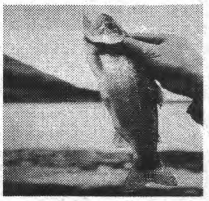
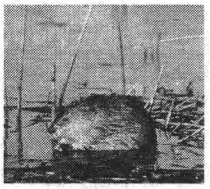
Canada Alberta Northwest Territories

Northern River Basins Study



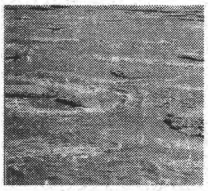


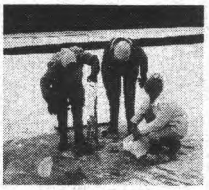
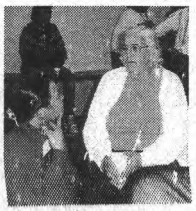





NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 138

BROAD SPECTRUM ANALYSIS OF MUNICIPAL AND INDUSTRIAL EFFLUENTS DISCHARGED INTO THE PEACE, ATHABASCA AND SLAVE RIVER BASINS: EVALUATION OF SURFACE WATERS



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Prepared for the
Northern River Basins Study
under Project 2921-D1

by

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Alberta Environmental Centre

NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 138

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Published by the
Northern River Basins Study
Edmonton, Alberta
February, 1997

CANADIAN CATALOGUING IN PUBLICATION DATA

Johnson, C. Ian

Broad spectrum analysis of municipal and industrial effluents discharged into the Peace, Athabasca and Slave river basins : evaluation of surface waters

(Northern River Basins Study project report, ISSN 1192-3571 ; no. 138)
Includes bibliographical references.
ISBN 0-662-24918-6
Cat. no. R71-49/3-138E

1. Wood-pulp industry -- Waste disposal -- Environmental aspects -- Alberta, Northern.
2. Sewage -- Environmental aspects -- Alberta, Northern.
3. Effluent quality -- Alberta, Northern.
I. Urso, Alex.
II. Northern River Basins Study (Canada)
III. Title.
IV. Series.

TD899.W65J65 1997 363.73'94'0971231 C96-980319-2

PREFACE:

The Northern River Basins Study was initiated through the "Canada-Alberta-Northwest Territories Agreement Respecting the Peace-Athabasca-Slave River Basin Study, Phase II - Technical Studies" which was signed September 27, 1991. The purpose of the Study is to understand and characterize the cumulative effects of development on the water and aquatic environment of the Study Area by coordinating with existing programs and undertaking appropriate new technical studies.

This publication reports the method and findings of particular work conducted as part of the Northern River Basins Study. As such, the work was governed by a specific terms of reference and is expected to contribute information about the Study Area within the context of the overall study as described by the Study Final Report. This report has been reviewed by the Study Science Advisory Committee in regards to scientific content and has been approved by the Study Board of Directors for public release.

It is explicit in the objectives of the Study to report the results of technical work regularly to the public. This objective is served by distributing project reports to an extensive network of libraries, agencies, organizations and interested individuals and by granting universal permission to reproduce the material.

This report contains referenced data obtained from sources external to the Northern River Basins Study. Individuals interested in using external data must obtain permission to do so from the donor agency.

NORTHERN RIVER BASINS STUDY
PROJECT REPORT RELEASE FORM

This publication may be cited as:

Johnson, C. Ian and Urso, Alex. 1997. *Northern River Basins Study Project Report No. 138, Broad Spectrum Analysis of Municipal and Industrial Effluents Discharged into the Peace, Athabasca and Slave River Basins: Evaluation of Surface Waters.* Northern River Basins Study, Edmonton, Alberta.

Whereas the above publication is the result of a project conducted under the Northern River Basins Study and the terms of reference for that project are deemed to be fulfilled,
IT IS THEREFORE REQUESTED BY THE STUDY OFFICE THAT;
this publication be subjected to proper and responsible review and be considered for release to the public.

(Dr. Fred J. Wrona, Science Director) — (Date) 14 May 96

Whereas it is an explicit term of reference of the Science Advisory Committee "to review, for scientific content, material for publication by the Board",
IT IS HERE ADVISED BY THE SCIENCE ADVISORY COMMITTEE THAT;
this publication has been reviewed for scientific content and that the scientific practices represented in the report are acceptable given the specific purposes of the project and subject to the field conditions encountered.
SUPPLEMENTAL COMMENTARY HAS BEEN ADDED TO THIS PUBLICATION: [ ] Yes [ ] No

(Dr. P. A. Larkin, Ph.D., Chair) — (Date) 24 May/96

Whereas the Study Board is satisfied that this publication has been reviewed for scientific content and for immediate health implications,
IT IS HERE APPROVED BY THE BOARD OF DIRECTORS THAT;
this publication be released to the public, and that this publication be designated for: **[ ] STANDARD AVAILABILITY [ ] EXPANDED AVAILABILITY**

(Lucille Partington, Co-chair) — (Date) May 29/96

(Robert McLeod, Co-chair) — (Date) May 21/96

BROAD SPECTRUM ANALYSIS OF MUNICIPAL AND INDUSTRIAL EFFLUENTS DISCHARGED INTO THE PEACE, ATHABASCA AND SLAVE RIVER BASINS: EVALUATION OF SURFACE WATERS

STUDY PERSPECTIVE

Under the Northern River Basins Study (NRBS), water, effluent, sediment, and biota have been sampled extensively and analyzed for specific contaminants known to be associated with developments within the study area, or known to be transported by aerial transport. To date, only "target compound" contaminant analyses have been conducted on these samples, and the results show generally low levels of these compounds. However, these types of specific analyses do not include other potential contaminants that are not currently known to be associated with man-made developments within the basins, or aerial transport, or for which there is little understanding of their environmental effects. Target compound analyses have been done with selected ion monitoring gas chromatography or mass spectrometry (GC/MS) with specific detectors. However, this method gives no indication of the other non-target compounds present, nor does it provide an "archive" record of chromatograms. An alternative experimental approach to characterizing the major effluents and receiving waters of the Athabasca and Peace river systems is by broad spectrum analysis.

Related Study Questions

4a) *What are the contents and nature of the contaminants entering the system and what is their distribution and toxicity in the aquatic ecosystem with particular reference to water, sediments and biota?*

8) *Recognizing that people drink water and eat fish from these river systems, what is the current concentration of contaminants in water and edible fish tissue and how are these levels changing through time and by location?*

13b) *What are the cumulative effects of man-made discharges on the water and aquatic environment?*

The project conducted broad spectrum analyses of water and effluent samples upstream and downstream of major effluent sources on the Athabasca, Peace and Wapiti-Smoky River systems. Analytical methods to classify organic constituents in effluents were based on full scan coupled GC/MS, and all significant compounds were characterized with respect to mass spectra and GC retention indices. The task was accomplished in three stages: (1) summary of results and review of raw GC/MS data from previous effluent analyses conducted between 1989 and 1994, (2) collection and analysis of current effluents, and (3) collection and analysis of receiving water samples.

Routine priority pollutant data for the analyses of municipal and industrial effluents, produced between 1989 and 1994, were reevaluated. Searchable mass spectral libraries were prepared for the organic components that were characterized. During that time period, improvements in effluent quality were observed, particularly for conventional bleached kraft mills. Generally, only low concentrations of contaminants were observed in sewage treatment plant (STP) effluent. Under the second task, 260 compounds were characterized from 1994 effluent samples, and a comparison of results revealed that the improvement in pulp mill effluent quality has continued. The third task determined that none of the contaminants observed in the discharged effluents were observed in surface waters in significant concentrations. Some of the compounds observed are ubiquitous in nature, and their presence cannot be attributed solely to industrial and municipal effluents.

Based on these results, it was concluded that the scope of future investigations should be narrowed to lipophilic classes of compounds in effluents and receiving waters, eliminating the compromises necessary to include hydrophilic compounds in the analysis. These analytical results will provide a permanent record of GC/MS data, allowing researchers to revisit the data in future years if other compounds become of interest.

This report provides analytical results arising from the collection and analysis of receiving water samples (Task 3). A summary of the results and review of raw GC/MC data from previous effluent analysis conducted between 1989 and 1994 (Task 1) is provided in Northern River Basins Study Project Report No. 111. Northern River Basins Study Project Report No. 121 provides information on the collection and analysis of current effluents (Task 2).

REPORT SUMMARY

Northern river basin surface waters receiving industrial and municipal effluents were analyzed for compounds observed previously in the screening of the effluents by broad spectrum analysis of organic compounds using coupled gas chromatography-mass spectrometry (GC-MS). Only phthalate esters, aliphatic hydrocarbons and fatty acids, as their methyl esters, were observed in the surface waters. Analysis of characteristic traces constructed from single ion chromatograms extracted from GC-MS data showed no patterns consistent with those observed previously in effluents.

ACKNOWLEDGEMENTS

The authors gratefully to acknowledge the assistance of Doreen LeClair and the sampling crews of Alberta Environmental Protection for collecting the samples, Brian Brownlee of National Water Research Institute for useful discussions and assistance in the preparation of this report and the Northern River Basins Study Board for partial funding of this work.

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1.0 INTRODUCTION

Under the Northern River Basins Study Board, water, effluent, sediment, fish and benthic invertebrates have been sampled extensively and analyzed for a wide variety of specific contaminants known to be associated with the developments within the Northern Basins. To date only target compound analysis for specific contaminants has been undertaken. These analyses are for specific contaminants and yield no information regarding other contaminants which may be present. To observe these other compounds full scan GC-MS analysis of samples, followed by interpretation of the generated mass spectra is required.

The characterization of effluents currently discharged into the northern river basins is described in the second report of this series (Johnson *et. al.* 1996). Major classes of compounds, and the construction of characteristic chromatograms representative of each class, from coupled gas chromatography-mass spectrometry data, are described, as well as the characterization of 260 compounds. This report, the third and last of this series describes the application of these results to the evaluation of surface waters.

2.0 MATERIALS AND METHODS

2.1 Solvents, Reagents and Equipment

All solvents were distilled in glass reagent grade purchased from BDH Inc. (Omnisolv grade). Tetrahydrofuran (THF) was purchased with BHT (0.25%) present as preservative and was redistilled in glass and preserved with ethanol (0.25%) prior to use. Acetic anhydride was freshly distilled prior to use. Amberlite XAD-2 resin was purchased from Axys Environmental Systems Ltd. and used without modification or from the Aldrich Scientific Company and soxhlet extracted with methyl-*t*-butyl ether (4 hr) followed by methanol (4 hr) prior to use. Glass fibre filters used in the extraction apparatus were Gelman Type A/E 142 mm glass fiber filters prepared following AEC Environmental Chemistry SOP SB16.0, "Preparation of Gelman type A/E filters for Infiltrex II sampler". Extractions were done with an Infiltrex II sampler purchased from Axys Environmental Systems Ltd.

2.2 Sample Collection, Transport, and Storage

Large volume samples were collected by *in situ* solid phase extraction (SPE) using an Infiltrex II extractor fitted with an XAD-2 cartridge. Samples were collected using a pumping rate of 100 mL/min.

Grabs of effluents were collected, without preservation, in methyl-*t*-butyl ether rinsed 4L amber glass bottles fitted with PFTE lined screw caps. Samples were shipped by overnight courier to the Alberta Environmental Centre in Vegreville Alberta where they were stored at 4° C until analyzed.

2.3 Sample Extraction

Grab samples were extracted, without acidification, using an Infiltrex automatic sampler fitted with a Gelman Type A/E glass fiber filter and XAD-2 extraction cartridge. The 4.0 L of sample was pumped through the sampler at a rate of 40 mL/min. The glass fiber filter was removed from the filter assembly and extracted with 300 mL of freshly distilled tetrahydrofuran in a soxhlet extractor for 4 hr. The extraction cartridge was removed and excess water was expelled with a gentle stream of UHP grade nitrogen gas. The extraction column was then eluted with 150 mL THF which was collected and combined with the filter extract. The column was then eluted with nitrogen-purged methanol and stored for further use. The sample bottle was rinsed with 100 mL of tetrahydrofuran which was combined with the previous tetrahydrofuran extracts and concentrated by rotary evaporator and made up to 10 mL in freshly distilled THF. The extract was then dried by passing through 1 g of granular anhydrous sodium sulphate packed in a 6" Pasteur pipette.

Large volume SPE samples were handled in a similar manner. The glass fiber filter was removed from the filter assembly and extracted with 300 mL of freshly distilled tetrahydrofuran in a soxhlet extractor for 4 hr. The extraction cartridge was removed and excess water was expelled with a gentle stream of UHP grade nitrogen gas. The extraction column was then eluted with 150 mL tetrahydrofuran which was collected and combined with the filter extract. The column was then eluted with nitrogen-purged methanol and stored for further use. The THF extract was then concentrated by rotary evaporator and made up to 10 mL in methyl-*t*-butyl ether and methylated with diazomethane following AEC Environmental Chemistry SOP SB22.0,

"Methylation of organic acids with diazomethane generated from Diazald®" evaporated to 1 mL under a stream of nitrogen and stored at -20°C for analysis by coupled gas chromatography-mass spectroscopy.

2.4 Fractionation of Low Molecular Weight Fraction of Effluent Extracts

Extracts were fractionated repeatedly in 2 mL portions. A 2 mL portion of the low molecular weight fraction of extract was combined with 40 mL of distilled deionized water and 1.0 mL of aqueous potassium carbonate (75%) in a 50 mL Mixxor liquid/liquid extractor. The aqueous phase was extracted with 10 mL of pentane which was then dried by elution through a 1 g column of granular anhydrous sodium sulphate (fraction A).

Freshly distilled acetic anhydride, 0.3 mL, was then added to the aqueous solution which was then extracted with 10 mL pentane. The pentane was then dried by elution through a 1 g column of granular anhydrous sodium sulphate (fraction B).

The aqueous solution was then extracted with 10 mL of methyl-*t*-butyl ether, which was then dried by elution through a 1 g column of granular anhydrous sodium sulphate (fraction C). The remaining aqueous solution was acidified by dropwise addition of 30% sulphuric acid to adjust the pH to below 2 and then extracted with methyl-*t*-butyl ether. The extract was also dried by elution through a 1 g column of granular anhydrous sodium sulphate (fraction D). Dried fractions from the low molecular weight fraction were pooled, concentrated and then diluted to 10 mL with methyl-*t*-butyl ether. Fractions A and B were then concentrated to 1 mL under a stream of nitrogen and stored at -20°C for analysis by coupled gas chromatography- mass spectroscopy. Fraction C was methylated with diazomethane generated from Diazald® following AEC Environmental Chemistry SOP SB22.0, "Methylation of organic acids with diazomethane generated from Diazald®" evaporated to 1 mL under a stream of nitrogen and stored at -20°C for analysis by coupled gas chromatography-mass spectroscopy. Fraction D was methylated with diazomethane generated from Diazald® following AEC Environmental Chemistry SOP SB22.0, "Methylation of organic acids with diazomethane generated from Diazald®" evaporated to 1 mL under a stream of nitrogen and stored at -20°C for analysis by coupled gas chromatography-mass spectroscopy.

2.5 Coupled Gas Chromatography-Mass Spectroscopy Analysis

Effluent extract fractions to which d_{10} phenanthrene had been added as the internal standard (2.4 µg /mL) were analyzed using a Hewlett Packard 5890 gas chromatograph coupled to a Hewlett Packard 5970 mass selective detector. The gas chromatograph was equipped with an HP 7470 autosampler, a split/splitless injector run in the splitless mode, and a fused silica capillary column (30m x 0.20 mm i.d.) coated with DB-1 methylsilicone stationary phase (film thickness 0.25µ). The mass selective detector had been fitted with a high energy dynode election multiplier to increase sensitivity. The mass spectrometer was tuned using perfluorotributylamine as calibrant, to give a 502 ion 25% of the 69 ion and a 219 ion 150% of the 69 ion. The injector was maintained at 290°C for 1.0 µL sample injections. The initial column oven temperature was 50°C, which was maintained for 2 minutes before being increased to 300°C at a rate of 5°C/min. and then maintained for 5 minutes at 300°C. The GC-MS interface was maintained at 280°C. GC-MS information was recorded and the analyzed on an Everdata 486 computer using Hewlett Packard G1045c MS Chemstation software.

2.6 Analysis of GC-MS Results

GC-MS data was analyzed using Hewlett Packard G1045c MS Chemstation software on an Everdata 486 computer. The retention times of *n*-alkanes (C_9 to C_{34}) were used to calculate retention times from the Kovats indices of compounds identified in effluents in the second report of this series (Johnson *et. al.* 1996). Extracted ion chromatograms of a quantitation ion and one qualification ion spanning the expected retention time of each compound were integrated. Table 1 lists the Kovats indices, the expected retention time, the quantitation ion, the qualification ion, and the ratio of the two observed in effluent extract. When the ratio of the qualification ion abundance to quantitation can abundance agreed within 50% to that in Table 1 and the retention time agreed within 0.1 min. to that in Table 1 the compound was deemed to be present.

Method blanks for the large volume SPE samples were evaluated to determine the contribution of the extraction and chromatographic materials to those observed in the final extract fractions. The method blanks were used to subtract "background" for the large volume *in situ* SPE samples. Grab samples were fractionated and the results of individual fractions

summed for this report. These were no background subtracted because of the uncertainty in the measurement of the background for this complicated extraction fractionation scheme.

Concentrations of compounds were estimated using d_{10} phenanthrene as internal standard. No standards for the compounds reported were run in the course of the analysis so compound concentrations were calculated assuming similar response factors for quantitation ions of the compounds and the m/e 188 ion of internal standard. These estimates are approximate at best and should only be considered accurate to within an order of magnitude.

Characteristic traces were constructed as previously reported (Johnson *et. al.* 1996) except the retention times were adjusted to accommodate the changes in retention times, using Kovats indices and the *n*-alkane retention times. Characteristic traces of mono- and dicarboxylic acids is the extracted ion chromatograms of m/e 74 and m/e 87 of the D fraction from 12 to 53 minutes added together. The extracted ion chromatogram of m/e 149 of the A fraction from 31 to 57 minutes is the characteristic trace of phthalate esters. The diterpene characteristic trace is the sum of the extracted ion chromatograms of m/e 272, m/e 270, m/e 257, m/e 255 and m/e 137 of the A fraction from 33 to 38 minutes. The characteristic trace of triterpenoids is the sum of the extracted ion chromatograms of m/e 380, m/e 382, m/e 384, m/e 394, m/e 396 and m/e 398 of the A fraction from 49 to 57 minutes merged with the sum of the extracted ion chromatograms of m/e 410 and m/e 412 of the A fraction from 53 to 57 minutes. The characteristic trace of nonylphenols is the sum of the extracted ion chromatograms of m/e 121, m/e 135, m/e 107 and m/e 149 of the A fraction from 27 to 32 minutes. The characteristic trace of the unidentified acids in the municipal STP effluents is the sum of the extracted ion chromatograms of m/e 117, m/e 251 and m/e 265 of the D fraction from 39 to 49 minutes.

3.0 RESULTS AND DISCUSSION

Surface water samples were collected from sites on the northern river systems as 4 L grab samples or as *in situ* extracts of greater than 10 L obtained using an Infiltrex II automated sampler with XAD-2 as the solid phase extractant. Table 2 lists the sample sites and type of sampling method employed. Grab samples were extracted by solid phase extraction in the laboratory and the fractionated by liquid/liquid partitioning following the scheme described in the

second report of this series (Johnson *et. al.* 1996) before analysis by GC-MS. The large volume *in situ* extracts were analyzed by GC-MS following methylation with diazomethane, without fractionation. Samples were collected above and below effluent discharges so the impact of the effluent(s) could be assessed.

3.1 Individual Compound Analysis

Each sample was analyzed for a list of 260 compounds, developed from the results of GC-MS analysis of effluents discharged into the northern rivers. These compounds are presented in Table 1. The results of analysis of the Athabasca River samples are presented in Table 4 and the results of analysis of the Wapiti/Smoky River system samples are presented in Table 5. The estimated concentrations are order of magnitude estimates, reported with one significant figure, based on the abundance of a quantitation ion relative to the abundance of the m/e 188 ion of d_{10} phenanthrene, added as a internal standard. The concentrations should not be regarded as accurate to more than one order of magnitude.

Very few of the compounds observed in effluents were observed in the surface waters. The compounds observed in the surface waters comprised linear alkanes, phthalate esters, and methyl esters of fatty acids. These compound, which were observed in very low concentrations, are, although anthropogenic, ubiquitous in nature and cannot be attributed to any one source and may in fact be simply analytical background.

3.2 Analysis of Characteristic Traces

A more sensitive method described in the second report of this series involves the construction of GC traces characteristic of classes of compound by summing and merging single ion chromatograms. Characteristic traces of methyl esters of carboxylic acids, phthalate esters, diterpenes, nonylphenols, and a group of acids specific to STP effluents for each of the sample and a method blank are presented in Figures 1 through 65. Attempts were made to construct characteristic traces of tritepenoids but no significant peaks were observed so no traces are presented.

The characteristic traces of methyl esters of mono- and dicarboxylic acids in the Athabasca River samples did not differ significantly from the method blank. In the

Wapiti/Smoky River samples compounds with intense m/e 87 ions, observed previously in method blank obscure this trace. Characteristic traces of phthalate esters did not vary much between samples and blanks except for the Wapiti River sample taken upstream of Grande Prairie. This contained a complicated mixture of phthalate esters not observed the subsequent downstream samples. No significant diterpene peaks were present in the diterpene characteristic traces of the Athabasca River sample. One large peak due to the methyl ester of hexadecanoic acid was present. No peaks were observed in the characteristic traces of nonylphenols and the methyl esters unidentified STP acids of the Athabasca River samples. The diterpene characteristic traces of the Wapiti/Smoky River samples did contain significant peaks but did not follow the profiles previously observed in effluents discharging to this system. Likewise the nonylphenol traces did contain peaks but did not follow the pattern associated with nonylphenol and were likely due to other compounds. The pattern of peaks associated with the methyl esters of unidentified STP acids were not observed in the Wapiti/Smoky River samples.

4.0 CONCLUSIONS

None of the contaminants observed in effluents currently discharged into the northern rivers, or those observed in past analysis of effluents discharged to the northern rivers were observed in surface waters in significant concentrations. Compounds which were observed are ubiquitous in nature and their presence cannot be attributed solely the industrial and municipal effluents. They may in fact be artifactual background.

While the water column, and no other compartments were assessed the results indicated that the target compound approach employed in the study did not miss other contaminants present in significant concentrations (< 0.1 µg/L). Hydrophilic compounds, which this work was specifically designed to include, were not observed, however, with the compromises which were required to broaden the scope of the analysis, and the attention to only one environmental compartment, it cannot be concluded that all organic contaminants in effluents have no significant presence in the northern rivers basin. This would require further work focusing specifically on lipophilic compounds and other environmental compartments.

5.0 SUGGESTIONS FOR FURTHER WORK

In further work the scope of the investigations should be narrowed to lipohilic classes of compounds in effluents and receiving waters, eliminating the need for compromises necessary to include hydrophilic compounds in the analysis, but which add to background. If such compounds are observed during the screening of effluents, but not receiving waters, the scope of the investigation should be extended to other environmental compartments. Also when focusing on these classes of compounds it is possible to employ fractionation procedures, such as preparative high performance liquid chromatography, which remove rather than add to background contamination.

6.0 REFERENCES

Johnson, C.I., A. Urso, and L. Geleta (1996). Broad Spectrum analysis of municipal and industrial effluents discharged into the northern river basins. Submitted to the Northern Rivers for review.

Table 1. Compound information of compounds identified in effluents discharged into the northern river basins.

BSA Compound Number	Compound Description	Kovats Index	Predicted Retention Time	Quantitation Ion	Qualifying Ion	Qualifying Ratio
BSA 001	Benzoic acid, methyl ester	1067	12.37	136	105	2.06
BSA 002	Dipropyl disulphide	1082	12.84	150	108	0.48
BSA 003	Octanoic acid, methyl ester	1106	13.60	74	87	0.39
BSA 004	4-Acetylmorpholine	1133	14.43	129	114	0.94
BSA 005	Benzene acetic acid, methyl ester	1146	14.83	150	91	2.05
BSA 006	Naphthalene	1158	15.20	128	127	0.19
BSA 007	Alkyl disulphide (C7H16S2)	1181	15.90	164	108	0.40
BSA 008	Dodecane	1197	16.39	57	71	0.63
BSA 009	Nonanoic acid, methyl ester	1206	16.66	74	87	0.46
BSA 010	Hexadioic acid, dimethyl ester	1206	16.66	143	114	1.71
BSA 011	Alkyl disulphide (C8H18S2)	1238	17.60	178	94	1.58
BSA 012	Phenoxyacetic acid, methyl ester	1265	18.39	166	107	0.91
BSA 013	Unidentified	1272	18.59	170	139	1.18
BSA 014	Unidentified hydrocarbon	1280	18.83	96	81	3.02
BSA 015	Dichlorobenzamine	1287	19.03	161	163	0.74
BSA 016	Unidentified alkyl alcohol	1290	19.12	128	113	1.16
BSA 017	Dipropyl trisulphide	1294	19.24	182	184	0.18
BSA 018	4-Acetoxybenzaldehyde	1299	19.38	121	122	0.76
BSA 019	Unidentified alkyl methyl ester	1300	19.40	131	59	2.14
BSA 020	Decanoic acid, methyl ester	1307	19.62	74	87	0.57
BSA 021	Alkyl disulphide (C9H20S2)	1311	19.72	192	108	1.72
BSA 022	Unidentified	1313	19.77	170	139	1.89
BSA 023	Alkyl disulphide (C9H20S2)	1326	20.13	192	108	1.36
BSA 024	Unidentified	1329	20.22	168	153	0.64
BSA 025	Unidentified chlorinated	1334	20.36	210	212	1.10
BSA 026	Unidentified methyl ester	1334	20.36	178	119	1.75
BSA 027	Unidentified methyl ester	1338	20.47	178	119	1.95
BSA 028	Unidentified methyl ester	1341	20.55	178	119	2.82
BSA 029	Unidentified hydrocarbon	1361	21.10	137	123	0.36
BSA 030	Unidentified methyl ester	1366	21.24	119	178	0.20
BSA 031	Subst. thiophene	1391	21.93	194	106	0.97
BSA 032	Fatty acid, methyl ester	1390	21.91	74	87	0.87
BSA 033	Unidentified	1400	22.18	179	194	0.66
BSA 034	Octandioic acid, dimethyl ester	1409	22.42	138	129	0.81
BSA 035	Subst. thiophene(s) coeluting	1427	22.89	122	192	0.29
BSA 036	Unidentified, (methyl ester 192)	1428	22.92	192	133	1.78
BSA 037	Unidentified alkyl methyl ester	1449	23.45	114	142	0.90
BSA 038	Dimethyl phthalate	1467	23.93	163	194	0.29

Table 1 continued. Compound information of compounds identified in effluents discharged into the northern river basins.

BSA Compound Number	Compound Description	Kovats Index	Predicted Retention Time	Quantitation Ion	Qualifying Ion	Qualifying Ratio
BSA 039	4-Acetoxy-3-methoxybenzaldehyde	1470	24.02	152	151	0.97
BSA 040	Unidentified	1465	23.89	157	167	0.57
BSA 041	Unidentified	1493	24.62	190	130	1.67
BSA 042	Pentadecane	1498	24.75	71	57	0.88
BSA 043	Unidentified dichloromethyl ester	1504	24.90	218	159	1.66
BSA 044	Docecanoic acid, methyl ester	1506	24.95	74	87	0.55
BSA 045	Unidentified substitiuted	1511	25.08	220	161	3.32
BSA 046	Nonadioic acid, dimethyl ester	1510	25.06	152	185	0.71
BSA 047	Subst. thiophene	1523	25.37	234	150	1.20
BSA 048	Branched alkane	1534	25.65	111	69	1.69
BSA 049	Subst. thiophene	1541	25.82	234	150	0.98
BSA 050	Diethyl phthalate	1553	26.12	149	177	0.29
BSA 051	Branched alkane	1543	25.87	71	85	0.76
BSA 052	Dodecanoic acid	1548	25.99	60	73	0.86
BSA 053	Subst. thiophene	1558	26.24	234	150	0.88
BSA 054	Alkyl alkene or alcohol	1554	26.13	111	69	1.50
BSA 055	Alicyclic alcohol	1556	26.19	170	139	0.42
BSA 056	Alkyl alcohol	1562	26.34	111	69	1.70
BSA 057	Unidentified terpenoid methyl ester	1571	26.56	87	114	0.94
BSA 058	Naphthalenecarboxylic acid, methyl	1602	27.33	186	155	1.33
BSA 059	N-Dimethylbenzenesulphamide	1600	27.28	91	185	0.45
BSA 060	Subst. thiophene	1607	27.45	226	87	1.02
BSA 061	Decadioic acid, dimethyl ester	1611	27.55	199	125	0.83
BSA 062	Phosphoric acid, tributyl ester	1613	27.58	211	155	1.49
BSA 063	Diacetylated catechol or resorcinol	1623	27.82	151	166	0.91
BSA 064	Alkyl polysulphide	1626	27.89	236	106	2.25
BSA 065	4-Hydroxy-3,5-	1659	28.67	182	181	0.41
BSA 066	Nonylphenol Isomer	1682	29.21	97	135	0.37
BSA 067	Unidentified	1678	29.12	206	175	1.24
BSA 068	Nonylphenol Isomer	1693	29.47	149	191	0.38
BSA 069	Unidentified Diterpene (C20H32)	1692	29.45	257	129	0.32
BSA 070	Subst. thiophene	1699	29.61	87	238	0.24
BSA 071	Unidentified	1702	29.68	206	175	0.85
BSA 072	Tetradecanoic acid, methyl ester	1707	29.78	74	87	0.59
BSA 073	Unidentified alkyl hydrocarbon	1713	29.92	113	181	0.59
BSA 074	Nonylphenol Isomer	1728	30.26	135	205	0.19
BSA 075	Dichloro unidentified	1734	30.39	230	232	0.75

Table 1 continued. Compound information of compounds identified in effluents discharged into the northern river basins.

BSA Compound Number	Compound Description	Kovats Index	Predicted Retention Time	Quantitation Ion	Qualifying Ion	Qualifying Ratio
BSA 076	Tetradecanoic acid	1740	30.52	185	228	5.85
BSA 077	Unidentified alkyl hydrocarbon	1757	30.91	99	85	1.56
BSA 078	Caffeine	1765	31.09	194	109	0.30
BSA 079	Branched C15:0 fatty acid methyl	1771	31.22	74	87	0.77
BSA 080	Branched C15:0 fatty acid methyl	1779	31.40	74	87	0.65
BSA 081	Pentadecanoic acid, methyl ester	1807	32.02	74	87	0.68
BSA 082	Phthalate ester	1820	32.29	149	223	0.14
BSA 083	C15:0 fatty acid	1810	32.08	185	242	0.53
BSA 084	Bis-(methylpropyl)-phthalate	1829	32.48	149	223	0.11
BSA 085	Unidentified diterpene	1831	32.53	243	258	0.34
BSA 086	Pentadecanoic acid	1839	32.69	185	242	0.74
BSA 087	Branched C16:0 fatty acid methyl	1872	33.40	74	87	0.58
BSA 088	Hexadecenoic acid, methyl ester	1881	33.59	236	74	1.30
BSA 089	Unidentified (Background)	1887	33.72	101	181	0.14
BSA 090	Unidentified methyl ester, terpenoid	1897	33.93	260	159	0.69
BSA 091	Hexadecanoic acid, methyl ester	1907	34.15	74	87	0.69
BSA 092	Dibutylphthalate	1919	34.39	149	223	0.09
BSA 093	Unidentified Diterpene (C20H32)	1915	34.30	257	272	0.86
BSA 094	Hexadecenoic acid	1916	34.32	236	254	0.31
BSA 095	Sandaracopimaridiene	1927	34.54	257	272	0.50
BSA 096	Branched alkane	1929	34.58	155	57	4.14
BSA 097	Sulphur S8	1942	34.85	256	192	0.26
BSA 098	Hexadecanoic acid	1943	34.86	256	213	0.80
BSA 099	Branched C17:0 fatty acid methyl	1953	35.06	74	87	0.63
BSA 100	2-Naphthaleneacetic acid, 6-	1975	35.52	244	185	1.91
BSA 101	Isopimaridiene	1972	35.46	257	272	0.70
BSA 102	Branched C17:0 fatty acid methyl	1973	35.47	74	87	0.70
BSA 103	Hexadecanoic acid, ethyl ester	1978	35.57	88	101	0.60
BSA 104	Branched C17:0 fatty acid methyl	1981	35.63	74	87	0.59
BSA 105	Unidentified	1981	35.64	253	268	0.20
BSA 106	Unidentified Diterpene (C20H32)	1990	35.82	257	272	0.25
BSA 107	Unidentified mw 292	1990	35.82	221	207	0.78
BSA 108	Eicosane	1996	35.95	57	71	0.60
BSA 109	Unidentified mw 292	1997	35.97	221	207	0.50
BSA 110	Heptadecanoic acid, methyl ester	2008	36.18	74	87	0.83
BSA 111	Unidentified	2019	36.39	301	133	2.14
BSA 112	Unidentified Diterpene (C20H32)	2021	36.43	255	270	0.35

Table 1 continued. Compound information of compounds identified in effluents discharged into the northern river basins.

BSA Compound Number	Compound Description	Kovats Index	Predicted Retention Time	Quantitation Ion	Qualifying Ion	Qualifying Ratio
BSA 113	Unidentified (mw 294)	2026	36.53	265	221	0.96
BSA 114	Unidentified	2036	36.72	309	324	0.28
BSA 115	Heptadecanoic acid	2038	36.77	270	129	0.94
BSA 116	Unidentified Diterpene (C20H32)	2057	37.13	272	229	0.87
BSA 117	Unidentified branched alkane	2068	37.34	57	249	0.33
BSA 118	9,12-Octadecadienoic acid, methyl	2069	37.36	67	81	0.91
BSA 119	9-Octadecen(Z)oic acid methyl	2079	37.55	264	265	0.64
BSA 120	9-Octadecen(E)oic acid methyl	2084	37.66	264	265	0.76
BSA 121	Heneicosane	2096	37.89	57	71	0.65
BSA 122	Unidentified Hydrocarbon	2100	37.96	280	235	0.46
BSA 123	Octadecanoic acid, methyl ester	2109	38.13	74	87	0.78
BSA 124	C18:1 Fatty acid	2111	38.17	129	264	0.94
BSA 125	C18:1 Fatty acid	2116	38.27	97	264	0.45
BSA 126	Unidentified	2128	38.48	221	207	0.70
BSA 127	C18:0 Fatty acid	2142	38.74	284	241	0.62
BSA 128	Octadecanoic acid, ethyl ester	2174	39.34	88	101	0.63
BSA 129	Phthalate Ester (di C6H13)	2190	39.63	149	251	0.22
BSA 130	Phthalate Ester (di C6H13)	2194	39.71	149	251	0.21
BSA 131	Branched alkane (C22H46)	2185	39.54	57	71	0.75
BSA 132	Nonadecenoic acid, methyl ester	2193	39.69	278	236	0.42
BSA 133	Docosane	2196	39.75	57	71	0.75
BSA 134	Phthalate Ester (di C6H13)	2208	39.96	149	251	0.28
BSA 135	Phthalate Ester (di C6H13)	2213	40.05	149	251	0.29
BSA 136	Unidentified Hydrocarbon	2207	39.95	263	334	0.17
BSA 137	Phthalate Ester (di C6H13)	2219	40.16	149	251	0.27
BSA 138	Nonadecanoic acid, methyl ester	2210	39.99	74	87	0.85
BSA 139	Unidentified Diterpene (C20H28O)	2211	40.02	269	284	0.60
BSA 140	Phthalate Ester (di C6H13)	2226	40.28	149	251	0.30
BSA 141	Unidentified alkene	2223	40.23	55	97	0.69
BSA 142	Phthalate Ester (di C6H13)	2233	40.40	149	251	0.32
BSA 143	Unidentified Hydrocarbon	2224	40.25	55	69	0.70
BSA 144	Unidentified	2225	40.27	210	281	0.16
BSA 145	Phthalate Ester (di C6H13)	2239	40.51	149	251	0.37
BSA 146	Phthalate Ester (di C6H13)	2246	40.63	149	251	0.18
BSA 147	Phthalate Ester (di C6H13)	2251	40.73	149	251	0.22
BSA 148	Unidentified (mw 336)	2242	40.57	221	307	0.26
BSA 149	Phthalate Ester (di C6H13)	2265	40.97	149	251	0.23

Table 1 continued. Compound information of compounds identified in effluents discharged into the northern river basins.

