U.S. Fish & Wildlife Service

Ecological Services
Anchorage Field Office

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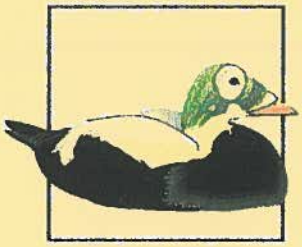
Technical Report WAES-TR-99-03

Habitat Conservation

Urban Contaminants Project: Fish and Hood Creeks, Anchorage, Alaska



Endangered Species

By:
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Environmental Contaminants

April 1999

URBAN CONTAMINANTS PROJECT

FISH AND HOOD CREEKS

ANCHORAGE, ALASKA

by

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and

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U.S. Fish and Wildlife Service
Anchorage Field Office

April, 1999

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INTRODUCTION

Urbanization has decreased water quality and adversely impacted biological communities in the lakes and streams of Anchorage, Alaska (Hock, 1981; Brabets, 1987; Milner and Oswood, 1989, 1990; Gabrielson and Milner, 1992). The loss of local wetlands by filling and paving to accommodate the expansion of Anchorage and the culverting of streams has altered hydrological cycles and decreased habitat diversity (Tande, 1988). Pollution from "point" and "non-point" sources have contaminated streams with fecal coliform bacteria, heavy metals, and petroleum products (Hock, 1981; Brabets, 1987), potentially producing adverse effects on fish and wildlife.

The Urban Contaminants Project

In 1991, the Environmental Contaminants staff, Anchorage Field Office, U.S. Fish and Wildlife Service, as part of the annual Contaminants Investigation proposal process, drafted a plan to implement a baseline monitoring study, called the Urban Contaminants Project, which would survey Ship, Chester, Campbell, Fish and Rabbit Creeks in the Anchorage urban area for wildlife use, biotic tissue contaminant levels, and sediment contamination on a five-year cycle. Each year a different stream would be monitored and every five years it would be re-examined and the results compared to earlier ones for the same stream. The intent was to gather information that could eventually provide linkage between contaminant levels and adverse effects to Service trust resources (i.e. migratory birds and anadromous fish). This information would be made available to the Anchorage community to assist with decisions regarding the need for remediation of local streams, ponds, and lakes.

Surveys would identify feeding and breeding areas for wildlife. Sediments in those areas would be sampled for chemical analyses and for bioassay testing. The sediment chemistry and the bioassay results would be compared to see if the bioassays which identified sample locations which resulted in high mortality to the test organisms also had chemical results which would

normally be identified as potentially having adverse effects on biota. If the chemical and bioassay results correlated well, the bioassays would be used as the first screen in future testing of stream sediment.

Chester Creek was selected for the first survey because of known pollution concerns and because some limnological and biological information already existed,. Results for this survey are reported in Gabrielson and Milner (1992) and USFWS (1994).

Fish Creek and Hood Creek were selected for the second survey because they, like Chester Creek, were heavily urbanized yet still supported wildlife. The watersheds were surveyed together because the watershed boundaries cannot be distinguished and because both receive flow from Lake Hood/Lake Spenard.

This report includes the results of chemical analyses for metals, petroleum hydrocarbons, and organochlorines in the sediment and from Microtox and *Chironomus tentans* bioassays conducted on sediment gathered separately from the same sample sites. No tissue samples were collected.

STUDY AREA

Fish Creek has been heavily impacted by Anchorage development. The total length flows through an urbanized and industrialized landscape which has obliterated the source of the creek. A 1979 USGS quadrangle map [Anchorage (A-8) NW, Alaska] shows Fish Creek originating in wetlands south of Chugach Way just off Spenard Road; however, an Anchorage Municipal storm-drain map (undated) shows it originating west of Old Seward Highway, across from the University Shopping Center. From this now undefined source Fish Creek flows westward to a storm-drain settling pond at Northwood Park, then northward until, near the junction of Spenard Road and Turnagain Street, it is augmented by the outflow from Lake Spenard and Lake Hood which is connected to Fish Creek via an overflow conduit. The combined flow continues northward until it empties into Knik Arm.

Hood Creek, which originates in Lake Hood, flows northward to Jones Lake and thence to Knik Arm.

The Fish Creek / Hood Creek drainages have been channelized and directed through culverts at many points. Numerous storm-drains empty into it. Oil sheens were frequently observed in the creeks during the study.

Although the Fish Creek / Hood Creek drainage no longer supports historical anadromous fish populations, it does provide habitat for numerous waterfowl. A comparison of Service waterfowl surveys at Lake Spenard - Lake Hood in 1971, 1983 and 1985 (unpublished data) showed increases in Canada geese (*Branta canadensis*), mallards (*Anas platyrhynchos)*, American wigeons (*Anas americana)*, greater scaup (*Aythya marila)*, and common goldeneye (*Bucephala clangula)*. This was attributed to habitat modifications that had, 1) created more shoreline, including a man-made island, 2) lowered the density of terrestrial predators, and 3) supported the proliferation of waterbird species that are habituated to human disturbance. Horned grebes (*Podiceps auritus)*and green-winged teal (*Anas crecca)* exhibited a marked reduction in population size, presumably because they are sensitive to human disturbance (Barnes and Trapp, 1985).

Waterfowl were observed at other lakes and ponds throughout the drainage during this survey. Canada geese, mallards, American wigeon and greater scaup were frequently seen at Northwood Park. A number of broods of mallards and American wigeons were raised there. Broods of mallards, American wigeons, Canada geese, and red-necked grebes (*Podiceps grisegena)* were also observed at Jones Lake along with Arctic loons (*Gavia arctica)*, northern pintails (*Anas acuta)*, northern shovelers (*Anas clypeata)*, and red-necked grebes. At the mouths of Fish and Hood Creeks on Knik Arm a large number and variety of waterfowl were frequently observed including: Canada geese, mallards, American wigeons, greater scaup, northern pintails, northern shovelers, green-winged teal, and common goldeneyes.

METHODS AND MATERIALS

Sediment samples for chemical analyses were collected from six sites (Site 5 not yet established) in September 1992 and once a month from May through August 1993 at seven sites

