations should not be conducted

ARCL-F

5 November 1968

Mr. J. B. Fitzgerald, Director
Department of Fish and Game

because of the proximity of streams, bodies of water, or human habitations, will be most helpful in further development of the project.

Sincerely yours,

2 Incl
As stated

RAYMOND P. RUCAHI
LTC, QMC
Chief, FDO

Copy furnished:
USARAL, ATTN: ARAEN-I

1755 ROBSON STREET,
VANCOUVER 5, B.C.

FILE No. 34-5-2-4
Nº DU DOSSIER

file
PR 20-64

CANADA

DEPARTMENT OF FISHERIES
MINISTÈRE DES PÊCHERIES
VANCOUVER

December 20, 1968

Colonel R. P. Rugani,
Petroleum Distribution Office,
United States Army,
Alaska Support Command,
Fort Richardson, Alaska, U.S.A.

Dear Sir:

This will acknowledge your letter of October 30, 1968 advising our Department of your proposed brush and weed control project along the Haines-Fairbanks pipeline right-of-way.

Members of our technical staff have examined the specifications for the project and it has been noted that you intend to employ a 500 foot unsprayed buffer swathe on each side of rivers and streams. In this regard we would like to inform you that it has been our experience that with the relatively low fish toxicity of brushkillers, safety zones greater than 100 feet are not required.

As requested, a set of strip maps with marked buffer zones is returned to you, and you may consider that the Department does not object to the aerial application of Tordon 101 at the specified rates with the provisos that:

(1) The washing of spray equipment and mixing of spray materials are done in an area well removed from lakes and streams or ditches leading to fish-bearing waters.

(2) Excess spray materials for disposal should be buried in plastic containers.

Your co-operation in this matter has been greatly appreciated

Yours very truly,

W. R. Hourston
DIRECTOR, PACIFIC REGION

Encl.

c.c. Mr. J.A. Summers,
District Conservation Officer,

Game Branch,
Box 2703,
Whitehorse, Yukon Territ

June 14th, 1968.

Raymond P. Rugani,
U.S. Army (USARAL),
Fort Richardson,
Alaska.

Dear Sir:

This is further to my letter of May 6th, 1968, concerning the use of Fenuron Weed and Brush Killer on the Yukon section of the Haines- Fairbanks Pipeline Right-of-way and Pump Stations.

Word has now been received from the Canadian Federal Fisheries and the Canadian Wildlife Service on the use of the above weed and brush killer. As the result of this information we would prefer that 2-4D be used and it is understood this is still available in almost any large center in Canada, however, in the event you cannot obtain 2-4-D it is suggested that Fenuron be substituted.

You can now consider this authority to apply either 2-4-D or Fenuron weed and Brush Killer on the Yukon section of your Haines-Fairbanks Pipeline Right-of-Way.

Kindest personal regards,

Sincerely,

J.B. Fitzgerald,
Director of Game.

JBF/pjh

FOR OFFICIAL USE ONLY

REAL PROPERTY FACILITIES PROJECT
~~MILITARY CONSTRUCTION LINE ITEM DATA~~

1. DATE	2. FISCAL YEAR	3. DEPARTMENT	4. INSTALLATION
29 Oct 63	1969	USARAL	Petroleum Distribution Office, United States Army, Alaska Support Command

5. PROPOSED AUTHORIZATION	6. PRIOR AUTHORIZATION	7. CATEGORY CODE NUMBER	8. PROGRAM ELEMENT NUMBER	9. STATE/COUNTRY
$ NA	P.L. NA			ALASKA

10. PROPOSED APPROPRIATION	11. BUDGET ACCOUNT NUMBER	12. LINE ITEM NUMBER	13. LINE ITEM TITLE
$ NA		PR 20-69	Haines-Fairbanks Pipeline Brush Control, Milepost 42.5 through 337.5, Canadian Portion.

SECTION A - DESCRIPTION OF LINE ITEM

14. TYPE OF CONSTRUCTION
- a. PERMANENT
- b. SEMI-PERMANENT
- c. TEMPORARY

15. TYPE OF WORK
- a. NEW FACILITY
- b. ADDITION
- c. ALTERATION
- d. CONVERSION
- e. OTHER (Specify)

16. REPLACEMENT

17. TYPE OF DESIGN
- a. STANDARD DESIGN
- b. SPECIAL DESIGN
- c. DRAWING NO.

18. PHYSICAL CHARACTERISTICS OF PRIMARY FACILITY

a. NO. OF BLDGS	NA	b. NO. OF STORIES	NA	c. LENGTH	NA	d. WIDTH	NA
e. DESIGN CAPACITY	NA			f. GROSS AREA	NA		
g. COOLING	NA	CAP.	NA	COST ($	NA)		

19. DESCRIPTION OF WORK TO BE DONE

Aerial spraying by helicopter of woody vegetation (deciduous) along the Haines-Fairbanks POL Pipeline from Pipeline Milepost 42.5 through 337.5, a total of 1329 acres.

METHOD: ☐ POST ENGR ☒ CONTRACT ☐ TROOP

SECTION B - COST ESTIMATES

20. PRIMARY FACILITY	U/M	QUANTITY	UNIT COST	COST ($000)
Aerial Spraying		1329	$ 71.62	$ 95.2
a. S & A Cost		( )		4.7
b. Contingency		( )		9.5
c.		( )		
d.		( )		
21. SUPPORTING FACILITIES				$
a.				
b.				
c.				
d.				
e.				
f.				
g.				
h.				
i. TOTAL UNFUNDED COST				1.5
j. TOTAL FUNDED COST				109.4
22. TOTAL LINE ITEM COST				$ 110.9

SECTION C - BASIS OF REQUIREMENT

23. QUANTITATIVE DATA (U/M Acres)		
a. TOTAL REQUIREMENT	1431	
b. EXISTING SUBSTANDARD	(1329)	
c. EXISTING ADEQUATE	102	
d. FUNDED, NOT IN INVENTORY	0	
e. ADEQUATE ASSETS (c + d)	102	
	AUTHORIZED	FUNDED
f. UNFUNDED PRIOR AUTHORIZATION	0	
g. INCLUDED IN FY ____ PROGRAM	0	0
h. DEFICIENCY (a - e - f - g)	1329	0

24. RELATED LINE ITEMS

a. INITIAL COST	$10,903,200
b. REPLACEMENT COST	15,576,600

25. REQUIREMENT FOR LINE ITEM

This item is required to provide control of woody vegetation (trees, brush and sprouts) along the POL Pipeline Right-of-Way from the South Canadian Border at Pipeline Milepost 42.5 to the North Canadian Border at Pipeline Milepost 337.5. Application of the Herbicide will be by helicopter equipped with a boom type dispenser capable of applying a thick granular appearing mixture. The designated areas will be given two primary treatments, one half the spray volume being applied in one direction and the other half in the opposite direction. The center 40-foot section of the 50-foot wide right-of-way is to be aerial sprayed with a maximum allowance of 5 feet for wind drift.

SUBMITTED BY: 30 OCT 1968 (DATE) — RAYMOND P. RUGANI, LTC, OMC, Chief, PDO ENGINEER

APPROVED BY: 3 Jan 68 (DATE) — WILLIAM R. JOHNSTON, COL, TC, (SIGNATURE ON COMPUTER)

DD FORM JUL 62 1391 OVERPRINT

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1. DATE	2. FISCAL YEAR	3. DEPARTMENT	4. INSTALLATION	5. POST REQUEST NO	6. PROJECT TITLE
29 Oct 63	1969	USARAL	Petroleum Distribution Office USARAL Support Command	PR 20-69	Haines-Fairbanks Pipeline Brush Control, Milepost 42.5 through 337.5, Canadian Portion.

7. ITEMIZED ESTIMATE: THIS ESTIMATE MUST INCLUDE THE TOTAL QUANTITIES AND COST OF ALL LABOR, SUPPLIES, ETC., NECESSARY TO COMPLETE THE JOB.

DESCRIPTION OF ITEMS	A. TOTAL FUNDED COST OF THE PROJECT						B. TOTAL UNFUNDED COST OF THE PROJECT					
	DIRECT LABOR	SUPPLIES (Include [illegible] equipment)				EQUIPMENT RENTAL	DIRECT LABOR	SUPPLIES (Include [illegible] equipment)				EQUIPMENT RENTAL
		UNIT	QUANTITY	UNIT COST	ITEM COST			UNIT	QUANTITY	UNIT COST	ITEM COST	
MOB & DEMOB	$3,000											
Equipment												
Helicopter						$22,000						
4,000 Gal Tank Truck						2,330						
2½ T, Stake Truck						1,452						
3/4 T, Pick-up						691						
Labor												
Pilot 1 ea.	3,520											
Truck operator 2 ea	1,964											
Material												
Herbicide, Tordon 101		GAL	3,987	8.00	31,896							
Norbak, Particulating Agent		LB	2,400	2.00	4,800							
Food & Lodging	2,450											
Insurance - Tax & Bond	1,500											
SUB TOTAL	$12,434				$36,696	$27,023						
15% Overhead	1,865				5,504	4,053						
10% Profit	1,243				3,670	2,702						
ESTIMATED CONTRACT COST	$15,542				$45,870	$33,778						
10% Contingency	1,554				4,587	3,373						
5% S & A	777				2,294	1,689						
2% Design							1,500					
TOTAL	$17,373				$52,751	$33,846	$1,500					

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ITEMIZED COST E[illegible]IMATE

FOR OFFICIAL USE ONLY

1. DATE	2. FISCAL YEAR	3. DEPARTMENT	4. INSTALLATION	5. POST REQUEST NO	5. PROJECT TITLE
29 Oct 68	1969	USARAL	Petroleum Distribution Office USARAL Support Command	PR 20-69	Haines-Fairbanks Pipeline Brush Control, Milepost 42.5 through 337.5, Canadian Portion

7. ITEMIZED ESTIMATE: THIS ESTIMATE MUST INCLUDE THE TOTAL QUANTITIES AND COST OF ALL LABOR, SUPPLIES, ETC., NECESSARY TO COMPLETE THE JOB.

DESCRIPTION OF ITEMS		A. TOTAL FUNDED COST OF THE PROJECT						B. TOTAL UNFUNDED COST OF THE PROJECT					
		DIRECT LABOR	SUPPLIES (Include installed equipment)				EQUIPMENT RENTAL	DIRECT LABOR	SUPPLIES (Include installed equipment)				EQUIPMENT RENTAL
			UNIT	QUANTITY	UNIT COST	ITEM COST			UNIT	QUANTITY	UNIT COST	ITEM COST	
SUMMARY													
Estimated Contract Cost	$95,191												
Contingency	9,519												
S & A Cost	4,760												
TOTAL EST. FUNDED COST	$109,470												
DESIGN COST	1,500												
TOTAL EST. PROJECT COST	$110,970												

USA... Form 5-2, 1 Jul 67

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US Army Corps of Engineers, Anch

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ARAEN-I

5 FEB 1969

SUBJECT: Use of Nonstandard Herbicide within Canada

Chief of Engineers
ATTN: ENGMC-FB
Department of the Army
Washington, D. C. 20315

1. The Petroleum Distribution Office, USARAL Support Command, Alaska, proposes to spray the Canadian portion of the Haines-Fairbanks pipeline right-of-way with a nonstandard herbicide formulation for brush control.

2. The project is based upon helicopter application of a thickened mixture of picloram plus 2,4-D similar to the project accomplished on the Alaska section of the pipeline during the summer of 1968. Estimated total cost for the project to spray the entire Canadian portion of the pipeline is $111,000 of which $95,000 covers the contract and $16,000 covers supervision and administration costs, contingency reserve, and engineering design costs. The project documents, including the Technical Provisions of the Specifications, Location and Vicinity Map, and Pipeline Strip Map, are forwarded as Inclosures 1, 2, and 3 respectively.

3. The project documents have been approved by the Canada Department of Agriculture, Plant Products Division, Ottawa, and the Department of Fisheries, Vancouver, B.C. The approval letters from these offices are forwarded as Inclosures 4 and 5 respectively.

4. In accordance with DA Circular 420-27, the proposed use of nonstandard material is forwarded for review by the Federal Committee on Pest Control and approval by The Surgeon General.

FOR THE COMMANDER:

5 Incl
as

ALBERT K. SWANSON
CPT, AGC
Asst Adjutant General

MFR: None

COORDINATION: See next page

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ARAEN-I (5 Feb 69) 2d Ind
SUBJECT: Use of Nonstandard Herbicide Within Canada

HEADQUARTERS, UNITED STATES ARMY, ALASKA, APO 98749 15 APR 1969

TO: Commanding Officer, USARAL Support Command, ATTN: ARCL,
US Army Forces, Alaska, APO 98749

Department of Army and Federal Committee on Pest Control approval of the proposal to spray the Canadian portion of the Haines to Fairbanks pipeline right-of-way with picloram plus 2,4-D mixture is forwarded.

FOR THE COMMANDER:

JOHN A. FULMER
1LT, AGC
Asst Adjutant General

1 Incl
wd incl 1-5

MFR: None G-4 Concur Cmo 15 Apr 69

COORDINATION: ENGR 14 Apr 69
COL LEON J. HAMERLY
DEP ENGR
LTC J. M. KILGOUR
INST 14 Apr
MR. E. J. RYAN
B&G 14 April
MR. O. V. KOLA
R&G 14 Apr '69
MR. J. L. EASTERDAY

ENGINEER RECORD COPY

AXYS | Axys Analytical Services Ltd

POST OFFICE BOX 2219, 2045 MILLS ROAD, SIDNEY, BRITISH COLUMBIA, CANADA V8L 3S8

TEL (604) 656-0881
FAX (604) 656-8250

December 10, 1993

Mr. David Peerla
Indian and Northern Affairs Canada
Suite 2600
650 West Georgia Street
Vancouver, B.C.
V6B 4N9

Dear Mr. Peerla:

The results of chlorinated dioxin and furan analyses of soil and fish from Klukshu (Haynes Junction), Yukon were reported to you last month. We have examined these results and compared them to typical data we have obtained on similar samples from other locations.

The soil sample contains elevated concentrations of 2,3,7,8-T_4CDD and lower concentrations of 2,3,7,8-T_4CDF. Most other dioxin/furan congeners were not detected. This is not typical of "background" soil samples in which 2,3,7,8-T_4CDD is usually not detected. OCDD is typically the most abundant congener in background samples, followed by H_7CDD. The observed data is consistent with 2,4,5-T (contaminated with 2,3,7,8-T_4CDD) being the source of the dioxin/furan contamination but it can not be said for certain that this is the source.

The burbot liver contains low concentrations of 2,3,7,8-T_4CDF and some pentachlorinated furans. This pattern appears unrelated to that observed in the soil and is more typical of [redacted] fish tissue from northern regions.

We can offer a few suggestions of other work which could be conducted to further answer your questions concerning the source and extent of contamination.

Soil was collected from a location on the pipeline right of way where it is believed that 2,4,5-T was not sprayed. This material is stored in our freezer and could be analyzed.

...../2

Soil was collected from a location on the pipeline right of way where it is believed that 2,4,5-T was sprayed but where there is more vegetation than at the location of the analyzed soil. This material is also in our freezer.

It was evident that a road grader had been at the site moving soil around. Soil was collected from the top of the berm created by this movement.

The burbot liver could be analyzed for other long range transport contaminants (organochlorines generally i.e., toxaphene, PCBs, chlordanes, DDTs, etc.) to provide support for the theory that this is the source of its 2,3,7,8-T_4CDF.

All of these suggestions are based on materials we have on hand. Of course more extensive surveys could be carried out to determine the extent of the soil contamination. The blood or adipose tissue of the residents of the area could also be analyzed for dioxin/furan content to determine whether they have been exposed.

These are some very general comments which I hope you will find useful.

Sincerely,
AXYS ANALYTICAL SERVICES LTD.

MCHamilton

M. COREEN HAMILTON, Ph.D.
Vice-president

FACSIMILE

from

INSTITUTE OF ENVIRONMENTAL CHEMISTRY

Prof. Christoffer Rappe
TEL: +46-90165266
FAX: +46-90186155
UNIVERSITY OF UMEÅ
S-901 87 UMEÅ
SWEDEN

DATE: November 10, 1993

To: Dr. David Peerla
Indian and Northern Affairs Canada
Vancouver BC Canada

Message: Dear Dr. Peerla,

Many thanks for your fax this morning concerning Dioxin/Furan Test Results.

Soil data

I find the pattern very unusual. Normally the 2,3,7,8-tetraCDD is below the detection limit, while higher chlorinated dioxins and furans can be detected, especially octaCDD. In my opinion, the reported pattern is a clear indication of a specific source of the 2,3,7,8-tetraCDD or in other words the 2,4,5,-T.