BSA Compound Number	Compound Description	Kovats Index	Predicted Retention Time	Quantitation Ion	Qualifying Ion	Qualifying Ratio
BSA 150	Unidentified	2259	40.86	103	341	0.45
BSA 151	Unidentified (mw 336)	2260	40.89	221	307	0.34
BSA 152	Phthalate Ester (di C6H13)	2271	41.08	149	251	0.24
BSA 153	Unidentified (mw 336)	2265	40.98	221	307	0.25
BSA 154	Unidentified alkene	2275	41.16	55	83	0.54
BSA 155	Unidentified (mw 336)	2277	41.19	279	117	0.73
BSA 156	Phthalate Ester (butyl,	2288	41.38	149	206	0.54
BSA 157	Phthalate Ester (di C6H13)	2302	41.63	149	251	0.17
BSA 158	Dehydroabietic acid. methyl ester	2293	41.47	239	299	0.16
BSA 159	Tricosane	2296	41.54	57	71	0.84
BSA 160	Unidentified	2305	41.68	260	193	0.37
BSA 161	Hexadioic acid, dioctyl ester	2366	42.73	129	147	0.27
BSA 162	Eicosanoic acid, methyl ester	2310	41.77	74	87	0.85
BSA 163	Phthalate Ester (di C6H13)	2322	41.98	149	251	0.15
BSA 164	Unidentified	2319	41.92	263	305	0.79
BSA 165	Phosphoric acid, triphenyl ester	2320	41.93	326	325	0.55
BSA 166	Unidentified	2323	41.99	115	263	0.61
BSA 167	Phthalate Ester	2339	42.27	149	251	0.28
BSA 168	Unidentified	2332	42.15	115	263	1.03
BSA 169	Unidentified	2332	42.15	279	117	0.45
BSA 170	Unidentified	2337	42.23	265	117	0.55
BSA 171	Unidentified Triterpenoid	2343	42.33	368	353	0.30
BSA 172	Phthalate Ester	2354	42.52	149	368	0.16
BSA 173	Unidentified	2346	42.38	115	263	1.00
BSA 174	Unidentified Diterpene acid	2349	42.44	302	187	1.19
BSA 175	Phthalate Ester	2367	42.74	149	167	0.33
BSA 176	2-Butoxyethanol phosphate (3:1)	2360	42.63	199	227	0.78
BSA 177	Hexadioic acid, dioctyl ester	2367	42.74	129	147	0.24
BSA 178	Unidentified (mw 352)	2371	42.81	251	117	0.53
BSA 179	Unidentified	2375	42.88	263	115	0.71
BSA 180	Dehydroabietic acid	2380	42.97	239	285	0.92
BSA 181	Phthalate Ester	2395	43.22	149	251	0.28
BSA 182	Unidentified	2388	43.10	279	131	0.71
BSA 183	Unidentified, tentatively diethylene	2388	43.10	105	77	0.45
BSA 184	Tetracosane	2396	43.24	57	71	0.78
BSA 185	Phthalate Ester	2419	43.61	149	265	0.21
BSA 186	Heneicosanoic acid, methyl ester	2410	43.47	74	87	0.78

Table 1 continued. Compound information of compounds identified in effluents discharged into the northern river basins.

BSA Compound Number	Compound Description	Kovats Index	Predicted Retention Time	Quantitation Ion	Qualifying Ion	Qualifying Ratio
BSA 187	Phthalate Ester	2431	43.82	149	265	0.19
BSA 188	Unidentified Diterpene acid	2428	43.77	302	136	0.63
BSA 189	Unidentified	2442	44.00	315	330	0.35
BSA 190	Unidentified Hydrocarbon (Dioic	2449	44.11	201	154	0.29
BSA 191	Unidentified mw 352	2454	44.19	251	117	0.48
BSA 192	Unidentified mw 352	2472	44.49	265	117	0.95
BSA 193	Triterpenoid acid, methyl ester	2476	44.55	371	386	0.35
BSA 194	Phthalate Ester	2495	44.87	149	265	0.15
BSA 195	Phthalate Ester	2509	45.09	149	167	0.49
BSA 196	Docosanoic acid, methyl ester	2512	45.13	74	87	0.69
BSA 197	Phthalate Ester	2527	45.37	149	167	0.63
BSA 198	Phthalate Ester	2540	45.58	149	167	0.35
BSA 199	Phthalate Ester	2553	45.78	149	167	0.33
BSA 200	Unidentified mw 380	2549	45.72	265	351	0.47
BSA 201	Phthalate Ester	2567	46.00	149	265	0.30
BSA 202	Unidentified mw 380	2573	46.10	265	117	0.52
BSA 203	Unidentified (mw 380)	2581	46.22	251	117	0.62
BSA 204	Phthalate Ester	2591	46.38	149	265	0.23
BSA 205	Phthalate Ester	2616	46.77	149	265	0.16
BSA 206	Tricosanoic acid, methyl ester	2612	46.71	74	87	0.83
BSA 207	Unidentified mw 380	2612	46.71	265	117	0.40
BSA 208	Unidentified mw 380	2617	46.78	265	117	0.40
BSA 209	Phthalate Ester	2628	46.95	149	293	0.15
BSA 210	Unidentified hydrocarbon	2642	47.16	91	196	0.46
BSA 211	Unidentified hydrocarbon	2642	47.16	251	117	0.43
BSA 212	Phthalate Ester	2667	47.55	149	167	0.32
BSA 213	Unidentified mw 380	2655	47.36	265	117	0.36
BSA 214	Unidentified hydrocarbon	2662	47.47	91	196	0.41
BSA 215	Unidentified mw 380	2669	47.58	265	117	0.40
BSA 216	Phthalate Ester	2691	47.92	149	265	0.08
BSA 217	Heptacosane	2695	47.96	57	71	0.54
BSA 218	Phthalate Ester	2710	48.19	149	167	0.57
BSA 219	Tetracosanoic acid, methyl ester	2713	48.23	74	87	0.85
BSA 220	Phthalate Ester	2760	48.92	149	293	0.24
BSA 221	Phthalate Ester	2777	49.18	149	265	0.31
BSA 222	Decanedioic acid, dioctyl ester	2773	49.12	185	203	0.07
BSA 223	Phthalate Ester	2795	49.44	149	293	0.24

Table 1 continued. Compound information of compounds identified in effluents discharged into the northern river basins.

BSA Compound Number	Compound Description	Kovats Index	Predicted Retention Time	Quantitation Ion	Qualifying Ion	Qualifying Ratio
BSA 224	Phthalate Ester	2797	49.46	149	265	0.39
BSA 225	Unidentified	2788	49.34	123	252	0.13
BSA 226	Octacosane	2795	49.44	57	71	0.62
BSA 227	Phthalate Ester	2812	49.69	149	293	0.14
BSA 228	Squalene	2809	49.64	69	81	0.66
BSA 229	Pentacosanoic acid, methyl ester	2813	49.70	74	87	0.96
BSA 230	Phthalate Ester	2828	49.91	149	321	0.12
BSA 231	Unidentified triterpenoid acid ester	2825	49.87	98	367	0.37
BSA 232	Unidentified triterpenoid	2859	50.35	296	341	0.63
BSA 233	Phthalate Ester	2890	50.79	149	265	0.20
BSA 234	Nonacosane	2894	50.84	57	71	0.88
BSA 235	Hexacosanoic acid, methyl ester	2914	51.12	74	87	0.82
BSA 236	Unidentified triterpenoid	2925	51.28	215	384	0.79
BSA 237	Unidentified triterpenoid	2938	51.46	275	396	0.43
BSA 238	Unidentified triterpenoid	2950	51.62	380	143	0.81
BSA 239	Unidentified triterpenoid	2972	51.92	382	147	0.91
BSA 240	Triacontane	2994	52.23	57	71	1.06
BSA 241	Phthalate Ester	3005	52.38	149	293	0.21
BSA 242	Phthalate Ester	3011	52.47	149	321	0.14
BSA 243	Unidentified triterpenoid	3005	52.38	396	255	1.24
BSA 244	Heptacosanoic acid	3014	52.52	74	87	1.02
BSA 245	Unidentified triterpenoid	3018	52.58	215	344	0.68
BSA 246	Unidentified triterpenoid	3031	52.77	255	396	0.85
BSA 247	Unidentified triterpenoid	3043	52.94	394	135	0.93
BSA 248	Unidentified triterpenoid	3065	53.27	396	381	0.37
BSA 249	Koprostan-3-one (tentative)	3073	53.38	430	165	0.61
BSA 250	Phthalate Ester	3085	53.57	149	293	0.11
BSA 251	Hentriacontane	3095	53.72	57	71	0.90
BSA 252	Octacosanoic acid	3115	54.04	74	87	0.92
BSA 253	Unidentified C29 tritepenoid	3155	54.72	370	355	0.29
BSA 254	Phthalate Ester	3167	54.92	149	293	0.09
BSA 255	Unidentified triterpene	3173	55.03	217	204	0.71
BSA 256	Phthalate Ester	3203	55.53	149	321	0.25
BSA 257	Cholest-5-en-3-ol(3.beta.)	3194	55.38	370	355	0.15
BSA 258	Phthalate Ester	3284	56.91	149	321	0.20
BSA 259	Unidentified triterpenoid	3276	56.77	218	203	0.67
BSA 260	Unidentified hydrocarbon	3295	57.09	196	162	0.86

Table 2. Sample types, sites and volumes.

Sample Site	Sample Type	Date Sampled	Volume Extracted
Athabasca River			
Upstream of Weldwood/Hinton Mill intake	*In situ* SPE	9-Feb-95	10
1 km Downstream of Weldwood/Hinton Mill	*In situ* SPE	9-Feb-95	13
21 km Downstream of Weldwood/Hinton Mill	*In situ* SPE	20-Jul-94	40
At town of Athabasca	*In situ* SPE	20-Jul-94	40
Upstream of Alberta Pacific Mill effluent.	Grab	20-Aug-95	4
Downstream of Alberta Pacific Mill effluent.	Grab	20-Aug-95	4
Upstream of Fort McMurray	*In situ* SPE	22-Feb-95	10
Wapiti/Smoky River System			
Wapiti R. upstream of Grande Prairie	Grab	15-Feb-95	4
Wapiti R. downstream of sewage treatment plant.	Grab	14-Feb-95	4
Wapiti R. at confluence with Smoky R.	Grab	14-Feb-95	4
Smoky R. upstream of Wapiti R.	Grab	14-Feb-95	4
Smoky R. at Watino.	Grab	15-Feb-95	4

Table 3. Concentration of contaminants in Athabasca River samples (µg/L) .

		Upstream Weldwood intake.	1 km Downstream Weldwood effluent.	21 km Downstream Weldwood effluent.	At town of Athabasca	Upstream of Alberta Pacific discharge	Downstream of Alberta Pacific discharge	Upstream of Ft McMurray
BSA 001	Benzoic acid, methyl ester				0.02			
BSA 002	Dipropyl disulphide							
BSA 003	Octanoic acid, methyl ester							
BSA 004	4-Acetylmorpholine							
BSA 005	Benzene acetic acid, methyl ester							
BSA 006	Naphthalene							
BSA 007	Alkyl disulphide (C7H16S2)							
BSA 008	Dodecane							
BSA 009	Nonanoic acid, methyl ester							
BSA 010	Hexadioic acid, dimethyl ester							
BSA 011	Alkyl disulphide (C8H18S2)							
BSA 012	Phenoxyacetic acid, methyl ester							
BSA 013	Unidentified							
BSA 014	Unidentified hydrocarbon							
BSA 015	Dichlorobenzamine							
BSA 016	Unidentified alkyl alcohol							
BSA 017	Dipropyl trisulphide							
BSA 018	4-Acetoxybenzaldehyde							
BSA 019	Unidentified alkyl methyl ester							
BSA 020	Decanoic acid, methyl ester							
BSA 021	Alkyl disulphide (C9H20S2)							
BSA 022	Unidentified							
BSA 023	Alkyl disulphide (C9H20S2)							

Table 3 continued. Concentration of contaminants in Athabasca River samples (µg/L).

		Upstream Weldwood intake.	1 km Downstream Weldwood effluent.	21 km Downstream Weldwood effluent.	At town of Athabasca	Upstream of Alberta Pacific discharge	Downstream of Alberta Pacific discharge	Upstream of Ft McMurray
BSA 024	Unidentified							
BSA 025	Unidentified chlorinated hydrocarbon							
BSA 026	Unidentified methyl ester							
BSA 027	Unidentified methyl ester							
BSA 028	Unidentified methyl ester							
BSA 029	Unidentified hydrocarbon							
BSA 030	Unidentified methyl ester							
BSA 031	Subst. thiophene							
BSA 032	Fatty acid, methyl ester							
BSA 033	Unidentified							
BSA 034	Octandioic acid, dimethyl ester							
BSA 035	Subst. thiophene(s) coeluting							
BSA 036	Unidentified, (methyl ester 192)							
BSA 037	Unidentified alkyl methyl ester							
BSA 038	Dimethyl phthalate							
BSA 039	4-Acetoxy-3-methoxybenzaldehyde							
BSA 040	Unidentified							
BSA 041	Unidentified							
BSA 042	Pentadecane					0.20		
BSA 043	Unidentified dichloromethyl ester							
BSA 044	Docecanoic acid, methyl ester			0.00				
BSA 045	Unidentified substitiuted benzeneacetic							
BSA 046	Nonadioic acid, dimethyl ester			0.01				

Table 3 continued. Concentration of contaminants in Athabasca River samples (µg/L).

		Upstream Weldwood intake.	1 km Downstream Weldwood effluent.	21 km Downstream Weldwood effluent.	At town of Athabasca	Upstream of Alberta Pacific discharge	Downstream of Alberta Pacific discharge	Upstream of Ft McMurray
BSA 047	Subst. thiophene							
BSA 048	Branched alkane							
BSA 049	Subst. thiophene							
BSA 050	Diethyl phthalate							
BSA 051	Branched alkane							
BSA 052	Dodecanoic acid							
BSA 053	Subst. thiophene							
BSA 054	Alkyl alkene or alcohol							
BSA 055	Alicyclic alcohol							
BSA 056	Alkyl alcohol							
BSA 057	Unidentified terpenoid methyl ester							
BSA 058	Naphthalenecarboxylic acid, methyl							
BSA 059	N-Dimethylbenzenesulphamide							
BSA 060	Subst. thiophene							
BSA 061	Decadioic acid, dimethyl ester							
BSA 062	Phosphoric acid, tributyl ester							
BSA 063	Diacetylated catechol or resorcinol (CH3							
BSA 064	Alkyl polysulphide							
BSA 065	4-Hydroxy-3,5-methoxybenzaldehyde							
BSA 066	Nonylphenol Isomer							
BSA 067	Unidentified							
BSA 068	Nonylphenol Isomer							
BSA 069	Unidentified Diterpene (C20H32)							

Table 3 continued. Concentration of contaminants in Athabasca River samples (µg/L).

		Upstream Weldwood intake.	1 km Downstream Weldwood effluent.	21 km Downstream Weldwood effluent.	At town of Athabasca	Upstream of Alberta Pacific discharge	Downstream of Alberta Pacific discharge	Upstream of Ft McMurray
BSA 070	Subst. thiophene							
BSA 071	Unidentified							
BSA 072	Tetradecanoic acid, methyl ester	0.02						0.02
BSA 073	Unidentified alkyl hydrocarbon							
BSA 074	Nonylphenol isomer							
BSA 075	Dichloro unidentified							
BSA 076	Tetradecanoic acid							
BSA 077	Unidentified alkyl hydrocarbon							
BSA 078	Caffeine							
BSA 079	Branched C15:0 fatty acid methyl ester			0.01				
BSA 080	Branched C15:0 fatty acid methyl ester							
BSA 081	Pentadecanoic acid, methyl ester			0.01				
BSA 082	Phthalate ester							
BSA 083	C15:0 fatty acid							
BSA 084	Bis-(methylpropyl)-phthalate							
BSA 085	Unidentified diterpene							
BSA 086	Pentadecanoic acid							
BSA 087	Branched C16:0 fatty acid methyl ester							
BSA 088	Hexadecenoic acid, methyl ester							
BSA 089	Unidentified (Background)							
BSA 090	Unidentified methyl ester, terpenoid							
BSA 091	Hexadecanoic acid, methyl ester			0.06				
BSA 092	Dibutylphthalate			0.01		0.03	0.30	
BSA 093	Unidentified Diterpene (C20H32)							
BSA 094	Hexadecenoic acid							

Table 3 continued. Concentration of contaminants in Athabasca River samples (µg/L).

		Upstream Weldwood intake.	1 km Downstream Weldwood effluent.	21 km Downstream Weldwood effluent.	At town of Athabasca	Upstream of Alberta Pacific discharge	Downstream of Alberta Pacific discharge	Upstream of Ft McMurray
BSA 095	Sandaracopimaridiene							
BSA 096	Branched alkane							
BSA 097	Sulphur S8							
BSA 098	Hexadecanoic acid						0.06	
BSA 099	Branched C17:0 fatty acid methyl ester							
BSA 100	2-Naphthaleneacetic acid, 6-methoxy, a-							
BSA 101	Isopimaridiene							
BSA 102	Branched C17:0 fatty acid methyl ester							
BSA 103	Hexadecanoic acid, ethyl ester							
BSA 104	Branched C17:0 fatty acid methyl ester							
BSA 105	Unidentified							
BSA 106	Unidentified Diterpene (C20H32)							
BSA 107	Unidentified mw 292							
BSA 108	Eicosane							
BSA 109	Unidentified mw 292							
BSA 110	Heptadecanoic acid, methyl ester			0.00				
BSA 111	Unidentified							
BSA 112	Unidentified Diterpene (C20H32)							
BSA 113	Unidentified (mw 294)							
BSA 114	Unidentified							
BSA 115	Heptadecanoic acid							
BSA 116	Unidentified Diterpene (C20H32)							
BSA 117	Unidentified branched alkane							
BSA 118	9,12-Octadecadienoic acid, methyl ester	0.02						

Table 3 continued. Concentration of contaminants in Athabasca River samples (µg/L).

		Upstream Weldwood intake.	1 km Downstream Weldwood effluent.	21 km Downstream Weldwood effluent.	At town of Athabasca	Upstream of Alberta Pacific discharge	Downstream of Alberta Pacific discharge	Upstream of Ft McMurray
BSA 119	9-Octadecen(Z)oic acid methyl ester			0.00				
BSA 120	9-Octadecen(E)oic acid methyl ester							
BSA 121	Heneicosane					0.03		
BSA 122	Unidentified Hydrocarbon							
BSA 123	Octadecanoic acid, methyl ester			0.03				
BSA 124	C18:1 Fatty acid							
BSA 125	C18:1 Fatty acid							
BSA 126	Unidentified							
BSA 127	C18:0 Fatty acid							
BSA 128	Octadecanoic acid, ethyl ester							
BSA 129	Phthalate Ester (di C6H13)							
BSA 130	Phthalate Ester (di C6H13)							
BSA 131	Branched alkane (C22H46)							
BSA 132	Nonadecenoic acid, methyl ester							
BSA 133	Docosane							
BSA 134	Phthalate Ester (di C6H13)							
BSA 135	Phthalate Ester (di C6H13)							
BSA 136	Unidentified Hydrocarbon							
BSA 137	Phthalate Ester (di C6H13)							
BSA 138	Nonadecanoic acid, methyl ester							
BSA 139	Unidentified Diterpene (C20H28O)							
BSA 140	Phthalate Ester (di C6H13)							
BSA 141	Unidentified alkene							
BSA 142	Phthalate Ester (di C6H13)							
BSA 143	Unidentified Hydrocarbon							

Table 3 continued. Concentration of contaminants in Athabasca River samples (µg/L).

		Upstream Weldwood intake.	1 km Downstream Weldwood effluent.	21 km Downstream Weldwood effluent.	At town of Athabasca	Upstream of Alberta Pacific discharge	Downstream of Alberta Pacific discharge	Upstream of Ft McMurray
BSA 144	Unidentified							
BSA 145	Phthalate Ester (di C6H13)							
BSA 146	Phthalate Ester (di C6H13)							
BSA 147	Phthalate Ester (di C6H13)							
BSA 148	Unidentified (mw 336)							
BSA 149	Phthalate Ester (di C6H13)							
BSA 150	Unidentified							
BSA 151	Unidentified (mw 336)							
BSA 152	Phthalate Ester (di C6H13)							
BSA 153	Unidentified (mw 336)							
BSA 154	Unidentified alkene							
BSA 155	Unidentified (mw 336)							
BSA 156	Phthalate Ester (butyl, methylphenyl)							
BSA 157	Phthalate Ester (di C6H13)							
BSA 158	Dehydroabietic acid, methyl ester							
BSA 159	Tricosane							
BSA 160	Unidentified							
BSA 161	Hexadioic acid, dioctyl ester					1.00	2.00	
BSA 162	Eicosanoic acid, methyl ester							
BSA 163	Phthalate Ester (di C6H13)							
BSA 164	Unidentified							
BSA 165	Phosphoric acid, triphenyl ester							
BSA 166	Unidentified							
BSA 167	Phthalate Ester							
BSA 168	Unidentified							

Table 3 continued. Concentration of contaminants in Athabasca River samples (µg/L).

		Upstream Weldwood intake.	1 km Downstream Weldwood effluent.	21 km Downstream Weldwood effluent.	At town of Athabasca	Upstream of Alberta Pacific discharge	Downstream of Alberta Pacific discharge	Upstream of Ft McMurray
BSA 169	Unidentified							
BSA 170	Unidentified							
BSA 171	Unidentified Triterpenoid							
BSA 172	Phthalate Ester							
BSA 173	Unidentified							
BSA 174	Unidentified Diterpene acid							
BSA 175	Phthalate Ester							
BSA 176	2-Butoxyethanol phosphate (3:1)							
BSA 177	Hexadioic acid, dioctyl ester							
BSA 178	Unidentified (mw 352)							
BSA 179	Unidentified							
BSA 180	Dehydroabietic acid							
BSA 181	Phthalate Ester							
BSA 182	Unidentified							
BSA 183	Unidentified, tentatively diethylene glycol							
BSA 184	Tetracosane							
BSA 185	Phthalate Ester							
BSA 186	Heneicosanoic acid, methyl ester							
BSA 187	Phthalate Ester							
BSA 188	Unidentified Diterpene acid							
BSA 189	Unidentified							
BSA 190	Unidentified Hydrocarbon (Dioic acid							
BSA 191	Unidentified mw 352							

Table 3 continued. Concentration of contaminants in Athabasca River samples (µg/L).

		Upstream Weldwood intake.	1 km Downstream Weldwood effluent.	21 km Downstream Weldwood effluent.	At town of Athabasca	Upstream of Alberta Pacific discharge	Downstream of Alberta Pacific discharge	Upstream of Ft McMurray
BSA 192	Unidentified mw 352							
BSA 193	Triterpenoid acid, methyl ester							
BSA 194	Phthalate Ester							
BSA 195	Phthalate Ester			0.90		0.30	0.60	
BSA 196	Docosanoic acid, methyl ester							
BSA 197	Phthalate Ester							
BSA 198	Phthalate Ester							
BSA 199	Phthalate Ester							
BSA 200	Unidentified mw 380							
BSA 201	Phthalate Ester							
BSA 202	Unidentified mw 380							
BSA 203	Unidentified (mw 380)							
BSA 204	Phthalate Ester							
BSA 205	Phthalate Ester							
BSA 206	Tricosanoic acid, methyl ester							
BSA 207	Unidentified mw 380							
BSA 208	Unidentified mw 380							
BSA 209	Phthalate Ester							
BSA 210	Unidentified hydrocarbon							
BSA 211	Unidentified hydrocarbon							
BSA 212	Phthalate Ester							
BSA 213	Unidentified mw 380							
BSA 214	Unidentified hydrocarbon							
BSA 215	Unidentified mw 380							
BSA 216	Phthalate Ester							

Table 3 continued. Concentration of contaminants in Athabasca River samples (µg/L).

		Upstream Weldwood intake.	1 km Downstream Weldwood effluent.	21 km Downstream Weldwood effluent.	At town of Athabasca	Upstream of Alberta Pacific discharge	Downstream of Alberta Pacific discharge	Upstream of Ft McMurray
BSA 217	Heptacosane							
BSA 218	Phthalate Ester							
BSA 219	Tetracosanoic acid, methyl ester			0.01				
BSA 220	Phthalate Ester							
BSA 221	Phthalate Ester							
BSA 222	Decanedioic acid, dioctyl ester							
BSA 223	Phthalate Ester							
BSA 224	Phthalate Ester							
BSA 225	Unidentified							
BSA 226	Octacosane							
BSA 227	Phthalate Ester							
BSA 228	Squalene							
BSA 229	Pentacosanoic acid, methyl ester							
BSA 230	Phthalate Ester							
BSA 231	Unidentified triterpenoid acid ester							
BSA 232	Unidentified triterpenoid							
BSA 233	Phthalate Ester							
BSA 234	Nonacosane							
BSA 235	Hexacosanoic acid, methyl ester							
BSA 236	Unidentified triterpenoid							
BSA 237	Unidentified triterpenoid							
BSA 238	Unidentified triterpenoid							
BSA 239	Unidentified triterpenoid							
BSA 240	Triacontane							
BSA 241	Phthalate Ester							

Table 3 continued. Concentration of contaminants in Athabasca River samples (µg/L).

		Upstream Weldwood intake.	1 km Downstream Weldwood effluent.	21 km Downstream Weldwood effluent.	At town of Athabasca	Upstream of Alberta Pacific discharge	Downstream of Alberta Pacific discharge	Upstream of Ft McMurray
BSA 242	Phthalate Ester							
BSA 243	Unidentified triterpenoid							
BSA 244	Heptacosanoic acid							
BSA 245	Unidentified triterpenoid							
BSA 246	Unidentified triterpenoid							
BSA 247	Unidentified triterpenoid							
BSA 248	Unidentified triterpenoid							
BSA 249	Koprostan-3-one (tentative)							
BSA 250	Phthalate Ester							
BSA 251	Hentriacontane							
BSA 252	Octacosanoic acid							
BSA 253	Unidentified C29 tritepenoid							
BSA 254	Phthalate Ester							
BSA 255	Unidentified triterpene							
BSA 256	Phthalate Ester							
BSA 257	Cholest-5-en-3-ol(3.beta.) (tentative)							
BSA 258	Phthalate Ester							
BSA 259	Unidentified triterpenoid							
BSA 260	Unidentified hydrocarbon							

Table 4. Concentration of contaminants in Wapiti/Smoky River system samples (µg/L).

		Wapiti River upstream of Grande Prairie	Wapiti River downstream of Grande Prairie STP effluent	Wapiti River mouth at Smoky River	Smoky River upstream of Wapiti River Confluenc.	Smoky River at Watino
BSA 001	Benzoic acid, methyl ester					
BSA 002	Dipropyl disulphide					
BSA 003	Octanoic acid, methyl ester					
BSA 004	4-Acetylmorphoiine					
BSA 005	Benzene acetic acid, methyl ester					
BSA 006	Naphthalene					
BSA 007	Alkyl disulphide (C7H16S2)					
BSA 008	Dodecane		2.00			
BSA 009	Nonanoic acid, methyl ester					
BSA 010	Hexadioic acid, dimethyl ester					
BSA 011	Alkyl disulphide (C8H18S2)					
BSA 012	Phenoxyacetic acid, methyl ester					
BSA 013	Unidentified					
BSA 014	Unidentified hydrocarbon					
BSA 015	Dichlorobenzamine					
BSA 016	Unidentified alkyl alcohol					
BSA 017	Dipropyl trisulphide					
BSA 018	4-Acetoxybenzaldehyde					
BSA 019	Unidentified alkyl methyl ester					
BSA 020	Decanoic acid, methyl ester					
BSA 021	Alkyl disulphide (C9H20S2)					
BSA 022	Unidentified					
BSA 023	Alkyl disulphide (C9H20S2)					

Table 4 continued. Concentration of contaminants in Wapiti/Smoky River system samples (µg/L).

		Wapiti River upstream of Grande Prairie	Wapiti River downstream of Grande Prairie STP effluent	Wapiti River mouth at Smoky River	Smoky River upstream of Wapiti River Confluenc.	Smoky River at Watino
BSA 024	Unidentified					
BSA 025	Unidentified chlorinated hydrocarbon					
BSA 026	Unidentified methyl ester					
BSA 027	Unidentified methyl ester					
BSA 028	Unidentified methyl ester					
BSA 029	Unidentified hydrocarbon					
BSA 030	Unidentified methyl ester					
BSA 031	Subst. thiophene					
BSA 032	Fatty acid, methyl ester					
BSA 033	Unidentified					
BSA 034	Octandioic acid, dimethyl ester					
BSA 035	Subst. thiophene(s) coeluting					
BSA 036	Unidentified, (methyl ester 192)					
BSA 037	Unidentified alkyl methyl ester					
BSA 038	Dimethyl phthalate					
BSA 039	4-Acetoxy-3-methoxybenzaldehyde					
BSA 040	Unidentified					
BSA 041	Unidentified					
BSA 042	Pentadecane	0.30	0.03	0.10	1.00	0.80
BSA 043	Unidentified dichloromethyl ester					
BSA 044	Docecanoic acid, methyl ester					

Table 4 continued. Concentration of contaminants in Wapiti/Smoky River system samples (µg/L).

		Wapiti River upstream of Grande Prairie	Wapiti River downstream of Grande Prairie STP effluent	Wapiti River mouth at Smoky River	Smoky River upstream of Wapiti River Confluenc.	Smoky River at Watino
BSA 045	Unidentified substituted benzeneacetic					
BSA 046	Nonadioic acid, dimethyl ester					
BSA 047	Subst. thiophene					
BSA 048	Branched alkane					
BSA 049	Subst. thiophene					
BSA 050	Diethyl phthalate					
BSA 051	Branched alkane					
BSA 052	Dodecanoic acid					
BSA 053	Subst. thiophene					
BSA 054	Alkyl alkene or alcohol					
BSA 055	Alicyclic alcohol					
BSA 056	Alkyl alcohol					
BSA 057	Unidentified terpenoid methyl ester					
BSA 058	Naphthalenecarboxylic acid, methyl					
BSA 059	N-Dimethylbenzenesulphamide					
BSA 060	Subst. thiophene					
BSA 061	Decadioic acid, dimethyl ester					
BSA 062	Phosphoric acid, tributyl ester					
BSA 063	Diacetylated catechol or resorcinol (CH3					
BSA 064	Alkyl polysulphide					

Table 4 continued. Concentration of contaminants in Wapiti/Smoky River system samples (µg/L).

		Wapiti River upstream of Grande Prairie	Wapiti River downstream of Grande Prairie STP effluent	Wapiti River mouth at Smoky River	Smoky River upstream of Wapiti River Confluenc.	Smoky River at Watino
BSA 065	4-Hydroxy-3,5-methoxybenzaldehyde					
BSA 066	Nonylphenol Isomer					
BSA 067	Unidentified					
BSA 068	Nonylphenol Isomer					
BSA 069	Unidentified Diterpene (C20H32)					
BSA 070	Subst. thiophene					
BSA 071	Unidentified					
BSA 072	Tetradecanoic acid, methyl ester					
BSA 073	Unidentified alkyl hydrocarbon					
BSA 074	Nonylphenol Isomer					
BSA 075	Dichloro unidentified					
BSA 076	Tetradecanoic acid					
BSA 077	Unidentified alkyl hydrocarbon					
BSA 078	Caffeine					
BSA 079	Branched C15:0 fatty acid methyl ester					
BSA 080	Branched C15:0 fatty acid methyl ester					
BSA 081	Pentadecanoic acid, methyl ester					
BSA 082	Phthalate ester					
BSA 083	C15:0 fatty acid					
BSA 084	Bis-(methylpropyl)-phthalate	0.10	0.30			0.20

Table 4 continued. Concentration of contaminants in Wapiti/Smoky River system samples (µg/L).

		Wapiti River upstream of Grande Prairie	Wapiti River downstream of Grande Prairie STP effluent	Wapiti River mouth at Smoky River	Smoky River upstream of Wapiti River Confluenc.	Smoky River at Watino
BSA 085	Unidentified diterpene					
BSA 086	Pentadecanoic acid					
BSA 087	Branched C16:0 fatty acid methyl ester					
BSA 088	Hexadecenoic acid, methyl ester					
BSA 089	Unidentified (Background)					
BSA 090	Unidentified methyl ester, terpenoid					
BSA 091	Hexadecanoic acid, methyl ester					
BSA 092	Dibutylphthalate	0.50	0.10			0.20
BSA 093	Unidentified Diterpene (C20H32)					
BSA 094	Hexadecenoic acid					
BSA 095	Sandaracopimaridiene					
BSA 096	Branched alkane					
BSA 097	Sulphur S8					
BSA 098	Hexadecanoic acid	0.10	0.10			0.04
BSA 099	Branched C17:0 fatty acid methyl ester					
BSA 100	2-Naphthaleneacetic acid, 6-methoxy, a-					
BSA 101	Isopimaridiene					
BSA 102	Branched C17:0 fatty acid methyl ester					
BSA 103	Hexadecanoic acid, ethyl ester					0.04

Table 4 continued. Concentration of contaminants in Wapiti/Smoky River system samples (µg/L).

		Wapiti River upstream of Grande Prairie	Wapiti River downstream of Grande Prairie STP effluent	Wapiti River mouth at Smoky River	Smoky River upstream of Wapiti River Confluenc.	Smoky River at Watino
BSA 104	Branched C17:0 fatty acid methyl ester					
BSA 105	Unidentified					
BSA 106	Unidentified Diterpene (C20H32)					
BSA 107	Unidentified mw 292					
BSA 108	Eicosane		0.03			
BSA 109	Unidentified mw 292					
BSA 110	Heptadecanoic acid, methyl ester					
BSA 111	Unidentified					0.60
BSA 112	Unidentified Diterpene (C20H32)					
BSA 113	Unidentified (mw 294)					
BSA 114	Unidentified					
BSA 115	Heptadecanoic acid					
BSA 116	Unidentified Diterpene (C20H32)					
BSA 117	Unidentified branched alkane					
BSA 118	9,12-Octadecadienoic acid, methyl ester					1.00
BSA 119	9-Octadecen(Z)oic acid methyl ester					
BSA 120	9-Octadecen(E)oic acid methyl ester					
BSA 121	Heneicosane			0.10		0.30
BSA 122	Unidentified Hydrocarbon					
BSA 123	Octadecanoic acid, methyl ester					
BSA 124	C18:1 Fatty acid					
BSA 125	C18:1 Fatty acid					

Table 4 continued. Concentration of contaminants in Wapiti/Smoky River system samples (µg/L).

		Wapiti River upstream of Grande Prairie	Wapiti River downstream of Grande Prairie STP effluent	Wapiti River mouth at Smoky River	Smoky River upstream of Wapiti River Confluenc.	Smoky River at Watino
BSA 126	Unidentified					
BSA 127	C18:0 Fatty acid					
BSA 128	Octadecanoic acid, ethyl ester					0.03
BSA 129	Phthalate Ester (di C6H13)					
BSA 130	Phthalate Ester (di C6H13)					
BSA 131	Branched alkane (C22H46)					
BSA 132	Nonadecenoic acid, methyl ester					
BSA 133	Docosane			0.02		0.03
BSA 134	Phthalate Ester (di C6H13)					
BSA 135	Phthalate Ester (di C6H13)					
BSA 136	Unidentified Hydrocarbon					
BSA 137	Phthalate Ester (di C6H13)					
BSA 138	Nonadecanoic acid, methyl ester					
BSA 139	Unidentified Diterpene (C20H28O)					
BSA 140	Phthalate Ester (di C6H13)					
BSA 141	Unidentified alkene					
BSA 142	Phthalate Ester (di C6H13)					
BSA 143	Unidentified Hydrocarbon					
BSA 144	Unidentified					
BSA 145	Phthalate Ester (di C6H13)					
BSA 146	Phthalate Ester (di C6H13)					
BSA 147	Phthalate Ester (di C6H13)					
BSA 148	Unidentified (mw 336)					

Table 4 continued. Concentration of contaminants in Wapiti/Smoky River system samples (µg/L).

		Wapiti River upstream of Grande Prairie	Wapiti River downstream of Grande Prairie STP effluent	Wapiti River mouth at Smoky River	Smoky River upstream of Wapiti River Confluenc.	Smoky River at Watino
BSA 149	Phthalate Ester (di C6H13)					
BSA 150	Unidentified	0.02		0.10		0.10
BSA 151	Unidentified (mw 336)					
BSA 152	Phthalate Ester (di C6H13)					
BSA 153	Unidentified (mw 336)					
BSA 154	Unidentified alkene					
BSA 155	Unidentified (mw 336)					
BSA 156	Phthalate Ester (butyl, methylphenyl)					
BSA 157	Phthalate Ester (di C6H13)	0.04				
BSA 158	Dehydroabietic acid. methyl ester					
BSA 159	Tricosane	0.08	0.07			0.04
BSA 160	Unidentified					
BSA 161	Hexadioic acid, dioctyl ester	4.00	3.00			0.20
BSA 162	Eicosanoic acid, methyl ester					
BSA 163	Phthalate Ester (di C6H13)	0.10				
BSA 164	Unidentified					
BSA 165	Phosphoric acid, triphenyl ester					
BSA 166	Unidentified					
BSA 167	Phthalate Ester					
BSA 168	Unidentified					
BSA 169	Unidentified					
BSA 170	Unidentified					
BSA 171	Unidentified Triterpenoid					

Table 4 continued. Concentration of contaminants in Wapiti/Smoky River system samples (µg/L).

		Wapiti River upstream of Grande Prairie	Wapiti River downstream of Grande Prairie STP effluent	Wapiti River mouth at Smoky River	Smoky River upstream of Wapiti River Confluenc.	Smoky River at Watino
BSA 172	Phthalate Ester					
BSA 173	Unidentified					
BSA 174	Unidentified Diterpene acid					
BSA 175	Phthalate Ester					
BSA 176	2-Butoxyethanol phosphate (3:1)					
BSA 177	Hexadioic acid, dioctyl ester					
BSA 178	Unidentified (mw 352)					
BSA 179	Unidentified					
BSA 180	Dehydroabietic acid					
BSA 181	Phthalate Ester					
BSA 182	Unidentified					
BSA 183	Unidentified, tentatively diethylene glycol					
BSA 184	Tetracosane					
BSA 185	Phthalate Ester					
BSA 186	Heneicosanoic acid, methyl ester					
BSA 187	Phthalate Ester					
BSA 188	Unidentified Diterpene acid					
BSA 189	Unidentified					
BSA 190	Unidentified Hydrocarbon (Dioic acid					
BSA 191	Unidentified mw 352					
BSA 192	Unidentified mw 352					
BSA 193	Triterpenoid acid, methyl ester					

Table 4 continued. Concentration of contaminants in Wapiti/Smoky River system samples (µg/L).