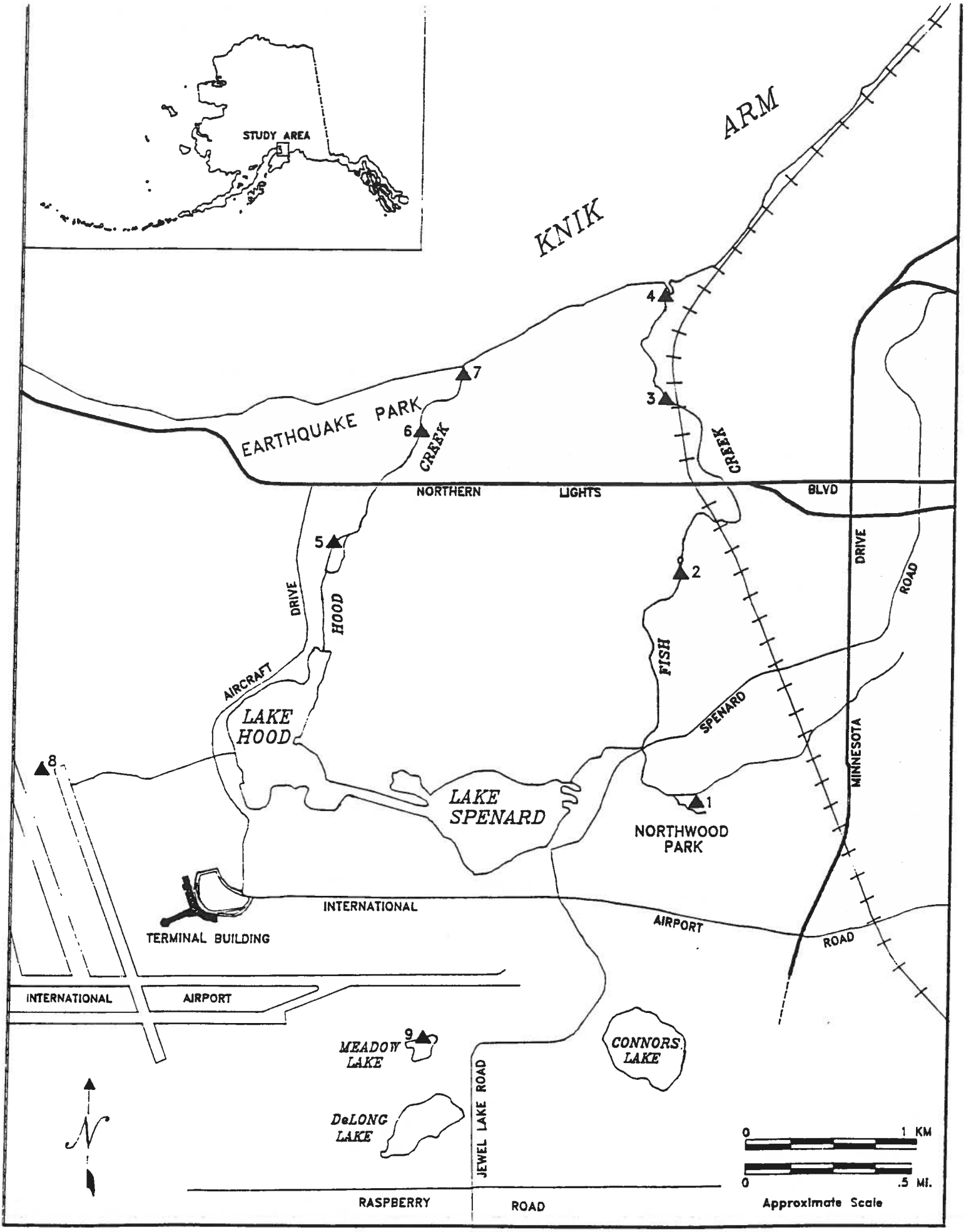
(Map 1) along Fish and Hood Creeks and at two pond sites removed from the creeks but within the drainage areas. The control site was located on the North Fork of Campbell Creek (Map 2), a stream which is relatively undeveloped compared to Fish/Hood Creeks. Sediment samples were also collected from August through October 1992 from the same sites for bioassay testing. No bioassay testing was performed on the 1993 samples.

Sampling sites

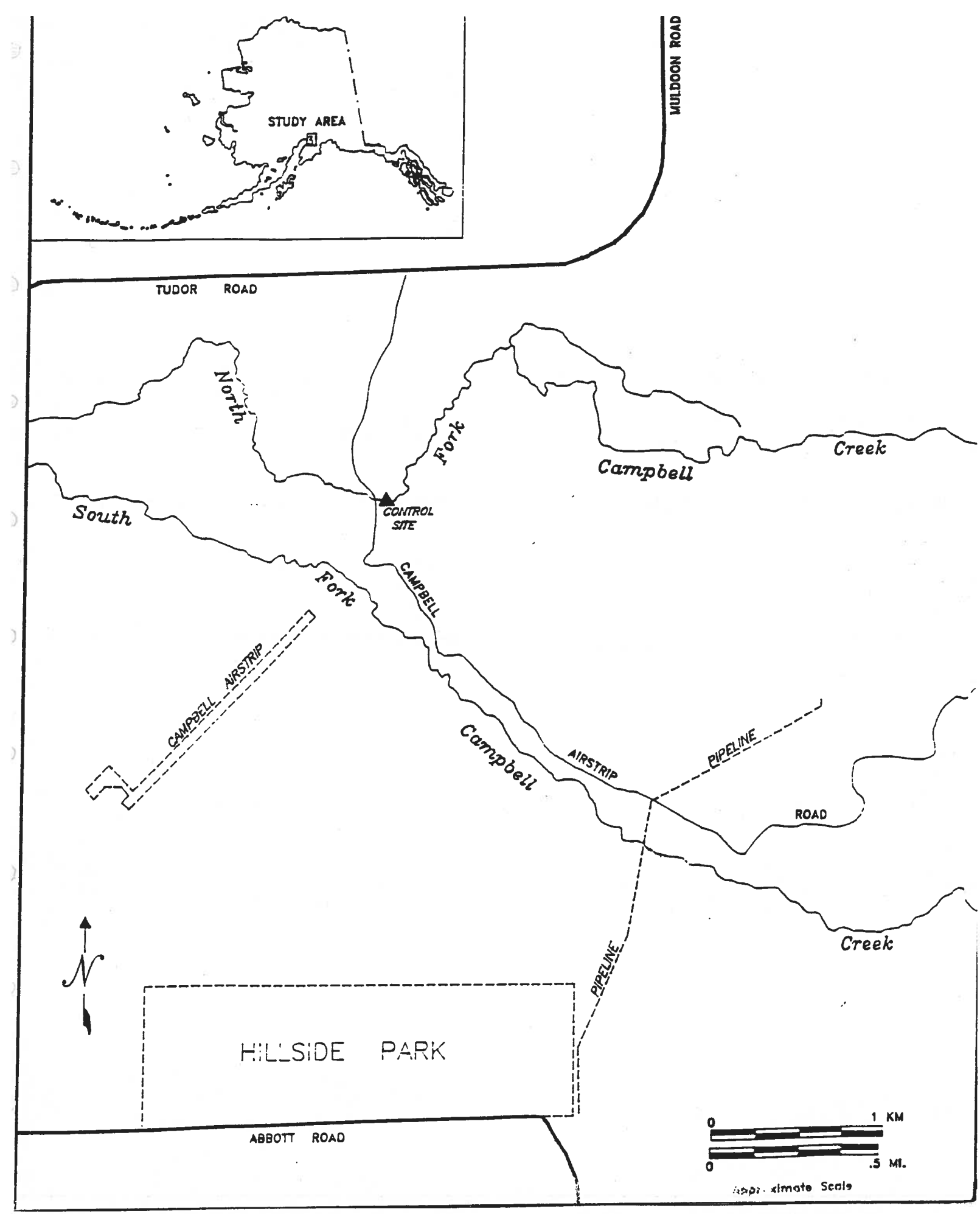
Sites 1 through 4 were located on Fish Creek. Site 1 was at the north end of the retention basin at Northwood Park. It is a popular recreational area for the neighborhood and the pond supports numerous waterfowl. Sediment samples for bioassay were collected in September and October 1992 using a clean sample jar as a scoop ("jar grab") to collect sediment from one pond bank location. Sediment samples for chemical analysis were collected from four sites around the retention basin in September, 1992 using either a clean stainless steel spoon to fill a clean sample jar or by using a clean jar to scoop a sample. In 1993, one jar grab sample was taken each month from May through August for chemical analysis from the northeast end of the settling basin, which was visually judged to be the most contaminated area of the site based on hydrocarbon sheening.

Site 2, the inlet of the small pond at Barbara Street Park, was sampled for sediment bioassays in August and September, 1992. It also is a well-frequented neighborhood recreation area and supports a breeding population of watefowl. Cores were composited from three separate locations close to each other on the bank, mixed and subsampled. A composite was required because the sediment was underlain by a thick peat mat at about six inches. Two replicate samples composed of two composited cores each, mixed and subsampled, were collected in September for chemical analysis. Two replicated samples, comprised of subsampled composited cores, were taken for chemical analysis in May and June, 1993. In July and August, 1993, a single jar grab sample was taken each month.