Fish data

We have analyzed some samples of burbot liver from the northern part of the Bothnian Bay. The dominating congener is 2,3,7,8-tetraCDF, and also some 2,3,4,7,8-pentaCDF. Most of this undergoes long range aereal transport, and I think this is the reason why you could find them in this sample of pooled burbot livers. This is also in agreement with the earlier data on toxaphene, dieldrin and chlordane from the Lower Mackenzie River.

Sincerely yous Christoffer Rappe

Number of pages (including this coverpage): 2

most toxic form of dioxin.
Finding the pattern of dioxin/furan contamination in the soil at Klukshu that was found. I think it is reasonable to conclude that the herbicide Esteron, a 2,4-D/2,4,5-T mixture contaminated with the 2,3,7,8-tetraCD[dioxin] was applied to the pipeline at Lot 22, Klukshu.

Appendix 3: PCDD/F Data for Fish Tissue, Small Mammals, Sediments and Air Analysed from Klukshu Camp and Klukshu Lake, 1997 and 1998

KLUKSHU LAKE ENVIRONMENTAL STUDY

Results of Analysis Performed by Axys Analytical Services for PCDD/F

MDA Sample No.	Proc. Blank	Spiked Matrix		3211	3214	3216	3220	3223			
Batch ID No.	DX-1768	DX-943	9745-02	9745-03	9745-04	9745-05	9745-06	9745-07	9745-08	9745-09
Sample Type	NA	NA	Sockeye	Sockeye	Sockeye	Chinook	Chinook	Chipmunk	Composite #1	Composite # 2
Matrix Type	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Date of Sample	NA	NA						Sept. 24/97	Sept. 24/97	Sept. 24/97
Location of Sample	NA	NA						Pipeline Rt. Of	Pipeline Rt. Of	Pipeline Rt. Of Way
Date of analysis	May 11/98	May 11/98	May 11/98	May 11/98	May 11/98	May 11/98	May 11/98	May 11/98	May 11/98	May 11/98
Sample Size (g)	10.0	10.0	11.0 g wet	10.9 g wet	10.9 g wet	10.5 g wet	11.0 g wet	9.93 g wet	10.3 g wet	11.0 g wet
% Lipid	NA	NA	1.6	1.0	1.9	1.3	1.4	3.3	3.3	4.3
Method No.	DX-T-02/Ver.2	DX-T-03/Ver.2	DX-T-03/Ver.2	DX-T-03/Ver.2	DX-T-03/Ver.2	DX-T-03/Ver.2	DX-T-03/Ver.2	DX-T-03/Ver.2	DX-T-03/Ver.2	DX-T-03/Ver.2
Instrument	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS
Dioxins (pg/g) (SDL)										
T4CDD - Total	ND {0.2}		0.2 {0.1}	ND {0.1}	0.2 {0.1}	ND {0.1}	ND {0.1}	ND {0.2}	1.4 {0.1}	ND {0.1}
2,3,7,8	ND {0.2}	1.7 [1.8]a (94%)b	ND {0.1}	ND {0.1}	ND {0.1}	ND {0.1}	ND {0.1}	ND {0.2}	1.4 {0.1}	ND {0.1}
P5CDD - Total	ND {0.2}		ND {0.1}	ND {0.1}	ND {0.1}	ND {0.1}	ND {0.1}	ND {0.2}	ND {0.1}	ND {0.1}
1,2,3,7,8	ND {0.2}	5.4 [5.0] (108%)	ND {0.1}	ND {0.1}	ND {0.1}	ND {0.1}	ND {0.1}	ND {0.2}	ND {0.1}	ND {0.1}
H6CDD - Total	ND {0.3}		ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}
1,2,3,4,7,8	ND {0.3}	5.2 [5.4] (96%)	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}
1,2,3,6,7,8	ND {0.3}	5.7 [5.0] (114%)	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}
1,2,3,7,8,9	ND {0.3}	4.8 [5.2] (92%)	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}
H7CDD - Total	ND {0.5}		ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}
1,2,3,4,6,7,8	ND {0.5}	3.8 [4.4] (86%)	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}
O8CDD - Total	ND {0.8}	7.0 [7.4] (95%)	ND {0.7}	ND {0.7}	ND {0.7}	ND {0.8}	ND {0.7}	ND {0.8}	1.0 {0.8}	ND {0.7}
PCDD Total										
Furans (pg/g) (SDL)										
T4CDF - Total	ND {0.2}		0.3 {0.1}	0.2 {0.1}	0.4 {0.1}	0.5 {0.1}	0.5 {0.1}	ND {0.2}	ND {0.1}	ND {0.1}
2,3,7,8	ND {0.2}	4.5 [4.4] (102%)	0.3 {0.1}	0.2 {0.1}	NDR(0.3) {0.1}	0.5 {0.1}	0.5 {0.1}	ND {0.2}	ND {0.1}	ND {0.1}
P5CDF - Total	ND {0.2}		ND {0.1}	ND {0.1}	ND {0.1}	0.1 {0.1}	ND {0.1}	ND {0.2}	ND {0.1}	ND {0.1}
1,2,3,7,8	ND {0.2}	5.0 [4.6] (109%)	ND {0.1}	ND {0.1}	ND {0.1}	ND {0.1}	ND {0.1}	ND {0.2}	ND {0.1}	ND {0.1}
2,3,4,7,8	ND {0.2}	5.5 [4.6] (120%)	ND {0.1}	ND {0.1}	NDR(0.1) {0.1}	0.1 {0.1}	NDR(0.2) {0.1}	ND {0.2}	ND {0.1}	ND {0.1}
H6CDF - Total	ND {0.3}		ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}
1,2,3,4,7,8	ND {0.3}	4.8 [4.6] (104%)	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}
1,2,3,6,7,8	ND {0.3}	5.3 [4.6] (115%)	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}
2,3,4,6,7,8	ND {0.3}	5.0 [4.6] (109%)	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}
1,2,3,7,8,9	ND {0.3}	5.4 [4.6] (117%)	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}	ND {0.3}
H7CDF - Total	ND {0.5}		ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}
1,2,3,4,6,7,8	ND {0.5}	4.5 [5.2] (87%)	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}
1,2,3,4,7,8,9	ND {0.5}	5.5 [4.6] (120%)	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}	ND {0.5}
O8CDF - Total	ND {0.8}	8.6 [7.4] (116%)	ND {0.7}	ND {0.7}	ND {0.7}	ND {0.8}	ND {0.7}	ND {0.8}	ND {0.8}	ND {0.7}
Total PCDF										
	% Recovery									
Surrogate Standards										
13C-T4CDF	64	72	71	74	71	72	76	68	69	83
13C-T4CDD	70	67	77	79	86	79	79	72	74	85
13C-P5CDF	68	64	76	75	75	74	72	69	71	83
13C-P5CDD	79	68	83	81	81	87	83	74	76	90
13C-H6CDF	85	59	76	77	74	70	78	67	64	70
13C-H6CDD	83	67	76	76	74	70	74	67	64	72
13C-H7CDF	75	51	75	71	72	69	69	64	63	69
13C-H7CDD	69	61	74	66	68	63	66	64	60	74
13C-O8CDD	61	39	68	58	63	56	55	56	49	56

SDL - sample detection limit
ND - not detected
NDR - Peak detected but did not meet quantification criteria
Note - Concentrations are recovery corrected
a - expected value
b - % recovery
Composite #1 = 2 redback voles, 1 meadow vole
Composite #2 = 5 Deer mice

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)								
2,3,7,8 - TCDD TEQs (ND = 1/2 DL)	0.25 pg/g	0.24	0.22	0.29	0.27	0.33	1.6	0.22
2,3,7,8 - TCDD TEQs (ND = 0)	0.03 pg/g	0.02	0	0.1	0.05	0	1.4	0

KLUKSHU LAKE ENVIRC

Results of Analysis Perfo

MDA Sample No.	MDA PUF Blank	Proc. Blank	812-98-P1a&b	812-98-P1a&b	812-98-P2a&b	812-98-P2a&b	812-98-P2a&b	812-98-P3a&b	812-98-P3a&b	812-98-P3a&b	
Batch ID No.	DX-P-BLK 1749	DX-PF-BLK 1833	9745-10	9745-10	9745-11	9745-11	9745-11	9745-12	9745-12	9745-12	
Sample Type	PUF Proc. Blank	PUF Blank	PUF &Filter Fiek	PUF &Filter Fiek	Clean Wood	Clean Wood	Clean Wood	Pipeline Wood	Pipeline Wood	Pipeline Wood	
Matrix Type	High-Vol. Air	High-vol. Air	High-vol. Air	High-vol. Air	High-vol. Air	High-vol. Air	High-vol. Air	High-vol. Air	High-vol. Air	High-vol. Air	
Date of Sample	NA	NA	Mar. 11/98	Mar. 11/98	March 12/98	March 12/98	March 12/98	Mar. 12-13/98	Mar. 12-13/98	Mar. 12-13/98	
Location of Sample	NA	NA	Klukshu Camp	Klukshu Camp	Klukshu Camp	Klukshu Camp	Klukshu Camp	Klukshu Camp	Klukshu Camp	Klukshu Camp	
Date of analysis	Mar. 10/98	Aug. 20/98	Aug. 20/98	Aug. 20/98	Aug. 20/98	Aug. 20/98	Aug. 20/98	Aug. 20/98	Aug. 20/98	Aug. 20/98	
Sample Size (g)	1.0	1.0	1	1	1	1	1	1	1	1	
% Lipid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	% Moisture
Method No.	DX--PUF-01/Ver.3	DX-PF-01/Ver.3	DX-PF-01/Ver.3	DX-PF-01/Ver.3	DX-PF-01/Ver.3	DX-PF-01/Ver.3	DX-PF-01/Ver.3	DX-PF-01/Ver.3	DX-PF-01/Ver.3	DX-PF-01/Ver.3	
Instrument	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	
							Field Blank Corrected			Field Balnk Corrected	

Dioxins (pg/g) {SDL}	pg/PUF	pg/PUF	pg/PUF	Concentration (258 m3) pg/m3	pg/PUF	Concentration (144 m3) pg/m3	pg/m3	pg/PUF	Concentration (144 m3) pg/m3	pg/m3
T4CDD - Total	ND {0.3}	ND {0.3}	ND {0.3}	ND	1.1 {0.3}	0.008	**0.008**	0.5 {0.3}	0.003	**0.003**
2,3,7,8	ND {0.3}	ND {0.3}	ND {0.3}	ND	ND {0.3}	ND	ND	ND {0.3}	ND	ND
P5CDD - Total	ND {0.4}	ND {0.2}	ND {0.2}	ND	0.5 {0.2}	0.003	**0.003**	0.2 {0.2}	0.001	**0.001**
1,2,3,7,8	ND {0.4}	ND {0.2}	ND {0.2}	ND	0.3 {0.2}	0.002	**0.002**	0.2 {0.2}	0.001	**0.001**
H6CDD - Total	0.5 {0.4}	ND {0.2}	0.3 {0.2}	0.001	5.1 {0.2}	0.035	**0.034**	1.0 {0.2}	0.007	**0.006**
1,2,3,4,7,8	ND {0.4}	ND {0.2}	ND {0.2}	ND	0.3 {0.2}	0.002	**0.002**	ND {0.2}	ND	ND
1,2,3,6,7,8	ND {0.4}	ND {0.2}	ND {0.2}	ND	0.7 {0.2}	0.005	**0.005**	ND {0.2}	ND	ND
1,2,3,7,8,9	0.5 {0.4}	ND {0.2}	NDR(0.3) {0.2}	ND	0.8 {0.2}	0.006	**0.006**	NDR(0.4) {0.2}	ND	ND
H7CDD - Total	ND {0.8}	ND {0.2}	3.2 {0.2}	0.012	9.3 {0.2}	0.065	**0.053**	3.4 {0.2}	0.024	**0.011**
1,2,3,4,6,7,8	ND {0.8}	NDR(0.9) {0.2}	1.6 {0.2}	0.006	5.3 {0.2}	0.037	**0.031**	1.7 {0.2}	0.012	**0.006**
O8CDD - Total	2.5 {0.6}	4.3 {0.8}	9.5 {0.8}	0.037	20 {0.8}	0.139	**0.102**	6.9 {0.8}	0.048	**0.011**
PCDD Total				0.050			**0.200**			**0.032**

Furans (pg/g) {SDL}										
T4CDF - Total	ND {0.3}	ND {0.2}	0.3 {0.2}	0.001	3.3 {0.2}	0.023	**0.022**	0.3 {0.2}	0.002	**0.001**
2,3,7,8	ND {0.3}	ND {0.2}	0.3 {0.2}	0.001	0.8 {0.2}	0.006	**0.004**	0.3 {0.2}	0.002	**0.001**
P5CDF - Total	ND {0.4}	ND {0.2}	ND {0.2}	ND	1.3 {0.2}	0.009	**0.009**	ND {0.2}	ND	ND
1,2,3,7,8	ND {0.4}	ND {0.2}	ND {0.2}	ND	NDR(0.2) {0.2}	ND	ND	ND {0.2}	ND	ND
2,3,4,7,8	ND {0.4}	ND {0.2}	ND {0.2}	ND	NDR(0.3) {0.2}	ND	ND	ND {0.2}	ND	ND
H6CDF - Total	ND {0.3}	ND {0.3}	0.9 {0.3}	0.003	2.5 {0.3}	0.017	**0.014**	0.3 {0.3}	0.002	ND
1,2,3,4,7,8	NDR(0.5) {0.3}	ND {0.3}	0.4 {0.3}	0.002	0.4 {0.3}	0.003	**0.001**	ND {0.3}	ND	ND
1,2,3,6,7,8	ND {0.3}	ND {0.3}	ND {0.3}	ND	NDR(0.4) {0.3}	ND	ND	ND {0.3}	ND	ND
2,3,4,6,7,8	ND {0.3}	ND {0.3}	ND {0.3}	ND	0.4 {0.3}	0.003	**0.003**	ND {0.3}	ND	ND
1,2,3,7,8,9	NDR(0.5) {0.3}	ND {0.3}	ND {0.3}	ND	0.4 {0.3}	0.003	**0.003**	ND {0.3}	ND	ND
H7CDF - Total	1.6 {1.4}	ND {0.4}	1.9 {0.4}	0.007	2.0 {0.4}	0.014	**0.007**	0.5 {0.4}	0.003	ND
1,2,3,4,6,7,8	ND {1.4}	ND {0.4}	1.1 {0.4}	0.004	1.1 {0.4}	0.008	**0.003**	0.5 {0.4}	0.003	ND
1,2,3,4,7,8,9	1.6 {1.4}	ND {0.4}	ND {0.4}	ND	0.4 {0.4}	0.003	**0.003**	ND {0.4}	ND	ND
O8CDF - Total	1.1 {0.6}	ND {0.8}	2.2 {0.8}	0.009	1.2 {0.8}	0.008	ND	ND {0.8}	ND	ND
Total PCDF				0.021			0.051			0.001

Surrogate Standards							
13C-T4CDF	93	70	82		69	82	
13C-T4CDD	100	74	86		74	89	
13C-P5CDF	93	83	70		62	74	
13C-P5CDD	120	73	75		64	78	
13C-H6CDF	130	80	82		74	86	
13C-H6CDD	110	80	86		75	87	
13C-H7CDF	130	67	80		61	78	
13C-H7CDD	120	68	81		63	78	
13C-O8CDD	140	63	89		60	82	

SDL - sample detection li									
ND - not detected									
NDR - Peak detected but			0.4	0.33	0.8	0.22	0.5		0.31
meet quantification criteri									
Note - Concentrations are			0.1	0.00	0.6	0.01	0.2		0.00
a - expected value									
b - % recovery		Hours Operated	21.5		12		12		
Composite #1 = 2 redbac		Air Vol (0.2 m3/m	258		144		144		
Composite #2 = 5 Deer m									