		Wapiti River upstream of Grande Prairie	Wapiti River downstream of Grande Prairie STP effluent	Wapiti River mouth at Smoky River	Smoky River upstream of Wapiti River Confluenc.	Smoky River at Watino
BSA 194	Phthalate Ester	0.10				
BSA 195	Phthalate Ester	2.00	1.00	0.90	0.50	1.00
BSA 196	Docosanoic acid, methyl ester					
BSA 197	Phthalate Ester					
BSA 198	Phthalate Ester					
BSA 199	Phthalate Ester					
BSA 200	Unidentified mw 380					
BSA 201	Phthalate Ester					
BSA 202	Unidentified mw 380					
BSA 203	Unidentified (mw 380)					
BSA 204	Phthalate Ester					
BSA 205	Phthalate Ester					
BSA 206	Tricosanoic acid, methyl ester					
BSA 207	Unidentified mw 380					
BSA 208	Unidentified mw 380					
BSA 209	Phthalate Ester					
BSA 210	Unidentified hydrocarbon					
BSA 211	Unidentified hydrocarbon					
BSA 212	Phthalate Ester					
BSA 213	Unidentified mw 380					
BSA 214	Unidentified hydrocarbon					
BSA 215	Unidentified mw 380					
BSA 216	Phthalate Ester	0.10				

Table 4 continued. Concentration of contaminants in Wapiti/Smoky River system samples (µg/L).

		Wapiti River upstream of Grande Prairie	Wapiti River downstream of Grande Prairie STP effluent	Wapiti River mouth at Smoky River	Smoky River upstream of Wapiti River Confluenc.	Smoky River at Watino
BSA 217	Heptacosane					
BSA 218	Phthalate Ester					
BSA 219	Tetracosanoic acid, methyl ester					
BSA 220	Phthalate Ester					
BSA 221	Phthalate Ester					
BSA 222	Decanedioic acid, dioctyl ester					
BSA 223	Phthalate Ester					
BSA 224	Phthalate Ester					
BSA 225	Unidentified					
BSA 226	Octacosane					
BSA 227	Phthalate Ester					
BSA 228	Squalene					
BSA 229	Pentacosanoic acid, methyl ester					
BSA 230	Phthalate Ester					
BSA 231	Unidentified triterpenoid acid ester					
BSA 232	Unidentified triterpenoid					
BSA 233	Phthalate Ester					
BSA 234	Nonacosane					
BSA 235	Hexacosanoic acid, methyl ester					
BSA 236	Unidentified triterpenoid					
BSA 237	Unidentified triterpenoid					
BSA 238	Unidentified triterpenoid					
BSA 239	Unidentified triterpenoid					

Table 4 continued. Concentration of contaminants in Wapiti/Smoky River system samples (µg/L).

		Wapiti River upstream of Grande Prairie	Wapiti River downstream of Grande Prairie STP effluent	Wapiti River mouth at Smoky River	Smoky River upstream of Wapiti River Confluenc.	Smoky River at Watino
BSA 240	Triacontane					
BSA 241	Phthalate Ester					
BSA 242	Phthalate Ester					
BSA 243	Unidentified triterpenoid					
BSA 244	Heptacosanoic acid					
BSA 245	Unidentified triterpenoid					
BSA 246	Unidentified triterpenoid					
BSA 247	Unidentified triterpenoid					
BSA 248	Unidentified triterpenoid					
BSA 249	Koprostan-3-one (tentative)					
BSA 250	Phthalate Ester	0.02				
BSA 251	Hentriacontane					
BSA 252	Octacosanoic acid					
BSA 253	Unidentified C29 tritepenoid					
BSA 254	Phthalate Ester					
BSA 255	Unidentified triterpene					
BSA 256	Phthalate Ester					
BSA 257	Cholest-5-en-3-ol(3.beta.) (tentative)					
BSA 258	Phthalate Ester					
BSA 259	Unidentified triterpenoid					
BSA 260	Unidentified hydrocarbon					

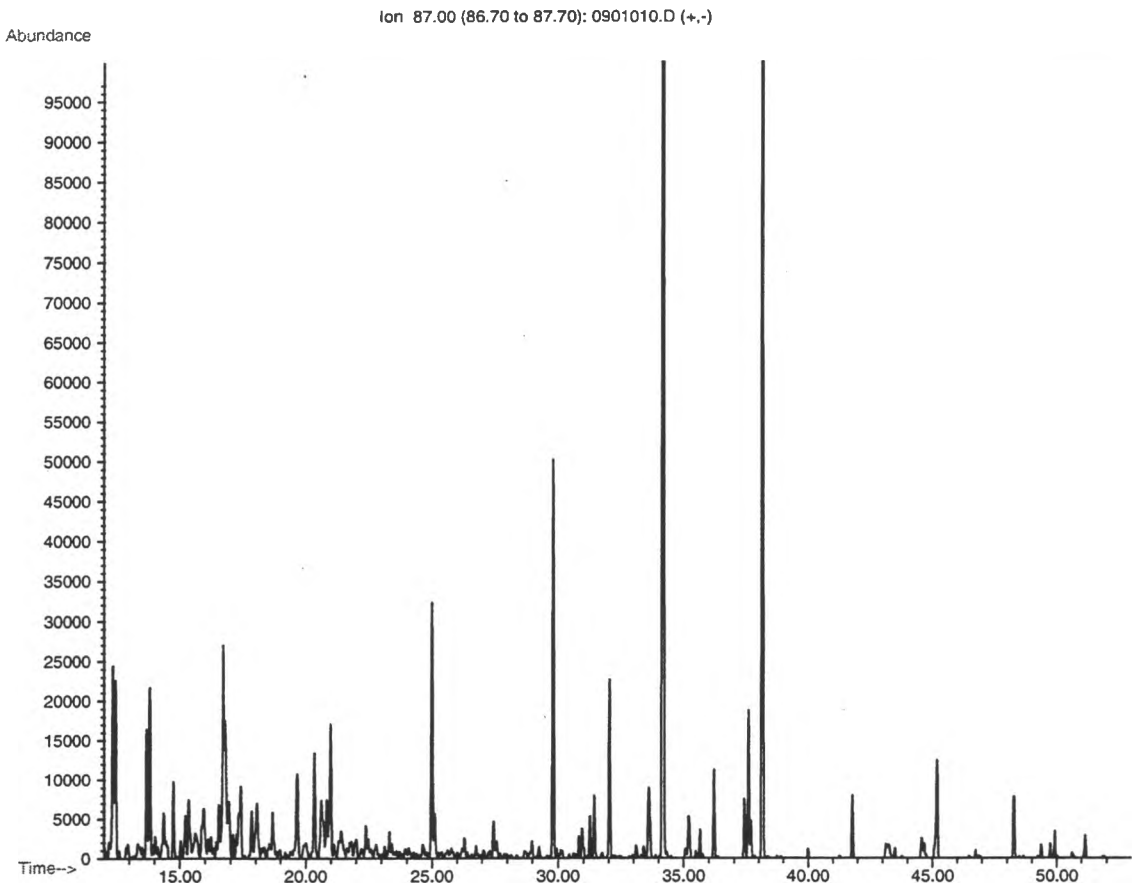

Figure 1. Mono- and dicarboxylic acid, methyl ester characteristic trace of the Athabasca River upstream Weldwood intake.

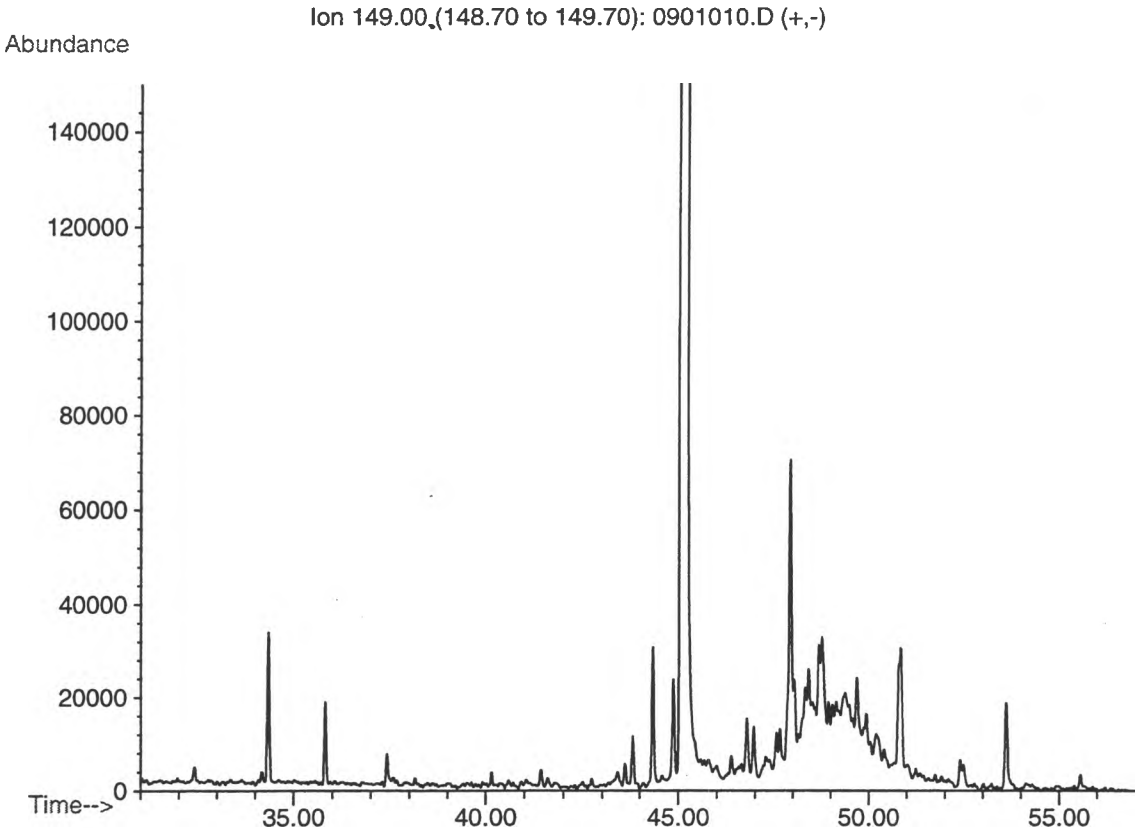

Figure 2. Phthalate ester characteristic trace of the Athabasca River upstream Weldwood intake.

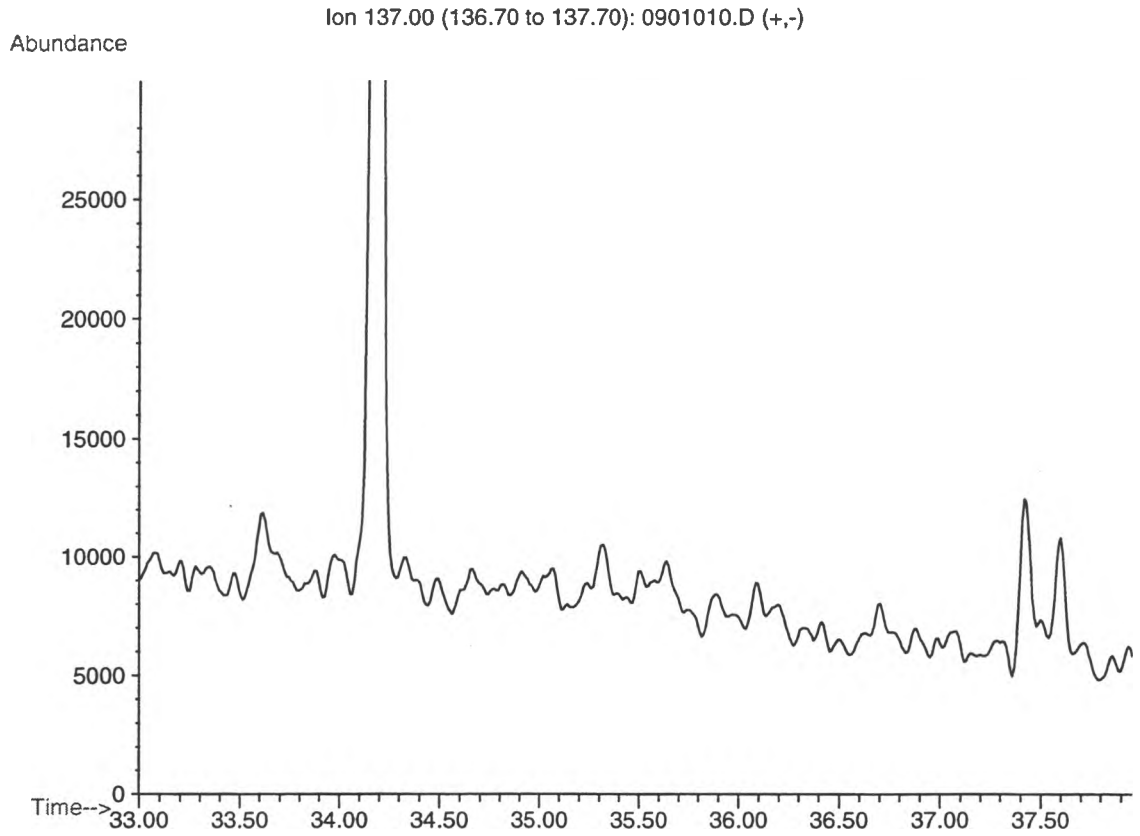

Figure 3. Diterpene characteristic trace of the Athabasca River upstream Weldwood intake.

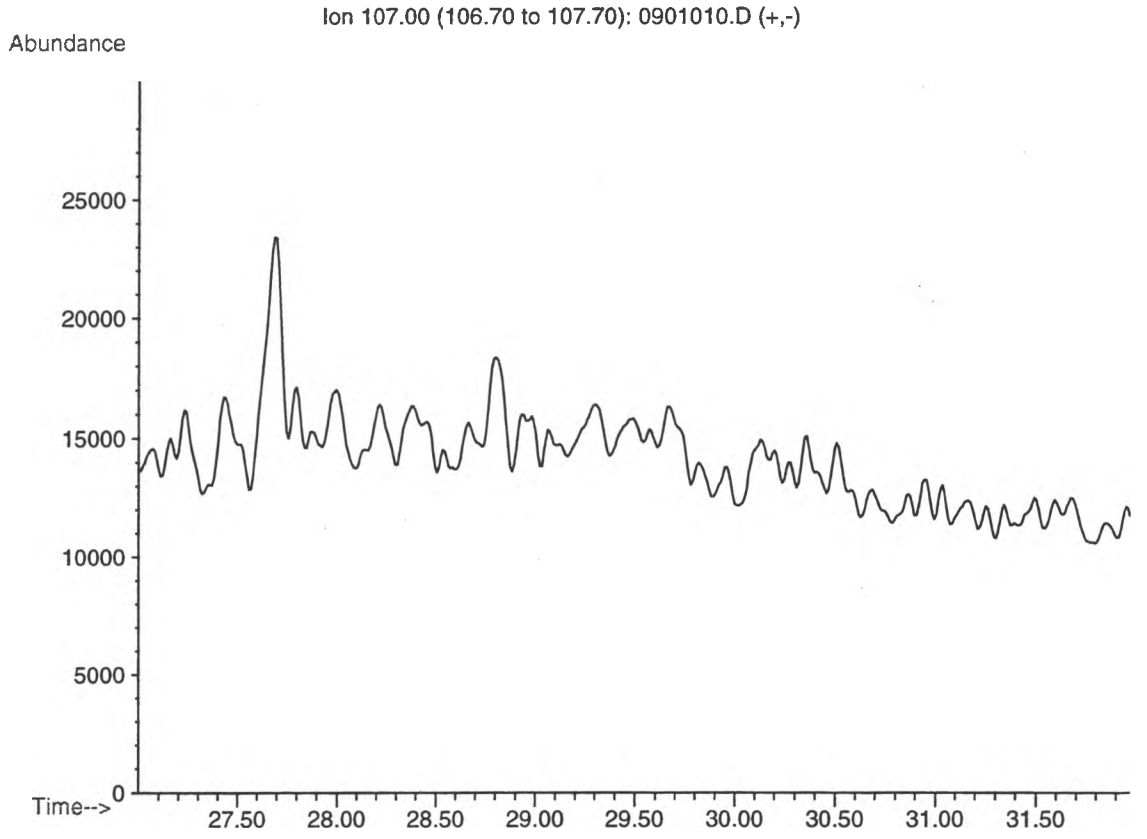

Figure 4. Nonylphenol characteristic trace of the Athabasca River upstream Weldwood intake.

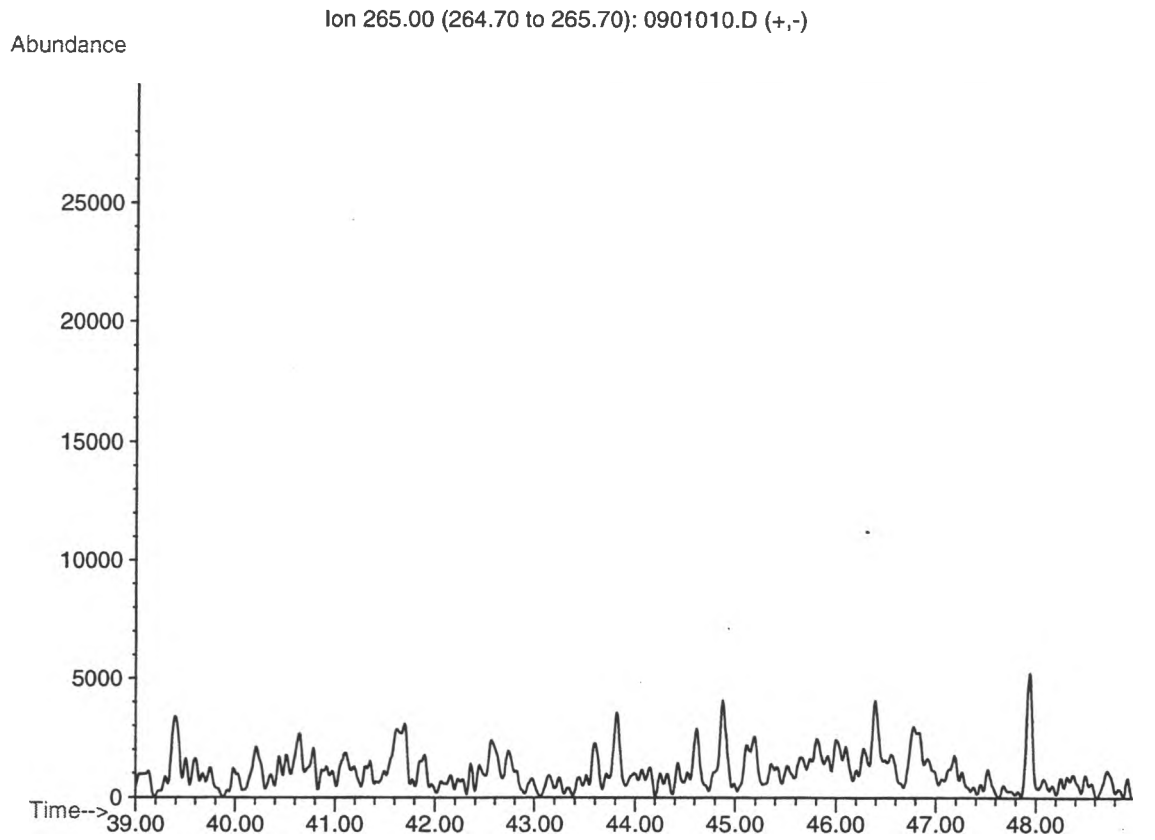

Figure 5. Unidentified STP acid esters characteristic trace of the Athabasca River upstream Weldwood intake.

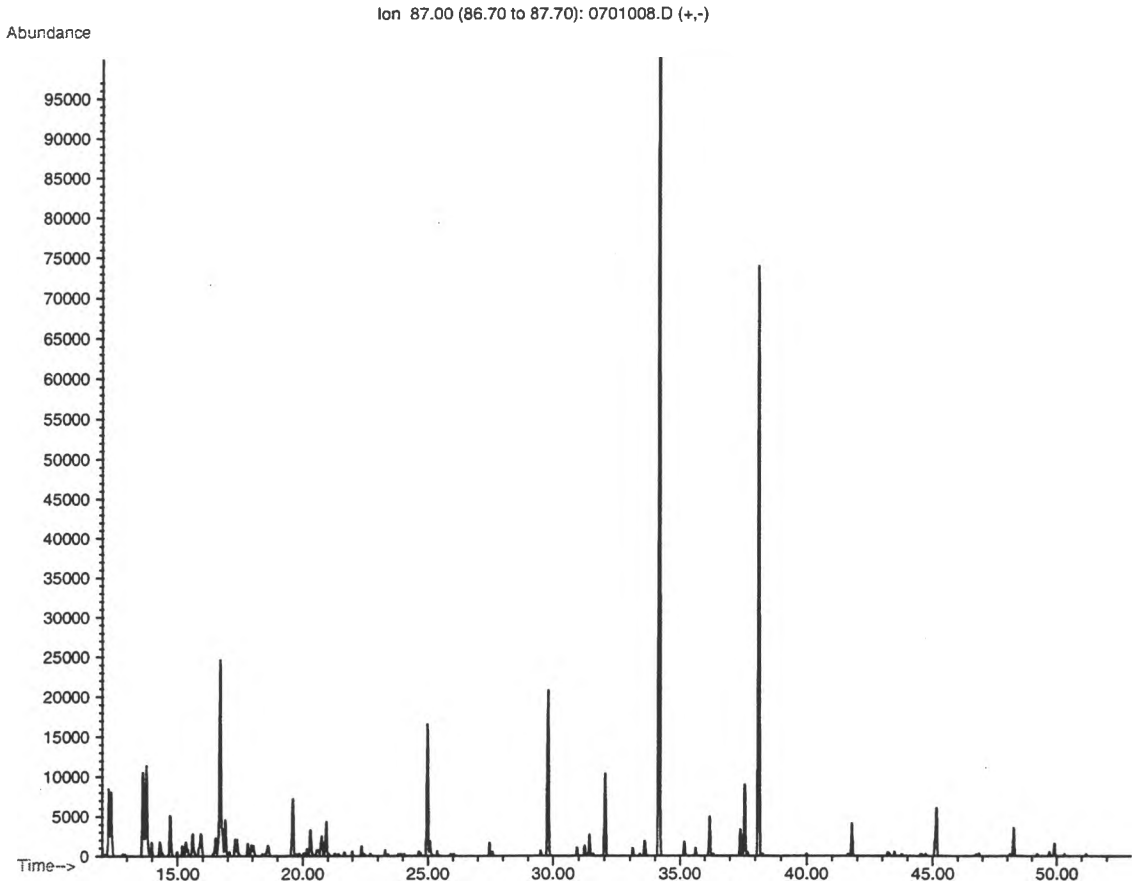

Figure 6. Mono- and dicarboxylic acid, methyl ester characteristic trace of the Athabasca River 1 km downstream Weldwood effluent.

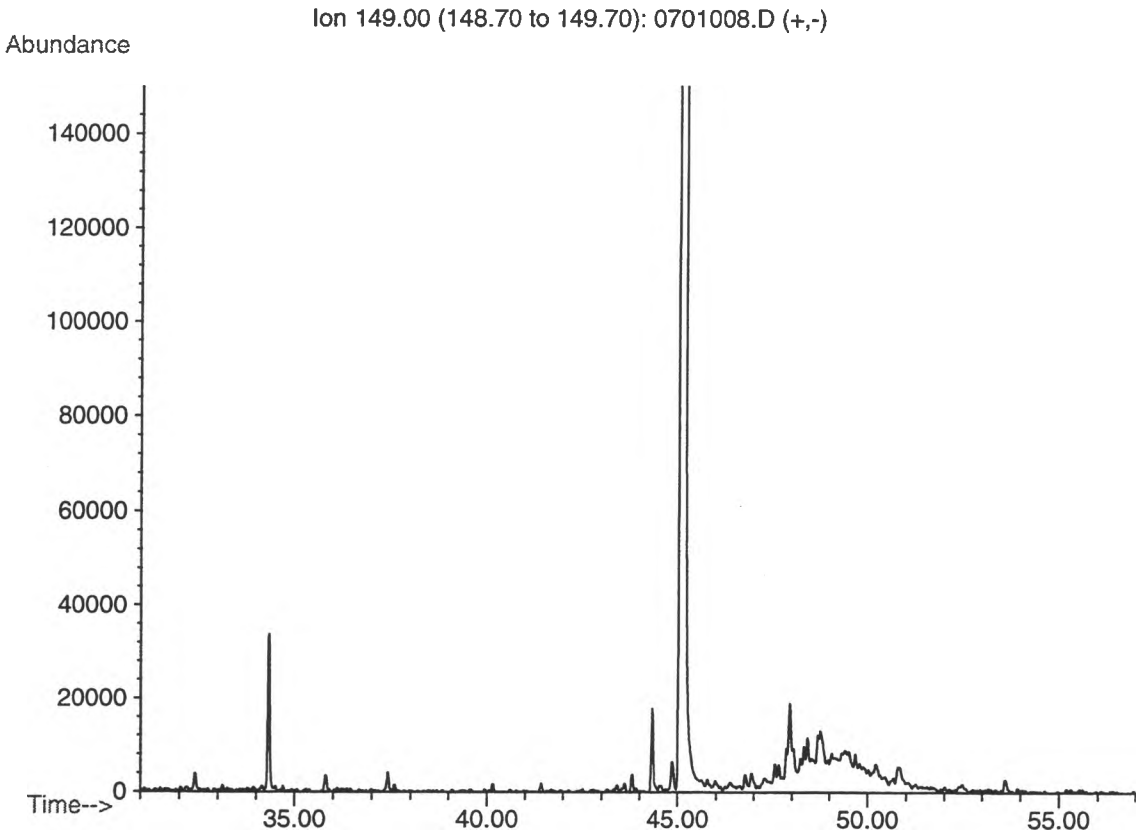

Figure 7. Phthalate ester characteristic trace of the Athabasca River 1 km downstream Weldwood effluent.

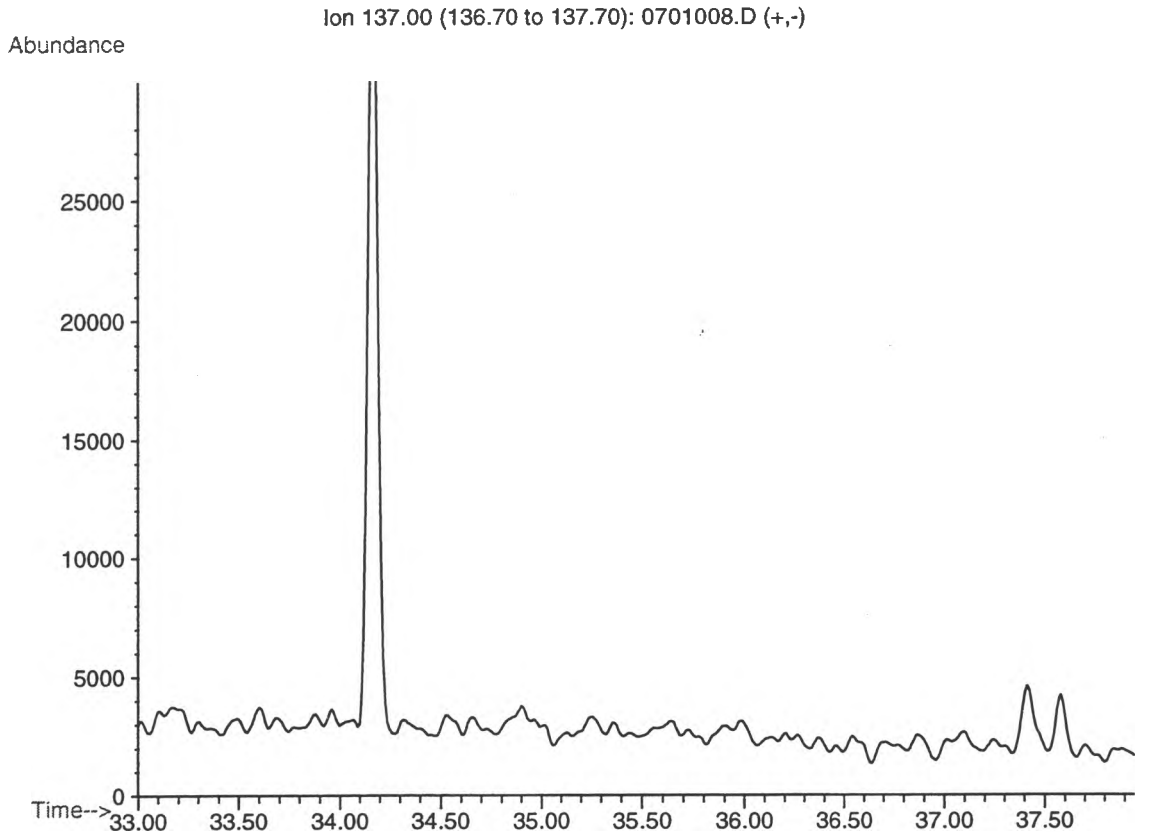

Figure 8. Diterpene characteristic trace of the Athabasca River 1 km downstream Weldwood effluent.

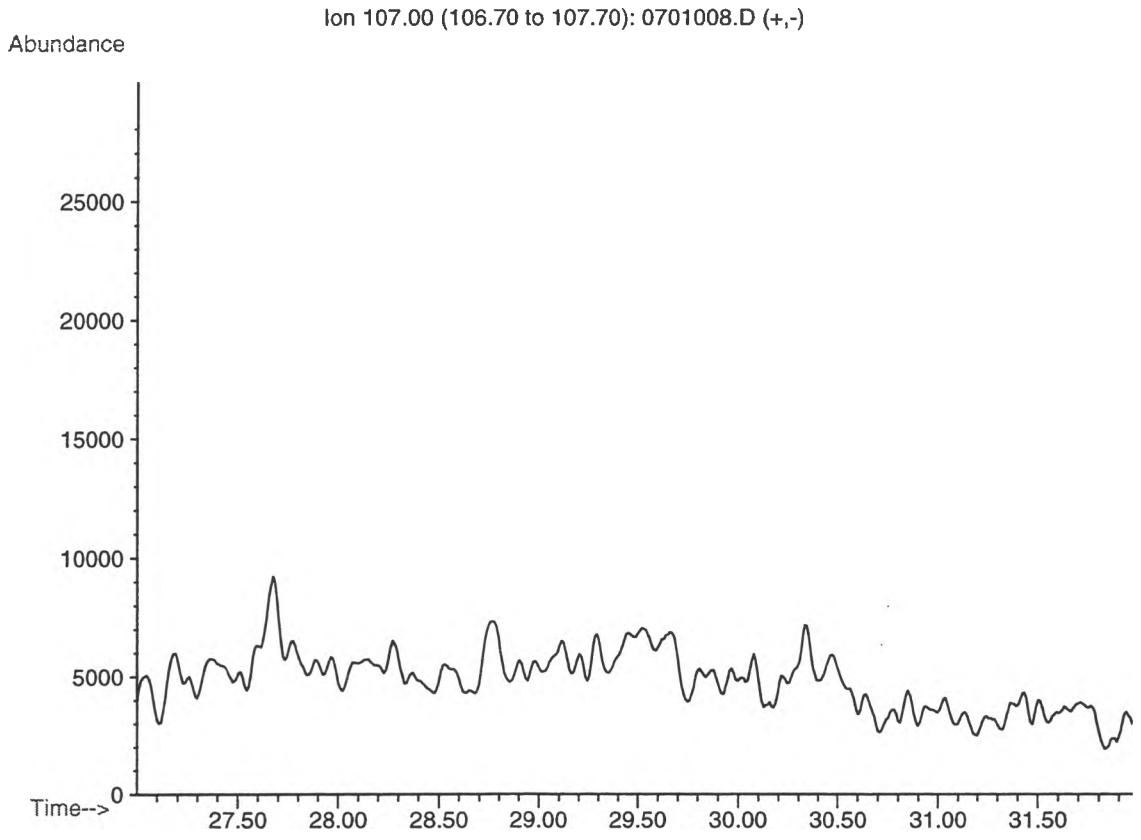

Figure 9. Nonylphenol characteristic trace of the Athabasca River 1 km downstream Weldwood effluent.

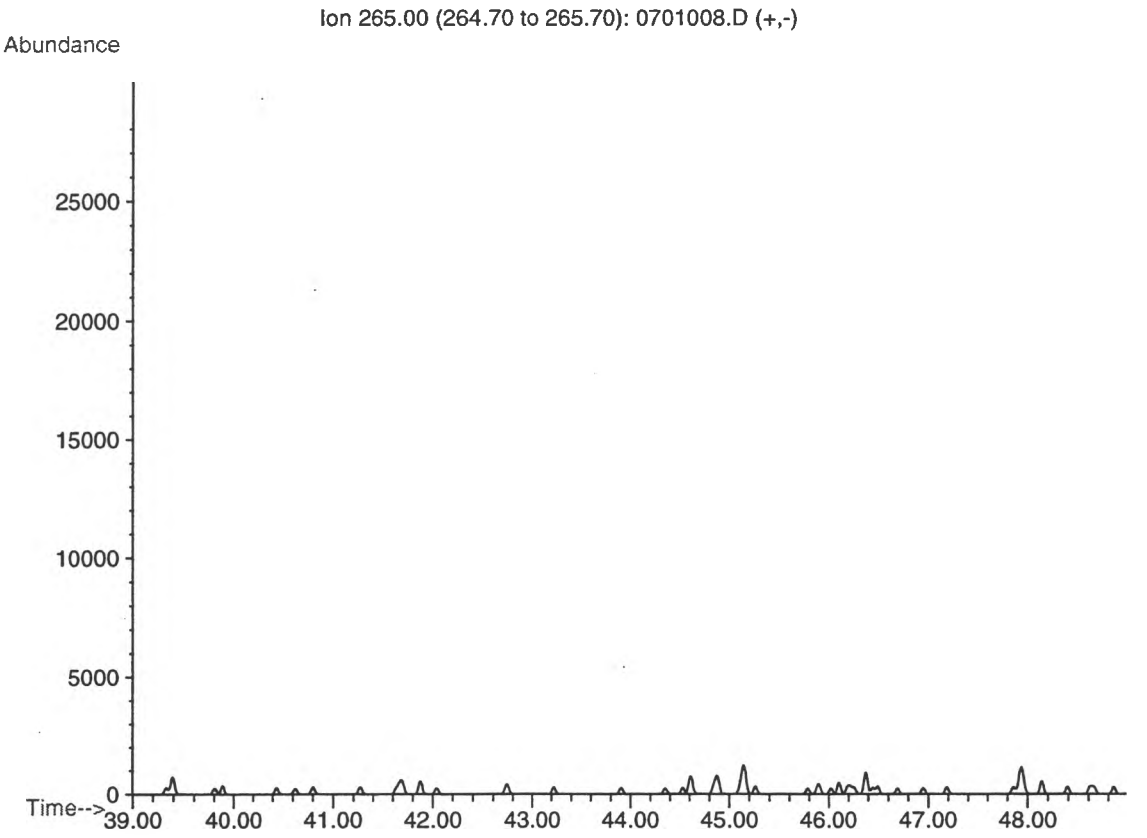

Figure 10. Unidentified STP acid esters characteristic trace of the Athabasca River 1 km downstream Weldwood effluent.

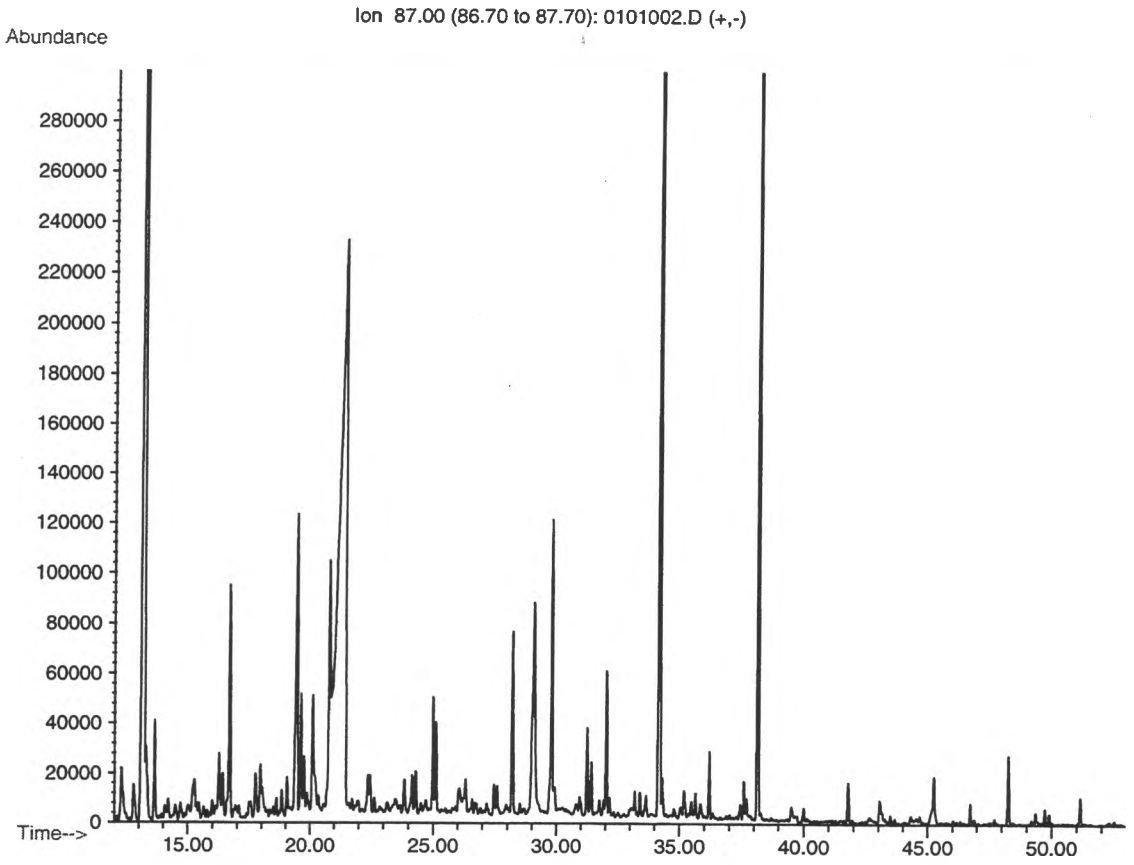

Figure 11. Mono- and dicarboxylic acid, methyl ester characteristic trace of the Athabasca River 21 km downstream Weldwood effluent.