Site 3, downstream from the railroad tracks and just above tidal influence from Knik Arm at the south end of the saltmarsh, was selected to compare possible differences between



MAP 1. LOCATION OF SAMPLING SITES ALONG FISH/HOOD CREEK DRAINAGES, ANCHORAGE, ALASKA



MAP 2. LOCATION OF CONTROL SITE ALONG NORTH FORK OF CAMPBELL CREEK, ANCHORAGE, ALASKA

freshwater and marine-influenced sediment contaminant loads. It was sampled in September and October, 1992 for sediment bioassays. Both samples were collected using a clean spoon to fill a sample jar. Sediment for chemical analysis was sampled earlier in September, 1992 with two separate jar grab samples. In 1993, a single jar grab sample was taken May through August for chemical analysis.

Site 4, below the Coastal Trail bridge crossing and just above the mouth of Fish Creek, was sampled for sediment bioassay in September, 1992 using a jar grab. This site is inundated daily by Knik Inlet tides and is a regular feeding area for waterfowl. Two separate jar grab samples of sediment for chemical analysis were collected that month on a different day. In 1993, a single jar grab sample was taken each month May through August for chemical analysis.

Sites 5, 6, and 7 were located on Hood Creek. Site 5 was located at the south end of Jones Lake approximately 50 feet from shore. It was not sampled for bioassay in 1992 because there was essentially no bank to sample and we lacked a means to reach out into the lake. A canoe was procured in 1993 and used to collect sediment samples for chemical analysis from May through August A single core was taken each month and subsampled for chemical analysis.

Site 6, located at the small pond at 3340 Clay Products Drive, was sampled in September 1992 for sediment bioassay using a jar grab. This is a residential pond with no public access which supports a few nesting waterfowl. On a separate day in September two separate jar grab samples were taken for chemical analysis. Single jar grab samples were collected May through August 1993 for chemical analysis.

Site 7, located near the mouth of the creek on Knik Arm, was sampled for sediment bioassay in September 1992 using a jar grab. This site is also inundated daily by the tides and is a feeding area for waterfowl. Sediment for chemical analysis was collected separately using a jar grab in September 1992 and May through August 1993.

Sites 8 and 9 were located at ponds near the Anchorage International Airport. Both are restricted from public access and both support small populations of waterfowl. Site 8, located at a small pond at the north end of the taxiway just south of the airport security building, was sampled for sediment bioassay in September 1992 using a jar grab. Sediment for chemical analysis was collected separately in September 1992 with two separate jar grab samples. One jar grab sample

for chemical analysis was collected each month May through August 1993.

Site 9, located at the northeast end of Meadow Lake, was sampled for sediment bioassay in September 1992 from a subsampled core composite. One subsampled composite sediment sample was collected for chemical analysis earlier in September 1992. Subsampled core composites for chemical analysis were taken May through August 1993. Replicate samples (samples taken close to each other but not from the same hole) were taken in July and August 1993.

The control site was located on Campbell Creek, approximately 100 meters upstream from where Campbell Airstrip Road crosses the creek. Sediment for bioassay was collected in August, September, and October 1992. Sediment was difficult to find so the sample was collected from three or four different locations within a 100 foot stream stretch using a clean spoon to fill a sample jar Two additional separate sediment samples for chemical analysis were collected at the same time. Samples for chemical analysis were collected using the same technique May through August 1993.

Collection Procedures

Grab samples were collected either using a clean spoon to fill sample jars or by scooping sediment directly with an I-Chem Series 300 pre-cleaned glass jar. At sites 2, 5, and 9 a Wildco model 2420-G55 hand corer was used as the collection device. Core samples were thoroughly mixed with a clean stainless steel spoon in a clean stainless steel mixing bowl and large chunks of organic matter removed with a clean gloved hand before a subsample was taken.

The corer and stainless steel mixing bowl were cleaned in the field between samples by scrubbing with a brush and rinsing in tap water followed by acetone. They were cleaned at the end of each field sampling by thorough scrubbing with Alconox and water, then rinsing with tap and deionized water and acetone. Stainless steel mixing spoons were washed, rinsed in tap and deionized water, acetone rinsed, and wrapped in acetone-rinsed foil in the lab. A clean spoon was used to mix each sample.

Sediment samples for chemical analysis were stored and shipped frozen to the analytical

laboratory. All sediment samples used for bioassays were held at approximately four degrees C until they were analyzed.

Analytical Procedures

Metal analyses of sediment samples collected in September 1992 and May 1993 were performed by Research Triangle Institute, Research Triangle Park, North Carolina. Mississippi State Chemical Laboratory at Mississippi State University analyzed samples for aliphatic hydrocarbons (AH), polycyclic aromatic hydrocarbons (PAH), and organochlorines (OC).

Metal, AH, PAH, OC, and polychlorinated biphenyl (PCB) analyses for sediment samples collected June, July, and August 1993 were performed by the Geochemical & Environmental Research Group, Texas A&M.

AH, PAH, OC, and PCB fractions were isolated by means of column chromatography, and analyzed by gas chromatography.

Concentrations of arsenic, cadmium, lead, and selenium were measured by Graphite Furnace Atomic Absorption following nitric acid digestion. Concentrations of mercury were measured by Cold Vapor Atomic Absorption following nitric acid digestion. Aluminum, boron, barium, beryllium, chromium, copper, iron, magnesium, manganese, molybdenum, nickel, strontium, vanadium, and zinc were measured by Inductively Coupled Plasma Emission following nitric acid digestion.

Quality Assurance / Quality Control (QA/QC) Screening

Analytical data was screened based upon QA/QC criteria selected by the Environmental Contaminants Group of the Service's Anchorage Field Office. These criteria are used to standardize the quality of data presented in contaminant survey reports. If any one of the following criteria were not met, the data were not considered further.

1. All data discussed in this report must be >2x the detection limit. Normally, data would be further qualified by distinguishing between data which were greater than 2x but less than 10x

the detection limit by designating this data set as qualitative only. Concentrations greater than 10x the detection limit are considered quantitative.

This study was intended as an experiment and a screening exercise and the data collection was limited. In order to present as much of the data as possible, the decision was made to discuss all data which were greater than 2x the detection limit.

2. Precision was quantified by determining a relative percent difference (RPD) based on a comparison of duplicates: $RPD = ([D_1 - D_2]/(D_1 + D_2)/2]) \times 100$ where D_1 = concentration measured in the first analysis and D_2 = concentration measured in the second analysis. For samples with both duplicates above the limit of detection, the average RPD had to be less than or equal to20%.

3. Procedural blanks must be below the detection limit.

Spike results were available but not used in screening the data since sediments are extremely difficult to spike in a reproducible manner.

Data passing the above QA/QC screen are presented in Appendices A1 (September 1992), B1 (May 1993) , C1 (June 1993) , D1 (July 1993) , and E1 (August 1993) .

Bioassay Procedures

The first study performed under the Urban Contaminants Project was an investigation of Chester Creek (Gabrielson and Milner, 1992; USFWS, 1994). Service biologists performed the wildlife surveys and then collected tissue and sediment samples for chemical analyses and bioassays. Due to a lack of suitable laboratory space, the first bioassay study was contracted to the University of Alaska Anchorage, Environment and Natural Resources Institute (ENRI). Shortly after the completion of the Chester Creek study, the Service Field Office acquired laboratory space and equipped it for performing bioassays.