KLUKSHU LAKE ENVIRC

Results of Analysis Perfor

	60D 17' 58"N 137D 00'00"W		1971-86	1953-71			1986-97	1910-32
MDA Sample No.	NA	NA	812-98-2 (2-4)	812-98-3 (4-6)	NA	NA	812-98-1(0-2)	812-98-5(8-10)
Batch ID No.	DX-S-BLK 1874	DX-S-SPM	9745-14	9745-15	DX-S-BLK 1895	DX-S-SPM 1053	9745-13	9745-16
Sample Type	Proc. Blank	Spike Matrix	Sediment Core	Sediment Core	Proc. Blank	Spike Matrix	Sediment Core	Sediment Core
Matrix Type	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Date of Sample			March 12/98	March 12/98			March 12/98	March 12/98
Location of Sample			Klukshu L.	Klukshu L.			Klukshu L.	Klukshu L.
Date of analysis	Aug. 19/98	Aug. 19/98	Aug. 19/98	Aug. 19/98	Oct. 30/98	Oct. 30/98	Oct. 30/98	Oct. 30/98
Sample Size (g)	10	10	5.03 g dry	5.40 g dry	10	10	4.50 g dry	5.98 g dry
% Lipid	NA	NA	52	48	NA	NA	56	41
Method No.	DX-S-01/Ver.3	DX-S-01/Ver.3	DX-S-01/Ver.3	DX-S-01/Ver.3	DX-S-01/Ver.3	DX-S-01/Ver.3	DX-S-01/Ver.3	DX-S-01/Ver.3
Instrument	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS	GC-HRMS
Dioxins (pg/g) (SDL)								
T4CDD - Total	ND {0.1}		ND {0.3}	ND {0.3}	ND {0.1}		ND {0.3}	ND {0.3}
2,3,7,8	ND {0.1}	1.8 [1.8]a (100%)b	ND {0.3}	ND {0.3}	ND {0.1}	1.8 [1.8]a (100%)b	ND {0.3}	ND {0.3}
P5CDD - Total	ND {0.1}		ND {0.3}	ND {0.3}	ND {0.1}		ND {0.3}	ND {0.3}
1,2,3,7,8	ND {0.1}	5.4 [5.0] (108%)	ND {0.3}	ND {0.3}	ND {0.1}	5.2 [5.0] (104%)	ND {0.3}	ND {0.3}
H6CDD - Total	ND {0.2}		ND {0.6}	ND {0.6}	ND {0.3}		ND {0.7}	ND {0.5}
1,2,3,4,7,8	ND {0.2}	5.6 [5.4] (104%)	ND {0.6}	ND {0.6}	ND {0.3}	5.0 [5.4] (93%)	ND {0.7}	ND {0.5}
1,2,3,6,7,8	ND {0.2}	4.7 [5.0] (94%)	ND {0.6}	ND {0.6}	ND {0.3}	4.8 [5.0] (96%)	ND {0.7}	ND {0.5}
1,2,3,7,8,9	ND {0.2}	6.1 [5.2] (117%)	ND {0.6}	ND {0.6}	ND {0.3}	3.7 [5.2] (71%)	ND {0.7}	ND {0.5}
H7CDD - Total	ND {0.3}		ND {1.0}	ND {0.9}	ND {0.5}		ND {1.1}	ND {0.8}
1,2,3,4,6,7,8	ND {0.3}	4.7 [4.4] (107%)	ND {1.0}	ND {0.9}	ND {0.5}	4.2 [4.4] (95%)	ND {1.1}	ND {0.8}
O8CDD - Total	ND {0.5}	9.3 [7.4] (126%)	1.8 {1.6}	2.0 {1.5}	ND {0.8}	8.0 [7.4] (108%)	2.1 {1.8}	NDR(1.8) {1.3}
PCDD Total								
Furans (pg/g) (SDL)								
T4CDF - Total	ND {0.1}		0.3 {0.3}	0.6 {0.3}	ND {0.1}		ND {0.3}	ND {0.3}
2,3,7,8	ND {0.1}	1.8 [1.9] (95%)	ND {0.3}	ND {0.3}	ND {0.1}	1.8 [1.9] (95%)	ND {0.3}	ND {0.3}
P5CDF - Total	ND {0.1}		ND {0.3}	ND {0.3}	ND {0.1}		ND {0.3}	ND {0.3}
1,2,3,7,8	ND {0.1}	4.9 [4.6] (107%)	ND {0.3}	ND {0.3}	ND {0.1}	4.7 [4.6] (102%)	ND {0.3}	ND {0.3}
2,3,4,7,8	NDR(0.4) {0.1}	4.9 [4.6] (107%)	ND {0.3}	NDR(0.8) {0.3}	ND {0.1}	4.8 [4.6] (104%)	ND {0.3}	ND {0.3}
H6CDF - Total	ND {0.2}		ND {0.6}	ND {0.6}	ND {0.3}		ND {0.7}	ND {0.5}
1,2,3,4,7,8	ND {0.2}	5.3 [4.6] (115%)	ND {0.6}	ND {0.6}	ND {0.3}	4.9 [4.6] (107%)	ND {0.7}	ND {0.5}
1,2,3,6,7,8	ND {0.2}	5.2 [4.6] (113%)	ND {0.6}	ND {0.6}	ND {0.3}	4.8 [4.6] (104%)	ND {0.7}	ND {0.5}
2,3,4,6,7,8	ND {0.2}	5.1 [4.6] (111%)	ND {0.6}	ND {0.6}	ND {0.3}	3.8 [4.6] (83%)	ND {0.7}	ND {0.5}
1,2,3,7,8,9	ND {0.2}	6.0 [4.6] (130%)	ND {1.0}	ND {0.6}	ND {0.3}	3.2 [4.6] (70%)	ND {0.7}	ND {0.5}
H7CDF - Total	ND {0.3}		ND {1.0}	ND {0.9}	ND {0.5}		ND {1.1}	ND {0.8}
1,2,3,4,6,7,8	ND {0.3}	5.0 [4.6] (109%)	ND {1.0}	ND {0.9}	ND {0.5}	4.5 [4.6] (98%)	ND {1.1}	ND {0.8}
1,2,3,4,7,8,9	ND {0.3}	5.8 [4.6] (126%)	ND {1.0}	ND {0.9}	ND {0.5}	4.4 [4.6] (96%)	ND {1.1}	ND {0.8}
O8CDF - Total	ND {0.5}	7.9 [7.4] (107%)	ND {1.6}	ND {1.5}	ND {0.8}	8.7 [7.4] (118%)	ND {1.8}	ND {1.3}
Total PCDF								
Surrogate Standards								
13C-T4CDF	94	80	81	51	63	60	77	67
13C-T4CDD	96	92	90	60	69	60	81	65
13C-P5CDF	68	71	73	38	57	49	72	57
13C-P5CDD	62	82	79	40	57	49	75	56
13C-H6CDF	110	62	77	65	57	50	70	58
13C-H6CDD	89	63	78	49	55	46	65	55
13C-H7CDF	87	83	81	50	47	37	60	52
13C-H7CDD	75	90	81	36	45	35	57	45
13C-O8CDD	69	77	95	24	38	20	48	36
SDL - sample detection li								
ND - not detected								
NDR - Peak detected but			0.6	0.5			0.6	0.5
meet quantification criteri								
Note - Concentrations are			0	0			0	0

a - expected value
b - % recovery
Composite #1 = 2 redbac
Composite #2 = 5 Deer m

Appendix 4: PCDD/F Data for Soil, Fish Tissue and Wood Chips Collected by INAC and AXYS as Part of Previous Studies

FAX TRANSMISSION

AXYS | Axys Analytical Services Ltd

POST OFFICE BOX 2219, 2045 MILLS ROAD,
SIDNEY, BRITISH COLUMBIA, CANADA V8L 3S8

TEL (604) 656-0881
FAX (604) 656-4511

DATE: 30 January 1996 TIME: TOTAL PAGES (INCL. THIS PAGE) 11

CONTACT: Mark Palmer Batch ID: DX-1361

ORGANIZATION: Yukon College/DIAND Our File: 9514

ADDRESS: Sample: -316,317,318,319,320,321

FAX: 1-403-667-7073 PHONE:

FROM: Katharine Kaye

MESSAGE:

Attached are the results for one wood chip sample and five soil samples submitted for dioxin/furan analysis. If you have any questions, please do not hesitate to call.

Regards,

BATCH SUMMARY

Batch ID: DX-1361	***Date:*** 30 January 1996
Analysis Type: Dioxin/Furan	***Matrix Type:*** Soil/Wood Chips

BATCH MAKEUP

Samples: 9514 -316 -317 i -318 i -319 -320A -321 i	***Blank:*** DX-S-BLK 1361
	Reference or Spike: DX-S-SPM 623
	Duplicate: 9514 -320B
Comments	

ANALYSIS REPORT

POL[illegible]ORINATED DIBENZODIOXINS AND DIBENZOFURA

CLIENT SAMPLE I.D.: Spiked Matrix

CLIENT: DIAND

SAMPLE TYPE: Soil

SAMPLE SIZE: 10.0 g

AXYS FILE: DX-S-SPM 623

DATE: 30/Jan/96

METHOD NO.: DX-S-01/Ver.2

INSTRUMENT: GC-HRMS

CONCENTRATION IN: pg/g

Dioxins	Determined	Expected	% Recovery
T4CDD - Total			
2,3,7,8	1.9	1.8	106
P5CDD - Total			
1,2,3,7,8	5.5	5.0	110
H6CDD - Total			
1,2,3,4,7,8	6.0	5.4	111
1,2,3,6,7,8	5.4	5.0	108
1,2,3,7,8,9	5.2	5.2	100
H7CDD - Total			
1,2,3,4,6,7,8	5.5	5.5	100
O8CDD - Total	15	14	107

Furans	Determined	Expected	% Recovery
T4CDF - Total			
2,3,7,8	2.3	2.1	110
P5CDF - Total			
1,2,3,7,8	5.0	4.6	109
2,3,4,7,8	4.4	4.6	96
H6CDF - Total			
1,2,3,4,7,8	8.5	7.3	116
1,2,3,6,7,8	7.8	7.6	103
2,3,4,6,7,8	5.6	4.6	122
1,2,3,7,8,9	4.0	4.6	87
H7CDF - Total			
1,2,3,4,6,7,8	8.5	6.6	129
1,2,3,4,7,8,9	4.4	4.7	94
O8CDF - Total	9.2	7.8	118

Surrogate Standards	% Recovery
13C-T4CDF	67
13C-T4CDD	82
13C-P5CDF	81
13C-P5CDD	87
13C-H6CDF	82
13C-H6CDD	74
13C-H7CDF	87
13C-H7CDD	82
13C-O8CDD	51

1. Concentrations are recovery corrected

Approved

ANALYSIS REPORT

POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Procedural Blank

CLIENT: DIAND

SAMPLE TYPE: Blank

SAMPLE SIZE: 16.0 g

AXYS FILE: DX-S-BLK 1361

DATE: 30/Jan/96

METHOD NO.: DX-S-01/Ver.2

INSTRUMENT: GC-HRMS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.1	T4CDF - Total	ND	0.1
2,3,7,8	ND	0.1	2,3,7,8	ND	0.1
P5CDD - Total	ND	0.1	P5CDF - Total	ND	0.1
1,2,3,7,8	ND	0.1	1,2,3,7,8	ND	0.1
			2,3,4,7,8	ND	0.1
H6CDD - Total	ND	0.3			
1,2,3,4,7,8	ND	0.3	H6CDF - Total	ND	0.3
1,2,3,6,7,8	ND	0.3	1,2,3,4,7,8	ND	0.3
1,2,3,7,8,9	ND	0.3	1,2,3,6,7,8	ND	0.3
			2,3,4,6,7,8	ND	0.3
H7CDD - Total	ND	0.4	1,2,3,7,8,9	ND	0.3
1,2,3,4,6,7,8	ND	0.4			
			H7CDF - Total	ND	0.4
			1,2,3,4,6,7,8	ND	0.4
			1,2,3,4,7,8,9	ND	0.4
O8CDD - Total	ND	0.5	O8CDF - Total	ND	0.5

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

Surrogate Standards	% Recovery
13C-T4CDF:	58
13C-T4CDD:	78
13C-P5CDF:	70
13C-P5CDD:	60
13C-H6CDF:	69
13C-H6CDD:	67
13C-H7CDF:	65
13C-H7CDD:	64
13C-O8CDD:	74

Approved

ANALYSIS REPORT

CHLORINATED DIBENZODIOXINS AND DIBENZOFUF

HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: KLUKSHU NO GROWTH AREA OLD PIPE AUG 24/95

(presumably in spray area)

AXYS FILE: 9514-318 I

CLIENT: DIAND

DATE: 30/Jan/96

SAMPLE TYPE: Soil

METHOD NO.: DX-S-01/Ver.2

SAMPLE SIZE: 18.4 g dry

INSTRUMENT: GC-HRMS

% MOISTURE: 18

CONCENTRATION IN: pg/g

Dioxins		Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total		12	0.1	T4CDF - Total	3.1	0.1
2,3,7,8		9.0	0.1	2,3,7,8	1.3	0.1
P5CDD - Total		1.1	0.1	P5CDF - Total	0.3	0.1
1,2,3,7,8		ND	0.1	1,2,3,7,8	ND	0.1
				2,3,4,7,8	ND	0.1
H6CDD - Total		0.3	0.2			
1,2,3,4,7,8		ND	0.2	H6CDF - Total	ND	0.2
1,2,3,6,7,8		ND	0.2	1,2,3,4,7,8	ND	0.2
1,2,3,7,8,9		ND	0.2	1,2,3,6,7,8	ND	0.2
				2,3,4,6,7,8	ND	0.2
H7CDD - Total		0.5	0.3	1,2,3,7,8,9	ND	0.2
1,2,3,4,6,7,8	NDR	(0.6)	0.3			
				H7CDF - Total	0.4	0.3
				1,2,3,4,6,7,8	0.4	0.3
				1,2,3,4,7,8,9	ND	0.3
O8CDD - Total		2.7	0.4	O8CDF - Total	ND	0.4

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

Surrogate Standards	% Recovery
13C-T4CDF:	64
13C-T4CDD:	73
13C-P5CDF:	72
13C-P5CDD:	61
13C-H6CDF:	73
13C-H6CDD:	76
13C-H7CDF:	64
13C-H7CDD:	58
13C-O8CDD:	62

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 9.3 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 9.1 pg/g

Approved

ANALYSIS REPORT
'CHLORINATED DIBENZODIOXINS AND DIBENZOFU'
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: KLUKSHU INT. RIVER BED AUG 24/95

AXYS FILE: 9514-319

CLIENT: DIAND

DATE: 30/Jan/96

SAMPLE TYPE: Soil

METHOD NO.: DX-S-01/Ver.2

SAMPLE SIZE: 16.5 g dry

INSTRUMENT: GC-HRMS

% MOISTURE: 21

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	140	0.1	T4CDF - Total	15	0.1
2,3,7,8	140	0.1	2,3,7,8	11	0.1
P5CDD - Total	3.8	0.1	P5CDF - Total	3.8	0.1
1,2,3,7,8	0.1	0.1	1,2,3,7,8	0.3	0.1
			2,3,4,7,8	ND	0.1
H6CDD - Total	4.8	0.2			
1,2,3,4,7,8	ND	0.2	H6CDF - Total	0.2	0.2
1,2,3,6,7,8	ND	0.2	1,2,3,4,7,8	ND	0.2
1,2,3,7,8,9	0.3	0.2	1,2,3,6,7,8	ND	0.2
			2,3,4,6,7,8	ND	0.2
H7CDD - Total	3.2	0.3	1,2,3,7,8,9	ND	0.2
1,2,3,4,6,7,8	1.6	0.3			
			H7CDF - Total	18	0.3
			1,2,3,4,6,7,8	7.3	0.3
			1,2,3,4,7,8,9	5.8	0.3
O8CDD - Total	9.6	0.4	O8CDF - Total	0.7	0.4

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

Surrogate Standards	% Recovery
13C-T4CDF:	65
13C-T4CDD:	76
13C-P5CDF:	81
13C-P5CDD:	69
13C-H6CDF:	73
13C-H6CDD:	74
13C-H7CDF:	66
13C-H7CDD:	66
13C-O8CDD:	66

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 141.4 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 141.4 pg/g

Approved

ANALYSIS REPORT
'CHLORINATED DIBENZODIOXINS AND DIBENZOFU
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: KLUKSHU ROAD .5 METRES FROM END OF PIPE AUG 24/95

AXYS FILE: 9514-320 A

CLIENT: DIAND

DATE: 30/Jan/96

SAMPLE TYPE: Soil

METHOD NO.: DX-S-01/Ver.2

SAMPLE SIZE: 18.9 g dry

INSTRUMENT: GC-HRMS

% MOISTURE: 12

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	6.0	0.1	T4CDF - Total	0.4	0.1
2,3,7,8	7.5	0.1	2,3,7,8	0.3	0.1
P5CDD - Total	ND	0.1	P5CDF - Total	0.1	0.1
1,2,3,7,8	ND	0.1	1,2,3,7,8	ND	0.1
			2,3,4,7,8	ND	0.1
H6CDD - Total	ND	0.2			
1,2,3,4,7,8	ND	0.2	H6CDF - Total	ND	0.2
1,2,3,6,7,8	ND	0.2	1,2,3,4,7,8	ND	0.2
1,2,3,7,8,9	ND	0.2	1,2,3,6,7,8	ND	0.2
			2,3,4,6,7,8	ND	0.2
H7CDD - Total	0.9	0.3	1,2,3,7,8,9	ND	0.2
1,2,3,4,6,7,8	0.9	0.3			
			H7CDF - Total	0.3	0.3
			1,2,3,4,6,7,8	0.3	0.3
			1,2,3,4,7,8,9	ND	0.3
O8CDD - Total	6.2	0.4	O8CDF - Total	ND	0.4

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

Surrogate Standards	% Recovery
13C-T4CDF:	63
13C-T4CDD:	62
13C-P5CDF:	76
13C-P5CDD:	63
13C-H6CDF:	72
13C-H6CDD:	75
13C-H7CDF:	67
13C-H7CDD:	64
13C-O8CDD:	69