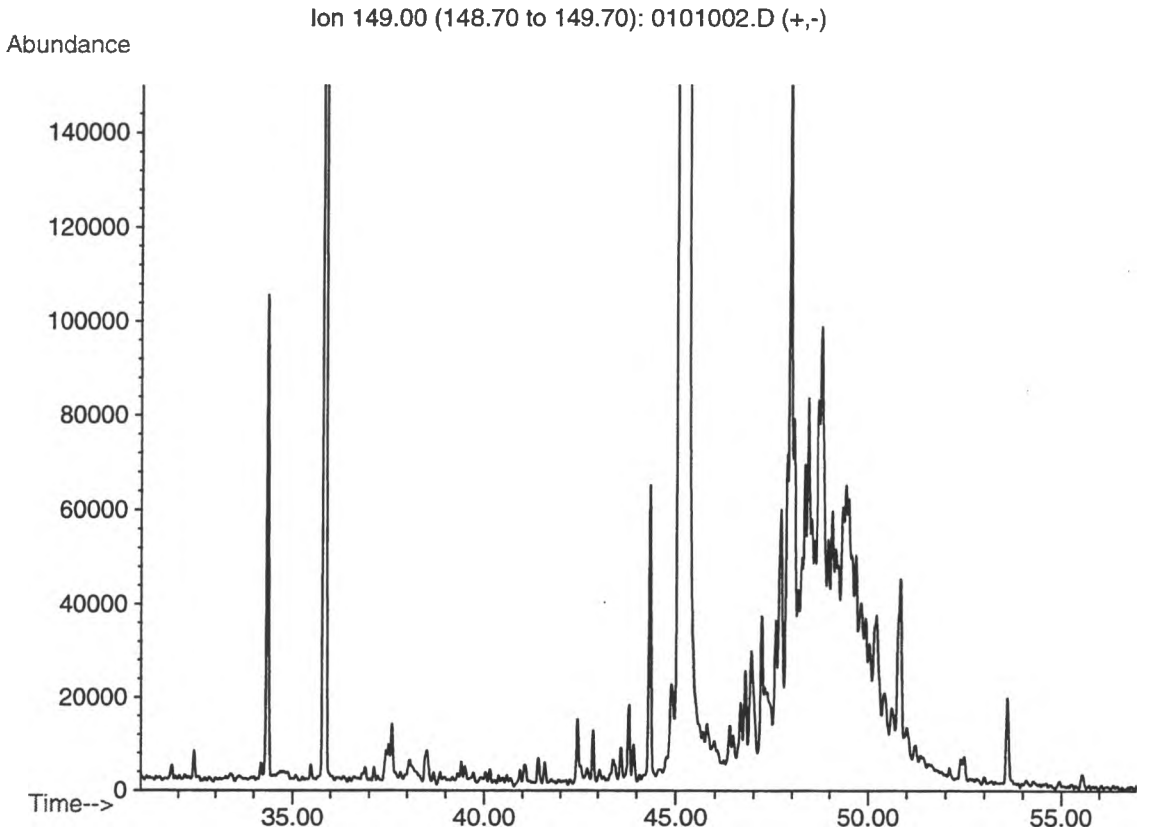

Figure 12. Phthalate ester characteristic trace of the Athabasca River 21 km downstream Weldwood effluent.

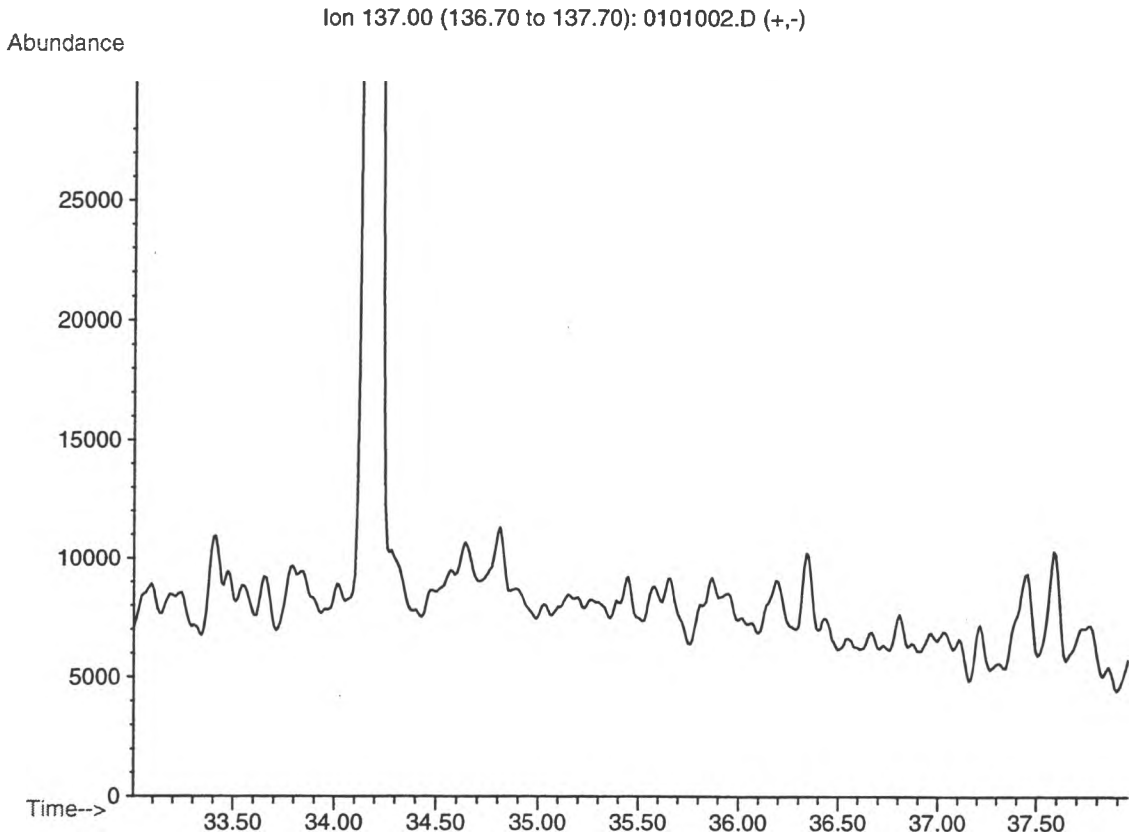

Figure 13. Diterpene characteristic trace of the Athabasca River 21 km downstream Weldwood effluent.

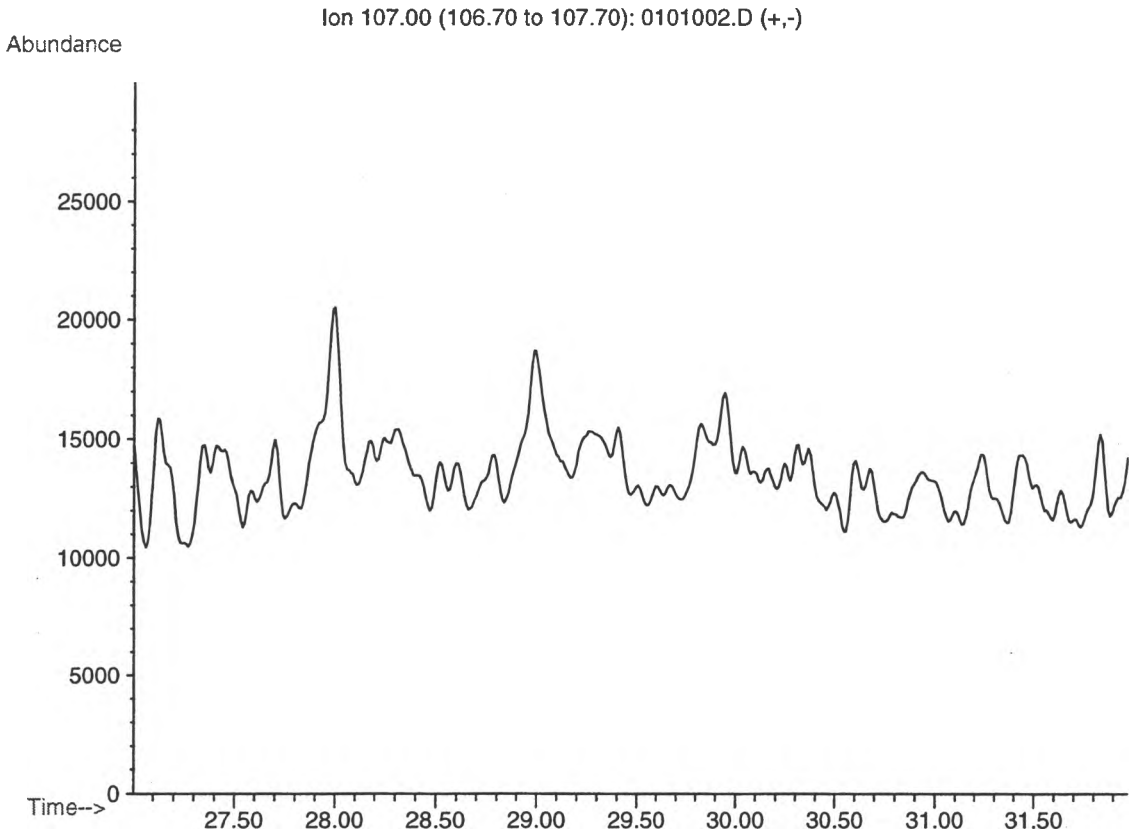

Figure 14. Nonylphenol characteristic trace of the Athabasca River 21 km downstream Weldwood effluent.

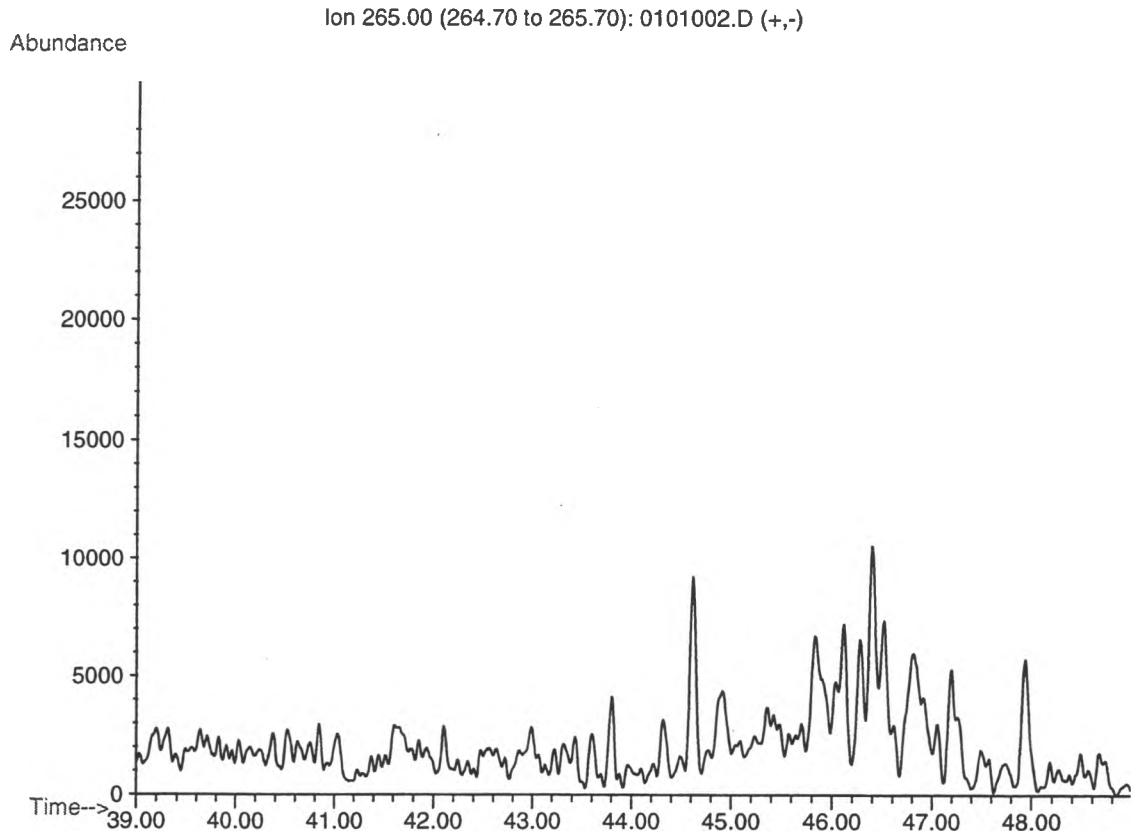

Figure 15. Unidentified STP acid esters characteristic trace of the Athabasca River 21 km downstream Weldwood effluent.

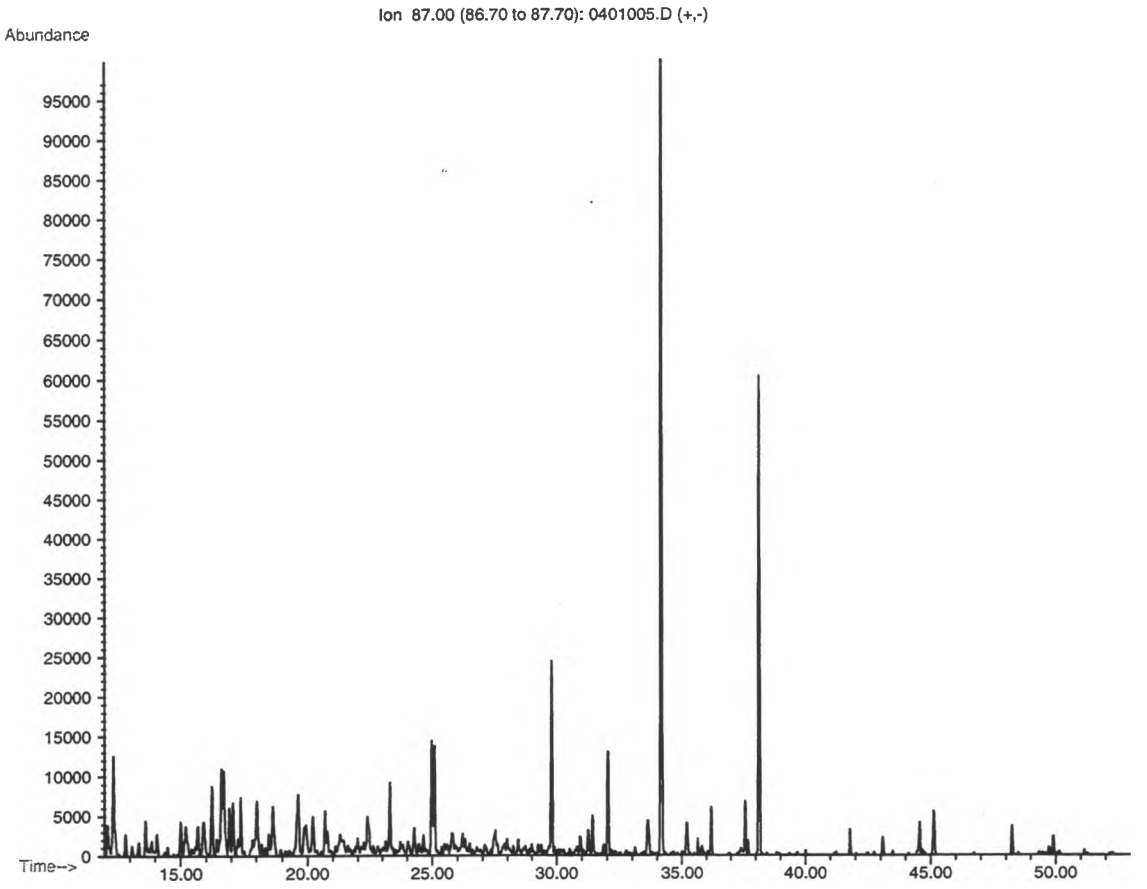

Figure 16. Mono- and dicarboxylic acid, methyl ester characteristic trace of the Athabasca River at the town of Athabasca.

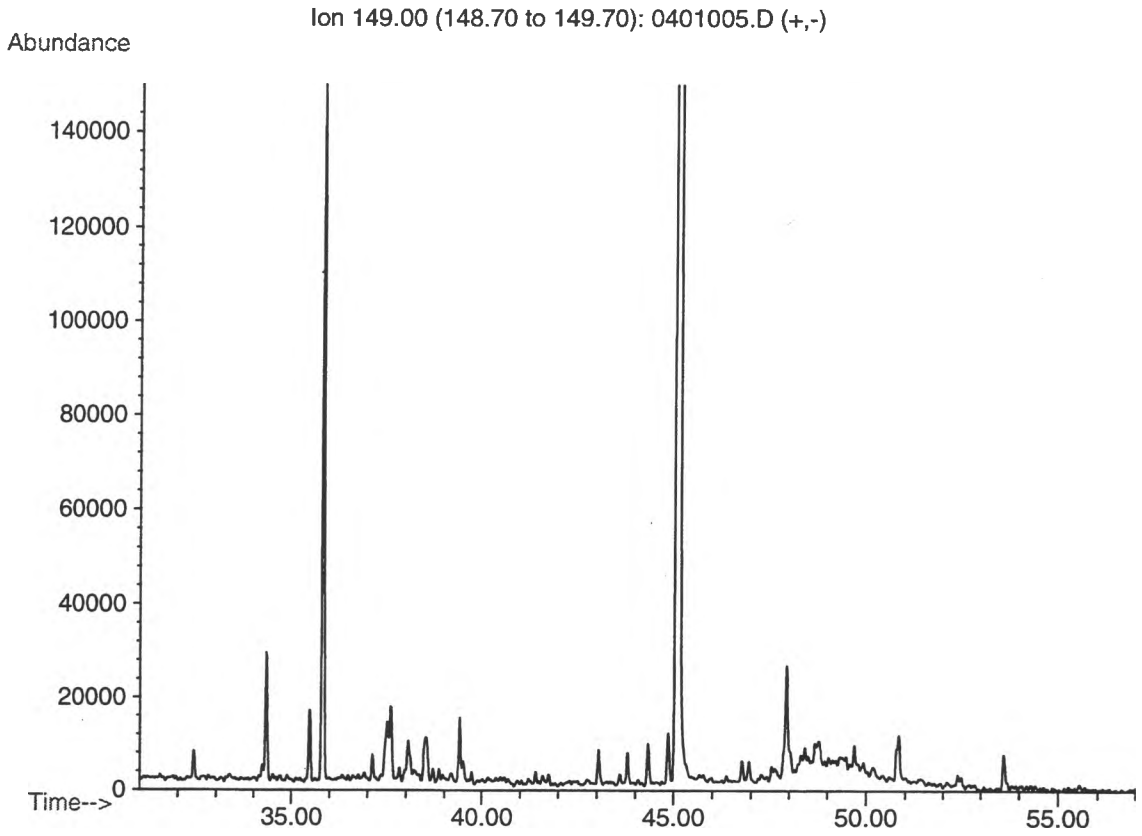

Figure 17. Phthalate ester characteristic trace of the Athabasca River at the town of Athabasca.

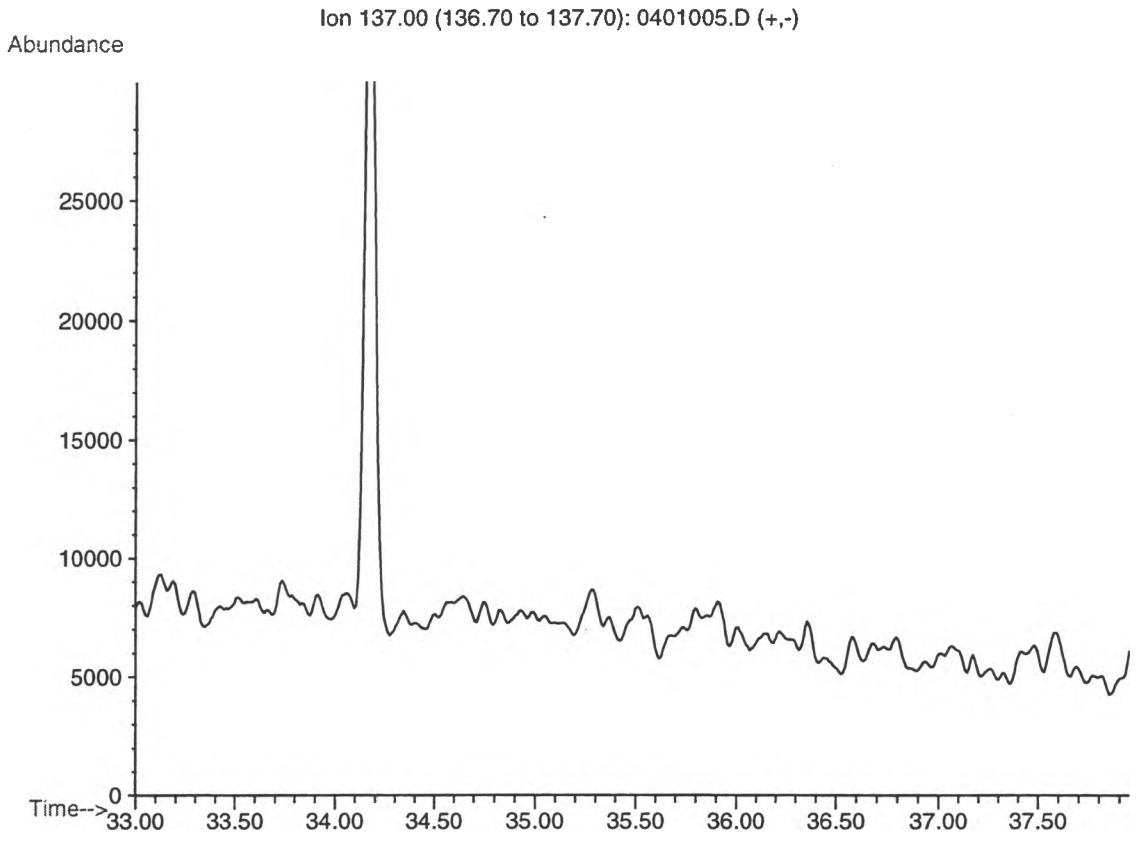

Figure 18. Diterpene characteristic trace of the Athabasca River at the town of Athabasca.

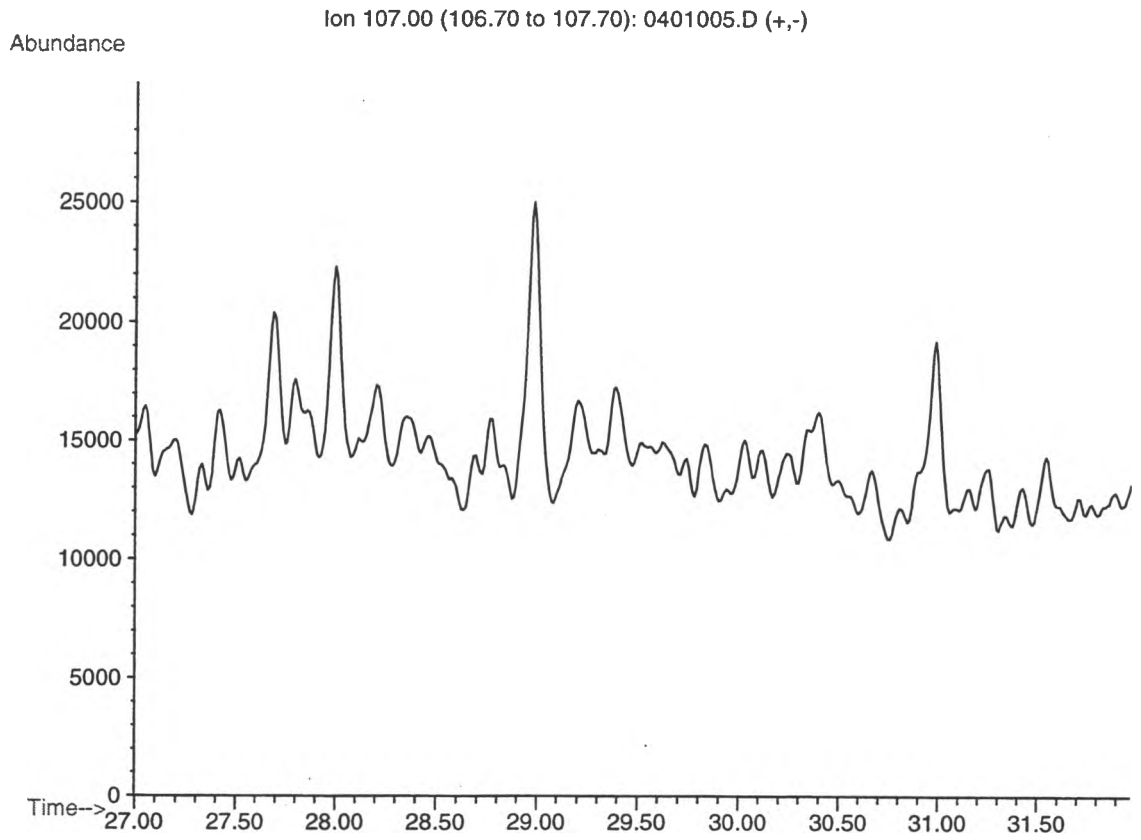

Figure 19. Nonylphenol characteristic trace of the Athabasca River at the town of Athabasca.

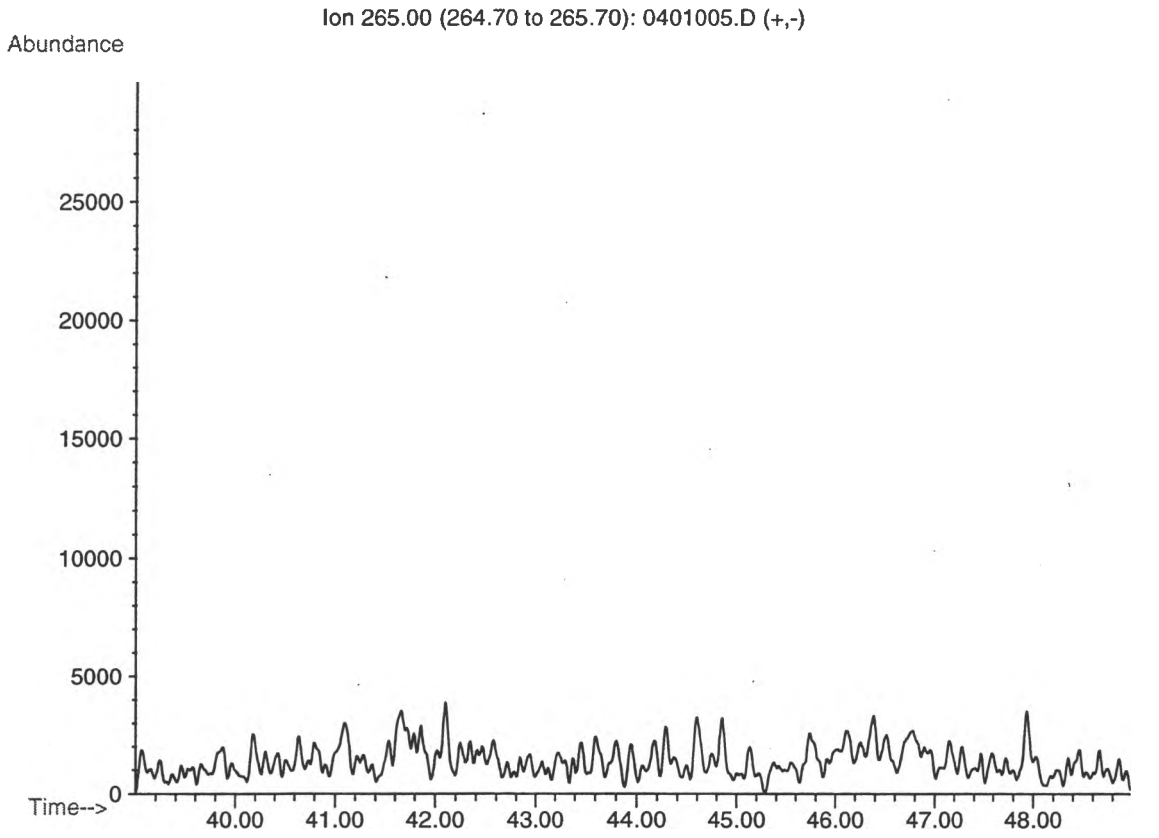

Figure 20. Unidentified STP acid esters characteristic trace of the Athabasca River at the town of Athabasca.

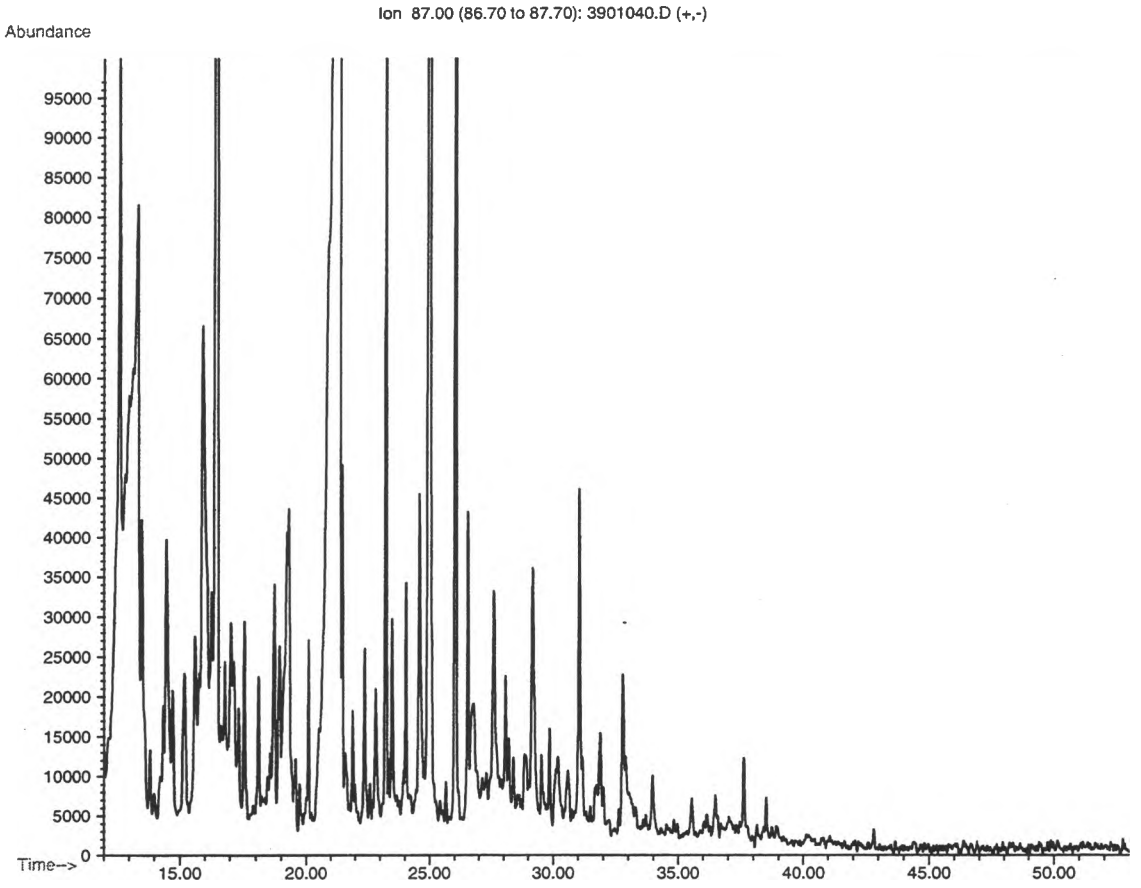

Figure 21. Mono- and dicarboxylic acid, methyl ester characteristic trace of the Athabasca River upstream of Alberta Pacific discharge.

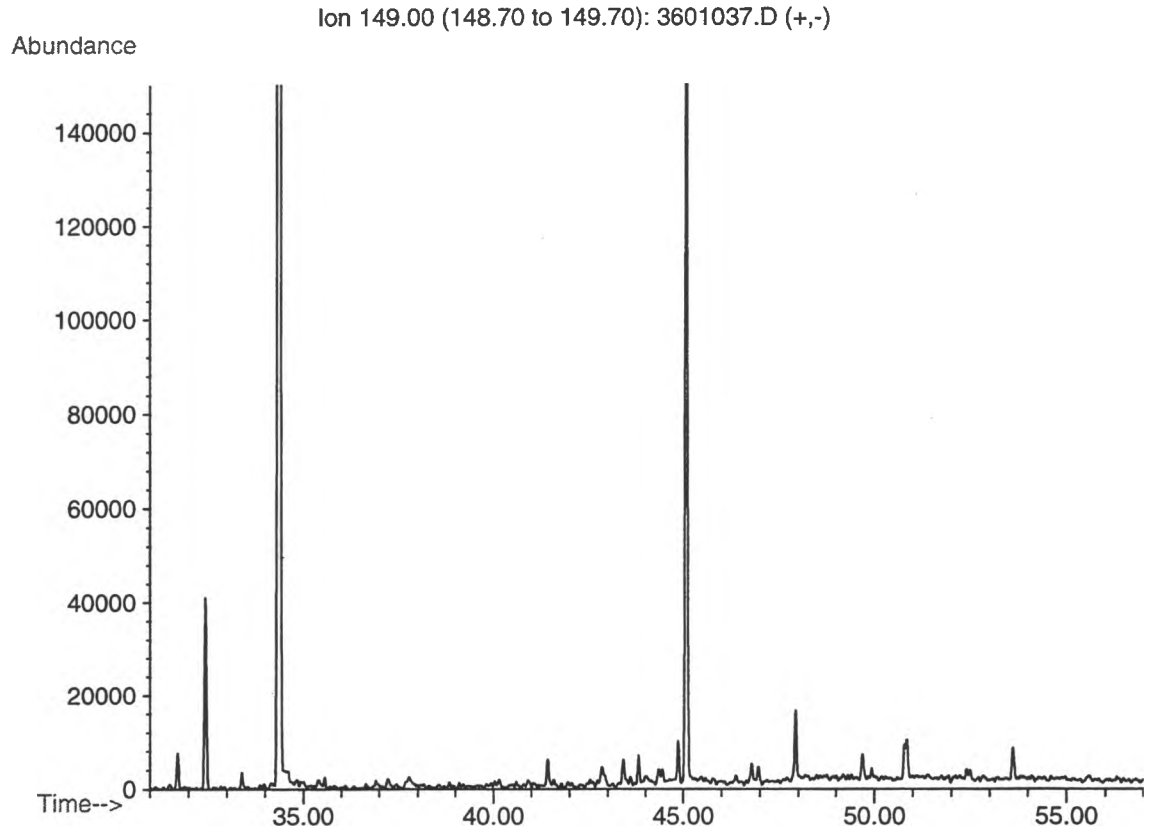

Figure 22. Phthalate ester characteristic trace of the Athabasca River upstream of Alberta Pacific discharge.