As reported by ENRI (Gabrielson and Milner, 1992), the decision was made to use several bioassay methods to test sediment samples. The Service laboratory in Minneapolis, Minnesota recommended using a variety of techniques including the Microtox bacterial bioassay and tests using *Chironomus tentans* larvae and *Daphnia magna* neonates. A battery of tests is the

recommended method for developing a weight-of-evidence approach for determining sediment quality (Rand, 1995).

Microtox Bioassays

Sediment samples were analyzed using the Microtox Solid-Phase Test bioassay procedure (Microbics Corporation, 1992), which involves exposing photoluminescent bacteria (*Photobacterium phosphoreum*) to a serial dilution of suspended sediment for a standard time at a standard temperature. The EC50 measurement produced indicates the effective sample concentration at which the luminescence of the bacteria is reduced by 50%. The luminescence of the bacteria is measured using a modified photometer and the toxicity measurement is calculated based on a dose-response (i.e. concentration-change in luminescence) curve. Interference to the light measurement caused by color or turbidity in the samples was corrected for using the Color Correction protocol (Microbics Corporation, 1992).

Sediment samples were tested using the Microtox procedure within one week from the time of collection as recommended in ASTM E 1383-90, Standard Guide for Conducting Sediment Toxicity Tests with Freshwater Invertebrates (ASTM,1991). Some of the sediment samples were sieved through a stainless steel screen to remove organic debris, obtain more uniform soil particle sizes and improve replicability. The practice was later discontinued because of the time required for extra handling and the potential for contamination.

Precision in pipetting serial dilutions of suspended sediment is critical for reliable Microtox bioassay results. Many of the problems related to this procedure occur because of pipetting error (Mueller, 1992). To develop pipetting skills, twenty-eight trial bioassays on both sediment and pore water were run in June and July 1992 according to the various Microtox protocols (Microbics Corporation, 1992) prior to running actual tests in August, September, and October 1992.

Chironomus Bioassays

C. tentans larvae for use in bioassays were ordered from a commercial supplier and cultured at the Service Fisheries Laboratory in Anchorage, AK according to the procedures of

Denny et. al. (1992). Six 10-gallon aquariums containing an artificial paper towel substrate were used to house hatched larvae. The aquariums were filled 10 cm deep with non-chlorinated well water which was kept at a temperature of ~23 degrees C using submersible 25 watt heaters. The larvae were fed 5 mls per day of a 10% Tetra Fin Flake Food solution (i.e. 10 grams of Tetra Fin Flake Food blended in 100 ml of deionized water).

Sediment samples were tested with the *C. tentans* bioassay within two days after collection using the 48-Hour Acute Toxicity Tests as described by Henry and Hickey (1991). The procedure requires four 250 ml beakers set up in duplicate. Each set of two beakers received twenty grams of sediment in the following combinations:

1. 100% test sediment (i.e. 20 grams of test sediment)
2. 50% test sediment (i.e. 10 grams of test sediment and 10 grams of sediment from the control site)
3. 100% control sediment (i.e. 20 grams of sediment from the control site)
4. 100% culture medium (i.e. 20 grams of paper towel substrate with added food and aerated overnight to simulate conditions in the aquaria)

After adding the sediment, 150 ml of well water was added to each beaker and the temperature, pH, dissolved oxygen, conductivity and water hardness were measured. Temperature was measured using a standard laboratory Centigrade thermometer. The pH was measured with an Orion SA 250 pH Meter. Dissolved oxygen was measured with a Hach Portable Dissolved Oxygen Meter (Hach, 1989). Conductivity was measured with a Hach Model 44600 Portable Conductivity/TDS Meter (Hach, 1989). Hardness was measured using Hach Buret Titration Methods (Hach, 1989)

Ten *C. tentans* larvae at the second instar stage of development (approximately twenty-four days after egg laying) were then added to each beaker. To confirm instar age, the head capsule widths of several larvae were measured using an ocular micrometer set on a dissecting scope. At the second instar stage they measure approximately 0.20 - 0.22 mm wide (Denny, et al. 1992).

After forty-eight hours the sediment was inspected for larvae. Numbers for alive, dead, and "not found" were recorded.

Daphnia Bioassays

Daphnia magna were ordered from a commercial supplier and cultured in the laboratory for use in bioassays of sediment pore water. Pore water best represents the concentrations of water-soluble contaminants that a burrowing, aquatic organism would contact in undisturbed sediment under *in situ* conditions (Bennett and Cubbage, 1992). No bioassays were conducted, however, for two reasons: 1) the difficulty in producing enough neonates, and 2) the lack of a method for efficiently extracting sufficient volumes of pore water for analysis.

The first problem was solved toward the end of the 1992 field season by supplementing the *Daphnia*'s food with the algal mixture that was growing in the *C. tentans* tanks. It is surmised that the adults had a deficiency of some nutrient which was provide by the algae. In any case, the population grew vigorously after the addition of the algae.

The second problem could not be solved during the project. The only available method for removing pore water from sediment samples was by centrifuging. This only produced 5-10 milliliters of pore water per centrifuging and was very time consuming. More efficient pore water extraction methods have since been developed (Winger and Lasier, 1991).

RESULTS

Chemical Analyses

Tables 1 and 2 present the concentrations (median values, ppm dry wt.) for metals, total AHs, and total PAHs in the September 25, 1992 sediment samples.

Tables 3 and 4 present the concentrations (median values, ppm dry wt.) for metals, total AHs, and total PAHs in sediment samples collected from May through August 1993.

Appendices A through E present the complete QA/QC screened data for September 1992 and May through August 1993.

Table 1. Metals Concentrations (median values, ppm dry wt.) in Sediment Samples Collected September 25, 1992 from Fish, Hood and Campbell Creeks, Anchorage, Alaska.

	Site */ Sample Size								
Analyte	1 (n=4)	2 (n=2)	3 (n=2)	4 (n=2)	6 (n=2)	7 (n=1)	8 (n=2)	9 (n=1)	Control (n=2)
As	16.1	16.8	13.9	27.6	19.6	18.6	5.8	5.7	8.5
Cd	0.5	0.7	0.8	1.2	1.1	0.0	0.0	0.0	0.0
Cr	71.1	53.8	58.3	54.6	51.1	89.6	35.8	31.0	60.5
Cu	39.1	29.6	49.7	62.7	55.4	49.0	50.3	33.0	26.7
Hg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ni	37.3	31.6	50.0	47.9	45.8	44.3	31.5	23.8	24.3
Pb	46.6	30.2	28.5	37.4	86.0	15.7	24.5	19.0	26.2
Se	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Sr	66.1	39.6	57.5	65.7	44.0	45.7	38.8	22.0	105.0
V	57.2	68.8	72.1	78.9	67.3	65.7	48.8	44.8	53.5
Zn	324.3	138.9	100.3	193.5	1603.2	105.4	96.5	58.1	59.0

*Site 5 not collected until 1993

Table 2. Total Aliphatic Hydrocarbons (AH) and Polycyclic Aromatic Hydrocarbon (PAH) Concentrations (median values, ppm dry wt.) in Sediment Samples Collected September 25, 1992 from Fish, Hood and Campbell Creeks, Anchorage, Alaska.