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 7.7 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 7.5 pg/g

Approved

ANALYSIS REPORT
CHLORINATED DIBENZODIOXINS AND DIBENZOFU.
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: KLUKSHU SMOKE HOUSE AUG 24/95

CLIENT: DIAND

SAMPLE TYPE: Wood Chips

SAMPLE SIZE: 1.78 g dry

% MOISTURE: 9.4

AXYS FILE: 9514-321 i

DATE: 30/Jan/96

METHOD NO.: DX-WC-01/Ver.2

INSTRUMENT: GC-HRMS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)
T4CDD - Total	21	0.9
2,3,7,8	ND	0.9
P5CDD - Total	40	1.0
1,2,3,7,8	7.6	1.0
H6CDD - Total	160	1.8
1,2,3,4,7,8	6.3	1.8
1,2,3,6,7,8	17	1.8
1,2,3,7,8,9	19	1.8
H7CDD - Total	300	2.8
1,2,3,4,6,7,8	160	2.8
O8CDD - Total	410	4.2

Furans	Concentration	(SDL)
T4CDF - Total	56	0.8
2,3,7,8	9.3	0.8
P5CDF - Total	64	1.0
1,2,3,7,8	2.9	1.0
2,3,4,7,8	4.0	1.0
H6CDF - Total	120	1.8
1,2,3,4,7,8	8.1	1.8
1,2,3,6,7,8	8.0	1.8
2,3,4,6,7,8	7.3	1.8
1,2,3,7,8,9	NDR (2.6)	1.8
H7CDF - Total	110	2.8
1,2,3,4,6,7,8	71	2.8
1,2,3,4,7,8,9	3.6	2.8
O8CDF - Total	32	4.2

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

Surrogate Standards	% Recovery
13C-T4CDF:	76
13C-T4CDD:	66
13C-P5CDF:	85
13C-P5CDD:	85
13C-H6CDF:	68
13C-H6CDD:	75
13C-H7CDF:	67
13C-H7CDD:	67
13C-O8CDD:	60

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 16.8 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 16.2 pg/g

Approved

ANALYSIS REPORT
'CHLORINATED DIBENZODIOXINS AND DIBENZOFU
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: KLUKSHU ROAD .5 METRES FROM END OF PIPE AUG 24/95

AXYS FILE: 9514-320 B
DUPLICATE

CLIENT: DIAND

DATE: 30/Jan/96

SAMPLE TYPE: Soil

METHOD NO.: DX-S-01/Ver.2

SAMPLE SIZE: 18.4 g dry

INSTRUMENT: GC-HRMS

% MOISTURE: 12

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	7.6	0.1	T4CDF - Total	0.4	0.1
2,3,7,8	7.2	0.1	2,3,7,8	0.3	0.1
P5CDD - Total	ND	0.1	P5CDF - Total	0.1	0.1
1,2,3,7,8	ND	0.1	1,2,3,7,8	ND	0.1
H6CDD - Total	ND	0.2	2,3,4,7,8	ND	0.1
1,2,3,4,7,8	ND	0.2	H6CDF - Total	ND	0.2
1,2,3,6,7,8	ND	0.2	1,2,3,4,7,8	ND	0.2
1,2,3,7,8,9	ND	0.2	1,2,3,6,7,8	ND	0.2
H7CDD - Total	0.8	0.3	2,3,4,6,7,8	ND	0.2
1,2,3,4,6,7,8	0.8	0.3	1,2,3,7,8,9	ND	0.2
			H7CDF - Total	0.3	0.3
			1,2,3,4,6,7,8	0.3	0.3
			1,2,3,4,7,8,9	ND	0.3
O8CDD - Total	4.9	0.4	O8CDF - Total	ND	0.4

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

Surrogate Standards	% Recovery
13C-T4CDF:	68
13C-T4CDD:	65
13C-P5CDF:	78
13C-P5CDD:	66
13C-H6CDF:	75
13C-H6CDD:	77
13C-H7CDF:	71
13C-H7CDD:	69
13C-O8CDD:	72

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 7.4 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 7.2 pg/g

Approved

FAX TRANSMISSION

AXYS | Axys Analytical Services Ltd

POST OFFICE BOX 2219, 2045 MILLS ROAD, SIDNEY, BRITISH COLUMBIA, CANADA V8L 3S8
TEL (604) 656-0881
FAX (604) 656-4511

DATE: 17 May 1995 TIME: TOTAL PAGES (INCL. THIS PAGE) 6

CONTACT: Mark Palmer

Batch ID: DX-1238

ORGANIZATION: D.I.A.N.D

Our File: 2776

ADDRESS:

Sample: -01,03

FAX: 1-403-667-7073 PHONE:

FROM: Dale Hoover

MESSAGE:

Attached are the results for two tissue samples submitted for dioxin/furan analysis. If you have any questions, please do not hesitate to call.

Regards,

Note: this is a repeat fax, with a correction on the spiked matrix.
I apologize for the inconvenience,
KKey

BATCH SUMMARY

Batch ID: DX-1238	***Date:*** 17 May 1995
Analysis Type: Dioxin/Furan	***Matrix Type:*** Tissue

BATCH MAKEUP

Samples: 2776 -01 -03	***Blank:*** DX-T-BLK 1238B
	Reference or Spike: DX-T-SPM 523A
	Duplicate:

Comments

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Spiked Matrix

CLIENT: D.I.A.N.D.

SAMPLE TYPE: Tissue

SAMPLE SIZE: 10.0 g

AXYS FILE: DX-T-SPM 523A

DATE: 17/May/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Determined	Expected	% Recovery
T4CDD - Total			
2,3,7,8	2.0	1.8	110
P5CDD - Total			
1,2,3,7,8	5.2	5.0	100
H6CDD - Total			
1,2,3,4,7,8	5.0	5.4	93
1,2,3,6,7,8	5.2	5.0	100
1,2,3,7,8,9	4.8	5.2	92
H7CDD - Total			
1,2,3,4,6,7,8	4.6	4.4	100
O8CDD - Total	8.4	8.0	110

Furans	Determined	Expected	% Recovery
T4CDF - Total			
2,3,7,8	4.4	4.4	100
P5CDF - Total			
1,2,3,7,8	4.7	4.6	100
2,3,4,7,8	4.5	4.6	100
H6CDF - Total			
1,2,3,4,7,8	6.7	7.3	92
1,2,3,6,7,8	6.6	7.6	87
2,3,4,6,7,8	5.7	4.6	120
1,2,3,7,8,9	4.7	4.6	100
H7CDF - Total			
1,2,3,4,6,7,8	5.2	6.0	87
1,2,3,4,7,8,9	4.2	4.7	89
O8CDF - Total	9.3	8.4	110

Surrogate Standards	% Recovery
13C-T4CDF:	94
13C-T4CDD:	80
13C-P5CDF:	92
13C-P5CDD:	99
13C-H6CDF:	92
13C-H6CDD:	92
13C-H7CDF:	90
13C-H7CDD:	78
13C-O8CDD:	59

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Procedural Blank

CLIENT: D.I.A.N.D.

SAMPLE TYPE: Blank

SAMPLE SIZE: 8.00 g

AXYS FILE: DX-T-BLK 1238B

DATE: 17/May/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.2	T4CDF - Total	ND	0.2
2,3,7,8	ND	0.2	2,3,7,8	ND	0.2
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	ND	0.4			
1,2,3,4,7,8	ND	0.4	H6CDF - Total	ND	0.4
1,2,3,6,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4
1,2,3,7,8,9	ND	0.4	1,2,3,6,7,8	ND	0.4
			2,3,4,6,7,8	ND	0.4
H7CDD - Total	ND	0.6	1,2,3,7,8,9	ND	0.4
1,2,3,4,6,7,8	ND	0.6			
			H7CDF - Total	ND	0.6
			1,2,3,4,6,7,8	ND	0.6
			1,2,3,4,7,8,9	ND	0.6
O8CDD - Total	ND	1.0	O8CDF - Total	ND	1.0

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria .

Surrogate Standards	% Recovery
13C-T4CDF:	86
13C-T4CDD:	79
13C-P5CDF:	89
13C-P5CDD:	83
13C-H6CDF:	90
13C-H6CDD:	88
13C-H7CDF:	78
13C-H7CDD:	66
13C-O8CDD:	54

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: .Composite A 5013,5029,5009,5021,5018

CLIENT: D.I.A.N.D.

SAMPLE TYPE: Tissue

SAMPLE SIZE: 10.1 g wet

Kluk Shu LT

(LT = Lake Trout)

AXYS FILE: 2776-01

DATE: 17/May/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.1	T4CDF - Total	0.1	0.1
2,3,7,8	ND	0.1	2,3,7,8	0.1	0.1
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	ND	0.3			
1,2,3,4,7,8	ND	0.3	H6CDF - Total	ND	0.3
1,2,3,6,7,8	ND	0.3	1,2,3,4,7,8	ND	0.3
1,2,3,7,8,9	ND	0.3	1,2,3,6,7,8	ND	0.3
			2,3,4,6,7,8	ND	0.3
H7CDD - Total	ND	0.5	1,2,3,7,8,9	ND	0.3
1,2,3,4,6,7,8	ND	0.5			
			H7CDF - Total	ND	0.5
			1,2,3,4,6,7,8	ND	0.5
			1,2,3,4,7,8,9	ND	0.5
O8CDD - Total	ND	0.7	O8CDF - Total	ND	0.7

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	78
13C-T4CDD:	63
13C-P5CDF:	71
13C-P5CDD:	61
13C-H6CDF:	68
13C-H6CDD:	66
13C-H7CDF:	61
13C-H7CDD:	53
13C-O8CDD:	30

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.3 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Composite C 5007,5005,5011,5023

CLIENT: D.I.A.N.D.

SAMPLE TYPE: Tissue

SAMPLE SIZE: 10.3 g wet

KLUKSH - LT

AXYS FILE: 2776-03

DATE: 17/May/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.1	T4CDF - Total	0.2	0.1
2,3,7,8	ND	0.1	2,3,7,8	0.2	0.1
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	ND	0.3			
1,2,3,4,7,8	ND	0.3	H6CDF - Total	ND	0.3
1,2,3,6,7,8	ND	0.3	1,2,3,4,7,8	ND	0.3
1,2,3,7,8,9	ND	0.3	1,2,3,6,7,8	ND	0.3
			2,3,4,6,7,8	ND	0.3
H7CDD - Total	ND	0.5	1,2,3,7,8,9	ND	0.3
1,2,3,4,6,7,8	ND	0.5			
			H7CDF - Total	ND	0.5
			1,2,3,4,6,7,8	ND	0.5
			1,2,3,4,7,8,9	ND	0.5
O8CDD - Total	ND	0.7	O8CDF - Total	ND	0.7

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	100
13C-T4CDD:	86
13C-P5CDF:	100
13C-P5CDD:	92
13C-H6CDF:	100
13C-H6CDD:	94
13C-H7CDF:	100
13C-H7CDD:	92
13C-O8CDD:	81

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.3 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

AXYS ANALYTICAL SERVICES LTD P.O. BOX 2219, 2045 MILLS RD., SIDNEY, B.C., CANADA V8L 3S8 TEL (604) 656-0881 FAX (604) 656-4511

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TEL (604) 656-0881
FAX (604) 656-4511

DATE: 05 June 1995 TIME: TOTAL PAGES (INCL. THIS PAGE) 13

CONTACT: Mark Palmer Batch ID: DX-1247

ORGANIZATION: D.I.A.N.D Our File: 2776

ADDRESS: Sample: -02,04,07,08,09,13,14,15

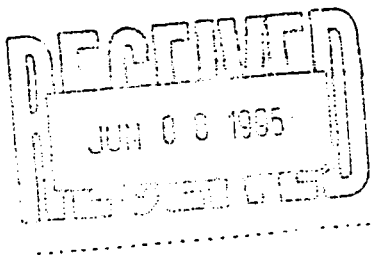
FAX: 1-403-667-7073 PHONE:

FROM: Dale Hoover

MESSAGE:

Attached are the results for eight tissue samples submitted for dioxin/furan analysis. If you have any questions, please do not hesitate to call.

Regards,



BATCH SUMMARY

Batch ID: DX-1247	***Date:*** 05 June 1995
Analysis Type: Dioxin/Furan	***Matrix Type:*** Tissue

BATCH MAKEUP

Samples: 2776 -02 -04 -07 -08 -09A -13 -14 -15	***Blank:*** DX-T-BLK 1252
	Reference or Spike: DX-T-SPM 531
	Duplicate: 2776 -09B

Comments

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Spiked Matrix

CLIENT: O.I.A.N.D.

SAMPLE TYPE: Tissue

SAMPLE SIZE: 10.0 g

AXYS FILE: DX-T-SPM 531

DATE: 05/Jun/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Determined	Expected	% Recovery
T4CDD - Total			
2,3,7,8	2.1	1.8	120
P5CDD - Total			
1,2,3,7,8	5.4	5.0	110
H6CDD - Total			
1,2,3,4,7,8	6.1	5.4	110
1,2,3,6,7,8	5.7	5.0	110
1,2,3,7,8,9	4.3	5.2	83
H7CDD - Total			
1,2,3,4,6,7,8	5.0	4.4	110
O8CDD - Total	8.3	8.2	100

Furans	Determined	Expected	% Recovery
T4CDF - Total			
2,3,7,8	4.7	4.4	110
P5CDF - Total			
1,2,3,7,8	5.1	4.6	110
2,3,4,7,8	5.1	4.6	110
H6CDF - Total			
1,2,3,4,7,8	7.4	7.3	100
1,2,3,6,7,8	7.0	7.6	92
2,3,4,6,7,8	5.2	4.6	110
1,2,3,7,8,9	3.4	4.6	70
H7CDF - Total			
1,2,3,4,6,7,8	5.7	6.0	95
1,2,3,4,7,8,9	3.4	4.7	72
O8CDF - Total	10	8.4	120

Surrogate Standards	% Recovery
13C-T4CDF:	85
13C-T4CDD:	65
13C-P5CDF:	74
13C-P5CDD:	69
13C-H6CDF:	66
13C-H6CDD:	58
13C-H7CDF:	56
13C-H7CDD:	37
13C-O8CDD:	24

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Procedural Blank

AXYS FILE: DX-T-BLK 1252

CLIENT: D.I.A.N.D.

DATE: 05/Jun/95

SAMPLE TYPE: Blank

METHOD NO.: DX-T-03/Ver.1

SAMPLE SIZE: 10.0 g

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.1	T4CDF - Total	ND	0.1
2,3,7,8	ND	0.1	2,3,7,8	ND	0.1
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	ND	0.4			
1,2,3,4,7,8	ND	0.4	H6CDF - Total	ND	0.4
1,2,3,6,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4
1,2,3,7,8,9	ND	0.4	1,2,3,6,7,8	ND	0.4
			2,3,4,6,7,8	ND	0.4
H7CDD - Total	ND	0.6	1,2,3,7,8,9	ND	0.4
1,2,3,4,6,7,8	ND	0.6			
			H7CDF - Total	ND	0.6
			1,2,3,4,6,7,8	ND	0.6
			1,2,3,4,7,8,9	ND	0.6
O8CDD - Total	ND	0.8	O8CDF - Total	ND	0.8

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	85
13C-T4CDD:	82
13C-P5CDF:	87
13C-P5CDD:	100
13C-H6CDF:	90
13C-H6CDD:	91
13C-H7CDF:	91
13C-H7CDD:	85
13C-O8CDD:	68

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Composite B 5027,5025,5001,5003,5015

AXYS FILE: 2776-02

CLIENT: D.I.A.N.D.

DATE: 05/Jun/95

SAMPLE TYPE: Tissue

Klukshu Lake Trout

METHOD NO.: DX-T-03/Ver.1

SAMPLE SIZE: 10.1 g wet

INSTRUMENT: GC-MS

% MOISTURE: 79

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.1	T4CDF - Total	0.1	0.1
2,3,7,8	ND	0.1	2,3,7,8	0.1	0.1
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	ND	0.4			
1,2,3,4,7,8	ND	0.4	H6CDF - Total	ND	0.4
1,2,3,6,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4
1,2,3,7,8,9	ND	0.4	1,2,3,6,7,8	ND	0.4
			2,3,4,6,7,8	ND	0.4
H7CDD - Total	ND	0.6	1,2,3,7,8,9	ND	0.4
1,2,3,4,6,7,8	ND	0.6			
			H7CDF - Total	ND	0.6
			1,2,3,4,6,7,8	ND	0.6
			1,2,3,4,7,8,9	ND	0.6
O8CDD - Total	ND	0.8	O8CDF - Total	ND	0.8

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	71
13C-T4CDD:	66
13C-P5CDF:	77
13C-P5CDD:	79
13C-H6CDF:	74
13C-H6CDD:	77
13C-H7CDF:	73
13C-H7CDD:	70
13C-O8CDD:	64

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.3 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Composite D 5039

CLIENT: D.I.A.N.D.