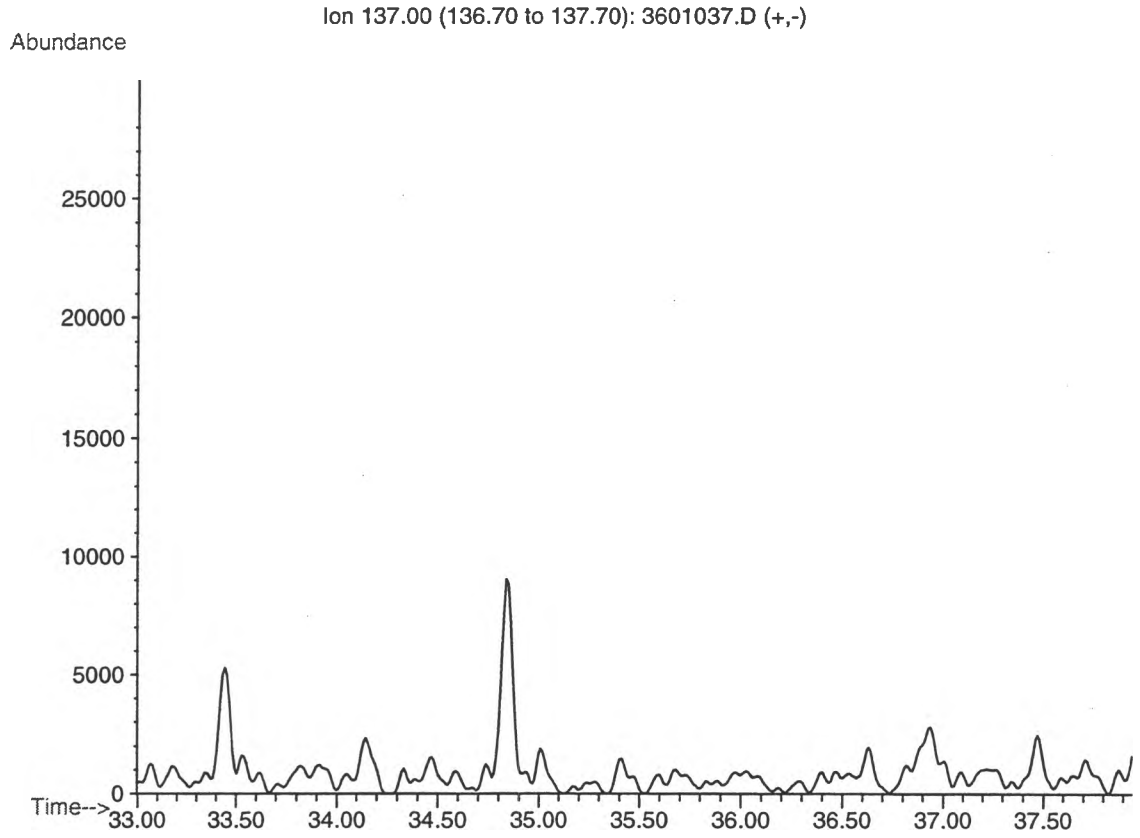

Figure 23. Diterpene characteristic trace of the Athabasca River upstream of Alberta Pacific discharge.

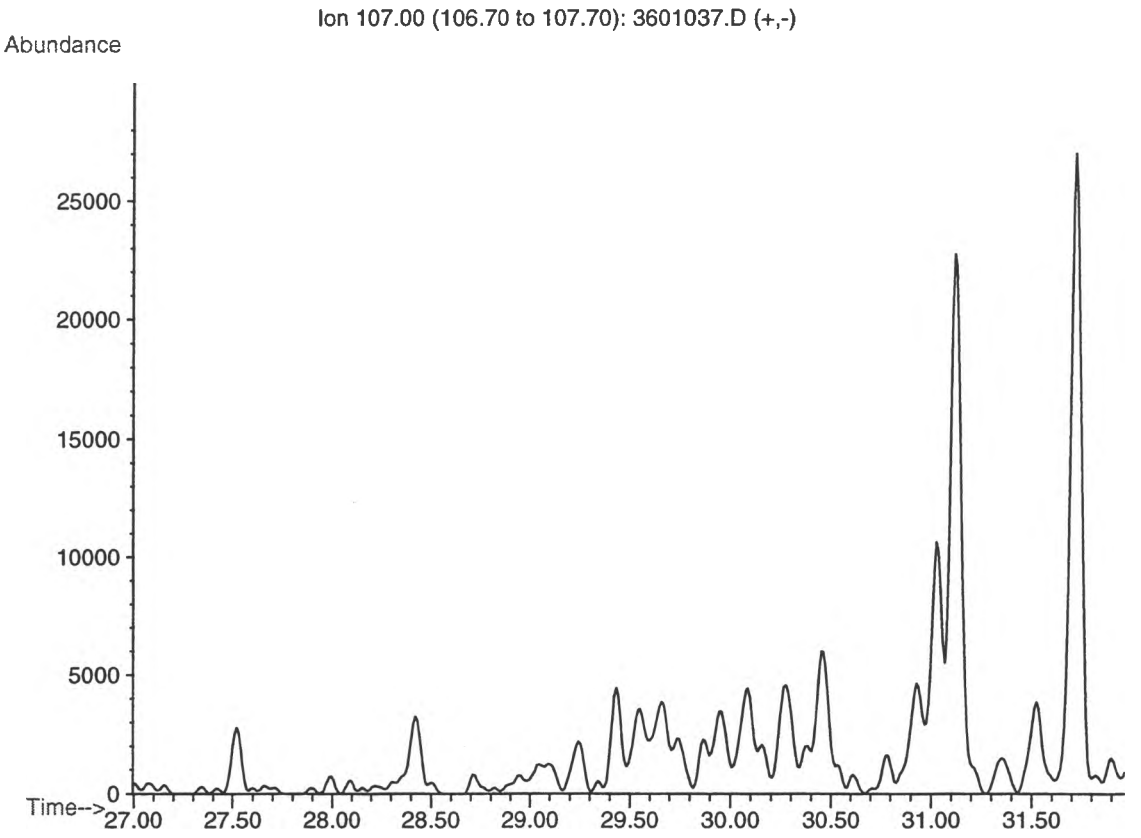

Figure 24. Nonylphenol characteristic trace of the Athabasca River upstream of Alberta Pacific discharge.

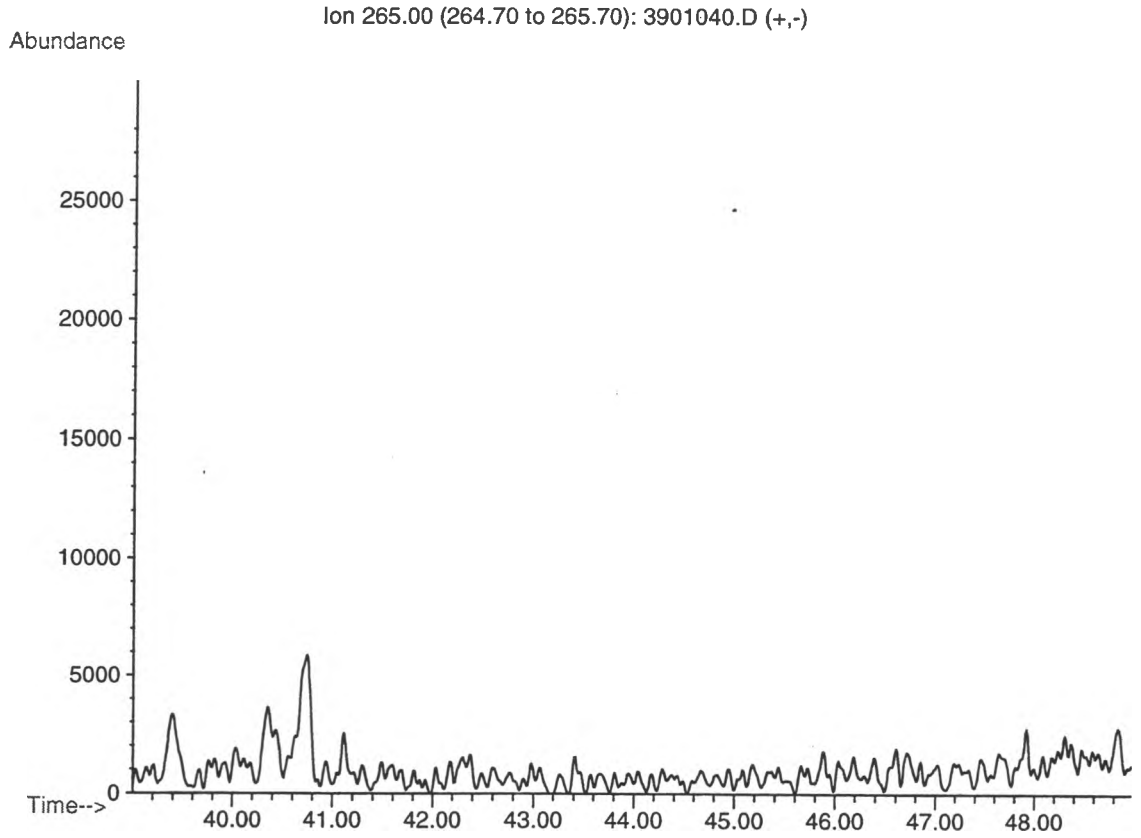

Figure 25. Unidentified STP acid esters characteristic trace of the Athabasca River upstream of Alberta Pacific discharge.

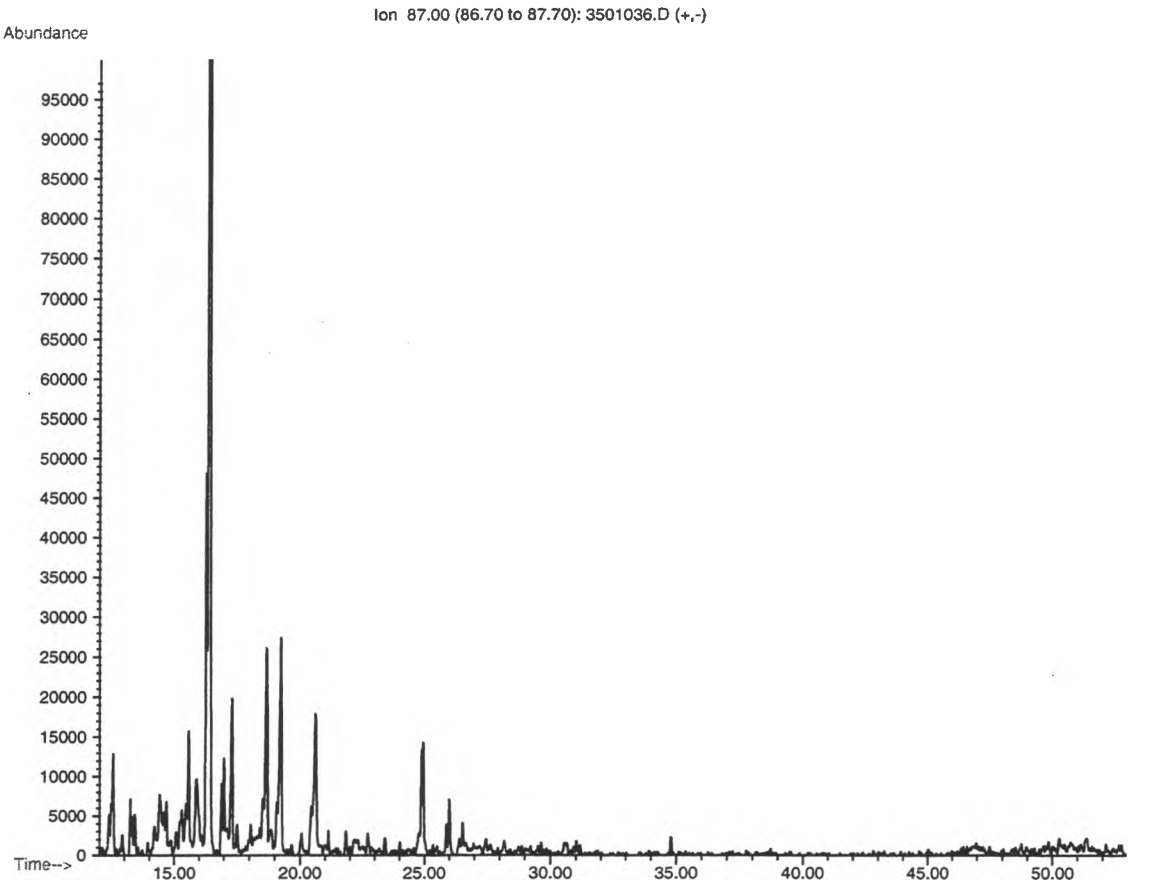

Figure 26. Mono- and dicarboxylic acid, methyl ester characteristic trace of the Athabasca River downstream of Alberta Pacific discharge.

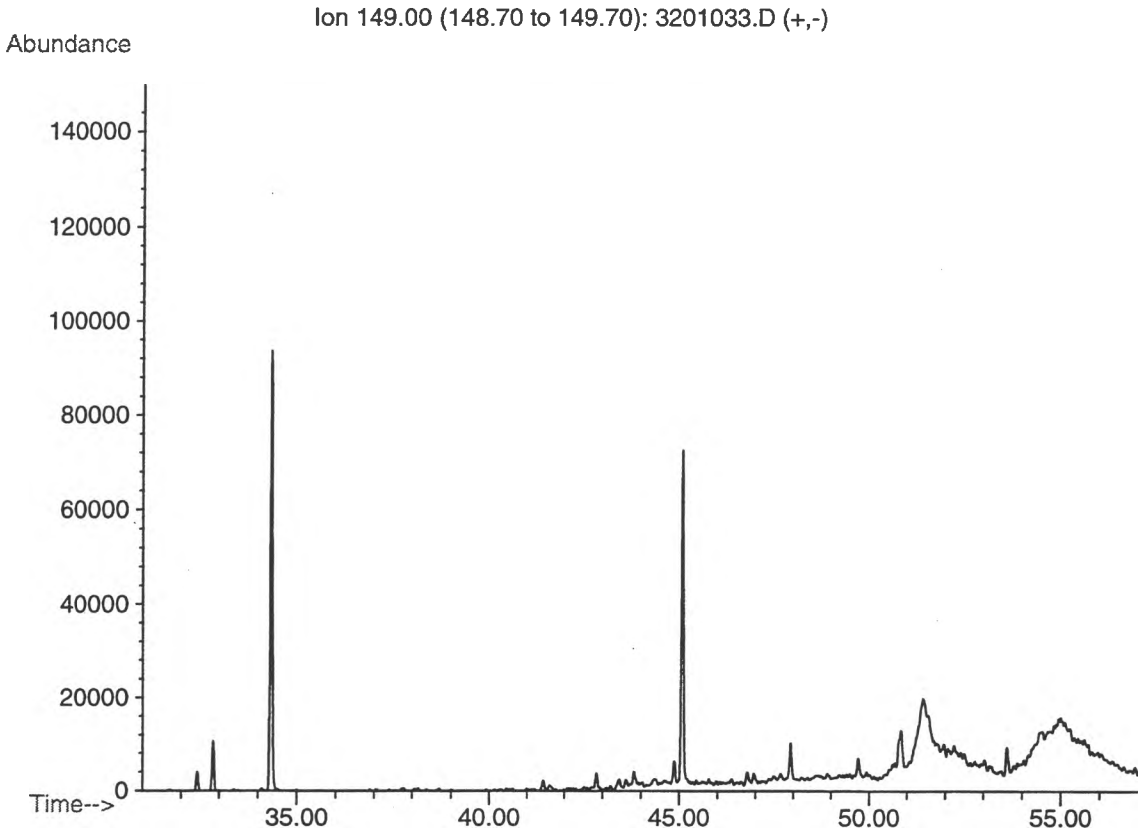

Figure 27. Phthalate ester characteristic trace of the Athabasca River downstream of Alberta Pacific discharge.

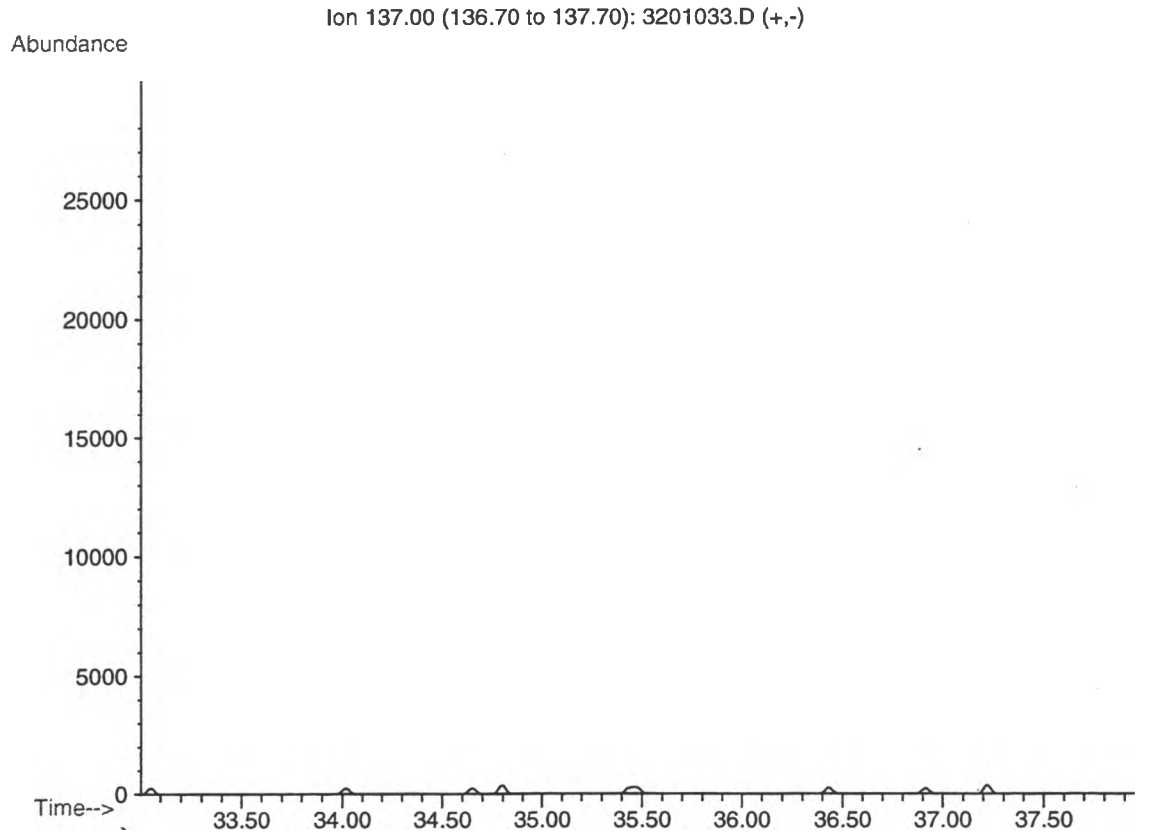

Figure 28. Diterpene characteristic trace of the Athabasca River downstream of Alberta Pacific discharge.

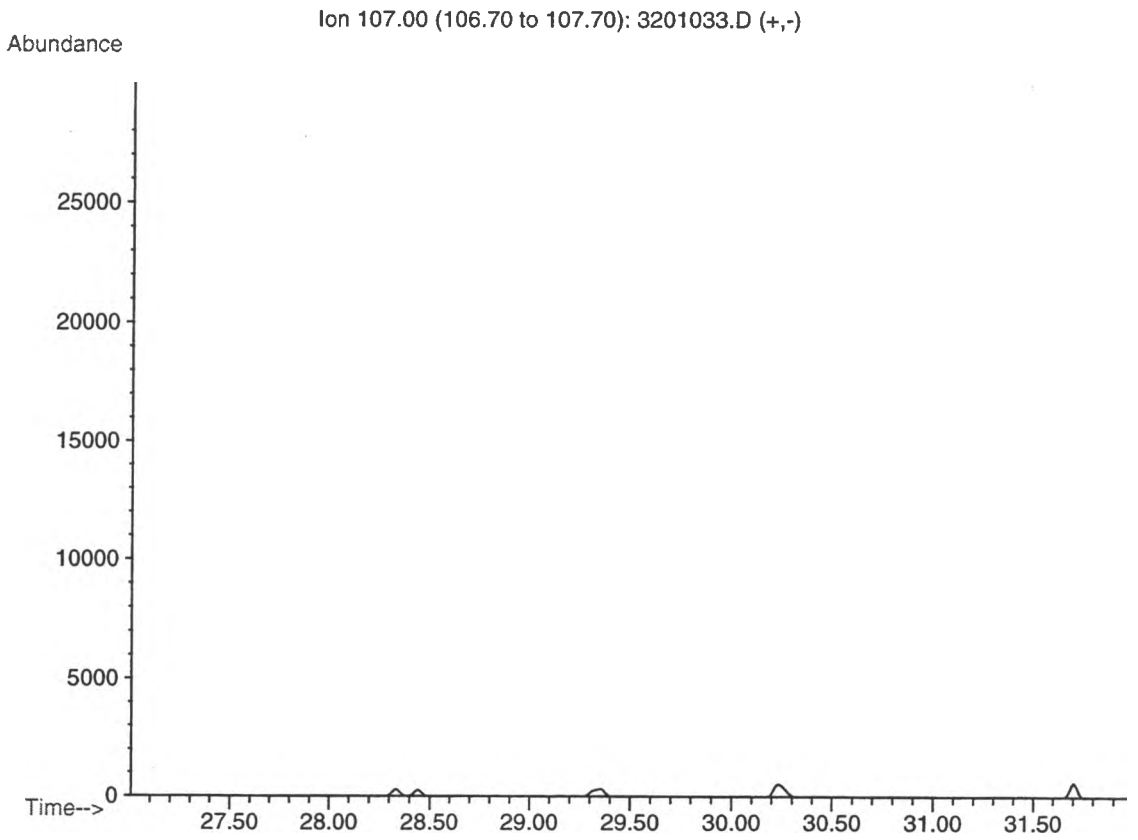

Figure 29. Nonylphenol characteristic trace of the Athabasca River downstream of Alberta Pacific discharge.

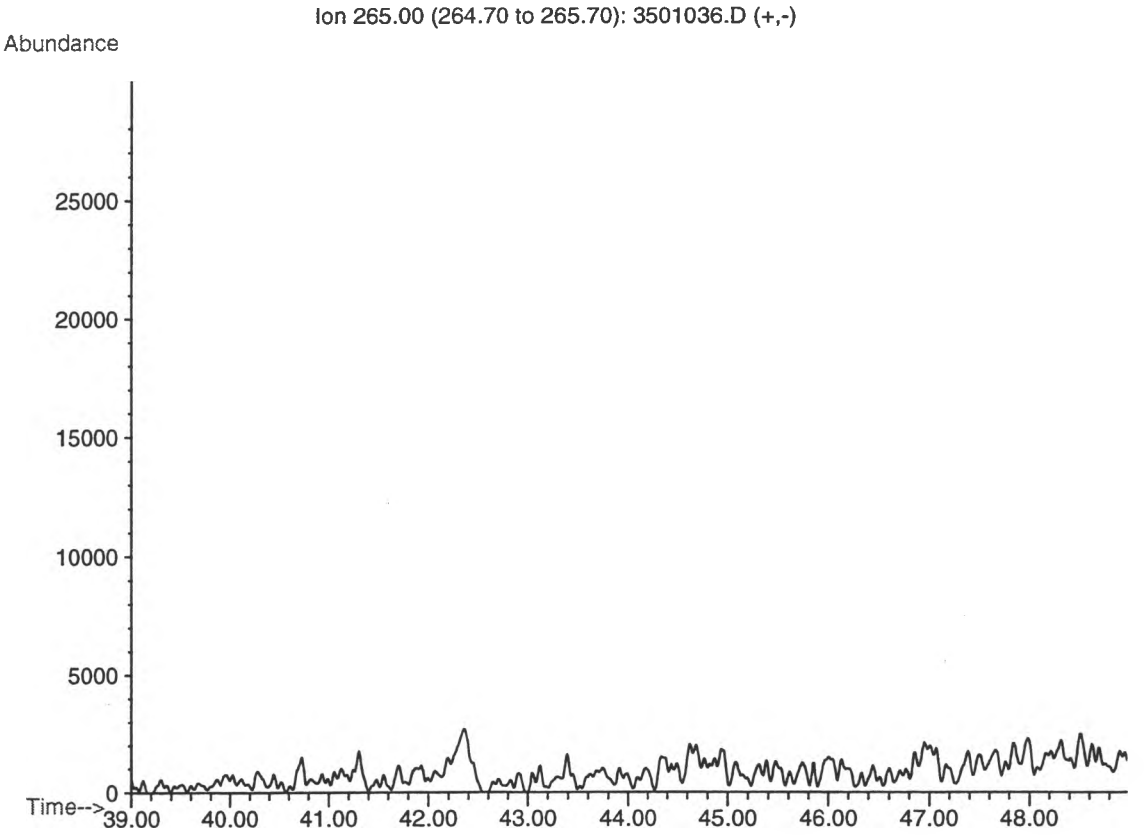

Figure 30. Unidentified STP acid esters characteristic trace of the Athabasca River downstream of Alberta Pacific discharge.

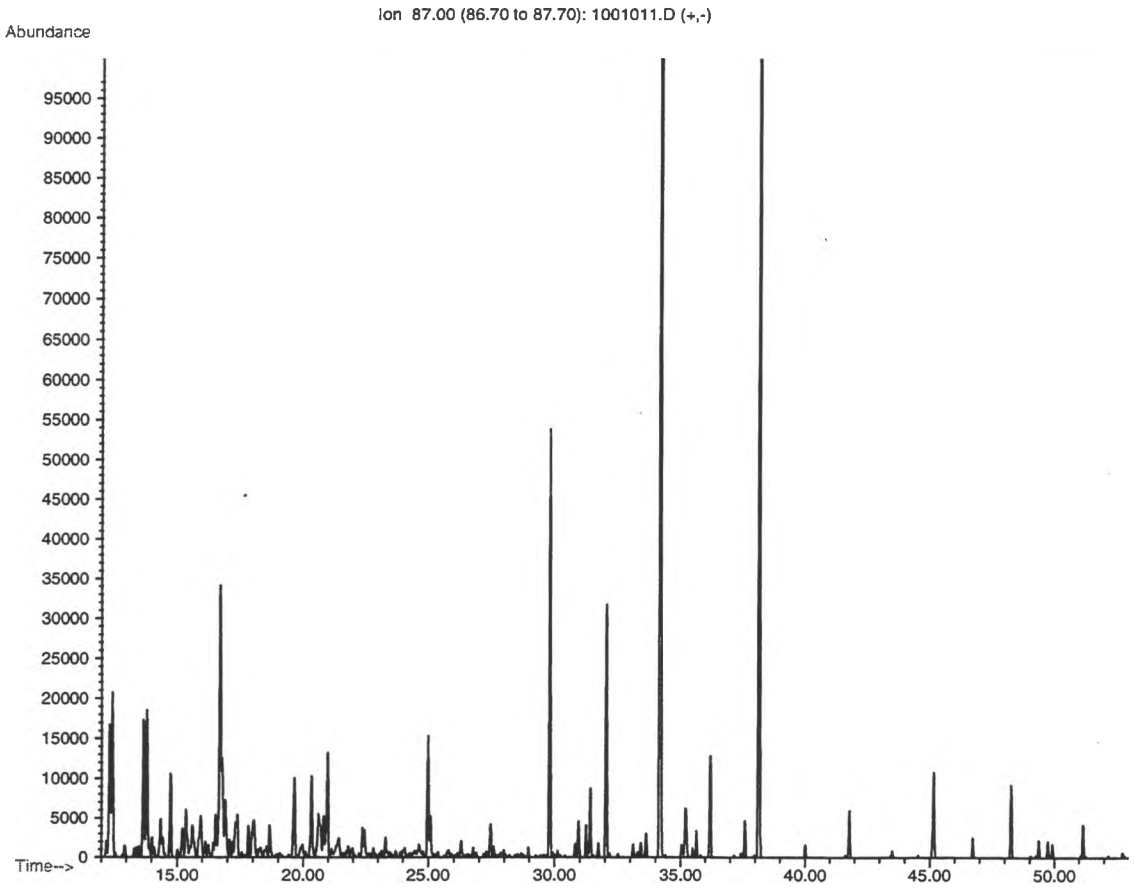

Figure 31. Mono- and dicarboxylic acid, methyl ester characteristic trace of the Athabasca River upstream of Fort McMurray.

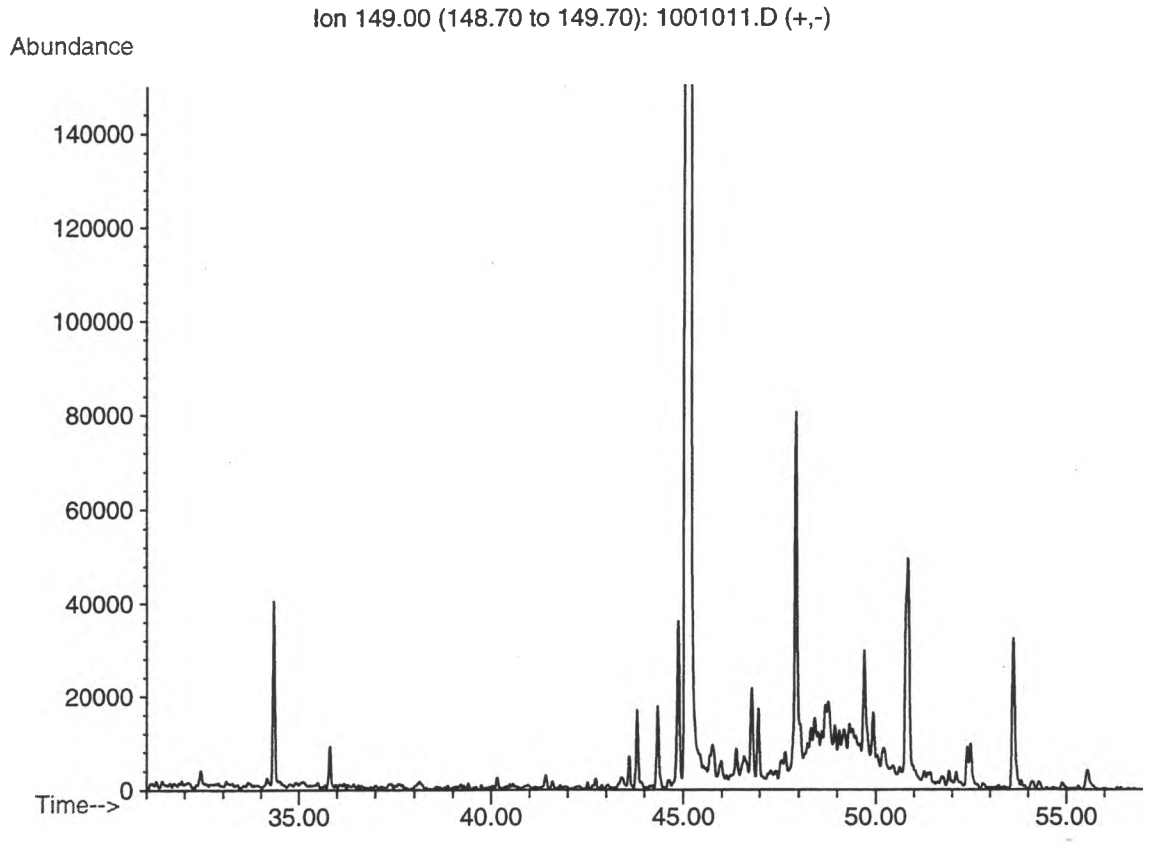

Figure 32. Phthalate ester characteristic trace of the Athabasca River upstream of Fort McMurray.

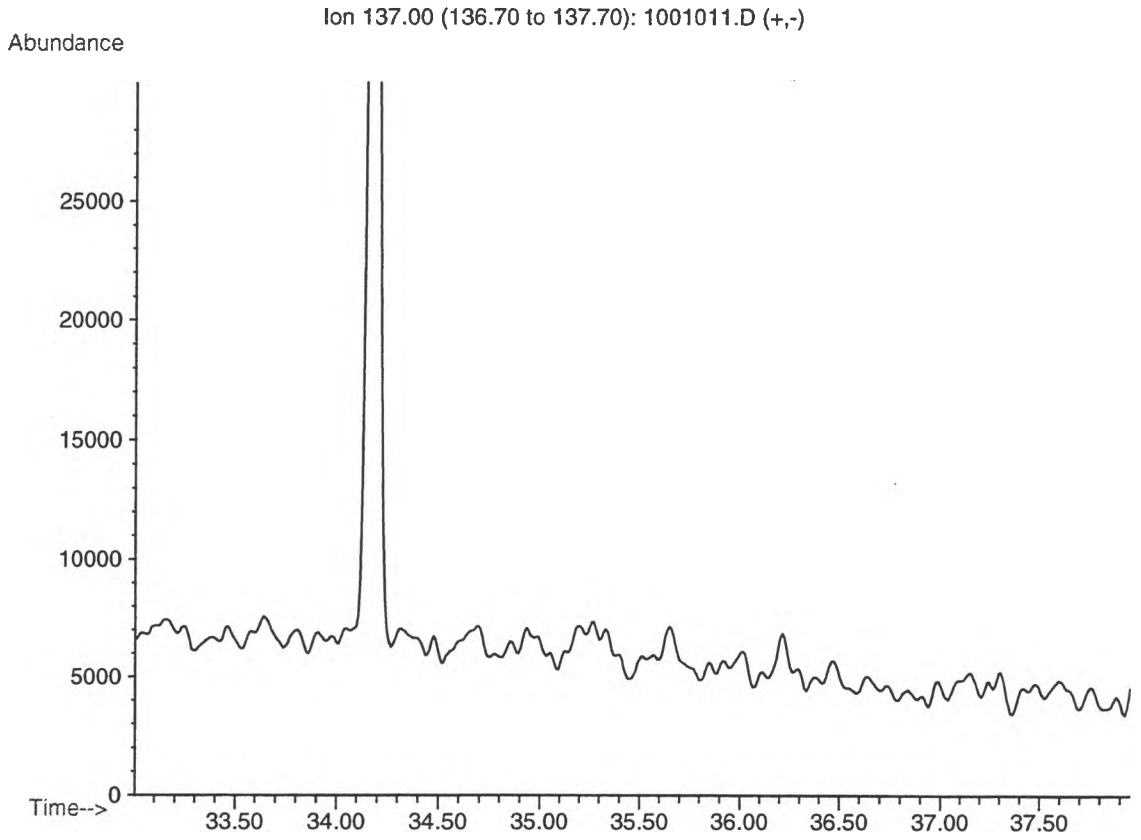

Figure 33. Diterpene characteristic trace of the Athabasca River upstream of Fort McMurray.

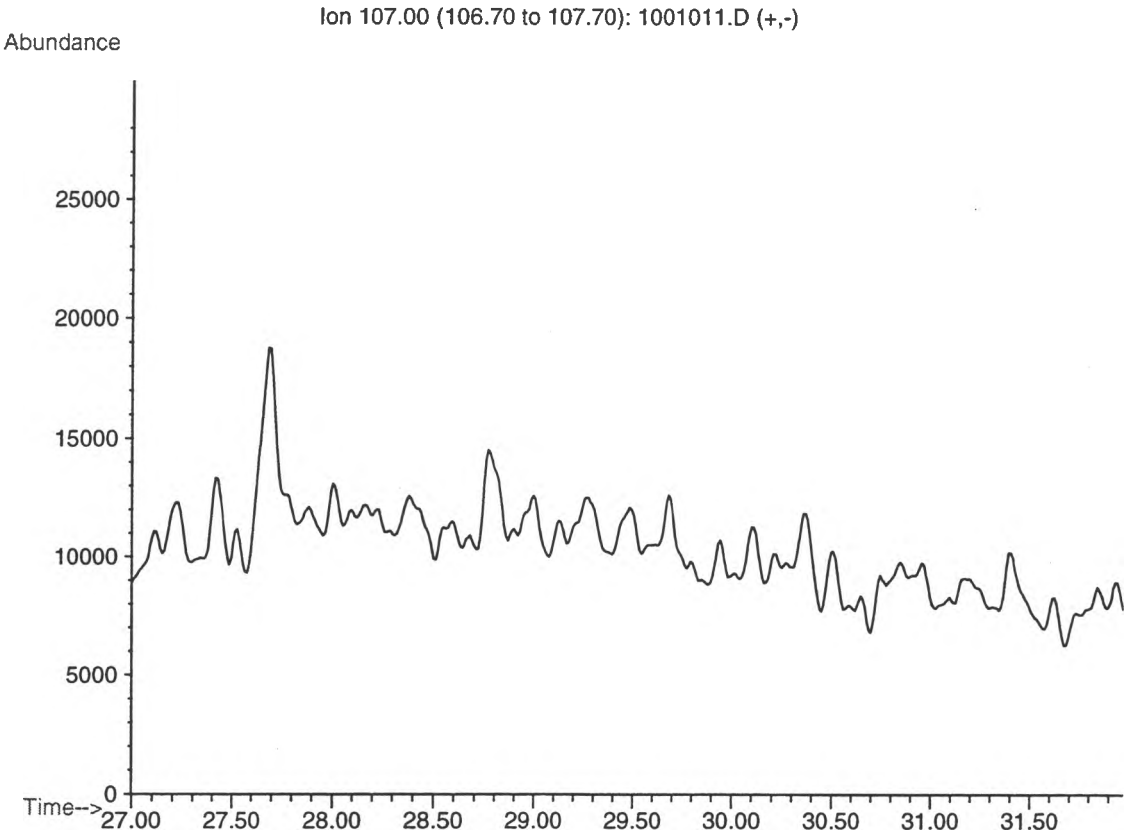

Figure 34. Nonylphenol characteristic trace of the Athabasca River upstream of Fort McMurray.