	Site* / Sample Size								
Analyte	1 (n=4)	2 (n=2)	3 (n=2)	4 (n=2)	6 (n=2)	7 (n=1)	8 (n=2)	9 (n=1)	Control (n=2)
AH	9.42	11.02	4.45	4.12	26.61	0.76	30.42	21.01	10.84
PAH	0.93	0.30	0.41	0.08	2.82	0.11	0.25	0.14	0.16

*Site 5 not collected until 1993

Table 3. Metal Concentrations (median values, ppm dry wt) in Sediment Samples Collected May - August 1993 From Fish, Hood and Campbell Creeks, Anchorage, Alaska

[Concentrations shown indicate range (top) and median values (bottom)]

	Site / Sample Size									
Analyte	1 (n=4)	2 (n=6)	3 (n=4)	4 (n=4)	5 (n=4)	6 (n=4)	7 (n=4)	8 (n=4)	9 (n=6)	Control (n=4)
As	4.9-12.5	7.7-14.1	7.1-11.2	19.8-24.7	5.5-9.1	5.5-23.3	10.9-21.1	4.9-7.4	3.5-6.6	4.0-8.1
	7.7	12.9	10.2	21.1	6.4	5.6	16.4	5.5	4.5	5.9
Cd	0.0-0.3	0.0-0.4	0.0-0.3	0.0-0.6	0.0	0.0-1.5	0.0-0.4	0.0-0.8	0.0	0.0
	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0
Cr	23.7-104.1	24.9-91.6	24.2-57.4	43.8-52.8	11.3-17.2	25.0-46.3	46.7-57.5	22.9-64.8	22.4-49.0	26.0-77.9
	31.6	35.2	43.7	48.2	13.0	32.5	48.1	43.2	28.5	46.3
Cu	17.9-29.5	16.9-30.4	16.3-50.9	48.0-56.6	12.8-16.0	20.8-64.9	41.1-60.1	18.5-60.0	20.6-32.7	12.5-27.6
	23.5	21.9	36.5	50.0	15.3	22.3	50.8	21.0	25.8	18.5
Hg	0.0-0.1	0.0	0.0-0.1	0.0	0.0	0.0-0.2	0.0-0.1	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ni	30.4-37.7	29.9-38.3	28.8-57.9	44.4-50.7	14.1-17.3	31.5-48.2	47.1-60.2	25.9-43.5	20.6-29.8	23.6-36.0
	36.4	35.0	51.2	46.5	16.5	36.0	53.5	33.4	26.5	31.8
Pb	0.0-17.5	12.4-52.8	0.0-17.0	14.0-21.4	0.0	0.0-131.9	0.0-18.0	0.0-51.6	0.0-18.5	0.0-11.5
	5.9	25.0	8.0	15.3	0.0	11.3	13.3	7.2	11.0	0.0
Se	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sr	28.6-52.9	19.5-35.9	22.2-45.3	42.6-48.3	27.8-35.2	20.3-54.9	49.2-59.7	12.6-41.8	15.3-27.4	26.9-63.2
	36.5	27.1	37.7	47.1	31.8	25.3	52.9	20.7	23.0	33.3
V	38.8-71.6	45.4-60.6	39.8-68.0	63.7-71.1	26.8-34.2	36.6-73.9	66.8-78.5	39.2-67.7	37.1-56.8	31.0-63.2
	54.6	57.9	62.8	67.2	32.1	48.8	68.9	56.6	50.5	53.5
Zn	103.2-406.2	107.1-307.1	86.1-219.7	153.7-175.7	59.5-73.4	169.0-2015	90.9-158.4	39.5-214.9	41.8-83.9	44.1-66.8
	168.6	173.6	94.9	154.8	70.0	220.5	109.6	55.2	53.9	57.3

Table 4. Total Aliphatic (AH) and Polycyclic Aromatic Hydrocarbons (PAH) Concentrations (median values, ppm dry wt) in Sediment Samples Collected May - August 1993 from Fish, Hood, and Campbell Creeks, Anchorage, Alaska.

[Concentrations shown indicate range (top) and median values (bottom)]

	Site / Sample Size									
	1 (n=4)	2 (n=6)	3 (n=4)	4 (n=4)	5 (n=4)	6 (n=4)	7 (n=4)	8 (n=4)	9 (n=6)	Control (n=4)
AH	9.45-37.50 14.77	4.55-11.56 10.58	1.99-5.71 5.04	3.07-6.79 6.12	55.33-155.45 131.65	9.04-59.00 15.69	1.75-3.47 3.23	2.08-79.85 20.03	17.87-72.36 65.52	3.84-30.08 5.68
PAH	0.31-1.63 0.40	0.38-1.73 1.15	0.33-0.43 0.41	0.10-0.52 0.22	1.03-1.22 1.12	1.37-8.17 2.49	0.06-0.83 0.42	0.00-2.21 0.00	0.08-0.23 0.20	0.00-0.14 0.02

Microtox Bioassays

Table 5 presents the EC50 values from the Microtox Solid-Phase bioassays conducted on August 11, September 8, 14, and 29, and October 13, 1992. The serial dilution of test sediment for each sample ranged from 0.0024% to 9.8680%. The higher the EC50 value the lower the general toxicity. Each sample was tested twice using the duplicate Solid-Phase Test.

On August 11, September 8 and 14, and October 13, both Microtox and *C. tentans* bioassays were completed using subsets of the same sediment samples. On September 29 only the Microtox bioassay was completed on sediment samples taken that day to compare with the samples taken for chemical analysis on September 25.

Complete Microtox Data Reports on each sample are available at the Anchorage Field Office.

Chironomus Bioassays

Tables 6, 7, 8, and 9 present the results of the 48-hour *C. tentans* bioassays conducted on August 11, September 8 and 14, and October 13, 1992. Water quality data are included for each test. Figure 1 presents a bar graph of the combined results of the tests on September 8 and 14, 1992.

DISCUSSION

Chemical Analyses

Metals

The science of determining what constitutes "contaminated" freshwater sediment is still evolving. There are two major issues for metals. One is the question of what is a valid determination of the metal content of sediment. Chemical values for sediments are dependent on method of extraction, organic matter content, relative percentages of sand, silt and clay, and the

Table 5. EC50 Values (%) for Microtox Solid-Phase Tests.

Date	Site* 1	2	3	4	6	7	8	9	Control
Aug.11, 1992	Not sampled	0.327 0.411	-	-	-	-	-	-	>10.000
Sept. 8, 1992	-	0.239(s) 0.101(s)	-	-	-	-	-	-	1.294(s) 1.360(s)
Sept.14, 1992	-	0.150(s) 0.165(s)	-	-	-	-	-	-	1.563(s) 1.445(s)
Sept. 29, 1992	0.213(s) 0.183(s)	0.117 0.107	3.325© 0.619© 0.162(s) 0.645(s)	0.110©	0.526©	0.039©	9.095©	6.06©	10.694© 8.783©
Oct. 13,1992	0.290 0.206	-	0.111© 0.591©	-	-	-	-	-	2.960© 2.257©

* Site 5 not sampled
(s) sediment sieved through a screen
© Microtox color correction procedure conducted

Table 6.48-Hour *Chironomus* Bioassay Performed on August 11, 1992

	100% Site 2 Sediment	100% Site 2 Sediment	50% Site 2, 50% Control Sediment	50% Site 2, 50% Control Sediment	100% Control Sediment	100% Control Sediment	Culture Medium	Culture Medium
Alive	8	5	6	5	3	4	7	9
Dead	0	1	0	1	2	2	1	1
Not Found	2	4	4	4	5	4	2	-

Water Quality in Test Beakers

	Well Water Added to Beakers	100% Site 2 (before)	100% Site 2 (after)
Temperature	20C	20.1C	20.5C
DO	9.3 mg/l (a)	4.4 mg/l	5.1 mg/l
pH	8.2	7.3	7.7
Conductivity	-	-	-
Hardness	148 mg/l	130 mg/l	-