SAMPLE TYPE: Tissue

SAMPLE SIZE: 6.01 g wet

% MOISTURE: 75

KLukshu WF.

(WF = White Fish)

AXYS FILE: 2776-04

DATE: 05/Jun/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.2	T4CDF - Total	ND	0.2
2,3,7,8	ND	0.2	2,3,7,8	ND	0.2
P5CDD - Total	ND	0.4	P5CDF - Total	ND	0.4
1,2,3,7,8	ND	0.4	1,2,3,7,8	ND	0.4
			2,3,4,7,8	ND	0.4
H6CDD - Total	ND	0.6			
1,2,3,4,7,8	ND	0.6	H6CDF - Total	ND	0.6
1,2,3,6,7,8	ND	0.6	1,2,3,4,7,8	ND	0.6
1,2,3,7,8,9	ND	0.6	1,2,3,6,7,8	ND	0.6
			2,3,4,6,7,8	ND	0.6
H7CDD - Total	ND	0.8	1,2,3,7,8,9	ND	0.6
1,2,3,4,6,7,8	ND	0.8			
			H7CDF - Total	ND	0.8
			1,2,3,4,6,7,8	ND	0.8
			1,2,3,4,7,8,9	ND	0.8
O8CDD - Total	ND	1.2	O8CDF - Total	ND	1.2

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	77
13C-T4CDD:	71
13C-P5CDF:	75
13C-P5CDD:	78
13C-H6CDF:	71
13C-H6CDD:	72
13C-H7CDF:	67
13C-H7CDD:	58
13C-O8CDD:	46

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.5 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Composite G 5063

CLIENT: D.I.A.N.D.

SAMPLE TYPE: Tissue

SAMPLE SIZE: 6.39 g wet

% MOISTURE: 80

Bs Kalzas - LT
Control Site - no road access
- no pipeline nearby

AXYS FILE: 2776-07

DATE: 05/Jun/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.2	T4CDF - Total	ND	0.2
2,3,7,8	ND	0.2	2,3,7,8	ND	0.2
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	ND	0.6			
1,2,3,4,7,8	ND	0.6	H6CDF - Total	ND	0.6
1,2,3,6,7,8	ND	0.6	1,2,3,4,7,8	ND	0.6
1,2,3,7,8,9	ND	0.6	1,2,3,6,7,8	ND	0.6
			2,3,4,6,7,8	ND	0.6
H7CDD - Total	ND	0.8	1,2,3,7,8,9	ND	0.6
1,2,3,4,6,7,8	ND	0.8			
			H7CDF - Total	ND	0.8
			1,2,3,4,6,7,8	ND	0.8
			1,2,3,4,7,8,9	ND	0.8
O8CDD - Total	ND	1.2	O8CDF - Total	ND	1.2

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	76
13C-T4CDD:	65
13C-P5CDF:	69
13C-P5CDD:	68
13C-H6CDF:	63
13C-H6CDD:	58
13C-H7CDF:	50
13C-H7CDD:	38
13C-O8CDD:	24

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.4 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Composite H 5059,5047,5052

AXYS FILE: 2776-08

CLIENT: D.I.A.N.D.

DATE: 05/Jun/95

SAMPLE TYPE: Tissue

METHOD NO.: DX-T-03/Ver.1

SAMPLE SIZE: 10.7 g wet

Big K . LT.

INSTRUMENT: GC-MS

% MOISTURE: 78

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.1	T4CDF - Total	0.2	0.1
2,3,7,8	ND	0.1	2,3,7,8	0.2	0.1
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	ND	0.4			
1,2,3,4,7,8	ND	0.4	H6CDF - Total	ND	0.4
1,2,3,6,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4
1,2,3,7,8,9	ND	0.4	1,2,3,6,7,8	ND	0.4
			2,3,4,6,7,8	ND	0.4
H7CDD - Total	ND	0.6	1,2,3,7,8,9	ND	0.4
1,2,3,4,6,7,8	ND	0.6			
			H7CDF - Total	ND	0.6
			1,2,3,4,6,7,8	ND	0.6
			1,2,3,4,7,8,9	ND	0.6
O8CDD - Total	ND	0.8	O8CDF - Total	ND	0.8

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	82
13C-T4CDD:	72
13C-P5CDF:	76
13C-P5CDD:	73
13C-H6CDF:	74
13C-H6CDD:	69
13C-H7CDF:	71
13C-H7CDD:	59
13C-O8CDD:	49

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.3 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Composite I 5054,5049,5061,5045,5057

AXYS FILE: 2776-09A

CLIENT: D.I.A.N.D.

DATE: 05/Jun/95

SAMPLE TYPE: Tissue

METHOD NO.: DX-T-03/Ver.1

SAMPLE SIZE: 10.7 g wet

Bis K. L.T.

INSTRUMENT: GC-MS

% MOISTURE: 79

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.1	T4CDF - Total	0.2	0.1
2,3,7,8	ND	0.1	2,3,7,8	0.2	0.1
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	ND	0.3			
1,2,3,4,7,8	ND	0.3	H6CDF - Total	ND	0.3
1,2,3,6,7,8	ND	0.3	1,2,3,4,7,8	ND	0.3
1,2,3,7,8,9	ND	0.3	1,2,3,6,7,8	ND	0.3
			2,3,4,6,7,8	ND	0.3
H7CDD - Total	ND	0.5	1,2,3,7,8,9	ND	0.3
1,2,3,4,6,7,8	ND	0.5			
			H7CDF - Total	ND	0.5
			1,2,3,4,6,7,8	ND	0.5
			1,2,3,4,7,8,9	ND	0.5
O8CDD - Total	ND	0.7	O8CDF - Total	ND	0.7

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	62
13C-T4CDD:	56
13C-P5CDF:	56
13C-P5CDD:	56
13C-H6CDF:	58
13C-H6CDD:	52
13C-H7CDF:	49
13C-H7CDD:	39
13C-O8CDD:	29

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.3 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Composite I 5054,5049,5081,5045,5057

CLIENT: D.I.A.N.D.

SAMPLE TYPE: Tissue

SAMPLE SIZE: 9.93 g wet

% MOISTURE: 78

Bis K LT

AXYS FILE: 2776-09B
Duplicate
DATE: 05/Jun/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.1	T4CDF - Total	0.2	0.1
2,3,7,8	ND	0.1	2,3,7,8	0.2	0.1
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	ND	0.4			
1,2,3,4,7,8	ND	0.4	H6CDF - Total	ND	0.4
1,2,3,6,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4
1,2,3,7,8,9	ND	0.4	1,2,3,6,7,8	ND	0.4
			2,3,4,6,7,8	ND	0.4
H7CDD - Total	ND	0.6	1,2,3,7,8,9	ND	0.4
1,2,3,4,6,7,8	ND	0.6			
			H7CDF - Total	ND	0.6
			1,2,3,4,6,7,8	ND	0.6
			1,2,3,4,7,8,9	ND	0.6
O8CDD - Total	ND	0.8	O8CDF - Total	ND	0.8

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	82
13C-T4CDD:	69
13C-P5CDF:	78
13C-P5CDD:	78
13C-H6CDF:	72
13C-H6CDD:	65
13C-H7CDF:	62
13C-H7CDD:	49
13C-O8CDD:	38

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.3 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Sample 5069

CLIENT: D.I.A.N.D.

SAMPLE TYPE: Tissue

SAMPLE SIZE: 12.6 g wet

% MOISTURE: 77

Bisk. WF

AXYS FILE: 2776-13

DATE: 05/Jun/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.1	T4CDF - Total	ND	0.1
2,3,7,8	ND	0.1	2,3,7,8	ND	0.1
P5CDD - Total	ND	0.1	P5CDF - Total	ND	0.1
1,2,3,7,8	ND	0.1	1,2,3,7,8	ND	0.1
			2,3,4,7,8	ND	0.1
H6CDD - Total	ND	0.3			
1,2,3,4,7,8	ND	0.3	H6CDF - Total	ND	0.3
1,2,3,6,7,8	ND	0.3	1,2,3,4,7,8	ND	0.3
1,2,3,7,8,9	ND	0.3	1,2,3,6,7,8	ND	0.3
			2,3,4,6,7,8	ND	0.3
H7CDD - Total	ND	0.4	1,2,3,7,8,9	ND	0.3
1,2,3,4,6,7,8	ND	0.4			
			H7CDF - Total	ND	0.4
			1,2,3,4,6,7,8	ND	0.4
			1,2,3,4,7,8,9	ND	0.4
O8CDD - Total	ND	0.6	O8CDF - Total	ND	0.6

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	85
13C-T4CDD:	74
13C-P5CDF:	81
13C-P5CDD:	77
13C-H6CDF:	83
13C-H6CDD:	77
13C-H7CDF:	80
13C-H7CDD:	68
13C-O8CDD:	59

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.2 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Sample 5067

CLIENT: D.I.A.N.D.

SAMPLE TYPE: Tissue

SAMPLE SIZE: 7.83 g wet

% MOISTURE: 80

Bis K - WF

AXYS FILE: 2776-14

DATE: 05/Jun/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.2	T4CDF - Total	ND	0.2
2,3,7,8	ND	0.2	2,3,7,8	ND	0.2
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	ND	0.5			
1,2,3,4,7,8	ND	0.5	H6CDF - Total	ND	0.5
1,2,3,6,7,8	ND	0.5	1,2,3,4,7,8	ND	0.5
1,2,3,7,8,9	ND	0.5	1,2,3,6,7,8	ND	0.5
			2,3,4,6,7,8	ND	0.5
H7CDD - Total	ND	0.7	1,2,3,7,8,9	ND	0.5
1,2,3,4,6,7,8	ND	0.7			
			H7CDF - Total	ND	0.7
			1,2,3,4,6,7,8	ND	0.7
			1,2,3,4,7,8,9	ND	0.7
O8CDD - Total	ND	1.0	O8CDF - Total	ND	1.0

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	88
13C-T4CDD:	75
13C-P5CDF:	88
13C-P5CDD:	97
13C-H6CDF:	80
13C-H6CDD:	72
13C-H7CDF:	70
13C-H7CDD:	54
13C-O8CDD:	38

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.4 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Sample 5065

CLIENT: D.I.A.N.D.

SAMPLE TYPE: Tissue

SAMPLE SIZE: 6.63 g wet

% MOISTURE: 80

Big K WF

AXYS FILE: 2776-15

DATE: 05/Jun/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.2	T4CDF - Total	ND	0.2
2,3,7,8	ND	0.2	2,3,7,8	ND	0.2
P5CDD - Total	ND	0.3	P5CDF - Total	ND	0.3
1,2,3,7,8	ND	0.3	1,2,3,7,8	ND	0.3
			2,3,4,7,8	ND	0.3
H6CDD - Total	ND	0.6			
1,2,3,4,7,8	ND	0.6	H6CDF - Total	ND	0.6
1,2,3,6,7,8	ND	0.6	1,2,3,4,7,8	ND	0.6
1,2,3,7,8,9	ND	0.6	1,2,3,6,7,8	ND	0.6
			2,3,4,6,7,8	ND	0.6
H7CDD - Total	ND	0.9	1,2,3,7,8,9	ND	0.6
1,2,3,4,6,7,8	ND	0.9			
			H7CDF - Total	ND	0.9
			1,2,3,4,6,7,8	ND	0.9
			1,2,3,4,7,8,9	ND	0.9
O8CDD - Total	ND	1.2	O8CDF - Total	ND	1.2

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	84
13C-T4CDD:	71
13C-P5CDF:	82
13C-P5CDD:	84
13C-H6CDF:	79
13C-H6CDD:	70
13C-H7CDF:	68
13C-H7CDD:	51
13C-O8CDD:	34

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.5 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

BATCH SUMMARY

Batch ID: DX-1274	***Date:*** 18 July 1995
Analysis Type: Dioxin/Furan	***Matrix Type:*** Tissue

BATCH MAKEUP

Samples: 2776 -05 R -06 R	***Blank:*** DX-T-BLK 1274
	Reference or Spike: DX-T-SPM 557
	Duplicate:

Comments

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Spiked Matrix

AXYS FILE: DX-T-SPM 557

CLIENT: D.I.A.N.D.

DATE: 18/July/95

SAMPLE TYPE: Tissue

METHOD NO.: DX-T-03/Ver.1

SAMPLE SIZE: 10.0 g

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Determined	Expected	% Recovery
T4CDD - Total			
2,3,7,8	1.6	1.8	90
P5CDD - Total			
1,2,3,7,8	4.4	5.0	90
H6CDD - Total			
1,2,3,4,7,8	4.4	5.4	81
1,2,3,6,7,8	5.1	5.0	100
1,2,3,7,8,9	4.8	5.2	92
H7CDD - Total			
1,2,3,4,6,7,8	4.1	4.4	90
O8CDD - Total	7.2	8.8	110

Furans	Determined	Expected	% Recovery
T4CDF - Total			
2,3,7,8	4.0	4.4	91
P5CDF - Total			
1,2,3,7,8	4.8	4.6	100
2,3,4,7,8	4.5	4.6	100
H6CDF - Total			
1,2,3,4,7,8	6.4	7.3	88
1,2,3,6,7,8	6.5	7.6	86
2,3,4,6,7,8	5.2	4.6	110
1,2,3,7,8,9	4.4	4.6	100
H7CDF - Total			
1,2,3,4,6,7,8	5.2	6.0	87
1,2,3,4,7,8,9	3.8	4.7	81
O8CDF - Total	7.6	8.4	90

Surrogate Standards	% Recovery
13C-T4CDF:	69
13C-T4CDD:	63
13C-P5CDF:	70
13C-P5CDD:	72
13C-H6CDF:	63
13C-H6CDD:	62
13C-H7CDF:	58
13C-H7CDD:	56
13C-O8CDD:	45

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Procedural Blank

CLIENT: D.I.A.N.D.

SAMPLE TYPE: Blank

SAMPLE SIZE: 6.0 g

AXYS FILE: DX-T-Blk 1274

DATE: 18/July/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.2	T4CDF - Total	ND	0.2
2,3,7,8	ND	0.2	2,3,7,8	ND	0.2
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	ND	0.2			
1,2,3,4,7,8	ND	0.2	H6CDF - Total	ND	0.2
1,2,3,6,7,8	ND	0.2	1,2,3,4,7,8	ND	0.2
1,2,3,7,8,9	ND	0.2	1,2,3,6,7,8	ND	0.2
			2,3,4,6,7,8	ND	0.2
H7CDD - Total	ND	0.3	1,2,3,7,8,9	ND	0.2
1,2,3,4,6,7,8	ND	0.3			
			H7CDF - Total	ND	0.2
			1,2,3,4,6,7,8	ND	0.2
			1,2,3,4,7,8,9	ND	0.2
O8CDD - Total	ND	0.5	O8CDF - Total	ND	0.3

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	81
13C-T4CDD:	71
13C-P5CDF:	77
13C-P5CDD:	78
13C-H6CDF:	78
13C-H6CDD:	76
13C-H7CDF:	65
13C-H7CDD:	61
13C-O8CDD:	42

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.3 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Composite E 5043,5037,5041,5033

AXYS FILE: 2776-05 R

CLIENT: D.I.A.N.D.

DATE: 18/May/95

SAMPLE TYPE: Tissue

METHOD NO.: DX-T-03/Ver.1

SAMPLE SIZE: 11.9 g wet

KLUKSHU WF

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.1	T4CDF - Total	ND	0.1
2,3,7,8	ND	0.1	2,3,7,8	ND	0.1
P5CDD - Total	ND	0.1	P5CDF - Total	ND	0.1
1,2,3,7,8	ND	0.1	1,2,3,7,8	ND	0.1
			2,3,4,7,8	ND	0.1
H6CDD - Total	ND	0.2			
1,2,3,4,7,8	ND	0.2	H6CDF - Total	ND	0.3
1,2,3,6,7,8	ND	0.2	1,2,3,4,7,8	ND	0.3
1,2,3,7,8,9	ND	0.2	1,2,3,6,7,8	ND	0.3
			2,3,4,6,7,8	ND	0.3
H7CDD - Total	ND	0.3	1,2,3,7,8,9	ND	0.3
1,2,3,4,6,7,8	ND	0.3			
			H7CDF - Total	ND	0.3
			1,2,3,4,6,7,8	ND	0.3
			1,2,3,4,7,8,9	ND	0.3
O8CDD - Total	ND	0.4	O8CDF - Total	ND	0.4

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

Surrogate Standards	% Recovery
13C-T4CDF:	67
13C-T4CDD:	61
13C-P5CDF:	69
13C-P5CDD:	72
13C-H6CDF:	64
13C-H6CDD:	62
13C-H7CDF:	58
13C-H7CDD:	53
13C-O8CDD:	40

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.2 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS
HIGH RESOLUTION GC/MS

CLIENT SAMPLE I.D.: Composite F 5035,5031

CLIENT: D.I.A.N.D.