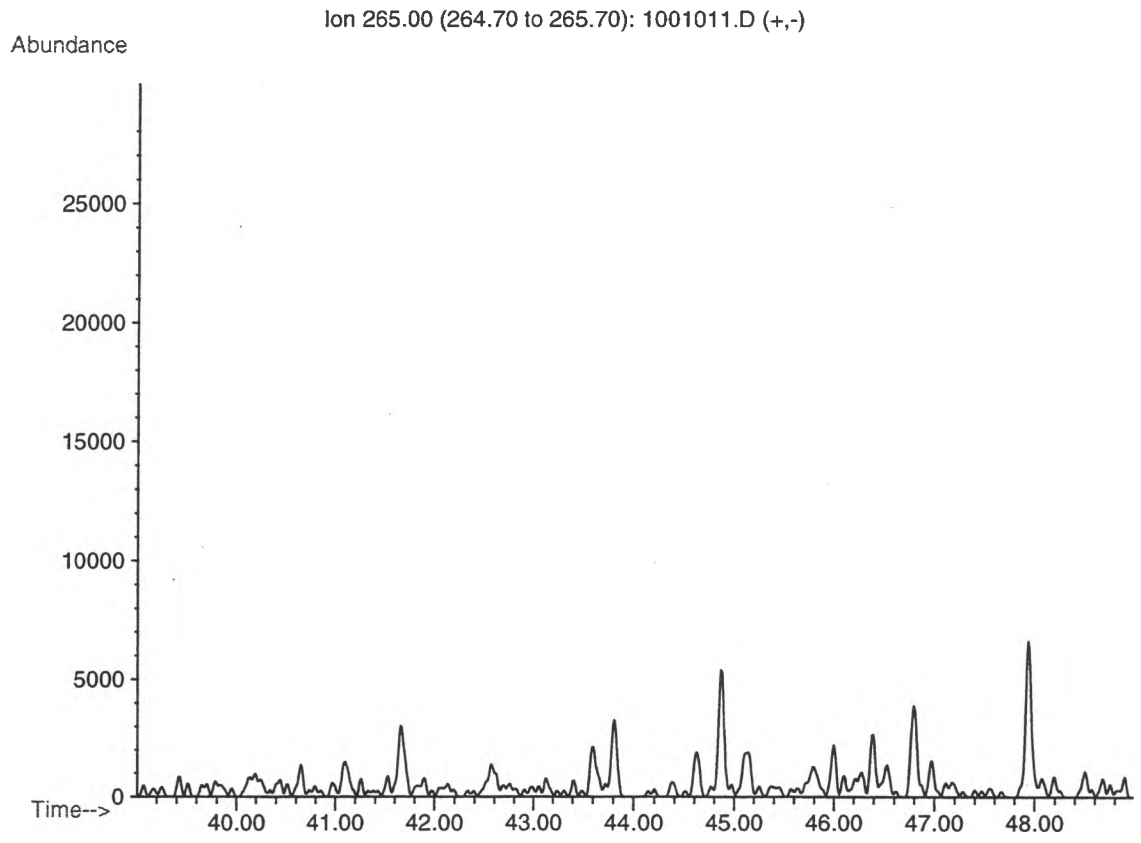

Figure 35. Unidentified STP acid esters characteristic trace of the Athabasca River upstream of Ft McMurray.

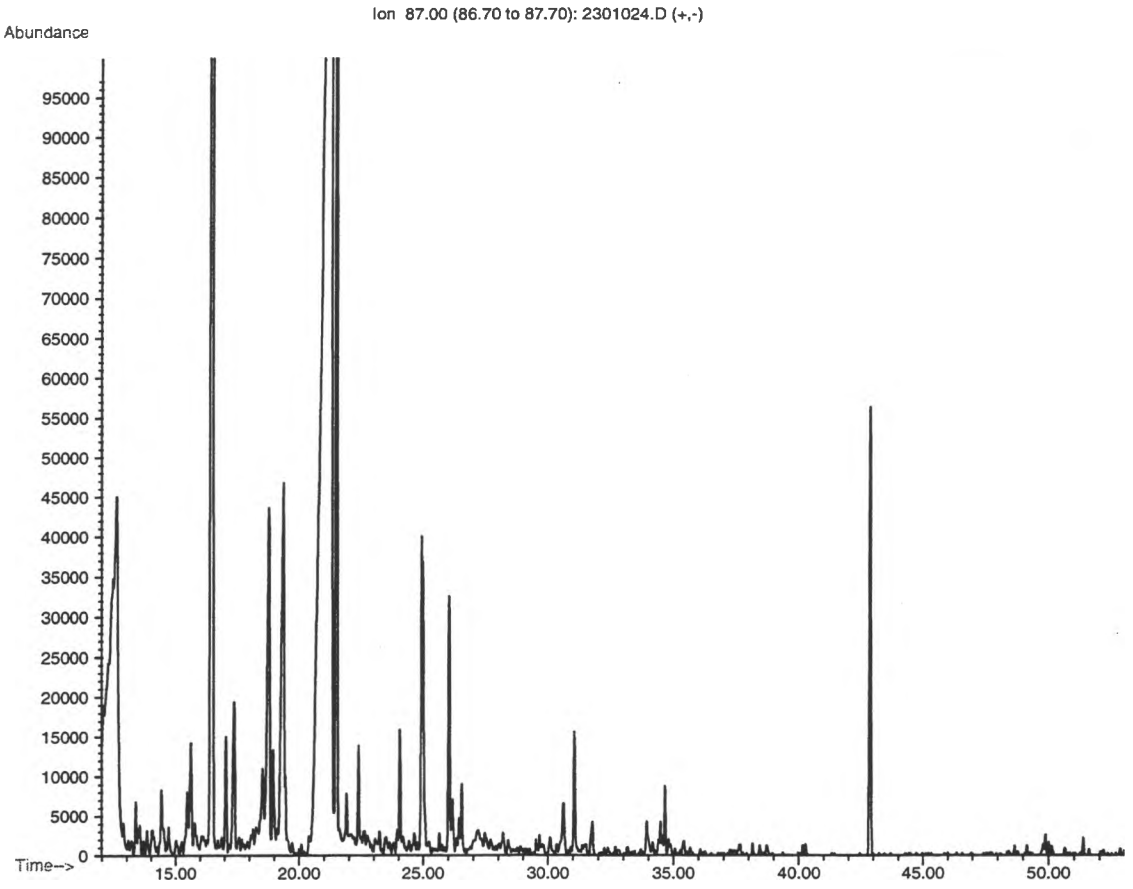

Figure 36. Mono- and dicarboxylic acid, methyl ester characteristic trace of the Wapiti River upstream of Grande Prairie.

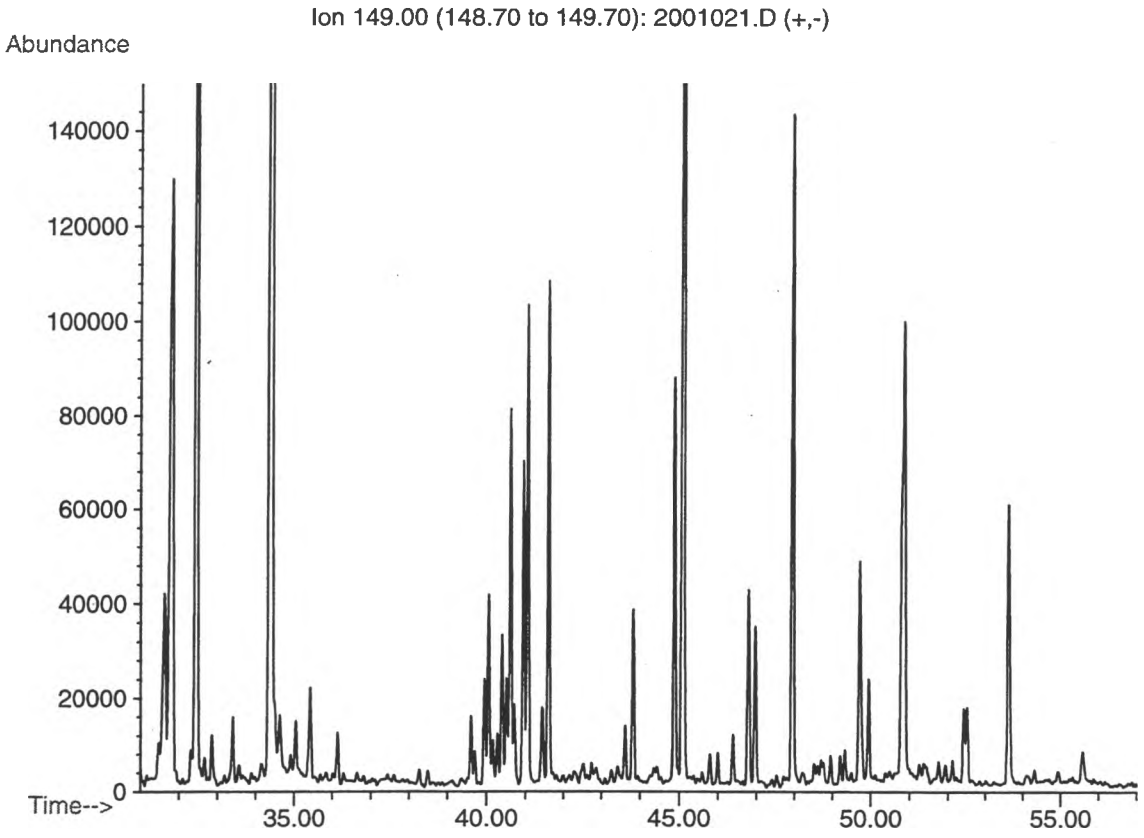

Figure 37. Phthalate ester characteristic trace of the Wapiti River upstream of Grande Prairie.

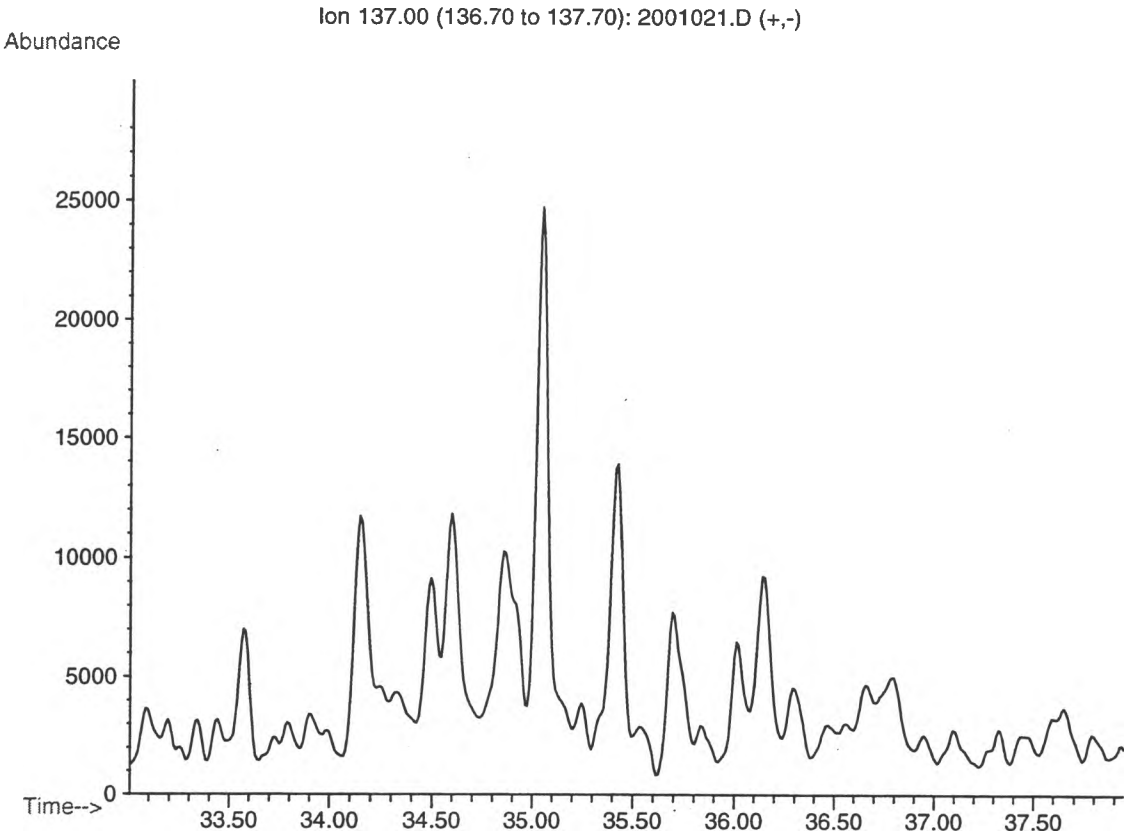

Figure 38. Diterpene characteristic trace of the Wapiti River upstream of Grande Prairie.

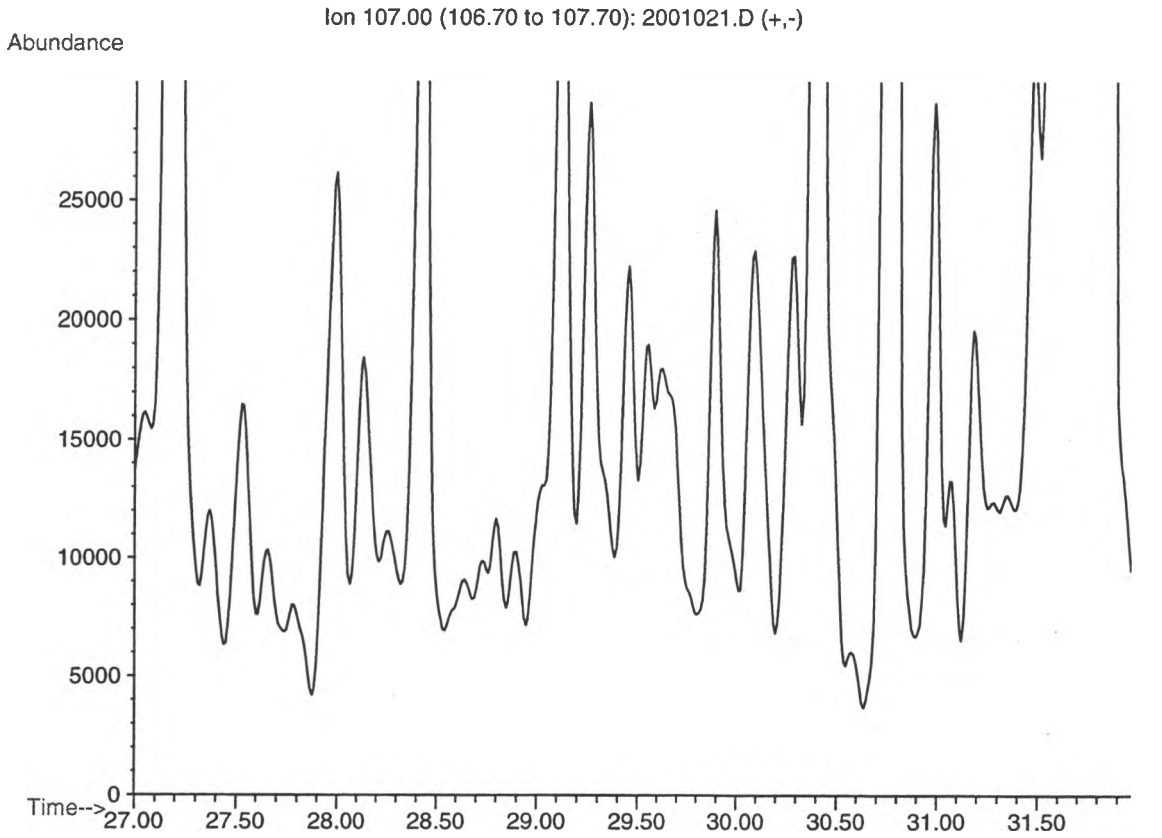

Figure 39. Nonylphenol characteristic trace of the Wapiti River upstream of Grande Prairie.

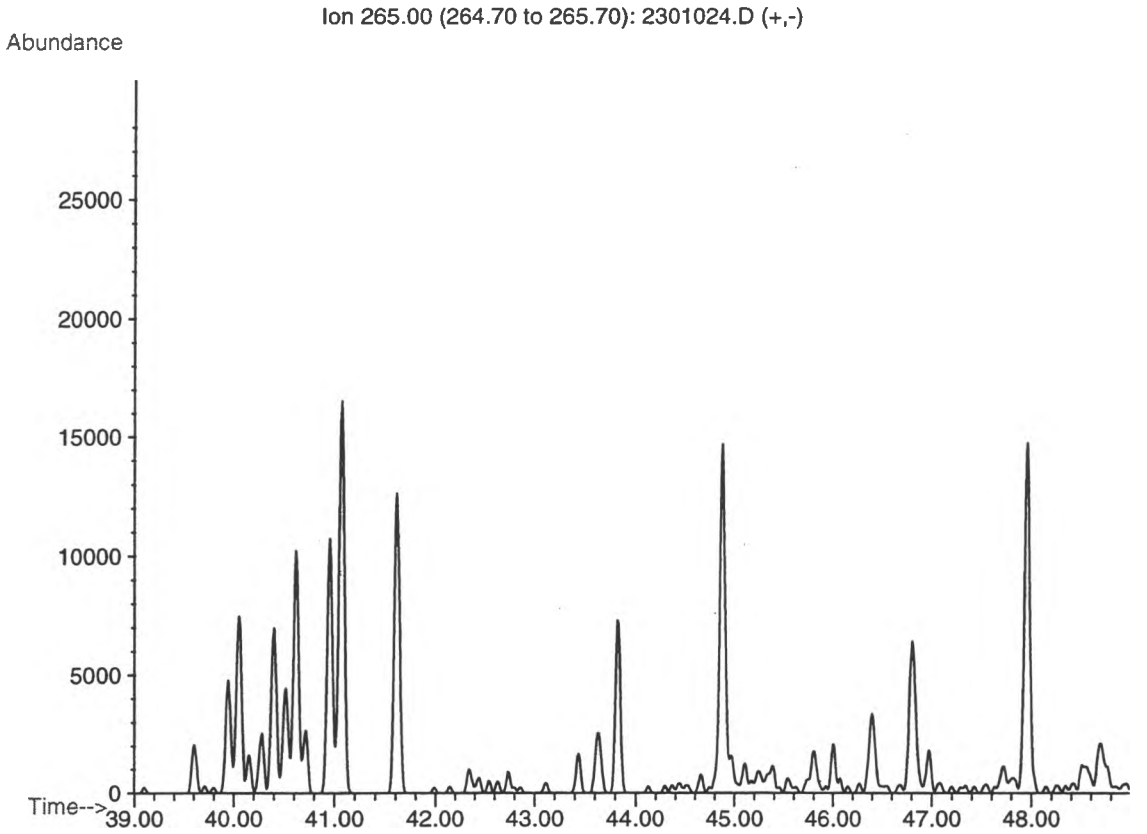

Figure 40. Unidentified STP acid esters characteristic trace of the Wapiti River upstream of Grande Prairie.

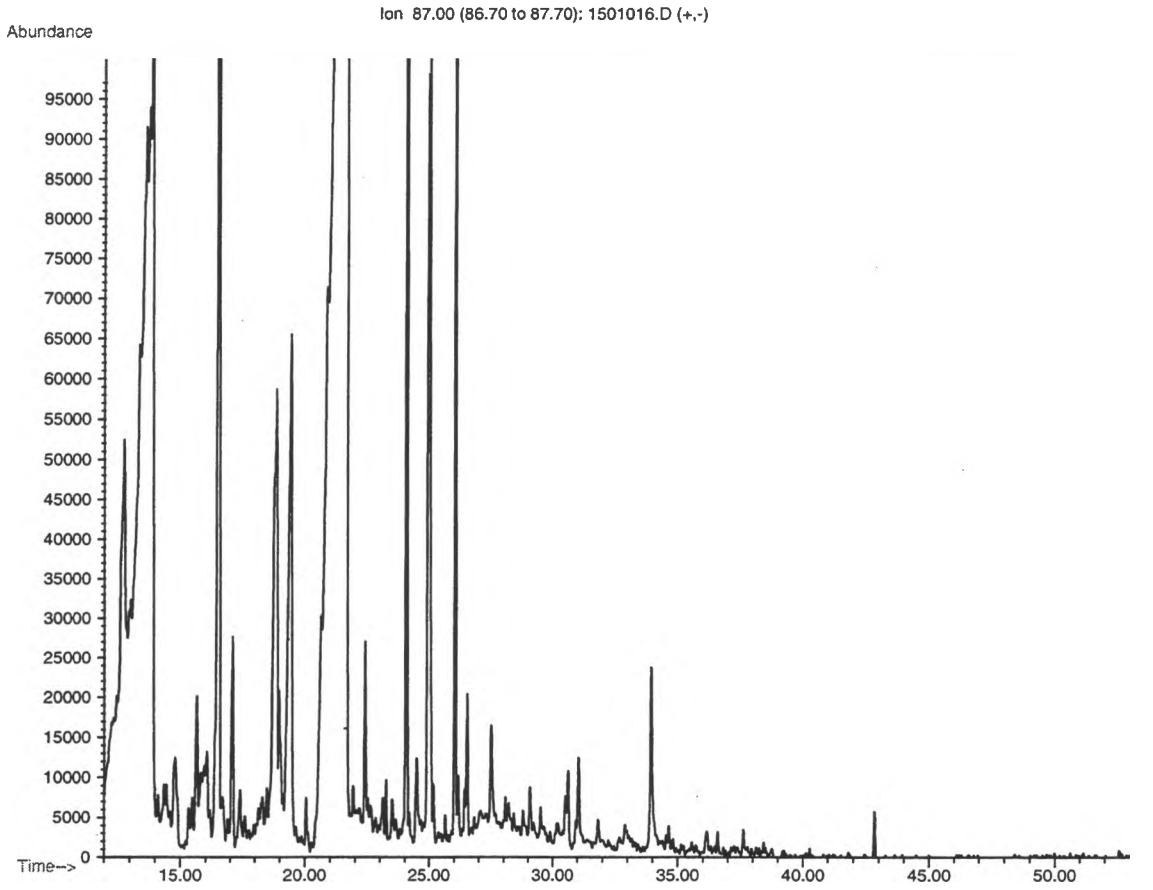

Figure 41. Mono- and dicarboxylic acid, methyl ester characteristic trace of the Wapiti River downstream of Grande Prairie STP effluent.

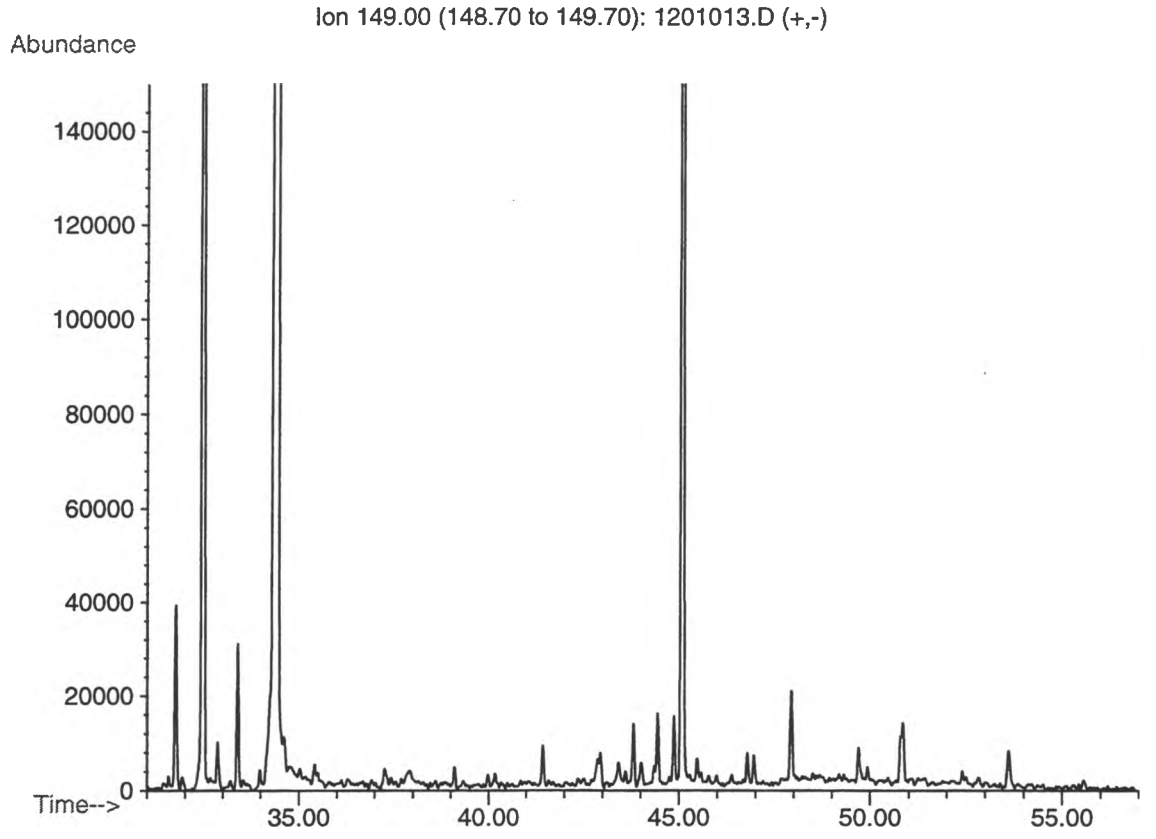

Figure 42. Phthalate ester characteristic trace of the Wapiti River downstream of Grande Prairie STP effluent.

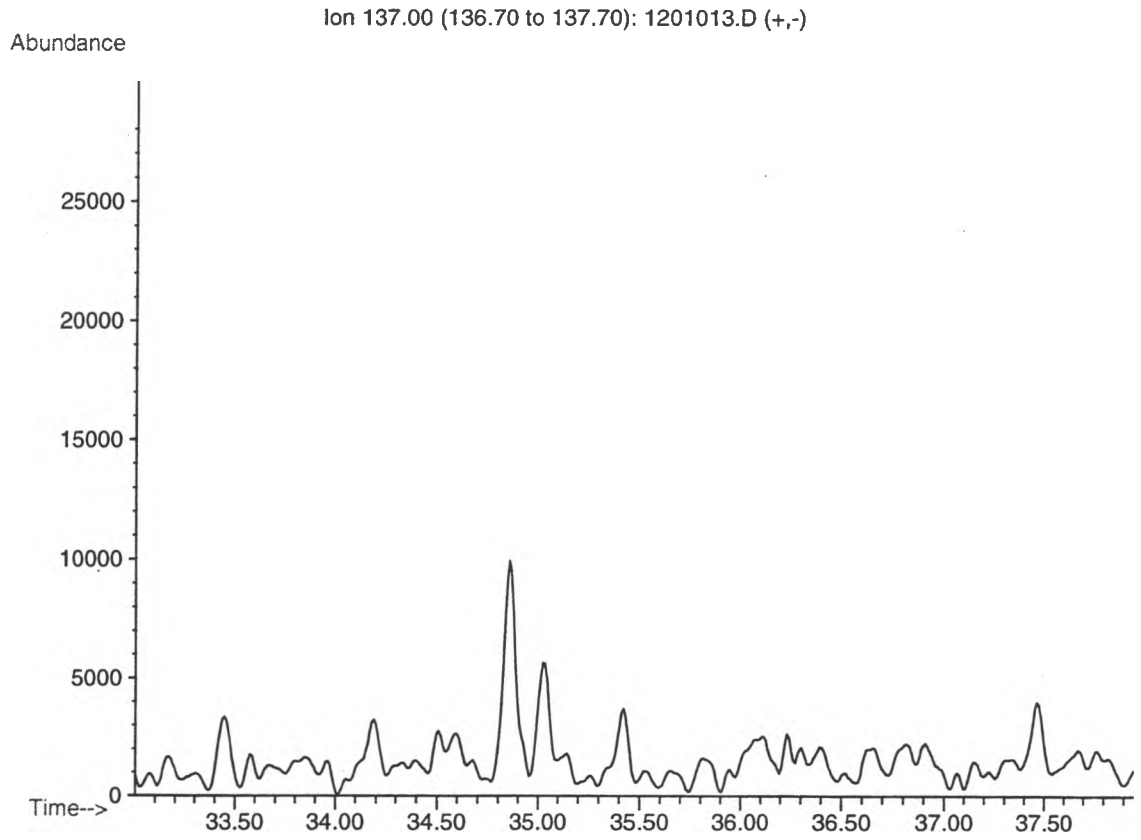

Figure 43. Diterpene characteristic trace of the Wapiti River downstream of Grande Prairie STP effluent.

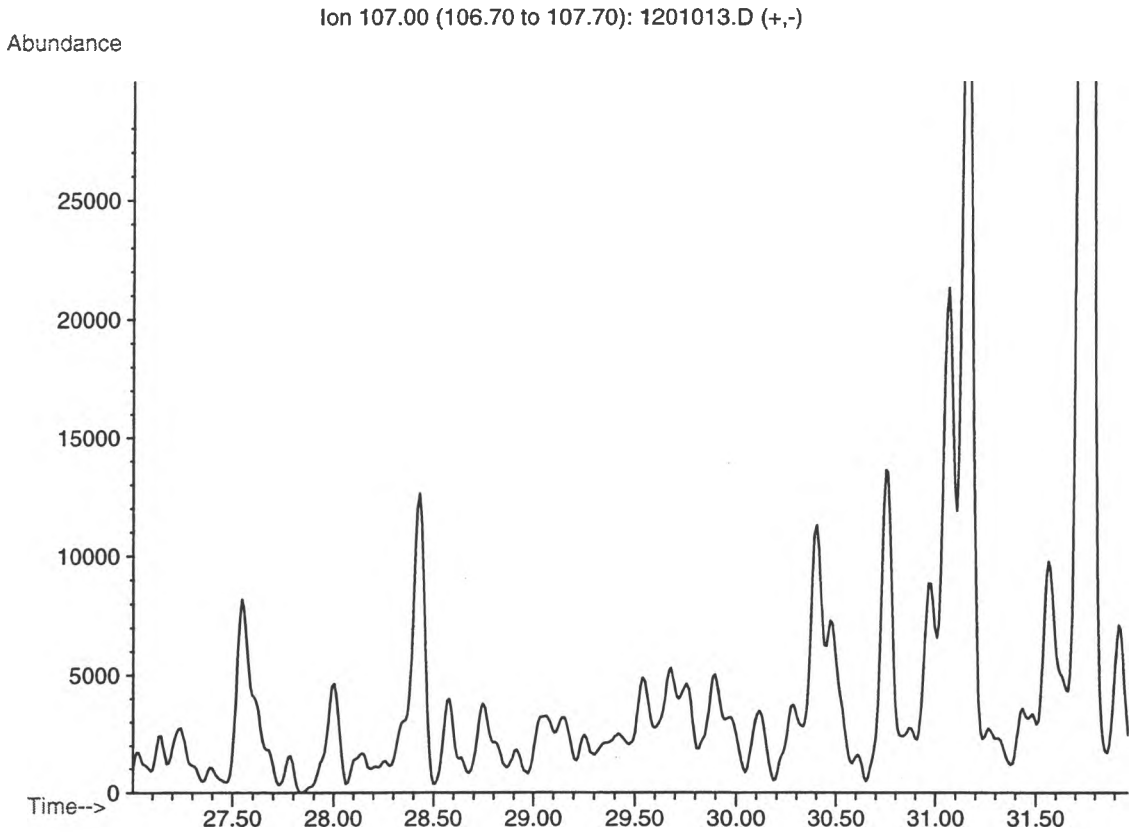

Figure 44. Nonylphenol characteristic trace of the Wapiti River downstream of Grande Prairie STP effluent.

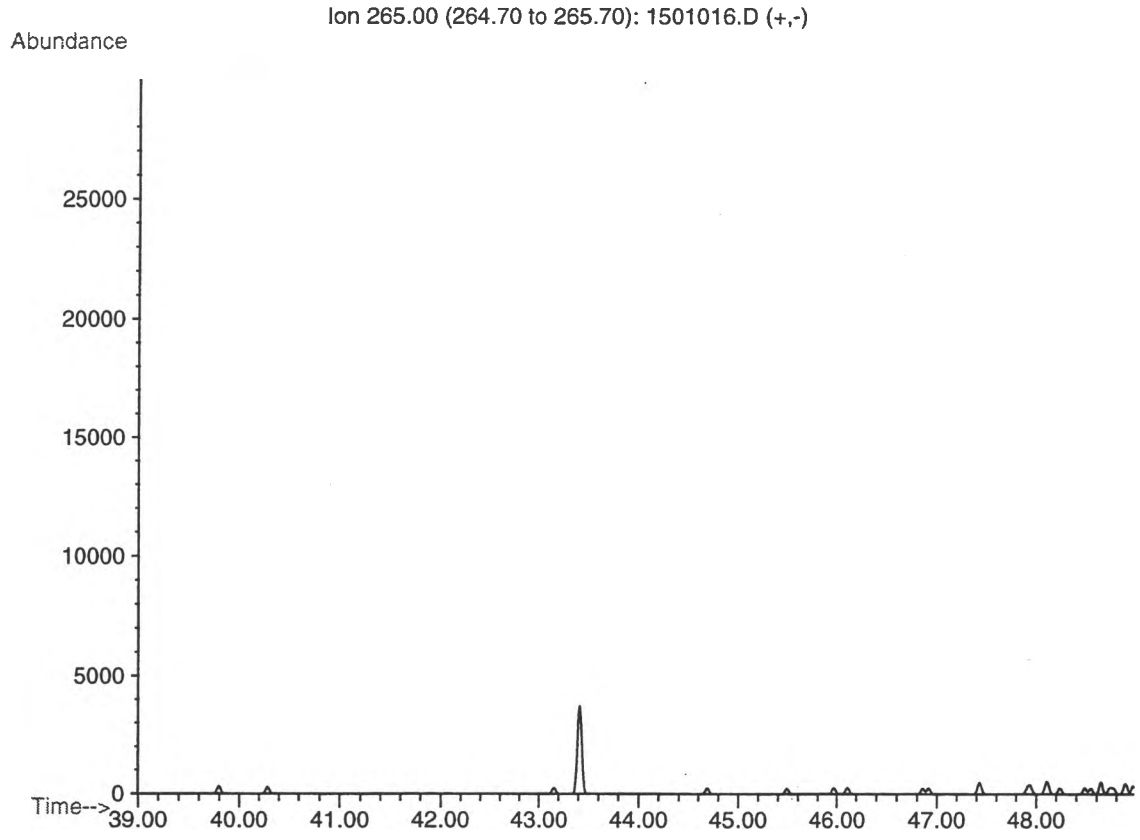

Figure 45. Unidentified STP acid esters characteristic trace of the Wapiti River downstream of Grande Prairie STP effluent.

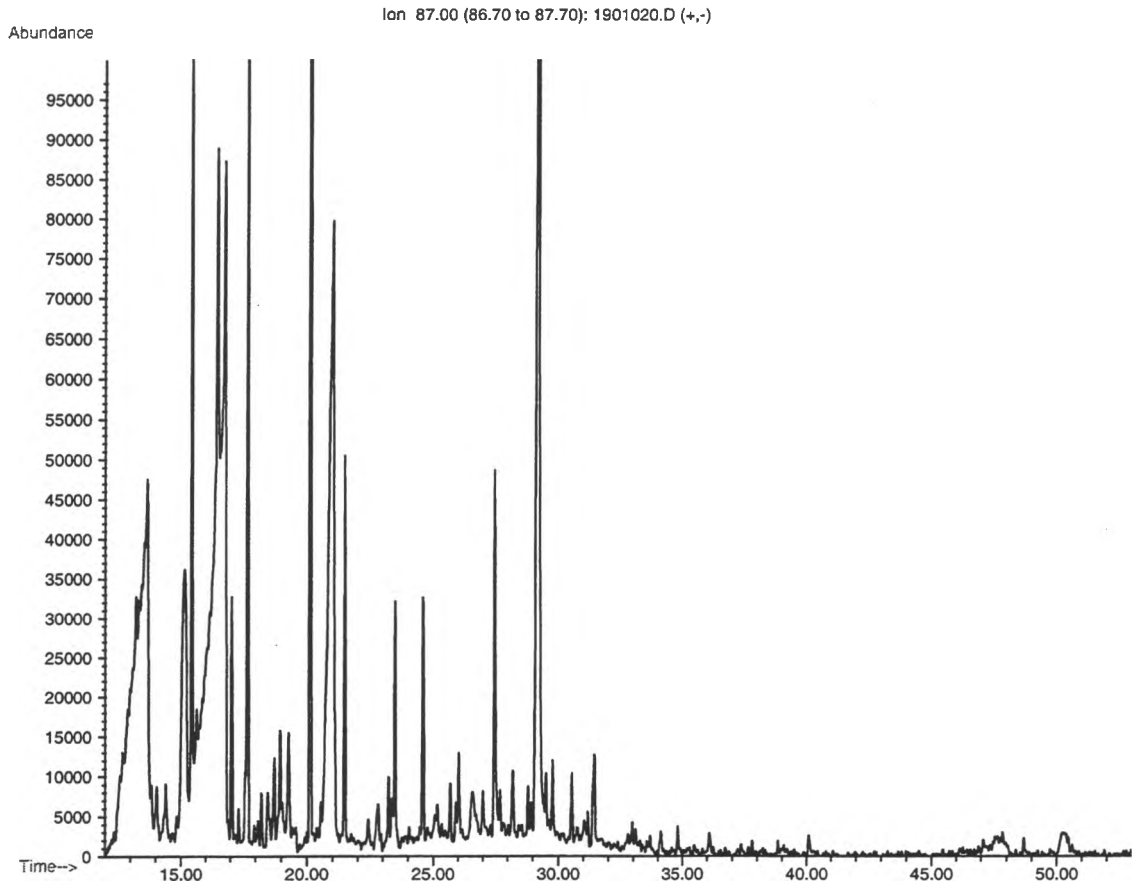

Figure 46. Mono- and dicarboxylic acid, methyl ester characteristic trace of the Wapiti River mouth at Smoky River.