(a) Water was aerated overnight

Table 7. 48-Hour *Chironomus* Bioassay Performed September 8, 1992

	100% Site 2 Sediment	100% Site 2 Sediment	50% Site 2, 50% Control Sediment	50% Site 2, 50% Control Sediment	100% Control Sediment	100% Control Sediment	Culture Medium	Culture Medium
Alive	7	8	8	8	10	9	10	9
Dead	1	-	-	1	-	-	-	-
Not Found	2	2	2	1	-	1	-	1

Water Quality in Test Beakers

	Well Water Added to Beakers	100% Site 2 (before)	100% control (before)
Temperature	20C	20C	20.1C
DO	6.8 mg/l	2.8 mg/l	4.2 mg/l
pH	8.3	7.2	7.3
Conductivity	-	-	-
Hardness	68 mg/l	54 mg/l	58 mg/l

Note: Sediments for bioassay were sieved through a stainless steel screen

Table 8. 48-Hour *Chironomus* Bioassay Performed September 14,1992

	100% Site 2 Sediment	100% Site 2 Sediment	50% Site 2, 50% Control Sediment	50% Site 2, 50% Control Sediment	100% Control Sediment	100% Control Sediment
Alive	8	6	8	7	9	8
Dead	1	-	-	1	-	-
Not Found	1	4	2	2	1	2

Water Quality in Test Beakers

	Well Water Added to Beakers	100% Site 2 (before)	100% control (before)
Temperature	15C	17C	17C
DO	7.2 mg/l	4.8 mg/l	5.6 mg/l
pH	8.1	7.4	7.6
Conductivity	-	-	-
Hardness	63 mg/l	62 mg/l	61 mg/l

Note: Sediments for bioassay were sieved through a stainless steel screen

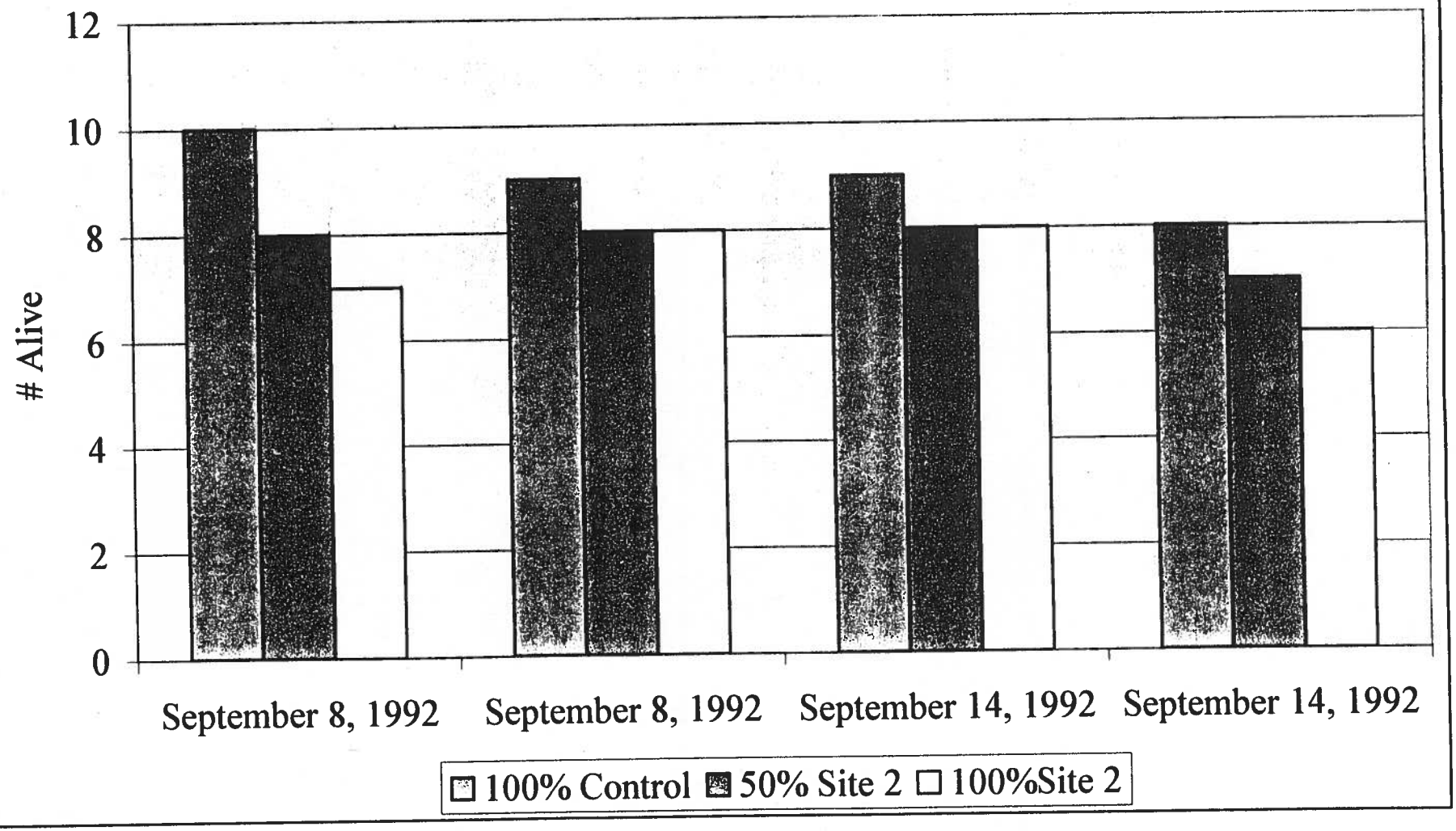
Table 9. 48-Hour *Chironomus* Bioassay Performed October 13, 1992

	100% Site 1 Sediment	100% Site 1 Sediment	50% Site 1, 50% Control Sediment	50% Site 1, 50% Control Sediment	100% Site 3 Sediment	100% Site 3 Sediment	50% Site 3, 50% Control Sediment	50% Site 3, 50% Control Sediment	100% Control Sediment	100% Control Sediment
Alive	8	7	9	9	9	10	8	8	10	6
Dead	-	-	-	-	-	-	-	-	-	1
Not Found	2	3	1	1	1	-	2	2	-	3

Water Quality in Test Beakers

	Well Water Added to Beakers	100% Site 1 (before)	100% Site 3 (before)	100% Control (before)
Temperature	18C	18C	18C	18C
DO	5.8 mg/l	2.8 mg/l	4.6 mg/l	4.9 mg/l
pH	8.1	7.2	7.7	7.4
Conductivity	155.3 us/cm	161.8 us/cm	174.7 us/cm	150.3 us/cm
Hardness	78 mg/l	80 mg/l	92 mg/l	72 mg/l

FIGURE 1. 48-HOUR *CHIRONOMUS* BIOASSAYS SURVIVAL RATE IN SITE 2 SEDIMENT



types of clays present. Above average amounts of organic matter content and the amount and type of clays will affect precision and accuracy. In addition, since the matrix is highly variable and difficult to analyze, acceptably representative sampling is difficult. Identifying the "true" value in sediments requires a greater sampling effort than that associated with water samples.

The second issue involves choosing the analytical technique to determine metal concentration. There is much controversy about whether the analytical results from different methods reflect true bioavailability. Metals may be extracted on a "total" or a "dissolved" basis. The usual assumption is that the dissolved fraction is more likely to be bioavailable. In addition, the presence of acid volatile sulfides may affect the bioavailability of metals and whether they are "toxic" or not.