SAMPLE TYPE: Tissue

SAMPLE SIZE: 8.31 g wet

AXYS FILE: 2776-06 R

DATE: 18/May/95

METHOD NO.: DX-T-03/Ver.1

INSTRUMENT: GC-MS

CONCENTRATION IN: pg/g

Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	ND	0.1	T4CDF - Total	ND	0.1
2,3,7,8	ND	0.1	2,3,7,8	ND	0.1
P5CDD - Total	ND	0.1	P5CDF - Total	ND	0.1
1,2,3,7,8	ND	0.1	1,2,3,7,8	ND	0.1
			2,3,4,7,8	ND	0.1
H6CDD - Total	ND	0.4	H6CDF - Total	ND	0.4
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4
			1,2,3,7,8,9	ND	0.4
H7CDD - Total	ND	0.5	H7CDF - Total	ND	0.5
1,2,3,4,6,7,8	ND	0.5	1,2,3,4,6,7,8	ND	0.5
			1,2,3,4,7,8,9	ND	0.5
O8CDD - Total	ND	0.6	O8CDF - Total	ND	0.6

SDL = Sample Detection Limit
ND = Not detected
NDR = Peak detected but did not meet quantification criteria

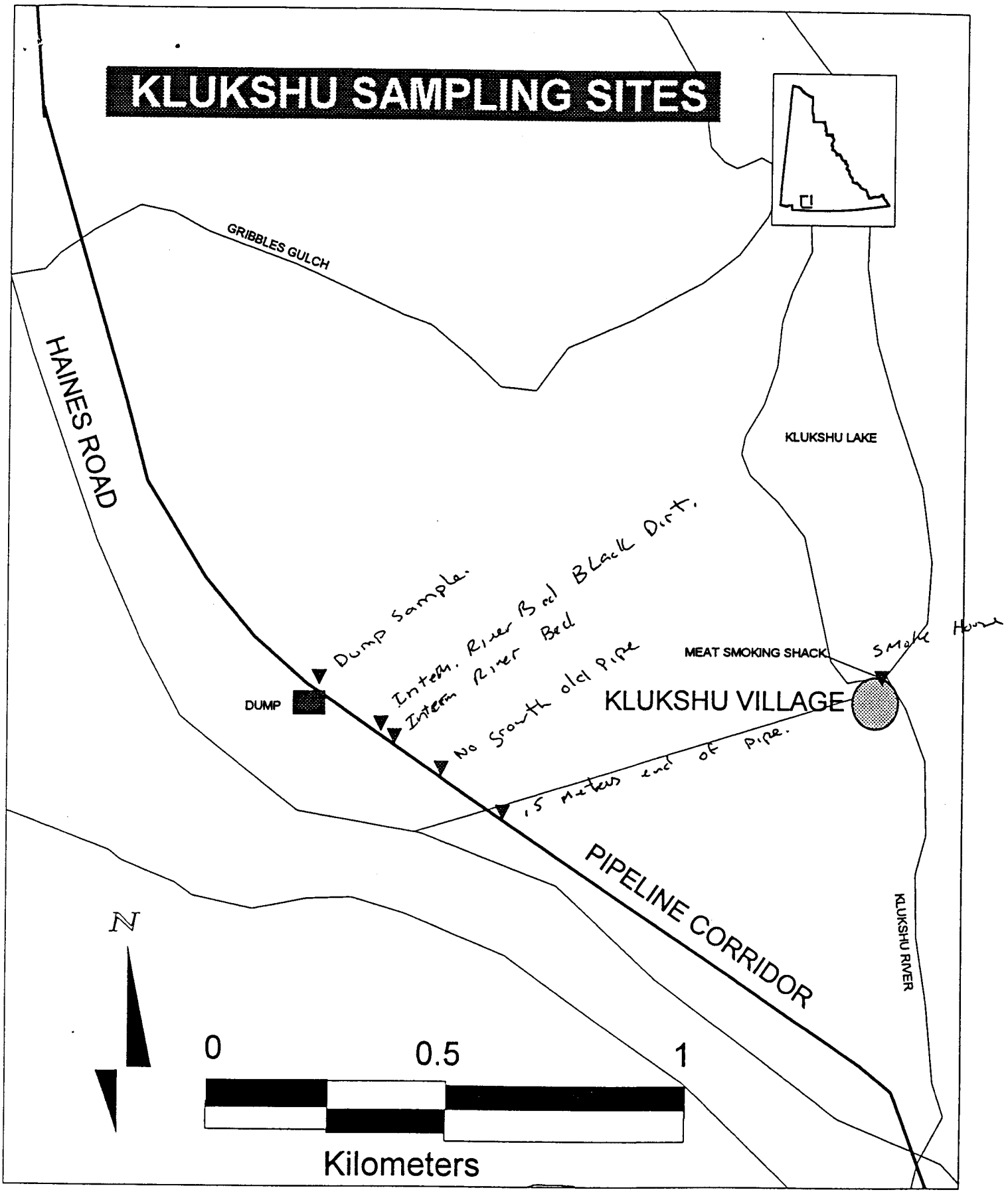
Surrogate Standards	% Recovery
13C-T4CDF:	69
13C-T4CDD:	67
13C-P5CDF:	73
13C-P5CDD:	76
13C-H6CDF:	73
13C-H6CDD:	70
13C-H7CDF:	65
13C-H7CDD:	67
13C-O8CDD:	52

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.3 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

Approved


KLUKSHU SAMPLING SITES
GRIBBLES GULCH
HAINES ROAD
KLUKSHU LAKE
Dump Sample.
Intert. River Bed Black Dirt.
Intert. River Bed
No Growth old Pipe
MEAT SMOKING SHACK
Smoke House
DUMP
KLUKSHU VILLAGE
15 Meters end of Pipe.
PIPELINE CORRIDOR
KLUKSHU RIVER
N
0
0.5
1
Kilometers

Appendix 5: Organochlorine and PCB data for Wolf Creek Snow Samples

Snow Chemistry - 1997/98		97-1	97-1	97-2	97-2	97-3	97-3	98-1	98-1	98-2	98-2	98-3	98-3	98-4	98-4	Volume	Seasonal	
ng/L	METHOD BLANK	12/04/97-12/22/97	Blank Corrected	12/22/97-12/29/97	Blank Corrected	12/30/97-01/14/98	Blank Corrected	01/14/98-01/26/98	Blank Corrected	01/26/98-02/13/98	Blank Corrected	02/13/98-03/04/98	Blank Corrected	03/04/98-04/13/98	Blank Corrected	Weighted Mean	Deposition	
Volume (L)	TOTAL NG	17		15.7		10.9		9.7		10.4		11.1		18.5		(ng/L)	ng/m2/season)	
1,3-DCB	0	0.0358	**0.0358**	0.0862	**0.0862**	0.0867	**0.0867**	0.2092	**0.2092**	0.1843	**0.1843**	0.0670	**0.0670**	0.0627	**0.0627**	0.0939	1.95	
1,4-DCB	1.4742	1.7091	**0.2349**	8.2068	**6.7326**	0.0000		16.6580	**15.1838**	0.0000		0.0000		0.0000		2.7543	**57.11**	
1,2-DCB	0.0000	0.0327	**0.0327**	0.1965	**0.1965**	0.1402	**0.1402**	0.4647	**0.4647**	0.2998	**0.2998**	0.1836	**0.1836**	0.0000	**0.0000**	0.1590	3.30	
1,3,5-TCB	0.0000	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0057	**0.0057**	0.0086	**0.0086**	0.0000	**0.0000**	0.0000	**0.0000**	0.0016	0.03	
1,2,4-TCB	0.0000	0.0296	**0.0296**	0.1714	**0.1714**	0.1922	**0.1922**	0.1684	**0.1684**	0.3414	**0.3414**	0.1140	**0.1140**	0.0607	**0.0607**	0.1379	2.86	
1,2,3-TCB	0.0000	0.0191	**0.0191**	0.0619	**0.0619**	0.1036	**0.1036**	0.0919	**0.0919**	0.1570	**0.1570**	0.0587	**0.0587**	0.0462	**0.0462**	0.0692	1.43	
1,2,3,4-TTCB	0.0000	0.0113	**0.0113**	0.0251	**0.0251**	0.0235	**0.0235**	0.0295	**0.0295**	0.0410	**0.0410**	0.0317	**0.0317**	0.0139	**0.0139**	0.0232	0.48	
PECB	0.0277	0.0907	**0.0630**	0.1080	**0.0804**	0.0505	**0.0228**	0.0476	**0.0199**	0.1128	**0.0851**	0.1255	**0.0978**	0.0570	**0.0294**	0.0567	1.18	
a-HCH	0.0000	0.2022	**0.2022**	0.3010	**0.3010**	1.1760	**1.1760**	1.7393	**1.7393**	0.5737	**0.5737**	0.3573	**0.3573**	0.5657	**0.5657**	0.6243	12.94	Sum Chlorober
HCB	0.0256	0.0245		0.0165		0.0603	**0.0347**	0.0432	**0.0176**	0.1908	**0.1652**	0.0474	**0.0218**	0.0309	**0.0053**	0.0279	0.58	68.91
g-HCH (Lindane)	0	0.1330	**0.1330**	0.3356	**0.3356**	0.7637	**0.7637**	1.0237	**1.0237**	0.4108	**0.4108**	0.2187	**0.2187**	0.2903	**0.2903**	0.4057	8.41	
Sum HCH	0.0000	0.3352	**0.3352**	0.6365	**0.6365**	1.9397	**1.9397**	2.7630	**2.7630**	0.9845	**0.9845**	0.5760	**0.5760**	0.8560		0.8603	17.84	
Heptachlor	0	0	**0.0000**	0	**0.0000**	0	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	0.00	
Aldrin	0.0000	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	0.00	
Heptachlor Epoxide	0	0.0145	**0.0145**	0.0080	**0.0080**	0.0178	**0.0178**	0.0284	**0.0284**	0.0315	**0.0315**	0.0221	**0.0221**	0.0389	**0.0389**	0.0229	0.47	
g-Chlordane	0	0.0150	**0.0150**	0.0070	**0.0070**	0.0261	**0.0261**	0.1694	**0.1694**	0.0364	**0.0364**	0.0223	**0.0223**	0.0029	**0.0029**	0.0319	0.66	
a-Endosulfan	0	0.1922	**0.1922**	0.1287	**0.1287**	0.2224	**0.2224**	0.2973	**0.2973**	0.2276	**0.2276**	0.2897	**0.2897**	0.5066	**0.5066**	0.2739	5.68	
a-Chlordane	0	0.0084	**0.0084**	0.0035	**0.0035**	0.0257	**0.0257**	0.1814	**0.1814**	0.0264	**0.0264**	0.0166	**0.0166**	0.0034	**0.0034**	0.0296	0.61	
Dieldrin	0	0.0342	**0.0342**	0.0164	**0.0164**	0.0450	**0.0450**	0.2529	**0.2529**	0.0839	**0.0839**	0.0501	**0.0501**	0.0214	**0.0214**	0.0601	1.25	
p,p-DDE	0	0.0078	**0.0078**	0.0154	**0.0154**	0.0082	**0.0082**	0.0044	**0.0044**	0.0026	**0.0026**	0.0077	**0.0077**	0.0000	**0.0000**	0.0066	0.14	
Endrin	0	0.0000	**0.0000**	0.0739	**0.0739**	0.0980	**0.0980**	0.0285	**0.0285**	0.0420	**0.0420**	0.0726	**0.0726**	0.0831	**0.0831**	0.0567	1.17	
b-Endosulfan	0	0.0034	**0.0034**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0077	**0.0077**	0.0000	**0.0000**	0.0047	**0.0047**	0.0024	0.05	
p,p-DDD	0	0.0171	**0.0171**	0.0045	**0.0045**	0.0040	**0.0040**	0.0299	**0.0299**	0.0000	**0.0000**	0.0100	**0.0100**	0.0106	**0.0106**	0.0107	0.22	
o,p-DDT	0	0.0220	**0.0220**	0.0092	**0.0092**	0.0000	**0.0000**	0.0080	**0.0080**	0.0195	**0.0195**	0.0349	**0.0349**	0.0000	**0.0000**	0.0127	0.26	Sum DDT
p,p-DDT	0	0.0431	**0.0431**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0078	0.16	0.79
Methoxychlor	0	0	**0.0000**	0	**0.0000**	0	**0.0000**	0	**0.0000**	0	**0.0000**	0	**0.0000**	0	**0.0000**	0.0000	0.00	
Mirex	0	0	**0.0000**	0.0029	**0.0029**	0.0051	**0.0051**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0000	**0.0000**	0.0011	0.02	
Internal Standards (% recovery)																		
1,3-DBB	***ND***	***47.5***		***57.8***		***77.2***		***87.7***		***99.2***		***97.1***		***106.2***				
1,3,5-TBB	ND	24.3		11.0		25.2		28.2		20.7		52.6		66.4				
1,2,4,5-TTBB	ND	19.7		13.5		28.9		39.6		17.6		49.8		57.5				
d-HCH	ND	92.3		89.5		62.9		89.5		70.8		72.9		58.0				
Endrin Ketone	***ND***	***31.7***		***18.8***		***15.3***		***29.3***		***26.1***		***19.8***		***17.2***				
PCB 30	***ND***	***104.5***		***95.3***		***101.4***		***113.9***		***103.2***		***85.1***		***85.9***				
PCB 204	***ND***	***79.5***		***93.4***		***99.1***		***103.3***		***102.0***		***110.4***		***108.7***				

PCBs

Snow Chemistry - PCBs - 1997/98		97-1	97-1	97-2	97-2	97-3	97-3	98-1	98-1	98-2	98-2	98-3	98-3	98-4	98-4
ng/L	METHOD BLANK	12/04/97-12/22/97		12/22/97-12/29/97		12/30/97-01/14/98		01/14/98-01/26/98		01/26/98-02/13/98		02/13/98-03/04/98		03/04/98-04/13/98	
Volume (L)	TOTAL NG	17		15.7		10.9		9.7		10.4		11.1		18.5	
1	0.0000	0.0166		0.0000		0.0000		0.0102		0.0103		0.0000		0.0066	
3	0.0000	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
4/10	0.0000	0.0096		0.0046		0.0000		0.0251		0.0163		0.0082		0.0113	
7/9	0.1007	0.0375		0.0471		0.0558		0.0626		0.0278		0.0268		0.0312	
6	0.0000	0.0000		0.0088		0.0052		0.0000		0.0000		0.0000		0.0048	
8/5	0.1678	0.0168		0.0228		0.0260		0.0276		0.0311		0.0231		0.0181	
19	0.0000	0.0000		0.0000		0.0000		0.0166		0.0096		0.0000		0.0000	
12/13	0	0.0000		0.0000		0.0097		0.0000		0.0059		0.0076		0.0070	
18	0.1972	0.0146		0.0170		0.0213		0.0254		0.0265		0.0229		0.0169	
15-17	0.1463	0.0173		0.0201		0.0322		0.0395		0.0389		0.0399		0.0219	
24-27	0.0000	0.0030		0.0037		0.0055		0.0048		0.0070		0.0034		0.0038	
16	0.0548	0.0060		0.0060		0.0125		0.0134		0.0125		0.0116		0.0076	
32	0.0351	0.0048		0.0027		0.0083		0.0080		0.0084		0.0093		0.0053	
54	0.0000	0.0153		0.0217		0.0220		0.0289		0.0267		0.0220		0.0158	
29	0.0251	0.0027		0.0046		0.0044		0.0061		0.0051		0.0043		0.0057	
26	0.0449	0.0108		0.0088		0.0162		0.0167		0.0208		0.0160		0.0129	
25	0.0045	0.0018		0.0019		0.0026		0.0015		0.0045		0.0017		0.0017	
31	0.0831	0.0441		0.0475		0.0805		0.0677		0.0794		0.0653		0.0465	
28-50	0.5027	0.1387		0.1327		0.2188		0.1503		0.2436		0.1801		0.1489	
33	0.0626	0.0000		0.0190		0.0062		0.0000		0.0000		0.0000		0.0031	
20	0.0667	0.0105		0.0089		0.0117		0.0120		0.0150		0.0109		0.0090	
53	0.0577	0.0067		0.0114		0.0133		0.0112		0.0193		0.0100		0.0090	
51	0.0000	0.0071		0.0053		0.0116		0.0079		0.0089		0.0076		0.0054	
22	0.0449	0.0080		0.0059		0.0071		0.0089		0.0103		0.0051		0.0054	
45	0.0417	0.0033		0.0074		0.0072		0.0088		0.0105		0.0083		0.0050	
46	0.0151	0.0027		0.0097		0.0150		0.0151		0.0136		0.0126		0.0068	
52	0.8271	0.1990		0.1889		0.2267		0.1839		0.2805		0.2526		0.1989	
49	0.0000	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
43	0.2007	0.0574		0.0530		0.0673		0.0532		0.0829		0.0818		0.0599	
47	0.0906	0.0380		0.0293		0.0443		0.0272		0.0386		0.0452		0.0288	
48	0.1385	0.0208		0.0216		0.0314		0.0289		0.0334		0.0307		0.0253	
44	0.3314	0.0394		0.0331		0.0405		0.0452		0.0696		0.0412		0.0352	
59	0.0159	0.0029		0.0024		0.0024		0.0030		0.0035		0.0036		0.0025	
42	0.0668	0.0137		0.0148		0.0160		0.0182		0.0191		0.0145		0.0137	
64-41-71	0.2795	0.0418		0.0368		0.0495		0.0465		0.0541		0.0441		0.0375	
40	0.0471	0.0016		0.0040		0.0028		0.0060		0.0059		0.0049		0.0010	
100	0.0000	0.0032		0.0046		0.0070		0.0064		0.0016		0.0055		0.0022	
63	0.0000	0.0028		0.0037		0.0053		0.0029		0.0041		0.0045		0.0053	
74	0.0000	0.0527		0.0530		0.0681		0.0451		0.0628		0.0582		0.0520	
70-76-98	0.3994	0.1556		0.1446		0.1683		0.1489		0.1717		0.1703		0.1646	
66	0.2109	0.0574		0.0659		0.0740		0.0650		0.0698		0.0654		0.0564	
95	0.5913	0.1055		0.0868		0.1048		0.1052		0.1307		0.1089		0.1063	
91	0.0782	0.0222		0.0220		0.0253		0.0257		0.0299		0.0298		0.0236	