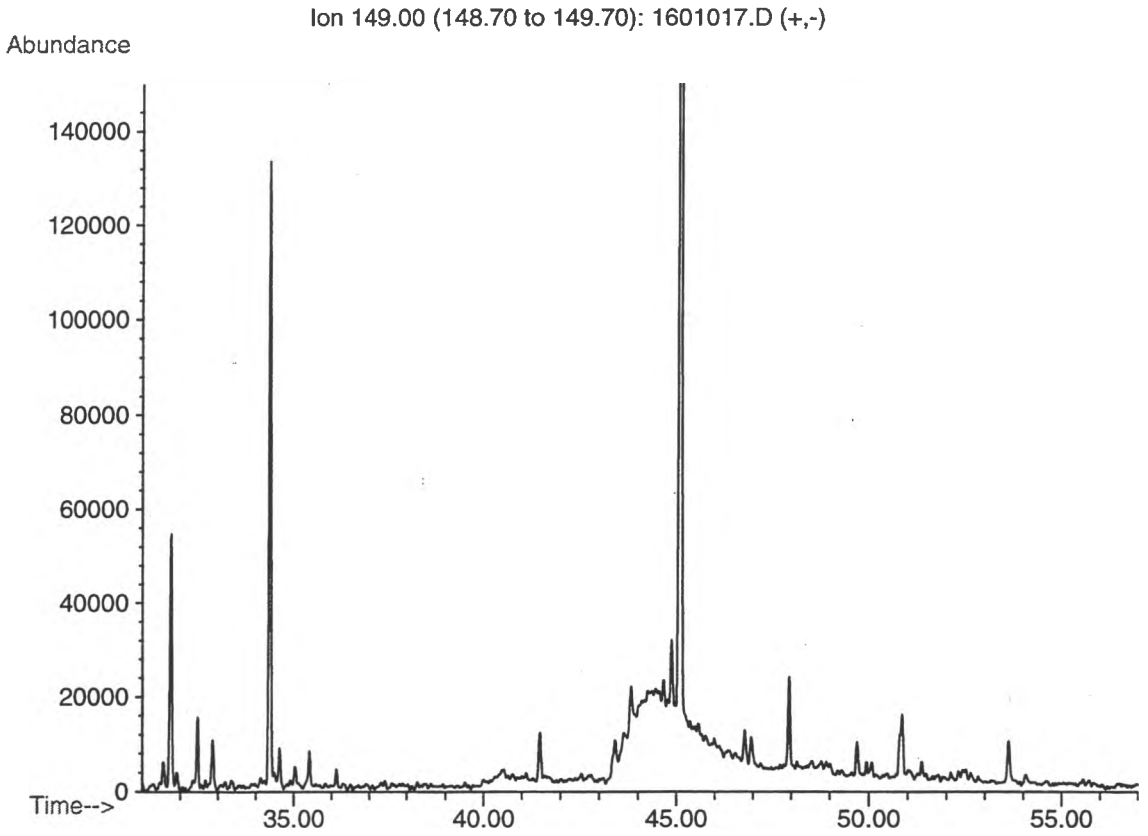

Figure 47. Phthalate ester characteristic trace of the Wapiti River mouth at Smoky River.

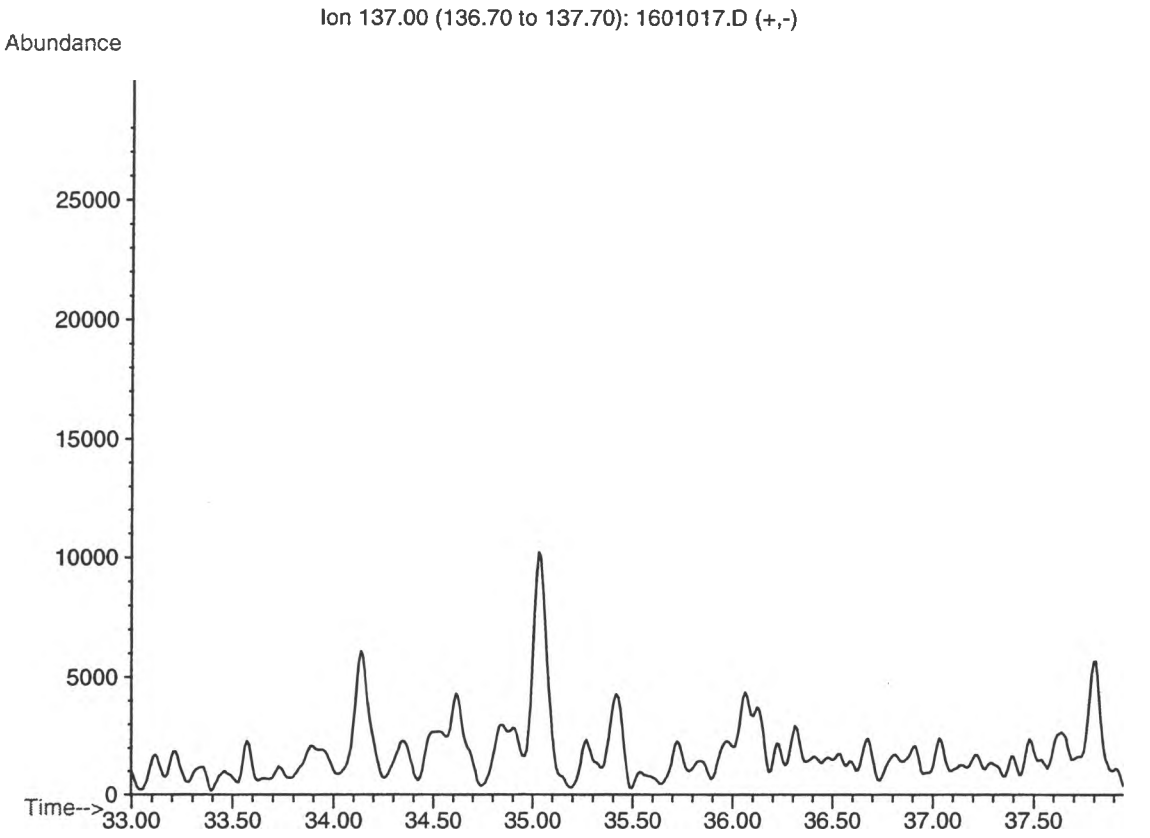

Figure 48. Diterpene characteristic trace of the Wapiti River mouth at Smoky River.

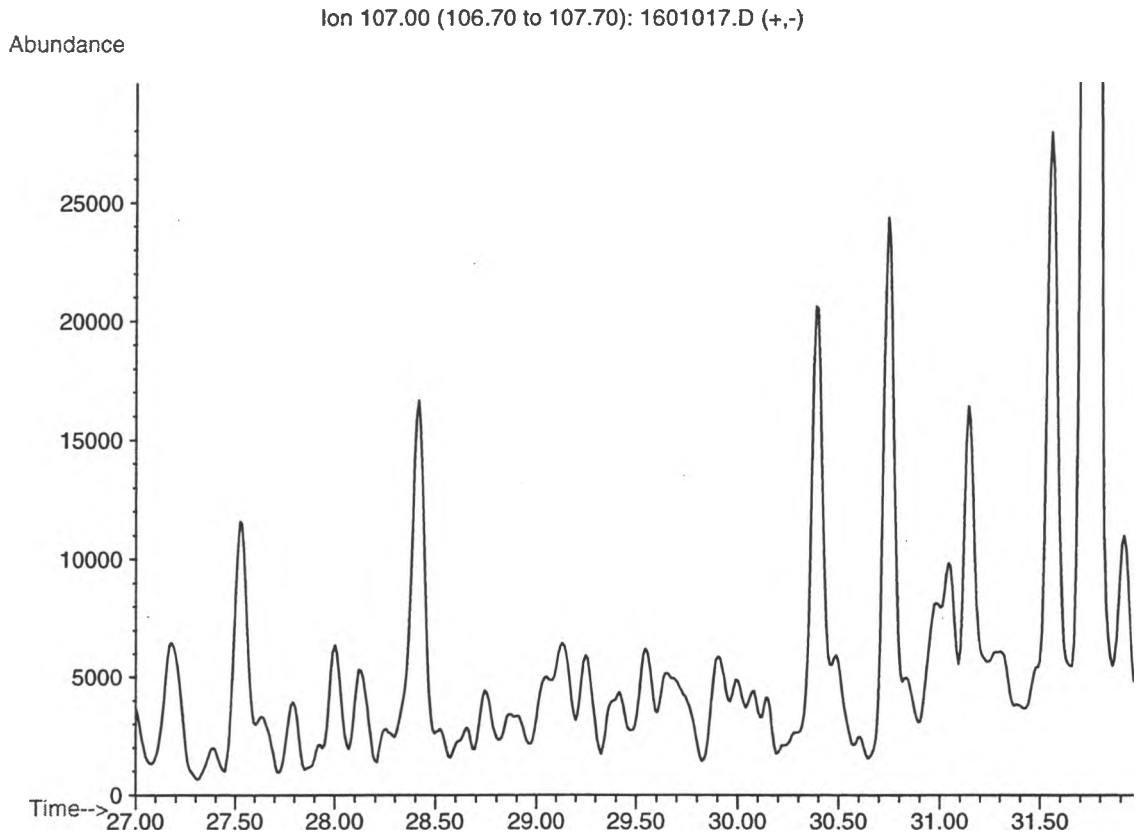

Figure 49. Nonylphenol characteristic trace of the Wapiti River mouth at Smoky River.

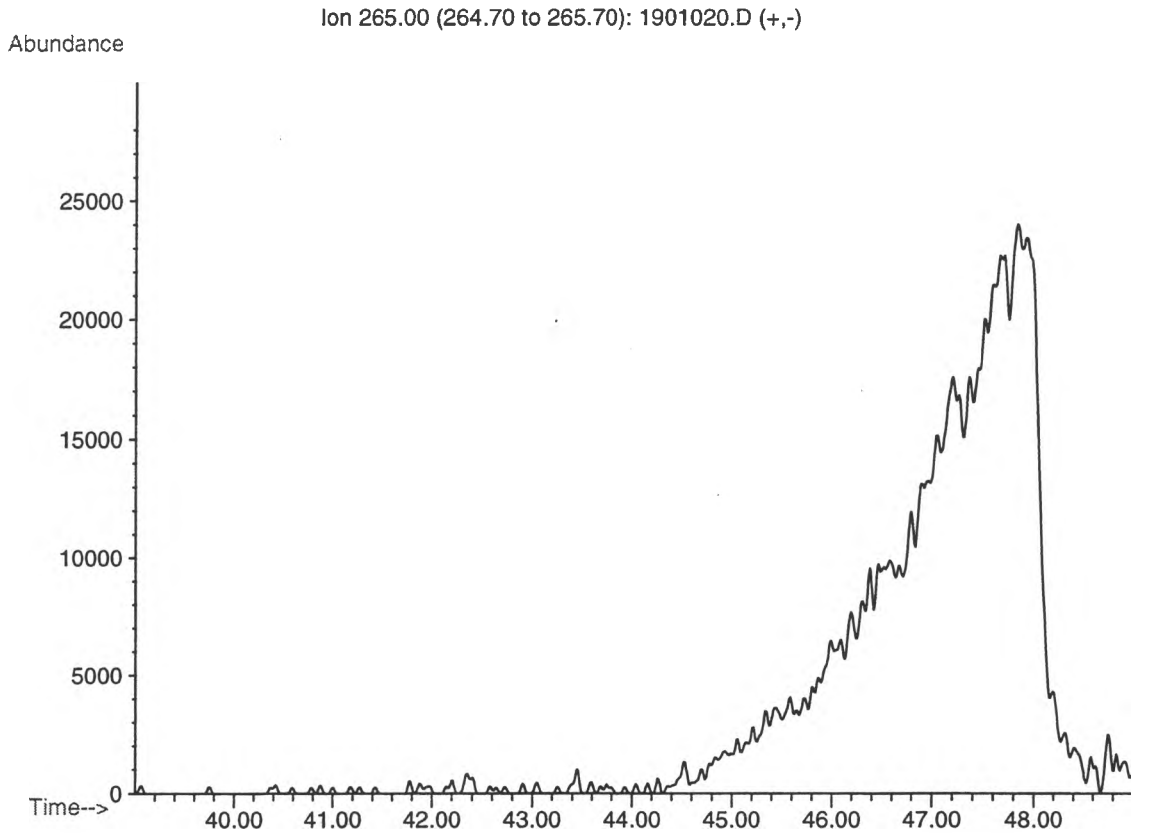

Figure 50. Unidentified STP acid esters characteristic trace of the Wapiti River mouth at Smoky River.

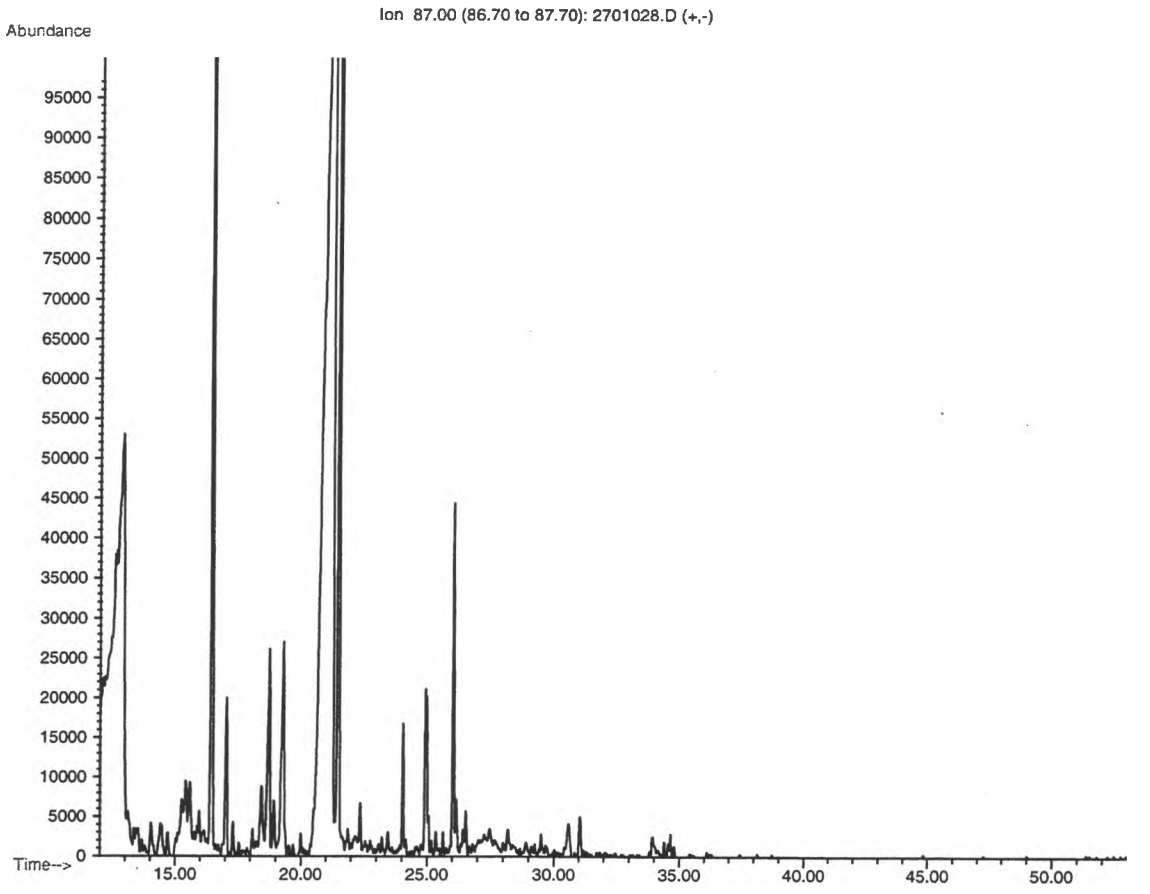

Figure 51. Mono- and dicarboxylic acid, methyl ester characteristic trace of the Smoky River upstream of Wapiti River confluence.

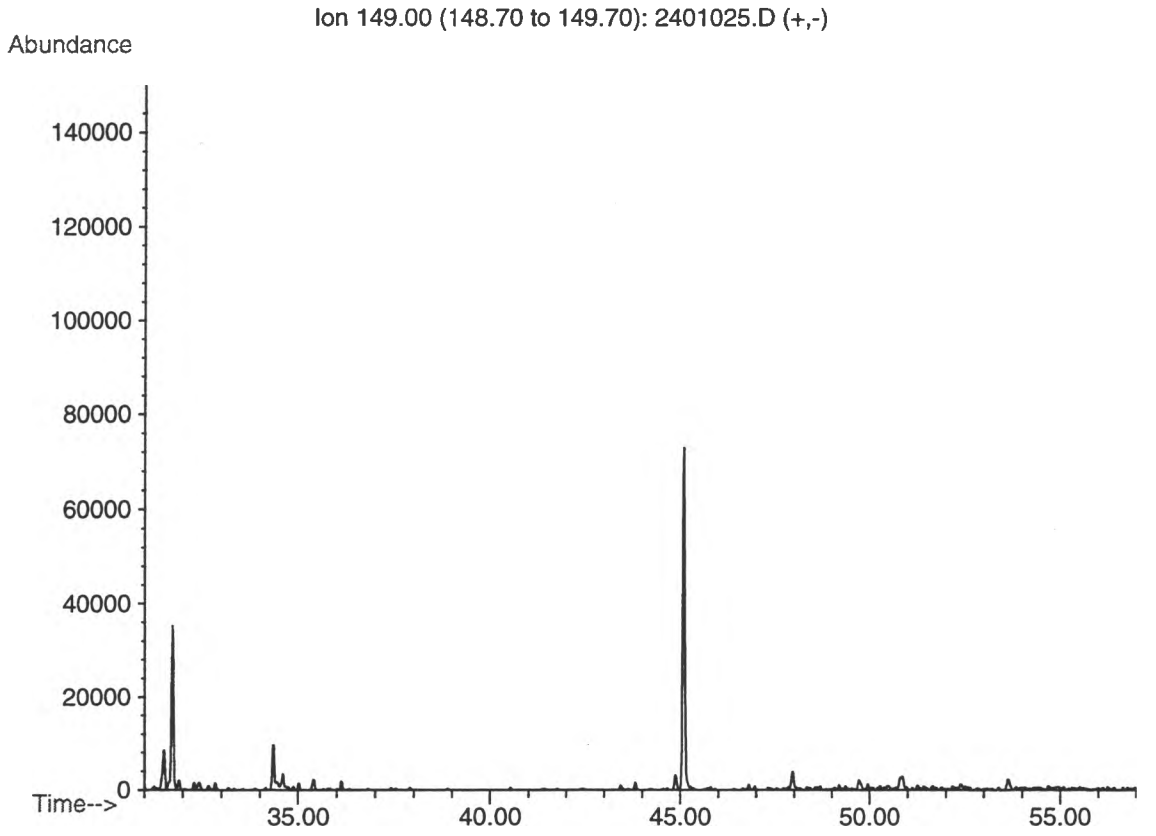

Figure 52. Phthalate ester characteristic trace of the Smoky River upstream of Wapiti River confluence.

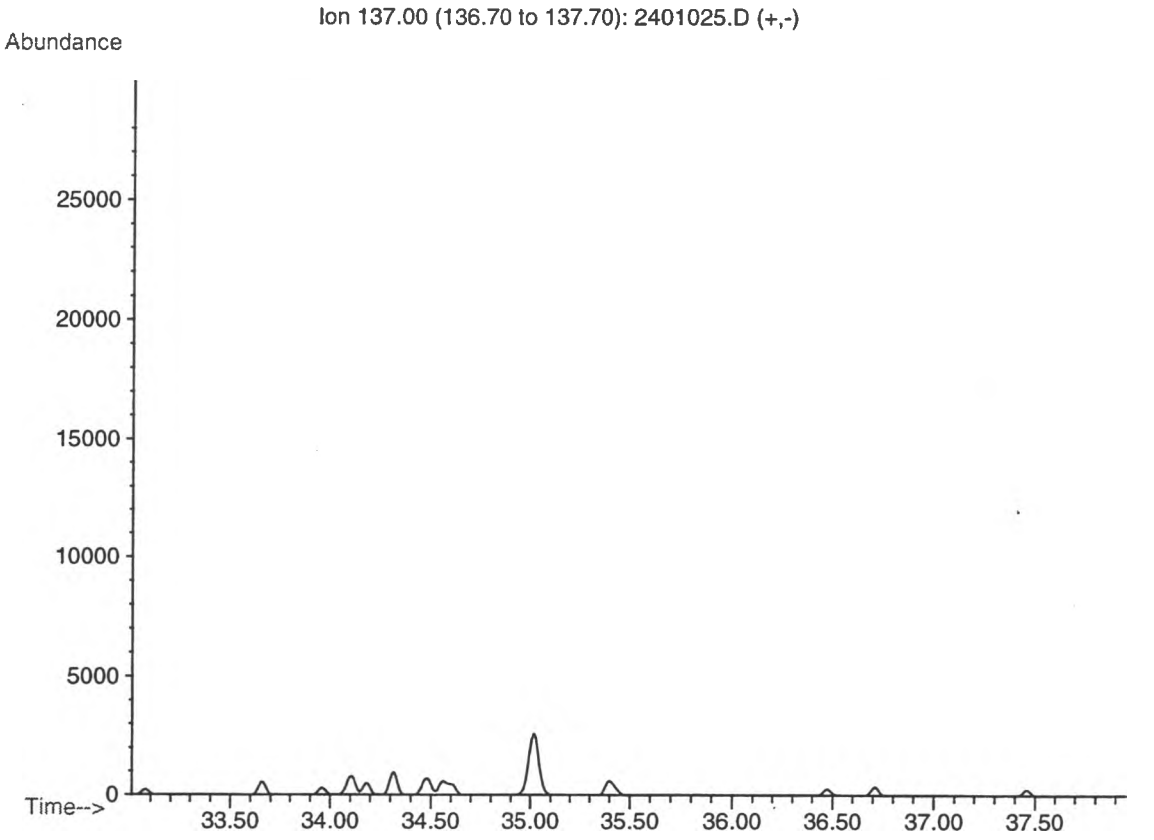

Figure 53. Diterpene characteristic trace of the Smoky River upstream of Wapiti River confluence.

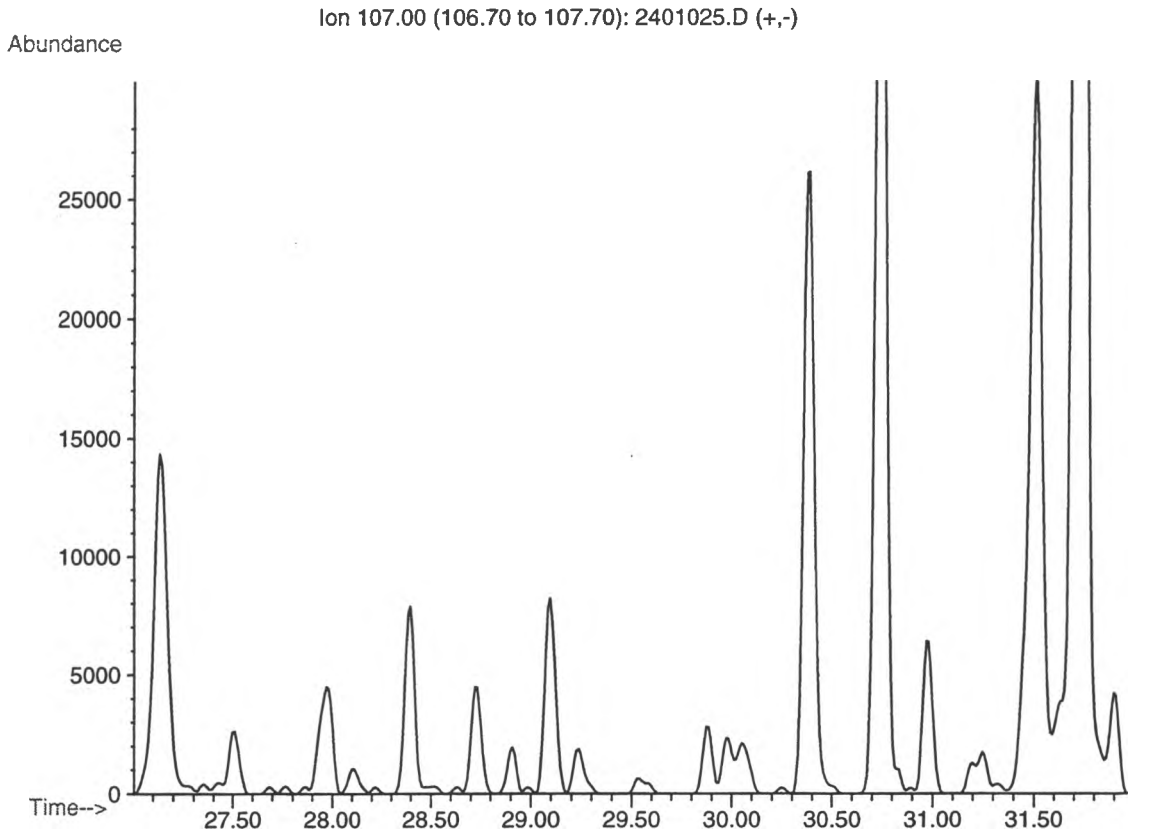

Figure 54. Nonylphenol characteristic trace of the Smoky River upstream of Wapiti River confluence.

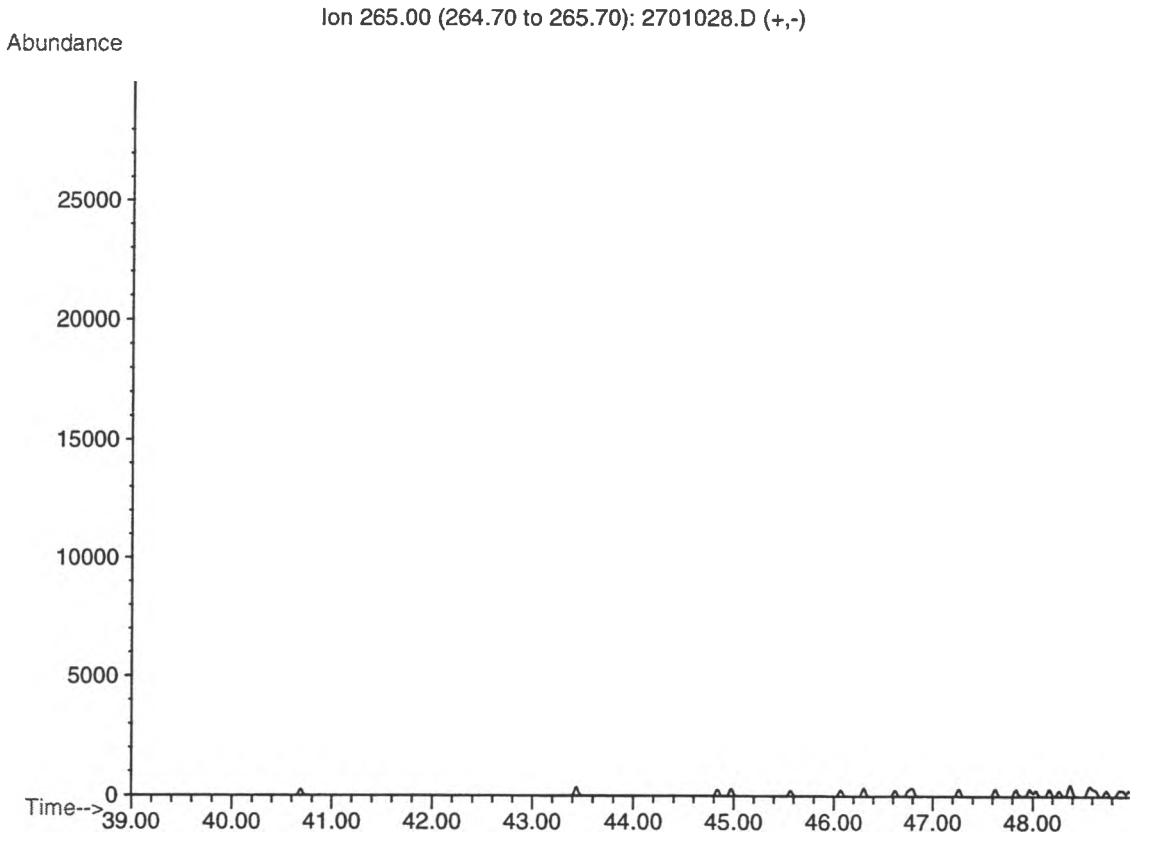

Figure 55. Unidentified STP acid esters characteristic trace of the Smoky River upstream of Wapiti River confluence.

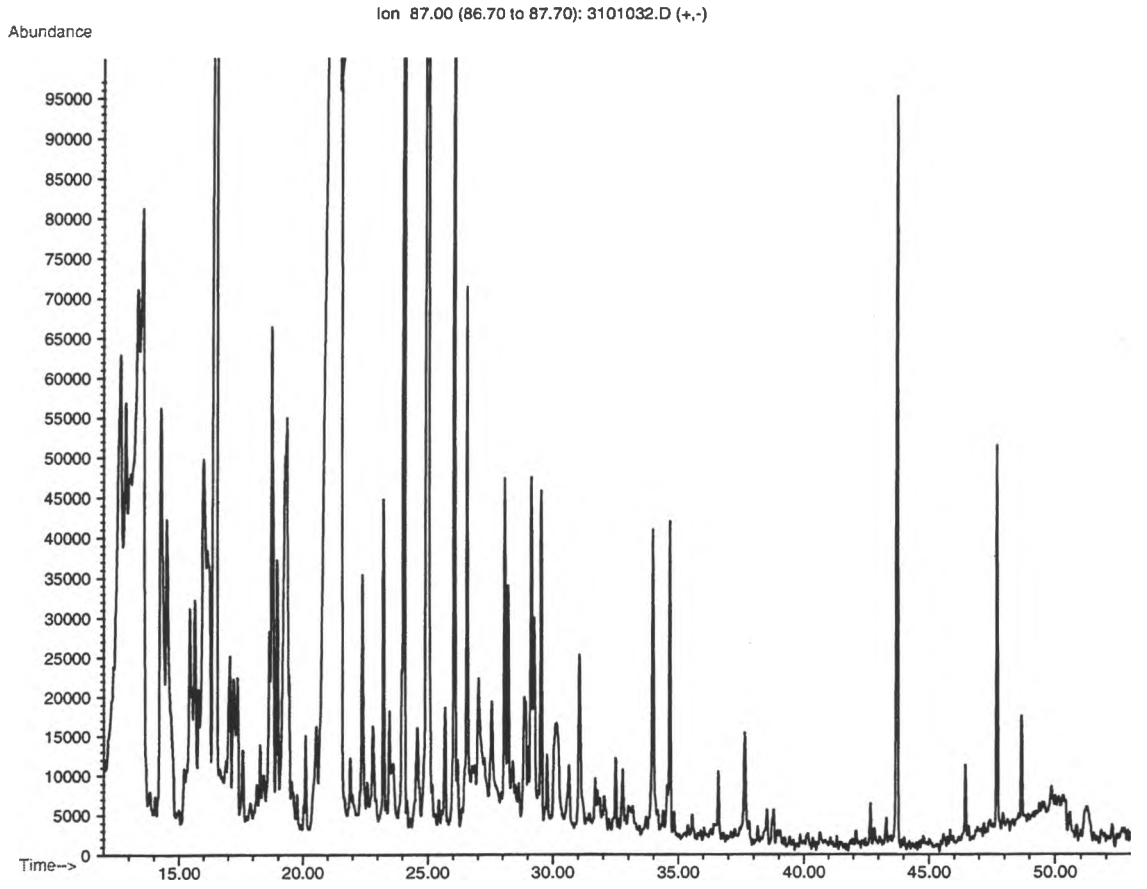

Figure 56. Mono- and dicarboxylic acid, methyl ester characteristic trace of the Smoky River at Watino.

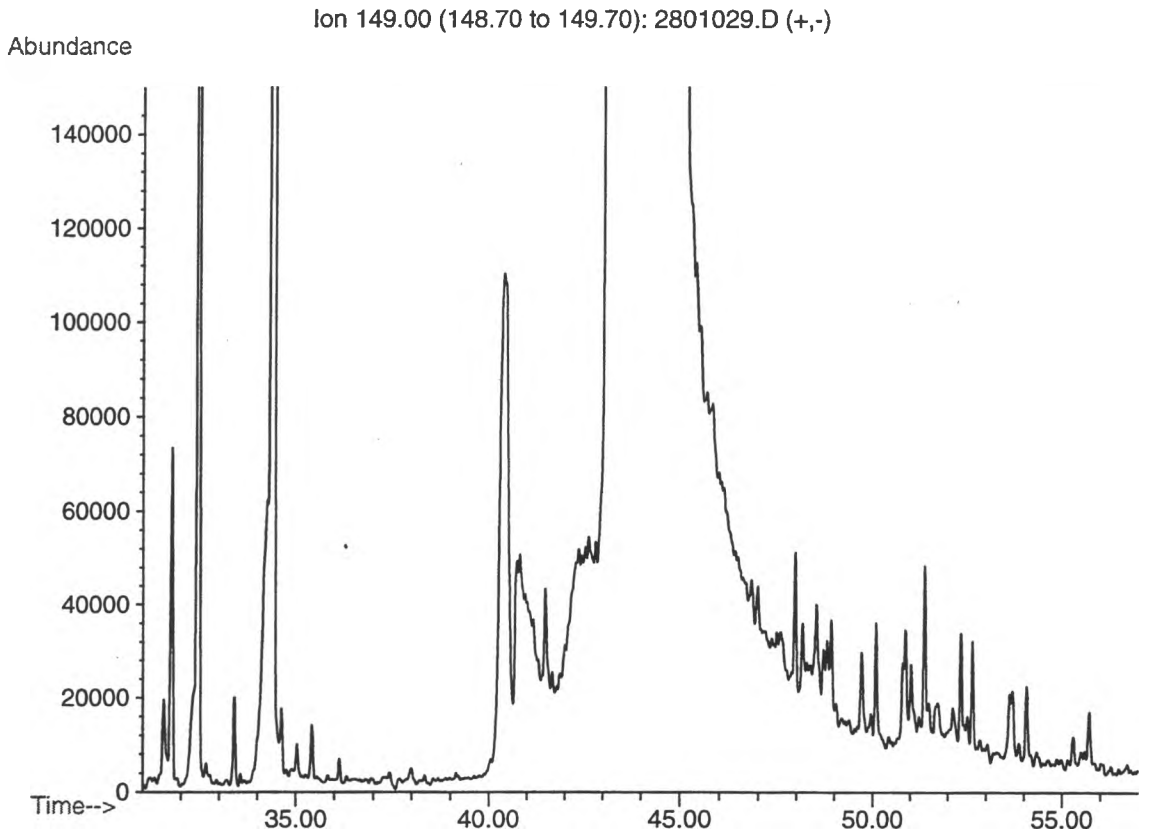

Figure 57. Phthalate ester characteristic trace of the Smoky River at Watino.

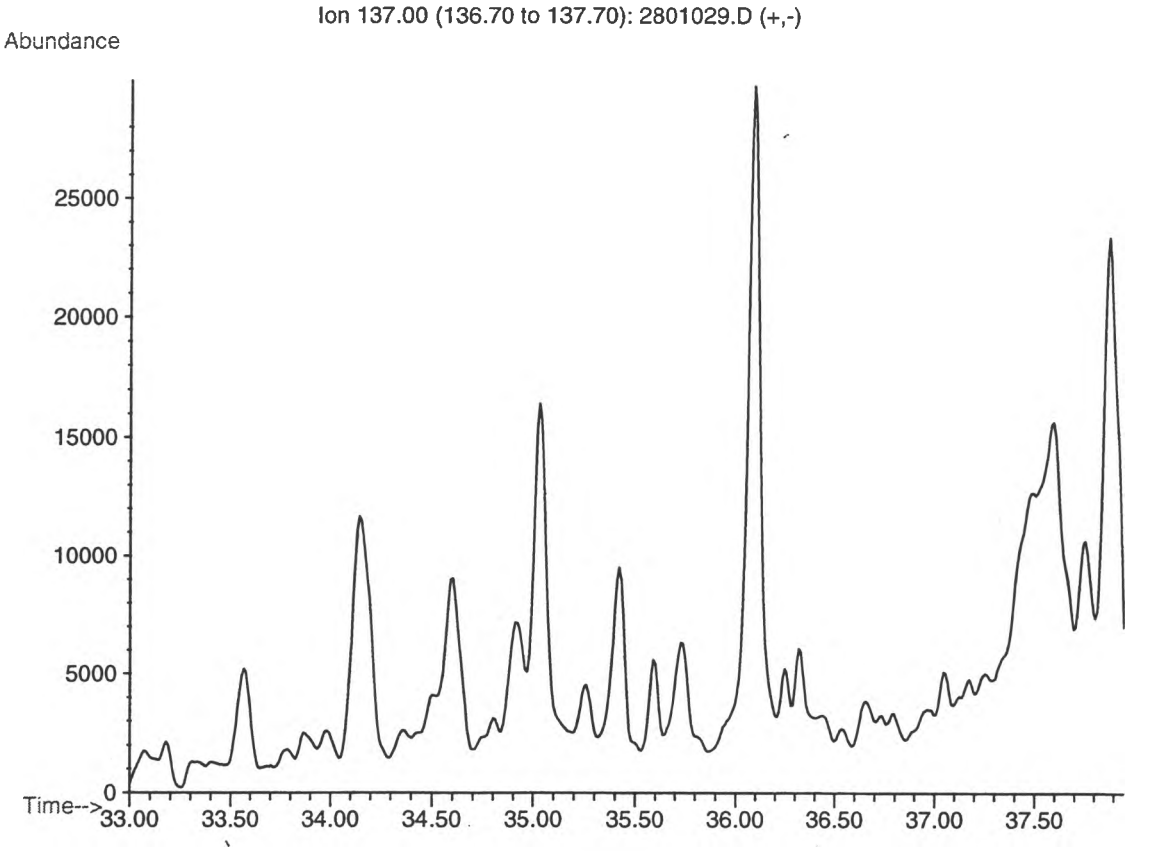

Figure 58. Diterpene characteristic trace of the Smoky River at Watino.