A third issue, which applies to all types of contaminant assessments, is how to determine the risk from a particular chemical level to the organism. There are a number of assessment techniques available for estimating no-effect, chronic effect or acute (lethal) effect. The one which appears to have received the greatest use in the scientific community is that of Edward R. Long and Lee G. Morgan, National Oceanic and Atmospheric Administration (NOAA), who reviewed several different approaches to develop informal guidelines for evaluating NOAA coastal estuarine and marine sediment data. Their published guidelines (Long and Morgan, 1991) have received wide use in estimating risk on a site-specific basis and were chosen to apply to this site. However, these values were developed for marine or brackish sites and should be used with caution when determining toxicity in freshwater environments.

All samples were analyzed for aluminum (Al), arsenic (As), barium (B), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn), nickel (Ni), lead (Pb), selenium (Se), strontium (Sr), vanadium (V), and zinc (Zn).

Values for 1992 (September) and 1993 (May through August) were collated separately (Tables 1 and 3) to see if a seasonal difference could be detected between them. Based on a purely visual inspection of the data, it appears that metal concentrations in September, including the control values, were generally higher than concentrations for May through August. The small sample size precludes any conclusions of cause. Speculation is that the September values reflect the accumulation of metals associated with high runoff during the usual rainy season from late August through the middle of September. Runoff in the spring from snowmelt may flush these concentrations downstream, reducing the metal load until the following fall.

Arsenic

Arsenic is carcinogenic and teratogenic in humans and animals. Acute toxicity, as well as sublethal effects, have been observed in fish and invertebrates. Acute toxicity can be very different among species, including those that are taxonomically related, and can be highly influenced by temperature, pH, speciation, and many other factors. Inorganic arsenicals are generally more toxic than organic forms (Eisler, 1988). Long and Morgan (1991) estimate with a moderate degree of confidence that the Effects Range-Low (which represents the lower 10th percentile value for all data) for arsenic equals 33.0 ppm dry weight. This value exceeds all the concentrations found in this study. However, the values presented in this study were not adjusted for grain size or total organic carbon, which affects the bioavailability of the metal.

Arsenic values for Fish Creek in September 1992 ranged from 13.9 ppm at Site 3 to a high of 27.6 ppm at the outlet to Knik Arm compared to 8.5 ppm at the control site on the North Fork of Campbell Creek. Hood Creek concentrations at Sites 6 and 7 were almost identical (Site 5 not established yet) at 18.6 to 19.6 ppm. Values at the airport sites were low (5.7 and 5.8 ppm).

Arsenic values for Fish Creek in 1993 ranged from a low of 7.7 ppm at Northwood Park (Site 1), comparable to the control median value of 5.9 ppm, to a high of 21.1 ppm associated with the outlet of the creek on Knik Arm. Hood Creek exhibits a similar pattern, ranging from 5.6 ppm at Jones Lake (Site 5) to 16.4 ppm at the outlet on Knik Arm. Values for the airport (5.5 and 4.5 ppm) are almost identical to that for the control.

Understanding that values for sediment and groundwater are not necessarily comparable but lacking other sediment chemical data for Anchorage, these values appear to be of the same magnitude found for Anchorage ground water values presented by Donaldson et. al. (1973), who found concentrations of arsenic ranging from 0 - 22 ppm.

Cadmium

Cadmium is a known teratogen and carcinogen, a probable mutagen, and has been implicated as the cause of severe deleterious effects on fish and wildlife. Resistance to effects is also higher among marine species than freshwater species (Eisler, 1985). Long and Morgan (1991) suggest with a high degree of confidence an ER-L of 5 ppm dry weight, which far exceeds any concentration found during this study.

Cadmium concentrations for 1992 increased from 0.5 ppm in the upstream sites to 1.2 ppm downstream as Fish Creek flowed toward Knik Arm. Concentrations in Hood Creek and the airport sites were below the detection limit, as was the control.

Cadmium concentrations in 1993 exhibited the same pattern as that seen for arsenic. The

values for Fish Creek doubled from 0.3 to 0.6 ppm from Northwood Park to the outlet. Hood Creek concentrations also rose from below the detection limit to 0.4 ppm. A moderately high value (0.8ppm) was found at the end of the runway at the airport (Site 8). Site 9, Meadow Lake had no values above the detection limit.

Chromium

Chromium at high levels is a mutagen, teratogen, and carcinogen but an essential trace element for humans and some animals. The data base is incomplete for other groups of organisms. Chromium levels are elevated in soil, air, water, and biota in urban and industrial areas. Chromium chemistry is very poorly understood and existing analytical methodologies are inadequate for the quantification of the species and ionic states. No biomagnification of Cr has been observed in food chains, toxic and sublethal effects of Cr are modified by a variety of biological and abiotic factors, and sensitivity varies even among closely related species (Eisler, 1986). Long and Morgan (1991) suggest an ER-L of about 80 ppm dry weight in sediment. Some values in this study approach this concentration and a few exceed it, specifically at Sites 1, 2, and 7. None approach the ER-M evaluation of about 145 ppm which represents the 50 percentile value of the Long and Morgan data. The degree of confidence in this data is considered moderate by Long and Morgan.

Chromium concentrations in Fish Creek in 1992 showed no particular pattern, ranging from 53.8 to 71.1 ppm. Concentrations in Hood Creek increased from 51.1 to 89.6 ppm at the outlet. The airport sites were much lower, averaging 33.5 ppm. The control was higher than all but two of the sites at 60.5 ppm.

Chromium values in 1993 repeated the pattern for arsenic but the values did not increase to the same extent and the values generally did not exceed the control value to 46.3 ppm. Values for Fish Creek ranged from 31.6 ppm at Northwood Park to a high of 48.2 ppm at the Knik Arm outlet. Hood Creek concentrations ranged from 13.0 ppm at Jones Lake to 48.1 ppm at Knik Arm. Site 8 at the end of the airport runway was 43.2 ppm and Site 9 at Meadow Lake was intermediate between the high and low overall values at 28.5 ppm.

Copper

Copper is considered to be an essential element for living organisms but may, as with all inorganics, accumulate to levels at which organisms may be adversely affected. Long and Morgan (1991) proposes with a high degreee of confidence a concentration of 70 ppm dry weight as the ER-L. Concentrations found in this study approached that value but did not exceed it.

Copper values on Fish Creek in 1992 indicated increasing values (39.1 to 62.7 ppm) from Northwood Park to the outlet. Concentrations on Hood Creek ranged from 49.0 to 55.4 ppm but showed no increase downstream. The value at site 8 at the end of the airport runway was intermediate at 50.3 ppm and site 9 at Meadow Lake was low at 33.0 ppm. The control was lowest at 26.7 ppm.

Copper values on Fish and Hood Creeks in 1993 were almost all higher than the concentration of 18.5 ppm at the Campbell Creek control site. Fish Creek concentrations ranged from 23.5 ppm at Northwoods Park to 50.0 ppm at the outlet. Hood Creek concentrations ranged from 15.3 to 50.0 ppm from Jones Lake to the outlet. The airport showed intermediate values of 21.0 and 25.8 ppm. Copper concentrations reported by Donaldson et. al. (1973) in Anchorage groundwater ranged from 0 - 40 ppm, similar to these sediment values.

Nickel

The role of nickel is poorly understood in biota. It does not seem to be an essential element and is poorly absorbed by mammals. It may play a role in the production of specific metalloenzymes or in the intestinal absorption of ferric iron (Nielson, 1987). Invertebrates such as shellfish and crustacea generally contain higher levels than fish (Sunderman and Oskarsson, 1991). Long and Morgan (1991) propose an ER-L of about 30 ppm dry weight with moderate confidence. That value was exceeded at every site excepting Site 5. The ER-M of 50 ppm was exceeded at Sites 3, 4, and 7.