ng/L	METHOD BLANK	2/04/97-12/22/97	12/22/97-12/29/97	12/30/97-01/14/98	01/14/98-01/26/98	01/26/98-02/13/98	02/13/98-03/04/98	03/04/98-04/13/98
Volume (L)	TOTAL NG	17	15.7	10.9	9.7	10.4	11.1	18.5
55	0.0110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
56-60	0.1433	0.0307	0.0241	0.0296	0.0273	0.0300	0.0225	0.0249
92	0.1351	0.0203	0.0226	0.0312	0.0280	0.0323	0.0310	0.0233
84	0.1390	0.0116	0.0143	0.0146	0.0238	0.0176	0.0137	0.0099
101	0.6648	0.1506	0.1599	0.2048	0.1648	0.1936	0.2095	0.1678
99	0.2100	0.0613	0.0653	0.0803	0.0579	0.0731	0.0785	0.0642
119	0.0000	0.0230	0.0258	0.0529	0.0582	0.0558	0.0558	0.0384
83	0.0196	0.0095	0.0087	0.0089	0.0071	0.0084	0.0076	0.0075
97	0.1608	0.0393	0.0378	0.0464	0.0415	0.0464	0.0430	0.0382
81	0.0000	0.0000	0.0020	0.0030	0.0000	0.0046	0.0036	0.0031
87	0.2240	0.0461	0.0485	0.0624	0.0499	0.0575	0.0526	0.0498
85	0.0999	0.0000	0.0267	0.0349	0.0308	0.0296	0.0312	0.0248
136	0.1191	0.0119	0.0141	0.0219	0.0220	0.0228	0.0204	0.0143
110	0.4045	0.0816	0.0752	0.0889	0.0872	0.0899	0.0784	0.0773
82	0.0539	0.0042	0.0037	0.0050	0.0046	0.0039	0.0033	0.0027
151	0.1414	0.0226	0.0272	0.0429	0.0382	0.0408	0.0398	0.0277
135	0.0600	0.0131	0.0175	0.0278	0.0176	0.0230	0.0221	0.0148
144	0.0357	0.0069	0.0065	0.0128	0.0064	0.0099	0.0103	0.0065
147	0.0181	0.0031	0.0042	0.0060	0.0061	0.0064	0.0055	0.0034
107	0.0248	0.0058	0.0053	0.0057	0.0059	0.0062	0.0066	0.0059
149	0.4416	0.0674	0.0773	0.1028	0.1171	0.1062	0.1048	0.0773
118	0.2158	0.0849	0.0793	0.0755	0.0721	0.0681	0.0665	0.0661
133	0.0294	0.0035	0.0066	0.0078	0.0076	0.0073	0.0078	0.0031
114	0.0110	0.0011	0.0012	0.0017	0.0015	0.0007	0.0018	0.0012
131	0.0000	0.0009	0.0015	0.0012	0.0000	0.0000	0.0000	0.0000
134	0.0000	0.0027	0.0032	0.0097	0.0160	0.0160	0.0153	0.0085
146	0.0620	0.0084	0.0119	0.0145	0.0184	0.0159	0.0162	0.0105
153	0.4266	0.0982	0.1112	0.1922	0.1855	0.1770	0.1821	0.1246
132	0.1189	0.0190	0.0197	0.0226	0.0252	0.0243	0.0188	0.0154
105	0.0917	0.0231	0.0200	0.0225	0.0202	0.0180	0.0172	0.0149
141	0.0954	0.0146	0.0179	0.0244	0.0251	0.0209	0.0229	0.0151
179	0.0721	0.0080	0.0114	0.0154	0.0149	0.0144	0.0149	0.0097
137	0.0000	0.0041	0.0051	0.0040	0.0045	0.0040	0.0054	0.0034
176	0.0222	0.0015	0.0039	0.0048	0.0037	0.0036	0.0042	0.0032
130	0.0000	0.0028	0.0046	0.0019	0.0043	0.0036	0.0060	0.0018
138-163	0.3386	0.0570	0.0653	0.0860	0.0877	0.0801	0.0771	0.0520
158	0.0522	0.0477	0.0164	0.0000	0.0084	0.0061	0.0079	0.0066
129	0.0192	0.0047	0.0028	0.0039	0.0030	0.0029	0.0030	0.0018
178	0.0338	0.0038	0.0057	0.0068	0.0075	0.0062	0.0073	0.0044
175	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0013	0.0005
187-182	0.1177	0.0216	0.0318	0.0362	0.0471	0.0424	0.0441	0.0276
183	0.0639	0.0095	0.0133	0.0163	0.0177	0.0164	0.0145	0.0090
128	0.0511	0.0060	0.0077	0.0086	0.0097	0.0074	0.0064	0.0045
167	0.0107	0.0021	0.0043	0.0057	0.0025	0.0031	0.0031	0.0006

ng/L	METHOD BLANK	12/04/97-12/22/97	12/22/97-12/29/97	12/30/97-01/14/98	01/14/98-01/26/98	01/26/98-02/13/98	02/13/98-03/04/98	03/04/98-04/13/98
Volume (L)	TOTAL NG	17	15.7	10.9	9.7	10.4	11.1	18.5
185	0.0000	0.0018	0.0026	0.0030	0.0020	0.0027	0.0034	0.0019
174	0.1915	0.0229	0.0264	0.0497	0.0374	0.0343	0.0344	0.0219
177	0.0669	0.0091	0.0135	0.0172	0.0199	0.0170	0.0161	0.0092
202-171	0.0473	0.0027	0.0067	0.0103	0.0123	0.0094	0.0108	0.0060
156	0.0273	0.0046	0.0048	0.0051	0.0077	0.0053	0.0053	0.0042
173	0.0000	0.0000	0.0017	0.0024	0.0000	0.0018	0.0016	0.0006
157-200	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
172	0.0262	0.0010	0.0029	0.0050	0.0037	0.0032	0.0023	0.0015
197	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
180	0.1837	0.0213	0.0314	0.0439	0.0479	0.0415	0.0425	0.0234
193	0.0000	0.0010	0.0017	0.0000	0.0000	0.0000	0.0000	0.0009
191	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
199	0.0000	0.0000	0.0030	0.0008	0.0017	0.0021	0.0017	0.0009
170	0.0926	0.0096	0.0141	0.0210	0.0237	0.0205	0.0213	0.0116
190	0.0983	0.0164	0.0000	0.0454	0.0456	0.0554	0.0553	0.0320
198	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
201	0.0527	0.0028	0.0066	0.0071	0.0080	0.0057	0.0073	0.0040
203-196	0.0445	0.0060	0.0085	0.0093	0.0093	0.0088	0.0100	0.0041
189	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
195	0.0000	0.0040	0.0046	0.0063	0.0028	0.0053	0.0027	0.0018
207	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
194	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
205	0.0432	0.0000	0.0008	0.0084	0.0000	0.0000	0.0000	0.0016
206	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
208	0.0000	0.0018	0.0000	0.0000	0.0000	0.0000	0.0022	0.0000
209	0.0000	0.0000	0.0000	0.0000	0.0000	0.0138	0.0191	0.0116
TcPCB	10.8821	2.3316	2.4231	3.2207	2.9786	3.3363	3.0780	2.4267

Note: "0" should be read as ND

	97-1	97-2	97-3	**98-1**	98-2	**98-3**	98-4	**Total**	
	12/04/97-12/22/97	12/22/97-12/29/97	12/29/97-01/14/98	**01/14/98-01/26/98**	01/26/98-02/13/98	**02/13/98-03/04/98**	03/04/98-04/13/98	**for Winter Season**	
Volume	17	15.7	10.9	**9.7**	10.4	**11.1**	18.5		
Sum PCB (ng/L)	2.3316	2.4231	3.2207	**2.9786**	3.3363	**3.0780**	2.4267		
Deposition (ng/m2)	8.8	8.5	7.8	**6.4**	7.7	**7.6**	10.0	**56.8**	ng/m2/season
Number of Days	18	7	16	**12**	18	**20**	9	**100**	
Flux (ng/m2/day)	0.5	1.2	0.5	**0.5**	0.4	**0.4**	1.1	**4.6**	
						Mean for winter season		**0.7**	ng/m2/day

Appendix 6: Organochlorine and PCB data for surface water of Wolf Creek

Wolf Creek PCBs																		Wolf Creek PCBs						
	28-1 f1	f2	Sum of	28-6	28-1 f1	49-5	49-5	49-5 Sum	49-7	49-5 Blank	49-6			49-6 Sum of	49-7	49-6 Blank		28-1 f1	49-5 Blank	49-6 Blank		Volume	Volume
	Wolk Crk (55)		Two	Proc. Blk	Wolk Crk (55)	Wolf 2(83)	Wolf 2	of Two	Proc. Blk	Corrected	Wolf 3(117)			Two Fractions	Proc. Blk	Corrected		Wolk Crk (55)	Corrected	Corrected		Weighted	Weighted
	88.5 L, Jun 24		Fractions		88.5 L, Jun 24	91.0 L, July 6	ng/L	Fractions		Wolf 2(83)	88.9 L, July 21					Wolf 3(117)		88.5 L, Jun 24	Wolf 2(83)	Wolf 3(117)		Mean Con	Mean Con
PCB CONGENERS	f2 dry in vial	ng/L	28-1		Blank Corrected	f1	f2			91.0 L, July 6	f1	f2				88.9 L, July 21	PCB CONGE	Blank Corrected	91.0 L, July 6	88.9 L, July 21		ng/L	pg/L
1			0.000		0.000	7.2401	0.080	7.320		7.320	1.1805	0.013	1.194			1.194	1		7.320	1.194		2.877109	2877.109
3	7.8268	0.088	7.915		7.915	2.2119	0.024	2.236		2.236	18.6888	0.210	18.899			18.899	3	7.915	2.236	18.899		9.627856	9627.856
4+10	0.3031	0.003	0.307		0.307			0.000		0.000	0.0848	0.001	0.086			0.086	4+10	0.307		0.086		0.129475	129.4746
7	0.226	0.003	0.229	0.3713		2.4697	0.027	2.497	0.389	2.108	0.6722	0.008	0.680	0.389		0.291	7		2.108	0.291		0.810962	810.9615
6			0.000		0.000	0.2032	0.002	0.205		0.205	0.0852	0.001	0.086			0.086	6		0.205	0.086		0.098189	98.18882
5+8	1.9969	0.023	2.019		2.019			0.000		0.000	0.0531	0.001	0.054			0.054	5+8	2.019		0.054		0.683667	683.6671
19	1.1583	0.013	1.171		1.171			0.000		0.000			0.000			0.000	19	1.171				0.386244	386.2439
30	0.0831	0.001	0.084		0.084	0.0287	0.000	0.029		0.029	0.0966	0.001	0.098			0.098	30	0.084	0.029	0.098		0.069904	69.90384
12+13	0.5991	0.007	0.606		0.606	0.6222	0.007	0.629		0.629	0.7024	0.008	0.710			0.710	12+13	0.606	0.629	0.710		0.648314	648.3145
15+18	1.4895	0.017	1.506		1.506	1.1854	0.013	1.198		1.198	0.1079	0.001	0.109			0.109	15+18	1.506	1.198	0.109		0.939148	939.1478
17			0.000		0.000			0.000		0.000			0.000			0.000	32+16			0.154		0.051147	51.14654
24+27			0.000		0.000			0.000		0.000			0.000			0.000	32	0.774	0.157			0.308157	308.157
32+16			0.000		0.000			0.000		0.000	0.1527	0.002	0.154			0.154	16		0.093			0.031364	31.36364
32	0.7649	0.009	0.774		0.774	0.1549	0.002	0.157		0.157			0.000			0.000	29	0.948	0.234			0.391965	391.9654
16			0.000		0.000	0.0915	0.001	0.093		0.093			0.000			0.000	54	0.000	0.223			0.075478	75.47839
29+54			0.000		0.000			0.000		0.000			0.000			0.000	26	0.051				0.01684	16.83961
29	0.9378	0.011	0.948		0.948	0.2312	0.003	0.234		0.234			0.000			0.000	25		0.981	0.890		0.627142	627.1424
54			0.000		0.000	0.2202	0.002	0.223		0.223			0.000			0.000	28	0.000	0.139	0.128		0.089432	89.43193
26	0.0505	0.001	0.051		0.051			0.000	0.1205				0.000	0.1205		0.000	31	0.064		0.284		0.115162	115.1615
25	0.2312	0.003	0.234	0.2469		0.97	0.011	0.981		0.981	0.8797	0.010	0.890			0.890	33+53	0.077	0.256	0.056		0.134184	134.1838
28+31			0.000		0.000			0.000		0.000			0.000			0.000	22		0.221	0.032		0.085618	85.61792
28			0.000		0.000	0.1371	0.002	0.139		0.139	0.1267	0.001	0.128			0.128	45	2.196	0.014	0.116		0.767115	767.115
31	0.0631	0.001	0.064		0.064			0.000		0.000	0.281	0.003	0.284			0.284	46	1.244				0.410086	410.0861
33+53	0.0764	0.001	0.077		0.077	0.2633	0.003	0.266		0.266	0.0551	0.001	0.056			0.056	52	2.428		0.863		1.085765	1085.765
22	0.0108	0.000	0.011	0.3753		0.219	0.002	0.221		0.221	0.0315	0.000	0.032			0.032	49	0.396	0.041	0.152		0.194825	194.8254
45	2.1718	0.025	2.196		2.196	0.0135	0.000	0.014		0.014	0.1143	0.001	0.116			0.116	42		0.156			0.05292	52.91952
46	1.2298	0.014	1.244		1.244	0.1083	0.001	0.109	0.566		0.0674	0.001	0.068	0.566		0.863	47+48	4.400		0.316		1.555679	1555.679
52	2.5204	0.028	2.549	0.1225	2.428			0.000		0.000	0.853	0.010	0.863				48		0.213			0.072325	72.32489
49	0.3919	0.004	0.396		0.396	0.151	0.002	0.153	0.112	0.041	0.2611	0.003	0.264	0.112		0.152	44		0.151	0.035		0.0629	62.89981
42			0.000		0.000	0.1714	0.002	0.173	0.0172	0.156			0.000	0.0172			47+71+64	0.110	0.035	0.007		0.050484	50.48364
47+48	4.3512	0.049	4.400		4.400			0.000		0.000	0.3127	0.004	0.316			0.316	100			0.137		0.045352	45.35194
47			0.000		0.000			0.000	0.0695				0.000	0.0695			63			0.200		0.066286	66.28618
48			0.000		0.000	0.211	0.002	0.213		0.213			0.000			0.000	74	0.337		0.705		0.344767	344.7669
44			0.000		0.000	0.1494	0.002	0.151		0.151	0.0349	0.000	0.035			0.035	70+76	2.551	0.541	0.555		1.208549	1208.549
47+71+64	0.109	0.001	0.110		0.110	0.0345	0.000	0.035		0.035	0.0069	0.000	0.007			0.007	66		0.449			0.152088	152.0879
100			0.000		0.000			0.000		0.000	0.1354	0.002	0.137			0.137	95	0.063	0.105	0.017		0.061983	61.98264
63			0.000		0.000			0.000		0.000	0.1979	0.002	0.200			0.200	95+66			0.077		0.025389	25.38905
74	0.3337	0.004	0.337		0.337			0.000		0.000	0.6971	0.008	0.705			0.705	91	0.258	0.194	0.257		0.235683	235.6832
70+76	3.4427	0.039	3.482	0.9302	2.551	0.5353	0.006	0.541		0.541	0.5487	0.006	0.555			0.555	56+60		0.130	0.185		0.105341	105.3409
66			0.000		0.000	0.4437	0.005	0.449		0.449			0.000			0.000	84+92	0.049	0.068	0.246		0.120734	120.7344
95	0.0619	0.001	0.063		0.063	0.1039	0.001	0.105		0.105	0.0171	0.000	0.017			0.017	89	0.077	0.024	0.015		0.038525	38.52511
95+66			0.000		0.000			0.000		0.000	0.0758	0.001	0.077			0.077	101		0.091	0.020		0.037312	37.31241
91	0.2549	0.003	0.258		0.258	0.1916	0.002	0.194		0.194	0.2538	0.003	0.257			0.257	99	0.312		0.011		0.10651	106.5096
56+60	0.0501	0.001	0.051	0.0566		0.1284	0.001	0.130		0.130	0.1831	0.002	0.185			0.185	119	0.029	0.010	0.025		0.021079	21.07943
84+92	0.0488	0.001	0.049	0	0.049	0.0674	0.001	0.068		0.068	0.2429	0.003	0.246			0.246	97	0.445	0.105	0.094		0.213585	213.585
84			0.000		0.000			0.000		0.000			0.000			0.000	81		0.025	0.054		0.026523	26.52329
92			0.000		0.000			0.000		0.000			0.000			0.000	87		0.018			0.006101	6.101341