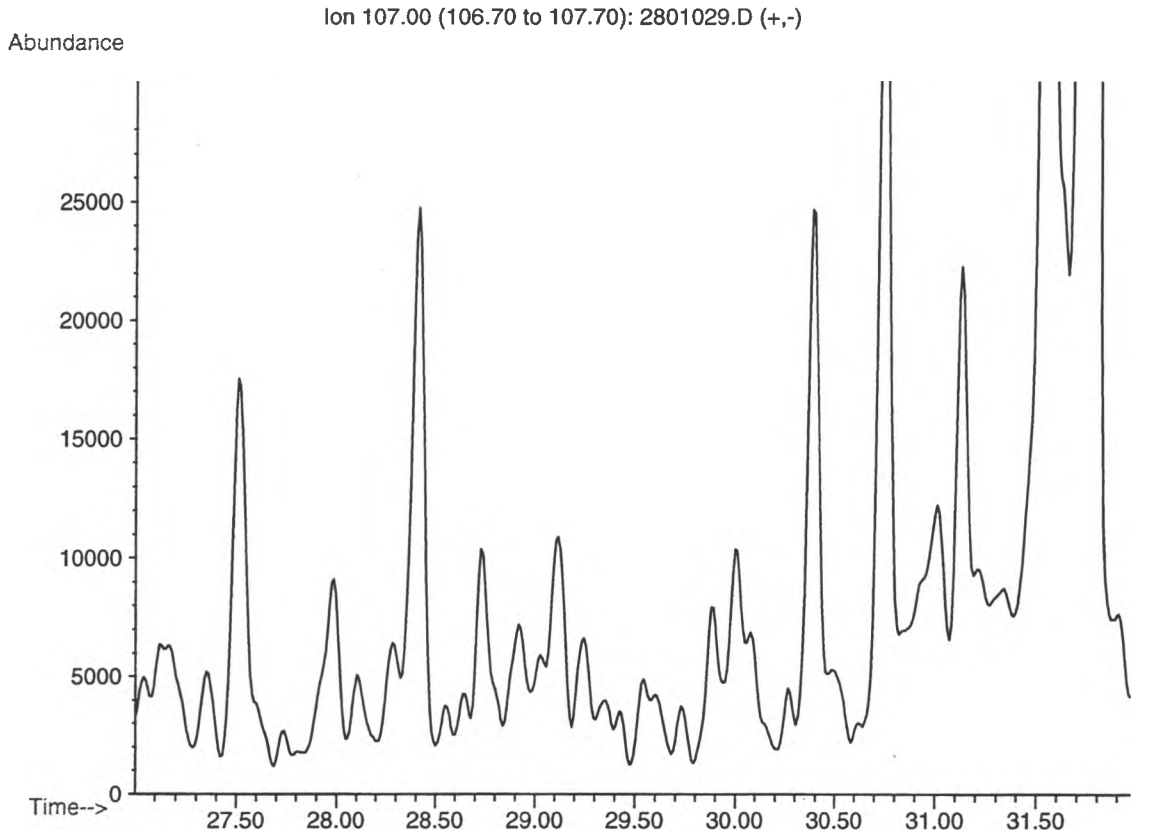

Figure 59. Nonylphenol characteristic trace of the Smoky River at Watino.

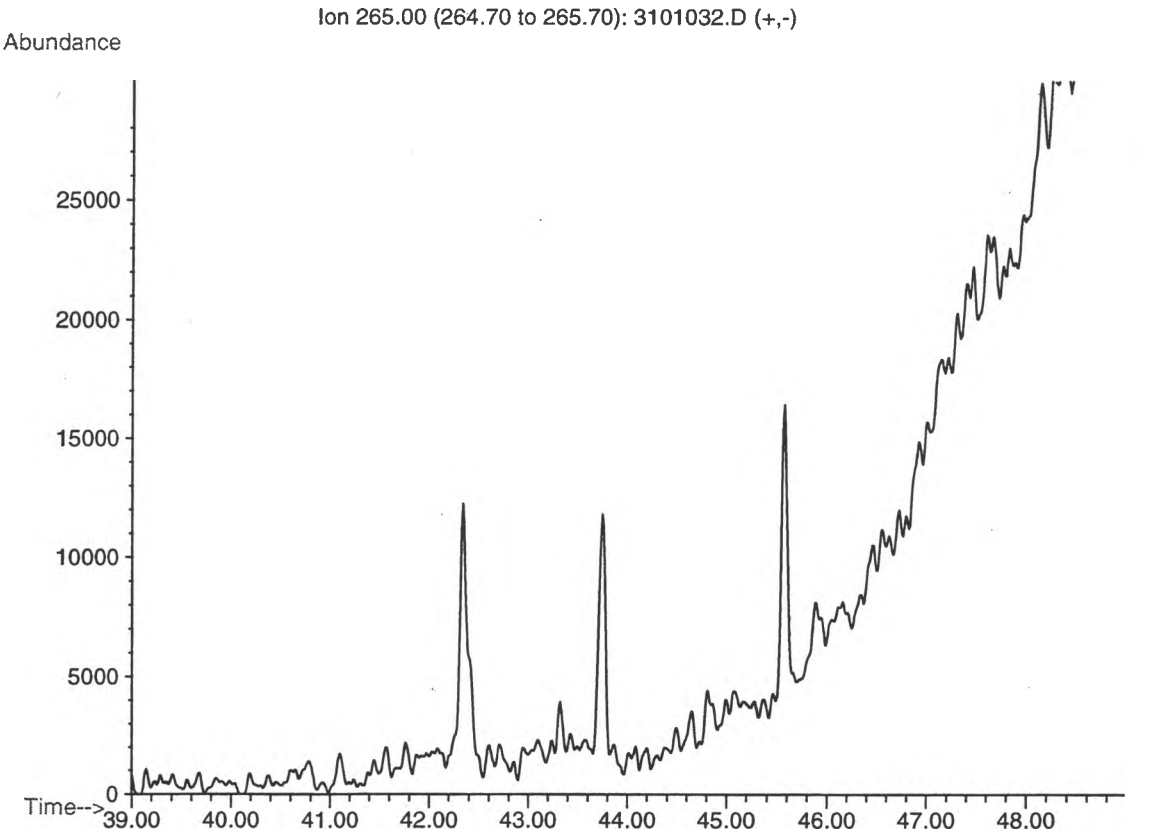

Figure 60. Unidentified STP acid esters characteristic trace of the Smoky River at Watino.

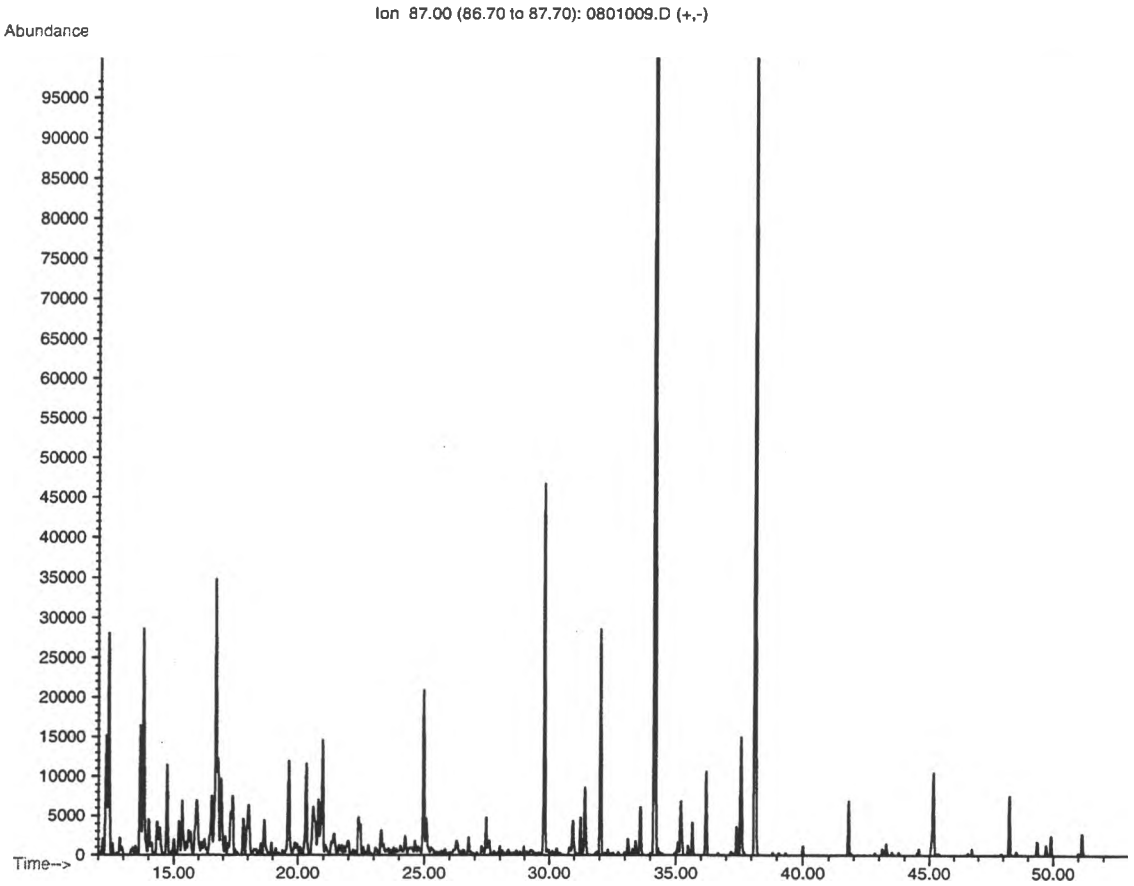

Figure 61. Mono- and dicarboxylic acid, methyl ester characteristic trace of blank.

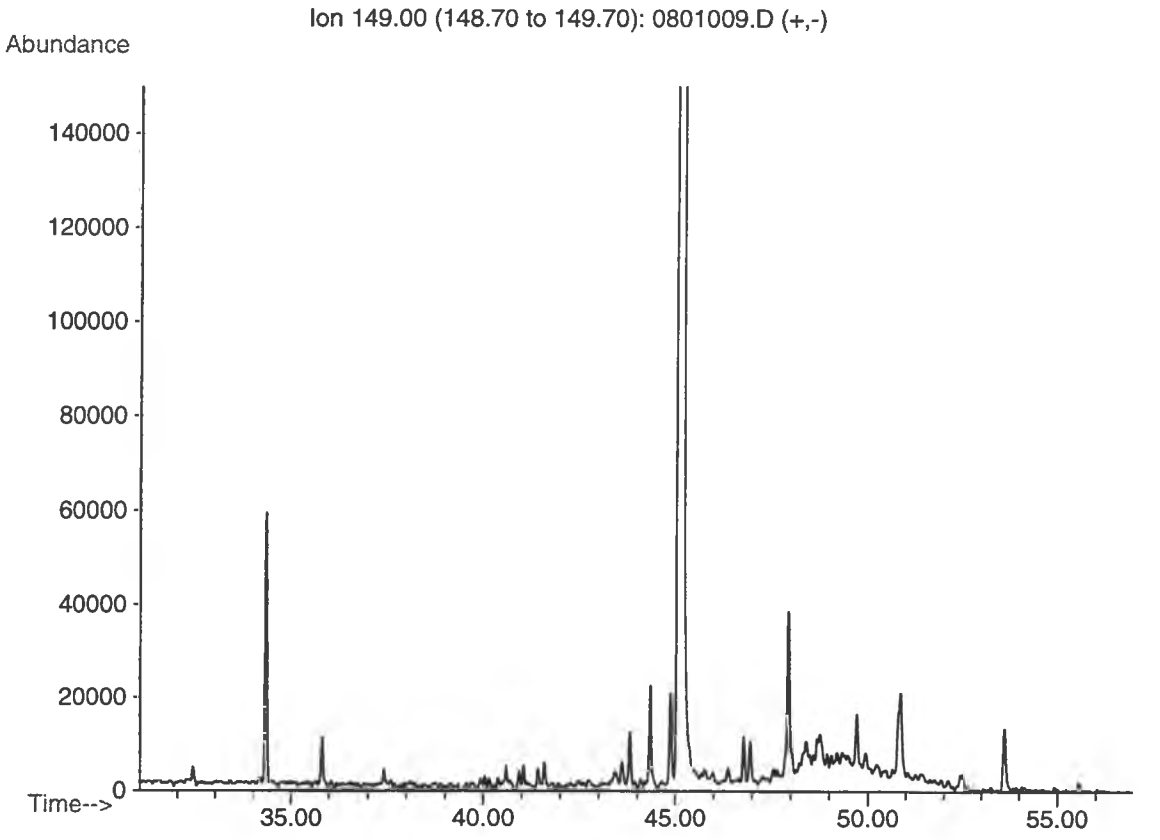

Figure 62. Phthalate ester characteristic trace of blank.

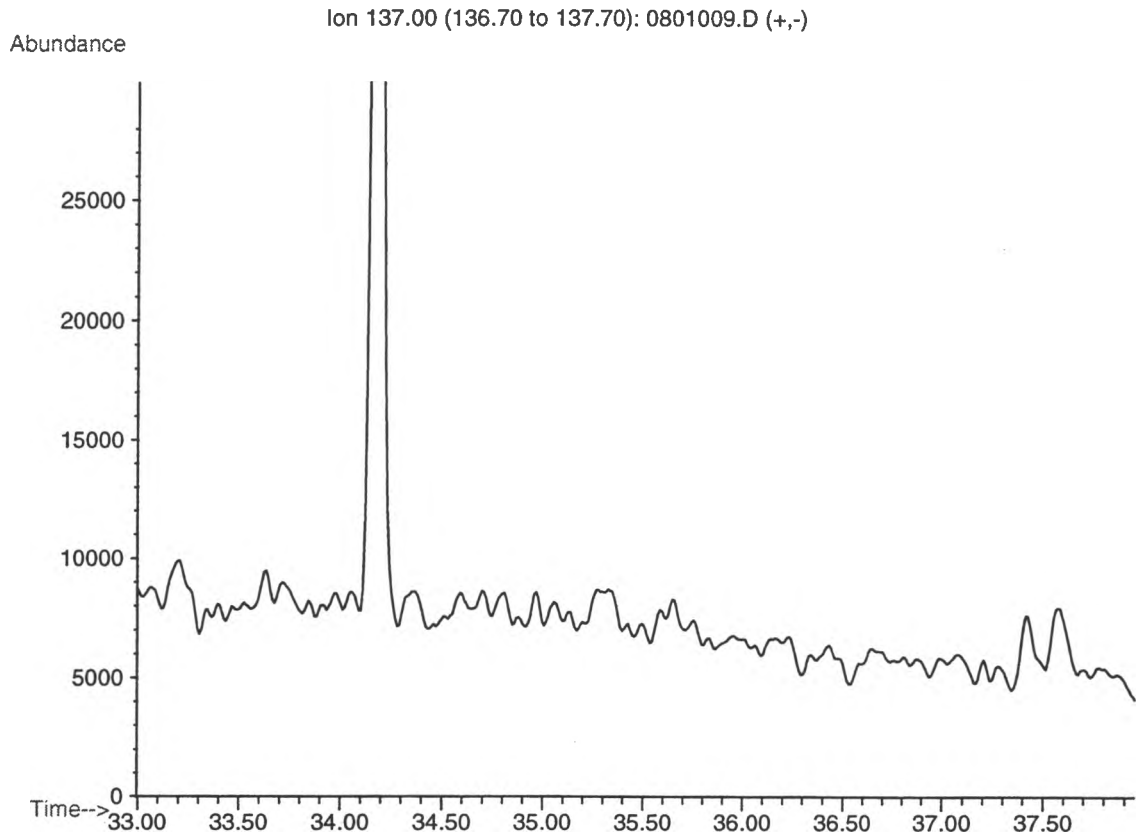

Figure 63. Diterpene characteristic trace of blank.

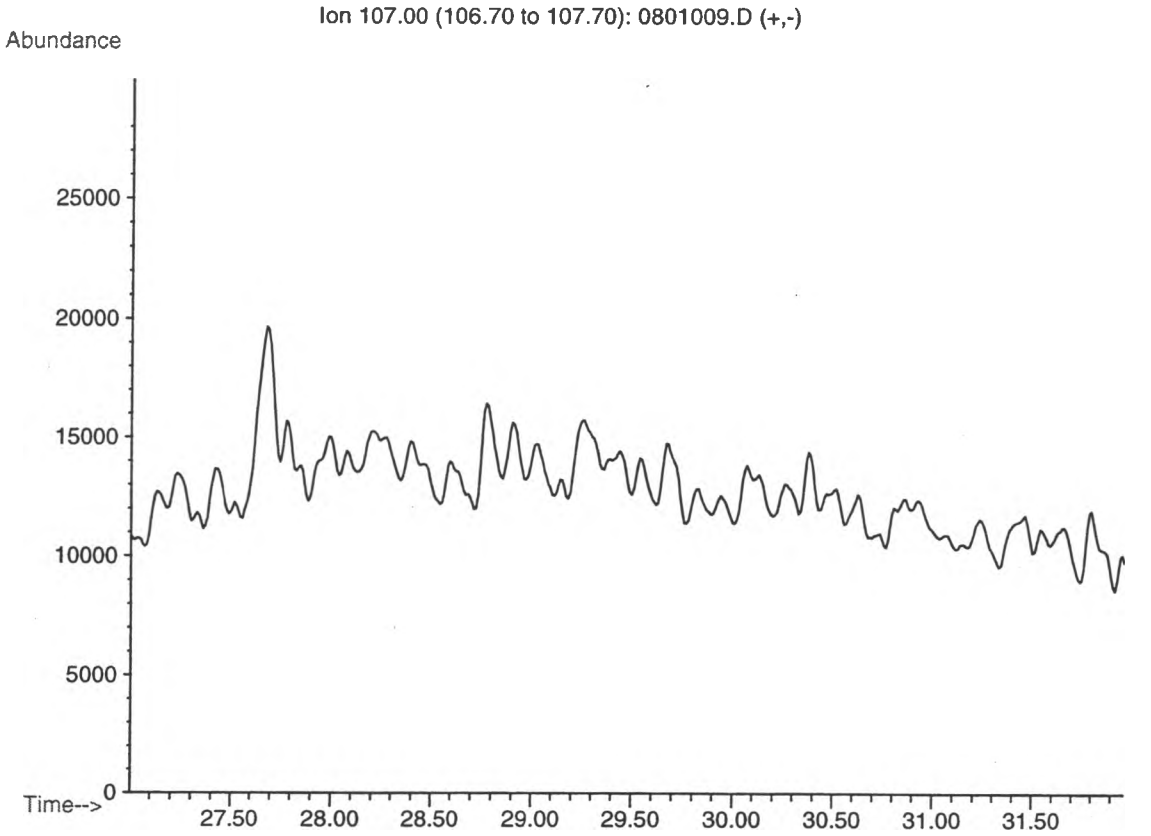

Figure 64. Nonylphenol characteristic trace of blank.

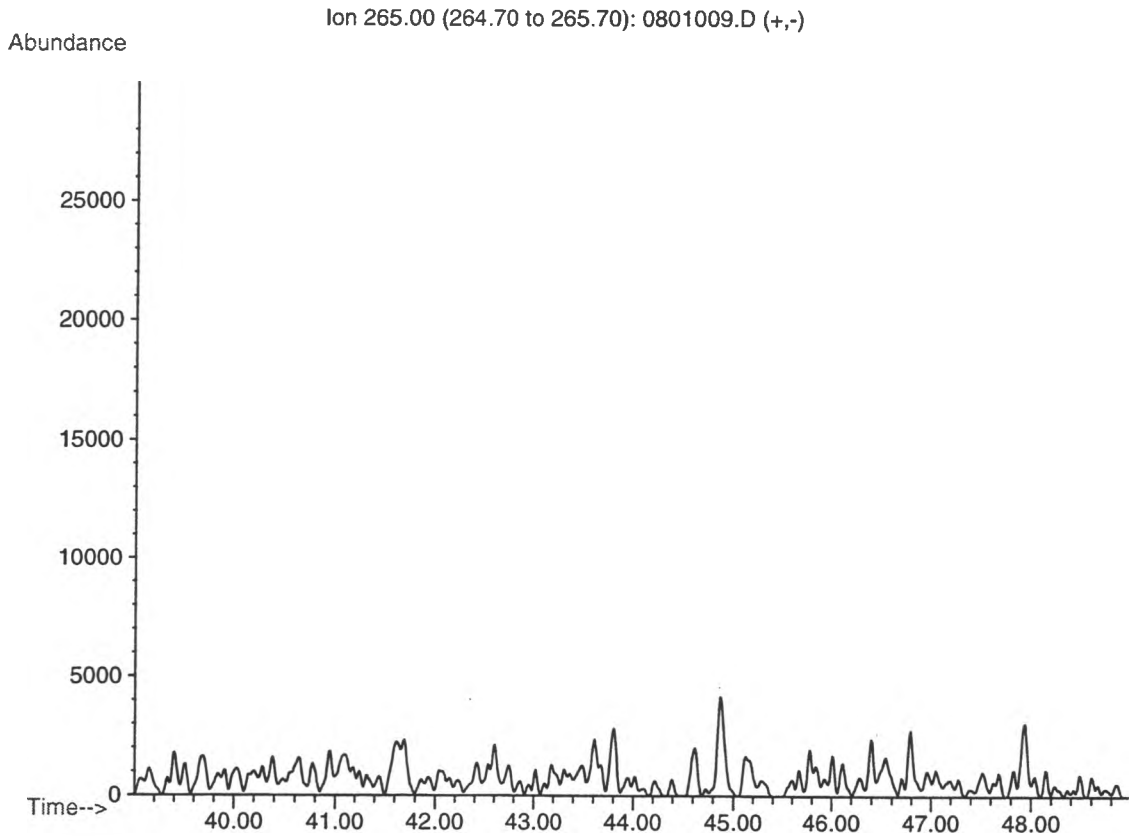

Figure 65. Unidentified STP acid esters characteristic trace of blank.

NORTHERN RIVER BASINS STUDY

APPENDIX A - TERMS OF REFERENCE

Project 2921-D1: Water and Effluent Basin-wide 1994 Survey - Broad Spectrum Analyses

I. BACKGROUND AND OBJECTIVES

Under the Northern River Basins Study, water, effluent, sediment, benthic invertebrates and fish have been sampled extensively and analyzed for a wide variety of specific contaminants known to be associated with developments within the Northern River Basins, or known to be transported into the study area by aerial transport. Aquatic systems that have been sampled include the Peace (including the Wapiti-Smoky systems) and Athabasca rivers (including the Athabasca Delta), in addition to sediment sampling from Lake Athabasca and other "reference" lakes. To date, only "target compound" contaminant analyses has been conducted on these samples. The list of target compounds includes: polychlorinated dioxins and furans (including di- and tri- and non-2,3,7,8-congeners), resin acids, polycyclic aromatic hydrocarbons, chlorophenolic compounds, polychlorinated biphenyls (congener specific), organochlorine pesticides including toxaphene, and metals. These results show generally low levels of these target contaminants for the samples analyzed. These types of specific analyses, however, do not include other potential contaminants that are not currently known to be associated with man-made developments within the basins, or aerial transport, or for which there is little understanding of their environmental effects.

The target compound analyses have been done using selected ion monitoring mass spectrometry or gas chromatography with specific detectors. This has two consequences: (1) as discussed above, it gives no indication of what other (non-target) compounds are present, and (2) there are no "archive" chromatograms such as the record provided by gas chromatography with a flame ionization detector (FID) or total ion mass chromatograms. Therefore, the most practical starting point in characterizing the major effluents and receiving waters of the Peace River and Athabasca River systems is by an experimental approach using broad spectrum analysis.

The purpose of this project is to conduct broad spectrum analyses of water and effluent samples upstream and downstream from major effluent sources on the Peace River (including the Wapiti-Smoky rivers) and the Athabasca River systems. These analyses will be used to identify other potential contaminants that may currently exist in the environment. They will also provide a permanent record, allowing researchers to revist the data in future years if other compounds become of interest.

II. GENERAL REQUIREMENTS

Organic constituents in effluents and receiving waters within the study area will be rigorously characterized by gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS).

Results are to be used to characterize current organic loads on the rivers from anthropogenic sources, and to evaluate future changes. All significant compounds (toxicants present in concentration > 1.0 μg/L in effluents) will be characterized with respect to mass spectra (electron impact, EI, and chemical ionization, CI) and GC retention indices (referenced to *n*-alkanes and aromatic ring size markers for the Suncor effluent). Mass spectra of significant compounds will be evaluated and, if possible, tentative structures proposed. When authentic standards are available, the tentative identifications will be confirmed. Effluent extracts and subfractions will be characterized for toxicity using the Microtox® test.

Over the past decade, effluents and receiving waters in northern Alberta have been analyzed at the Alberta Environmental Centre (AEC) as part of numerous surveys and monitoring programs of Alberta Environmental Protection. Organic constituents of these effluents and surface waters have been characterized by GC-MS following standard AEC Trace Organic Analysis Methods A105.1 for Extractable Priority Pollutants, and Method A102.1 for Automated Analysis of Volatile Priority Pollutants. These methods include a target compound analysis as well as a characterization of all organic constituents observed. The contractor is required to review this historical record, and incorporate it into this project.

A list of proposed river sampling sites and effluents is given in Schedule A. This table shows major effluent inputs from seven pulp mills and one oil sands plant, in addition to municipal inputs at Hinton (combined municipal and pulp mill), Whitecourt, Athabasca, Grande Prairie, Peace River and Fort McMurray. There are a total of 19 mainstream and 13 effluent sample sites where collections could be made.

III. SPECIFIC REQUIREMENTS

The workplan is to be organized into three tasks or stages. The first is to involve a summary of results and a review of the raw GC-MS data from previous effluent analyses. The second task is the collection and analysis of current effluents listed in Schedule A. The third stage is the collection and analysis of surface water samples (upstream and downstream of effluents outfalls) listed in Schedule A. In each section, the results are to be compiled and interpreted in reports and catalogues which will be the products delivered to the Study Office.

Task 1. Review Previous Effluent Results and Raw GC-MS Data Generated by the Trace Analysis Program from April 26, 1989, to July 1, 1994.

The results of this review is intended to provide a record of what has been discharged to the northern rivers in the past, and a context in which to evaluate current effluents. Results should also help in the interpretation of GC-MS data from current effluents.

a) Compile and review target compound analytical reports (EPP and VPP) for all relevant samples analyzed between April 26, 1989 and July 1, 1994.
b) Retrieve EPP GC-MS data and convert to either HP Chemstation or HP UNIX format (this will be considered a product to be delivered to the Study Office).

c) Identify compounds present in concentrations greater than 10 μg/L and compile characteristic total ion chromatograms (TIC) and extracted ion profiles (EIP) for ions characteristic of classes of compounds (e.g. m/z 91 for alkylbenzenes).

The products of this task will be: (1) a report describing the chemical characterization of effluents from data generated by the Trace Analysis Program (1989-1994), (2) a catalogue of effluent TICs and characteristic EIPs and a mass spectral library of characteristic compounds, and (3) retrieved GC-MS data for the years 1989-1994.

Task 2. Characterization of 1994 Effluents by GC-MS and GC-FID

a) Collect, extract, cleanup by gel permeation chromatography (GPC), and fractionate effluent samples listed in Appendix A. Solid phase extraction (SPE) with XAD-2 will be used. DOC and AOX (if appropriate) balances will be done to validate extractions. If warranted, other extraction techniques may be substituted for the SPE. Effluent extracts will be fractionated into four fractions by: (1) partitioning the extract between aqueous potassium carbonate and pentane, (2) extracting and derivatizing *in situ* the phenols in the aqueous layer by adding acetic anhydride and extracting with pentane, (3) extracting the resulting aqueous layer with methyl-*t*-butyl ether (MTBE), and (4) acidifying the resulting aqueous layer and extracting with MTBE. This entire scheme is shown in Appendix B. Operation 3 may be completed prior to 2 with hexane substituted for MTBE if this is found to improve the fractionation of some effluents.

b) Microtox® toxicity of each fraction will be measured and, if warranted, fractions will be fractionated chromatographically to isolate toxicants.

c) Fractions will be analyzed by GC-MS (electron impact and chemical ionization) and by GC-FID. *n*-Alkane retention indices will be determined for all fractions, and aromatic ring size retention indices will be determined for the Suncor effluent fraction.

The product of this task will be: (1) reports presenting the 1994 results and discussing the chemical characterization for each of the four types of effluents - kraft pulp mills, high yield pulp mills, municipal, and Suncor; (2) included in these reports will be a list and characterization of significant toxicants in effluents; and (3) a catalogue of current effluent fractions TICs and characteristic EIPs and a mass spectral library of characteristic compounds which can be used to evaluate surface waters in northern Alberta river basins.

Task 3. Characterization of Surface Water Above and Below Effluent Outfalls by GC-MS (EI only) and GC-FID.

Because contaminant concentrations in surface waters will be substantially lower than in effluent, the analysis of surface waters is to commence after the analysis of effluents has been completed. This will simplify the analysis of surface waters and the evaluation of the effects of effluents by identifying target areas where surface waters should be sampled. Sample sites for surface waters above and below effluent discharges are listed in Schedule A.

a) Collect, extract, cleanup by GPC and fractionate receiving water samples. SPE sample collection/extraction (Infiltrex, XAD-2) will be used if this method is found to be appropriate in Task 2 (a). Improvements to the fractionation procedure (if any) made in Task 2 (a) will be incorporated in the fractionation of surface water extracts.

b) GC-MS and GC-FID analysis of these extract fractions.

The product of this task will be a report discussing the effects of effluents on surface waters in northern Alberta river basins, including the contribution of these effluents to the organic composition in these waters. This report will refer to the results of the effluent analyses in Tasks 1 and 2.

IV. REPORTING REQUIREMENTS

1. Task 1 - ten copies of a Draft Report, catalogue and a mass spectral library along with an electronic disk copy are to be submitted to the Component Coordinator by **November 30, 1994**.

   Task 2 - ten copies each of four Draft Reports, catalogues and mass spectral libraries along with electronic disk copies are to be submitted to the Component Coordinator by **January 31, 1995**.

   Task 3 - ten copies of a Draft Report along with an electronic disk copy are to be submitted to the Component Coordinator by **March 31, 1995**.

2. Three weeks after the receipt of review comments on each of the draft reports, the Contractor is to provide the Component Coordinator with two unbound, camera ready copies and ten cerlox bound copies of each final report along with an electronic version.

3. The Contractor is to provide draft and final reports in the style and format outlined in the NRBS document, "A Guide for the Preparation of Reports," which will be supplied upon execution of the contract.

   The final report is to include the following: an acknowledgement section that indicates any local involvement in the project, Report Summary, Table of Contents, List of Tables, List of Figures and an Appendix with the Terms of Reference for this project.

   Text for the report should be set up in the following format:

   a) Times Roman 12 point (Pro) or Times New Roman (WPWIN60) font.
   b) Margins; are 1" at top and bottom, 7/8" on left and right.

c) Headings; in the report body are labelled with hierarchical decimal Arabic numbers.

d) Text; is presented with full justification; that is, the text aligns on both left and right margins.

e) Page numbers; are Arabic numerals for the body of the report, centred at the bottom of each page and bold.

- If photographs are to be included in the report text they should be high contrast black and white.
- All tables and figures in the report should be clearly reproducible by a black and white photocopier.
- Along with copies of the final report, the Contractor is to supply an electronic version of the report in Word Perfect 5.1 or Word Perfect for Windows Version 6.0 format.
- Electronic copies of tables, figures and data appendices in the report are also to be submitted to the Project Liaison Officer along with the final report. These should be submitted in a spreadsheet (Quattro Pro preferred, but also Excel or Lotus) or database (dBase IV) format. Where appropriate, data in tables, figures and appendices should be geo-referenced.

4. All figures and maps are to be delivered in both hard copy (paper) and digital formats. Acceptable formats include: DXF, uncompressed E⌀⌀, VEC/VEH, Atlas, windows metafile (WMF) and ISIF. All digital maps must be properly geo-referenced.

5. All sampling locations presented in report and electronic format should be geo-referenced. This is to include decimal latitudes and longitudes (to six decimal places) and UTM coordinates. The first field for decimal latitudes / longitudes should be latitudes (10 spaces wide). The second field should be longitude (11 spaces wide).

6. A presentation package of 35 mm slides that can be used at public meetings to summarize the project is to comprise of one original and four duplicates of each slide.

V. DELIVERABLES

1. A report reviewing previous data for 1989-94, including the GC-MS data in appendices. The contractor will also provide a catalogue of effluent TICs and EIPs, and a mass spectral library of characteristic compounds.

2. Reports characterizing all of the industrial/municipal effluents in the study area for 1994, including characterization of significant toxicants. The contractor will also provide catalogues of current effluent fractions TICs and EIPs, and mass spectral libraries of characteristic compounds.

3. A report characterizing the surface waters above and below effluents in the study area, including the contribution of effluents to the organic composition in these waters.

4. Ten to twenty-five 35 mm slides that can be used at public meetings to summarize the project, methods and key findings.

VI. CONTRACT ADMINISTRATION

This project has been proposed by the Contaminants Component of the Northern Rivers Basins Study (Contaminants Component Leader - Dr. John Carey, NWRI)

The Scientific Authority for this project is:

Dr. Brian Brownlee
National Water Research Institute
867 Lakeshore Road
P.O. Box 5050
Burlington, Ontario
L7R 4A6
phone: (905) 336-4706
fax: (905) 336-4972

Questions of a technical nature should be directed to him.

The Component Coordinator for this project is:

Richard Chabaylo
Northern River Basins Study
690 Standard Life Centre
10405 Jasper Avenue
Edmonton, Alberta T5J 3N4
phone: (403) 427-1742
fax: (403) 422-3055

Questions of an administrative nature should be directed to him.

SCHEDULE A

RIVER AND EFFLUENT SAMPLING SITES

Athabasca Mainstream:
upstream from Hinton
downstream from Hinton
upstream from Whitecourt
downstream from Whitecourt
upstream from Athabasca
downstream from Athabasca and upstream from AlPac mill
downstream from AlPac mill
upstream from Fort McMurray
downstream from Fort McMurray
downstream from Suncor

Athabasca Effluents:
Weldwood (Hinton Combined Effluent)
Alberta Newsprint effluent (Whitecourt)
Millar-Western effluent (Whitecourt)
Whitecourt municipal effluent
Slave Lake Pulp effluent (Lesser Slave River)
Athabasca municipal effluent
Alberta Pacific effluent (downstream from Athabasca)
Fort McMurray municipal effluent
Suncor effluent (downstream from Fort McMurray)

Wapiti-Smoky-Peace Mainstream:
Wapiti R. upstream from Grande Prairie
Wapiti R. downstream from municipal effluent and upstream from Weyerhaeuser mill
Wapiti R. downstream from Weyerhaeuser mill
Smoky R. upstream from confluence with Wapiti R.
Smoky R. downstream from confluence with Wapiti R.
Smoky R. at mouth
Peace R. upstream from confluence with Smoky R.
Peace R. downstream from Peace River
Peace R. downstream from Daishowa mill

Wapiti-Smoky-Peace Effluents:
Grande Prairie municipal effluent
Weyerhaeuser effluent (Grande Prairie)
Peace River municipal effluent
Daishowa effluent

APPENDIX B: BROAD SPECTRUM ANALYSIS OF MUNICIPAL AND INDUSTRIAL EFFLUENT DISCHARGED INTO THE PEACE, ATHABASCA AND SLAVE RIVER BASINS - DATABASE FILES

The disks provided in this Appendix contains the electronic versions of Northern River Basins Study's (NRBS) Project Report No's 138, 121 and 111 and their appendices (where electronic copies exist). This information is being provided to facilitate use by researchers. Users are encouraged to contact the authors of these reports for additional background information.

Disk No. 1 contains three files, using 990,161 bytes.

1. INSTALL.BAT; being 74 bytes in size.
2. PR138.EXE; being 989,601 bytes in size.
3. DISCLAIM.TXT; being 486 bytes in size.

- To install the text, copy the three files on this disk to a directory on your hard drive and type install.bat. The result will be 4 files totalling 6,326,371 bytes; these files contain the text for NRBS Project Report No's 138, 121 and 111. To use these files requires Word Perfect 5.1 for DOS.

Disk No. 2 contains three files, using 1,209,794 bytes.

1. INSTALL.BAT; being 80 bytes in size.
2. PR121APP.EXE; being 1,209,228 bytes in size.
3. DISCLAIM.TXT; being 486 bytes in size.

- To install the text, copy the three files on this disk to a directory on your hard drive and type install.bat. The result will be 5 files totalling 5,770,174 bytes; this file contains Appendices 1 through 6 from NRBS Project Report No. 121. To use this file requires Word Perfect 5.1 for DOS.

Disk No. 3 contains Appendices 4 through 11 from NRBS Project Report No. 111 (Appendices 1 through 3 are not available in electronic form). To use these files requires Hewlett Packard Chem Station Software (HPG1034C MS Chem Station). The files in directory "REVIEWLB" are from the 1989 to 1994 review and the files in directory "ANAL1994" are from the analysis of 1994 samples.

There is no warranty expressed or implied for the use of this database; the Northern River Basins Study does not guarantee the accuracy of the data. The NRBS does not assume any liability for actions or consequences resulting from the use of the data; individuals using this data do so entirely at their own risk. The NRBS will not update the data except as deemed necessary for its own purpose.