	28-1 f1	f2	Sum of	28-6	28-1 f1	49-5	49-5	49-5 Sum	49-7	49-5 Blank	49-6		49-6 Sum of	49-7	49-6 Blank		28-1 f1	49-5 Blank	49-6 Blank		Volume	Volume
	Wolk Crk (55)		Two	Proc. Blk	Wolk Crk (55)	Wolf 2(83)	Wolf 2	of Two	Proc. Blk	Corrected	Wolf 3(117)		Two Fractions	Proc. Blk	Corrected		Wolk Crk (55)	Corrected	Corrected		Weighted	Weighted
	88.5 L, Jun 24		Fractions		88.5 L, Jun 24	91.0 L, July 6	ng/L	Fractions		Wolf 2(83)	88.9 L, July 21				Wolf 3(117)		88.5 L, Jun 24	Wolf 2(83)	Wolf 3(117)		Mean Con	Mean Con
PCB CONGENERS	f2 dry in vial	ng/L	28-1		Blank Corrected	f1	f2			91.0 L, July 6	f1	f2			88.9 L, July 21	PCB CONGE	Blank Corrected	91.0 L, July 6	88.9 L, July 21		ng/L	pg/L
183			0.000		0.000	0.0288	0.000	0.029		0.029	0.0176	0.000	0.018		0.018							
193			0.000		0.000		0.000	0.000		0.000			0.000		0.000							
185			0.000		0.000			0.000		0.000	0.0173	0.000	0.017		0.017							
177			0.000	0.1994				0.000		0.000	0.0423	0.000	0.043		0.043							
174			0.000		0.000	0.0677	0.001	0.068		0.068	0.0031	0.000	0.003		0.003							
171			0.000		0.000			0.000		0.000	0.0015	0.000	0.002		0.002							
172+200+157			0.000		0.000			0.000		0.000			0.000		0.000							
157+202			0.000		0.000			0.000		0.000			0.000		0.000							
200			0.000		0.000			0.000		0.000			0.000		0.000							
172			0.000		0.000			0.000		0.000			0.000		0.000							
180			0.000		0.000			0.000		0.000			0.000		0.000							
197			0.000		0.000			0.000		0.000			0.000		0.000							
203			0.000		0.000	0.0579	0.001	0.059		0.059	0.0031	0.000	0.003		0.003							
193			0.000		0.000			0.000		0.000			0.000		0.000							
191			0.000		0.000	0.006	0.000	0.006		0.006			0.000		0.000							
199			0.000		0.000			0.000		0.000			0.000		0.000							
169			0.000	0.5873		1.2101	0.013	1.223		1.223	0.1542	0.002	0.156		0.156							
170			0.000		0.000			0.000		0.000			0.000		0.000							
190			0.000		0.000			0.000		0.000	0.003	0.000	0.003		0.003							
201			0.000		0.000			0.000		0.000			0.000		0.000							
198			0.000		0.000			0.000		0.000			0.000		0.000							
189			0.000		0.000			0.000		0.000	0.0056	0.000	0.006		0.006							
208			0.000		0.000	0.0029	0.000	0.003		0.003	0.0409	0.000	0.041		0.041							
195			0.000		0.000			0.000		0.000			0.000		0.000							
207			0.000		0.000			0.000		0.000			0.000		0.000							
194			0.000		0.000			0.000		0.000			0.000		0.000							
205	0.0207	0.000	0.021		0.021			0.000	0.0626		0.0077	0.000	0.008	0.0626								
206	0.0307	0.000	0.031		0.031	0.011	0.000	0.011		0.011	0.0163	0.000	0.016		0.016							
209			0.000		0.000			0.000		0.000			0.000		0.000							
Sum PCB			34.321		32.323			21.281		20.626			28.452		27.849							

Final Spreadsheet pcbs

	28-1 f1	f2	Sum of	28-6	28-1 f1	49-5	49-5	49-5 Sum	49-7	49-5 Blank	49-6		49-6 Sum of	49-7	49-6 Blank		28-1 f1	49-5 Blank	49-6 Blank	Volume	Volume
	Wolk Crk (55)		Two	Proc. Blk	Wolk Crk (55)	Wolf 2(83)	Wolf 2	of Two	Proc. Blk	Corrected	Wolf 3(117)		Two Fractions	Proc. Blk	Corrected		Wolk Crk (55)	Corrected	Corrected	Weighted	Weighted
	88.5 L, Jun 24		Fractions		88.5 L, Jun 24	91.0 L, July 6	ng/L	Fractions		Wolf 2(83)	88.9 L, July 21				Wolf 3(117)		88.5 L, Jun 24	Wolf 2(83)	Wolf 3(117)	Mean Con	Mean Con
PCB CONGENERS	f2 dry in vial	ng/L	28-1		Blank Corrected	f1	f2			91.0 L, July 6	f1	f2			88.9 L, July 21	PCB CONGE	Blank Corrected	91.0 L, July 6	88.9 L, July 21	ng/L	pg/L
89	0.0759	0.001	0.077		0.077	0.0238	0.000	0.024		0.024	0.0151	0.000	0.015		0.015	85	0.256	0.003		0.085316	85.31576
101			0.000		0.000	0.0898	0.001	0.091		0.091	0.0195	0.000	0.020		0.020	136	0.025		0.023	0.015862	15.86155
99	0.4195	0.005	0.424	0.1127	0.312			0.000		0.000	0.0113	0.000	0.011		0.011	110	0.201			0.066191	66.19132
119	0.0847	0.001	0.086	0.0569	0.029	0.0096	0.000	0.010		0.010	0.0248	0.000	0.025		0.025	82			0.015	0.005091	5.091207
83			0.000		0.000			0.000		0.000			0.000		0.000	151		0.054	0.034	0.029589	29.58864
97	0.4401	0.005	0.445		0.445	0.1038	0.001	0.105		0.105	0.0933	0.001	0.094		0.094	135		0.006	0.040	0.015323	15.32291
81			0.000	0.2479		0.0251	0.000	0.025		0.025	0.0535	0.001	0.054		0.054	144+107			0.013	0.004393	4.39266
87			0.000		0.000	0.0178	0.000	0.018		0.018			0.000		0.000	118	0.013			0.004302	4.301602
85	0.3034	0.003	0.307	0.0511	0.256	0.0029	0.000	0.003		0.003			0.000		0.000	149	0.090		0.022	0.037047	37.04687
136	0.0248	0.000	0.025		0.025	0.0055	0.000	0.006	0.0059	0.000	0.0285	0.000	0.029	0.0059	0.023	132	0.399	0.048	0.093	0.178778	178.778
110	0.1985	0.002	0.201		0.201	0.0182	0.000	0.018	0.0393		0.001	0.000	0.001	0.0393		153			0.032	0.01045	10.45037
82			0.000	0.528				0.000		0.000	0.0152	0.000	0.015		0.015	141	0.077	0.130	0.005	0.07123	71.22996
151			0.000		0.000	0.053	0.001	0.054		0.054	0.0341	0.000	0.034		0.034	137		0.014	0.051	0.021615	21.61475
135	0.1986	0.002	0.201	0.2081		0.0063	0.000	0.006		0.006	0.0393	0.000	0.040		0.040	176	0.524			0.172864	172.8644
144+107			0.000		0.000			0.000	0.0013		0.0144	0.000	0.015	0.0013	0.013	138+163	0.102		0.053	0.051197	51.19743
118+149			0.000		0.000			0.000		0.000			0.000		0.000	178			0.002	0.000569	0.569411
118	0.0129	0.000	0.013		0.013			0.000		0.000			0.000		0.000	187+182	0.167	0.565		0.24663	246.63
149	0.0888	0.001	0.090		0.090			0.000		0.000	0.0222	0.000	0.022		0.022	183		0.029	0.018	0.015767	15.76692
131			0.000		0.000	0.0027	0.000	0.003	0.0564		0.0177	0.000	0.018	0.0564		185			0.017	0.005795	5.794598
146			0.000		0.000			0.000		0.000			0.000		0.000	177			0.043	0.014168	14.16829
132	0.3947	0.004	0.399		0.399	0.0473	0.001	0.048		0.048	0.0924	0.001	0.093		0.093	174		0.068	0.003	0.024244	24.244
153			0.000		0.000			0.000		0.000	0.0312	0.000	0.032		0.032	171			0.002	0.000502	0.502422
141	0.0763	0.001	0.077		0.077	0.1284	0.001	0.130		0.130	0.0053	0.000	0.005		0.005	203		0.059	0.003	0.020885	20.88484
137			0.000		0.000	0.0142	0.000	0.014		0.014	0.05	0.001	0.051		0.051	191		0.006		0.002057	2.056632
176	0.5184	0.006	0.524		0.524			0.000		0.000			0.000		0.000	169		1.223	0.156	0.466437	466.4373
138+163	0.1007	0.001	0.102		0.102			0.000		0.000	0.0526	0.001	0.053		0.053	190			0.003	0.001005	1.004844
158			0.000		0.000			0.000		0.000			0.000		0.000	189			0.008	0.001876	1.875708
129			0.000		0.000			0.000		0.000			0.000		0.000	208		0.003	0.041	0.014893	14.89341
178			0.000		0.000			0.000		0.000	0.0017	0.000	0.002		0.002	205	0.021			0.006903	6.902571
175			0.000		0.000			0.000		0.000			0.000		0.000	206	0.031	0.011	0.016	0.019467	19.46729
128			0.000		0.000			0.000		0.000			0.000		0.000					0	0
187+182	0.165	0.002	0.167		0.167	0.559	0.006	0.565		0.565			0.000		0.000	Sum PCB	32.323	20.626	27.849	26.87539	26875.39

Wolf Creek OC's - Creek Water																				
	49-5		49-5	49-5	49-6		49-6	49-7	49-6	28-1 f1		28-1 f1	28-6	28-1 f1	Wolf Creek OC's - Creek Water					
	Wolf 2(83)		Wolf 2(83)	Wolf 2(83)	Wolf 3(117)		Wolf 3(117)	Proc. Blk	Wolf 3(117	Wolk Crk (55)		Wolk Crk (	Proc. Blk	Wolk Crk (55)		49-5	49-6	28-1 f1		
	91.0 L, July 6		91.0 L, Jul	91.0 L, July 6	88.9 L, July 21		88.9 L, July 2	spike #1	88.9 L, Jul	88.5 L, Jun 24		88.5 L, Jur	spike #2	88.5 L, Jun 24		Wolf 2(83)	Wolf 3(117	Wolk Crk (55)		
OCA		ng/L	Sum of 2	Blank		ng/L	Sum of 2		Blank	f2 dry	ng/L	Sum of 2		Blank	OCA	91.0 L, Jul	88.9 L, Jul	88.5 L, Jun 24		
	f2	f1	Fractions	Corrected	f2	f1	Fractions		Corrected	f2	f1	Fractions		Corrected		Blank	Blank	Blank		
135 TCB	0.000	0.000	0.000	0.000	2.268	0.026	2.294	0.000	2.294	2.429	0.027	2.456	0.000	2.456	135 TCB	Corrected	Corrected	Corrected		
124 TCB	3.769	0.041	3.810	3.810	6.483	0.073	6.555	0.000	6.555		0.000	0.000	1.168		1235 TTCE	0	2.293512	2.456446		
1235 TTCE	0.000	0.000	0.000	0.000	0.798	0.009	0.807	0.000	0.807	0.657	0.007	0.664	0.000	0.664	1234 TTCE	0	0.806976	0.664424		
1234 TTCE	0.000	0.000	0.000	0.000	0.236	0.003	0.238	0.000	0.238	0.527	0.006	0.533	0.000	0.533	PENTA CE	0	0.238452	0.532955		
PENTA CE	0.000	0.000	0.000	0.000	0.222	0.002	0.224	0.000	0.224		0.000	0.000	0.000	0.000	HCB	0.413292	0.224093	0		
HCB	0.409	0.004	0.413	0.413	0.000	0.000	0.000	0.000	0.000	0.487	0.006	0.493	0.000	0.493	44 DDE	0.411473	0	0.492503		
HEPTACH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	24 DDD	0.860352	1.148778	1.617068		
ALDRIN	0.000	0.000	0.000		0.135	0.002	0.136	0.290			0.000	0.000	0.242					2.440367		
T NONACH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000						
44 DDE	0.407	0.004	0.411	0.411	0.000	0.000	0.000	0.000	0.000	1.599	0.018	1.617	0.000	1.617	OCB					
24 DDD	0.851	0.009	0.860	0.860	1.136	0.013	1.149	0.000	1.149	2.413	0.027	2.440	0.000	2.440						
MIREX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	123 TCB	5.494624	18.04371	1.186861		
															1245 TTCE	7.851947	4.810105	1.747525		
			0.000												a-HCH	8.879388	5.368924	0		
OCB			0.000												b-HCH	0	0.661963	0		
			0.000												g-HCH	1.053174	0.110486	0		
123 TCB	5.435	0.060	5.495	5.495	17.843	0.201	18.044	0.000	18.044	1.174	0.013	1.187	0.000	1.187	HEPT. EP(	0	0	0.896719		
1245 TTCE	7.767	0.085	7.852	7.852	4.757	0.054	4.810	0.000	4.810	1.728	0.020	1.748	0.000	1.748	ENDO 1	0.459899	0.537984	1.669554		
A-BHC	9.290	0.102	9.392	8.879	5.816	0.065	5.882	0.513	5.369		0.000	0.000	0.000	0.000	a-CHLOR	0	0	0.64976		
B-BHC	0.000	0.000	0.000	0.000	0.655	0.007	0.662	0.000	0.662		0.000	0.000	0.000	0.000	DIELDRIN	0.257499	0.312375	0.862032		
G-BHC	1.162	0.013	1.175	1.053	0.230	0.003	0.232	0.122	0.110		0.000	0.000	0.000	0.000	24 DDT	0	0.293161	0		
HEPT. EP(	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.887	0.010	0.897	0.000	0.897	44 DDT	1.017965	1.026518	1.334106		
G CHLOR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.307	0.003	0.310	0.445					0		
24 DDE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000						
ENDO 1	0.455	0.005	0.460	0.460	0.532	0.006	0.538	0.000	0.538	1.651	0.019	1.670	0.000	1.670						
A CHLOR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.643	0.007	0.650	0.000	0.650						
DIELDRIN	0.255	0.003	0.257	0.257	0.309	0.003	0.312	0.000	0.312	0.852	0.010	0.862	0.000	0.862						
ENDO 2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000						
44 DDD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000						
24 DDT	0.000	0.000	0.000	0.000	0.290	0.003	0.293	0.000	0.293		0.000	0.000	0.000	0.000						
44 DDT	1.007	0.011	1.018	1.018	1.015	0.011	1.027	0.000	1.027	1.319	0.015	1.334	0.000	1.334						
PP METHOXYCHLOR											0.000	0.000	0.000	0.000						
Internal Standards (% recovery)																				
135 TBB	17.529	0.193	17.722		20.421	0.230	20.651	17.358		9.783	0.111		15.087							
D-BHC	6.307	0.069	6.376		12.938	0.146	13.084	9.860			0.000		11.673							
PCB 167	0.000	0.000	0.000		0.000	0.000	0.000	43.173			0.000		0.860							
OCN	15.730	0.173	15.903		26.557	0.299	26.856	12.396		5.026	0.057		9.309							