Nickel concentrations on Fish Creek in 1992 showed no particular pattern, with a low of 31.6 ppm at Site 2 and a high of 50.0 ppm at Site 3. Hood Creek concentrations were almost identical at 44.3 and 45.8 ppm. Site 9 at Meadow Lake was lower (23.8 ppm) than the control at 24.3 ppm. Site 8 at the end of the runway was 31.5 ppm.

Nickel concentrations in 1993 were all at the same order of magnitude as the control value of 31.8 ppm, ranging from 36.4 to 46.5 ppm for Fish Creek and from a low of 16.5 ppm at Jones Lake on Hood Creek to 53.5 ppm at the outlet. Airport values were 33.4 ppm at the end of the runway and 26.5 ppm at Meadow Lake.

Lead

Along with other adverse effects, lead can modify the function and structure of kidney, bone, the central nervous system, and the hepatopoietic system (Eisler, 1988). Adverse effects upon daphnid reproduction have been observed at concentrations in water as low as 1 ppm,

organolead compounds are generally more toxic than inorganic forms, adverse effects usually occur at concentrations ranging from 1.3 to 7.7 ppb in water ; and marine animals may be more resistant to effects of lead than freshwater species (Eisler, 1988). Long and Morgan (1991) propose a value of 35 ppm dry weight with moderate confidence for the ER-L. This was exceeded at all sites excepting Sites 5 and 9. The ER-M of 110 ppm, proposed with a high degree of confidence by Long and Morgan (1991) was exceeded at Site 6 in May 1993.

Lead concentrations in 1992 on Fish Creek showed no trend, ranging from a low of 28.5 ppm at Site 3 to a high of 46.6 ppm at Site 1. Hood Creek also showed no trend with the highest value overall (86.0 ppm) upstream at Site 6 and the lowest overall (15.7 ppm) at Site 7 on Knik Arm. The airport sites were low with 24.5 ppm at Site 8 and 19.0 ppm at Site 9. The control was higher than three sites at 26.2 ppm.

Lead concentrations in 1993 for all sites were variable, ranging from less than 5 ppm at Jones Lake to a high of 131.9 ppm at the pond at Clay Products Drive, which is just downstream from the Jones Lake site. Control values for four samples ranged from less than 5 ppm to 11.5 ppm.

Mercury

The literature is in agreement that mercury and its compounds have no known biological function and the presence of the metal in the cells of living organisms is undesirable and potentially hazardous. The forms of mercury with relatively low toxicity can be transformed into ones with very high toxicity, such as methyl mercury, through biological and other processes. Mercury can be bioconcentrated in organisms and biomagnified through food chains. It is known as a mutagen, teratogen, and carcinogen and causes embryocidal, cytochemical, and histopathological effects. Some species of fish and wildlife contain high concentrations of mercury which are not attributable to human activities but the anthropogenic use of mercury should be curtailed as the difference between tolerable natural background levels of mercury and harmful effects in the environment is exceptionally small (Eisler, 1987). He also states that lethal concentrations of total mercury to sensitive organisms varied from 0.1 to 2.0 ppb for aquatic fauna, that the toxicity is increased in the presence of zinc and lead, and that mercury is the most toxic trace metal to aquatic organisms.

Acute toxicity of mercury (II) to freshwater invertebrates ranges from 2.2 to 2,000 ppb and from 3.5 to 1678 ppb for marine organisms (EPA, 1986). Long and Morgan (1991) propose an ER-L of about 0.15 ppm (moderate confidence) and an ER-M of about 1.3 ppm (high confidence).

Mercury was below detection limits at all sites in September, 1992. In 1993, 0.1 ppm was found at Site 1, Site 3, and Site 7. A value of 0.2 ppm was found at Site 6.

Selenium

Selenium deficiency is not as well documented as selenium poisoning but may be equally significant. Selenium is released as a result of anthropogenic activities such as fossil fuel combustion and metal smelting and is naturally available from seleniferous areas. It poses a significant threat of poisoning to fish and wildlife resources. Selenium metabolism and degradation are both significantly modified by interaction with heavy metals, agricultural chemicals, microorganisms, and numerous physicochemical factors and until these interactions are resolved, it will be difficult to interpret selenium residues in tissues (Eisler, 1985).

Selenium was below detection limits at all sites for the duration of the study.

Strontium

Strontium data is available for human health but is currently unavailable for wildlife. However, the element is a common component of Alaskan geologic materials and it is assumed that Alaskan biota are exposed to it on a regular basis.

Strontium concentrations on Fish Creek in 1992 showed no pattern. Concentrations ranged from a low of 39.6 ppm at Site 2 to a high of 66.1 ppm at Site 1. Hood Creek concentrations were almost identical at 44.0 and 45.7 ppm. Site 8 at the end of the runway was low at 38.8 ppm and site 9 at Meadow Lake was lowest at 22.0 ppm. The control was highest of all sites at 105.0 ppm.

Strontium values in 1993 showed the same general pattern as that for most of the other metals. All values were within the same order of magnitude as the control (33.3 ppm) and ranged from 20.7 ppm at the end of the runway to a high of 52.9 ppm at the outlet of Hood Creek.

Vanadium

Literature survey reveals uncertainty as to whether vanadium is an essential trace element. However, there is evidence that it has pharmocologic, reproductive, and teratotgenic effects at high levels (Chang, 1996) but, at the levels normally found in human diet or drinking water, there would be no adverse effects on fertility or testicular function.. No literature was found discussing its possible role in freshwater sediments and Long and Morgan (1991) do not present vanadium data.

Vanadium is a common component of Alaskan geologic materials and of crude and refined

oils all over the world. It is assumed that the levels measured at these sites are at least partially natural but may also represent the input of refined petroleum to the streams either by runoff or from atmospheric deposition.

Vanadium concentrations showed a slightly increasing trend on Fish Creek from 57.2 ppm at Site 1 to 78.9 ppm at Site 4. Hood Creek concentrations were almost identical at 65.7 and 67.3 ppm. Site 8 at the end of the runway was lower than the creeks at 48.8 ppm and Site 9 at Meadow Lake was lowest at 44.8 ppm. The control was intermediate at 53.5 ppm.

Vanadium in 1993 demonstrated a similar pattern to that of lead with a low of 32.1 ppm at Jones Lake on Hood Creek and a high of 68.9 ppm at the next site downstream. Values ranged from 54.6 ppm at Northwood Park on Fish Creek to 67.2 ppm at the outlet.

Zinc

Zinc has its primary effect on zinc-dependent enzymes that regulate ribonucleic acid and deoxyribonucleic acid. The pancreas and bone are primary targets in birds and mammals; the gill epithelium is a primary target site in fish. Zinc is normally carcinogenic. However, growth of tumors is stimulated by zinc and retarded by zinc deficiency. The evidence for the mutagenic potential of inorganic zinc compounds is incomplete. Zinc deficiency can be very adverse to all stages of growth, development, reproduction, and survival for plants and animals (Eisler, 1993). Long and Morgan (1991) propose an ER-L of 120 ppm dry weight which is exceeded at least once at every site but Sites 5, 9, and the control. The suggested ER-M of 270 ppm was exceeded at Sites 1,2, and 6 at least once. The level of confidence in these values by Long and Morgan is relatively high.

Zinc concentrations on Fish Creek in 1992 were high compared to the control (59.0 ppm) but exhibited no particular pattern. Concentrations ranged from a high of 324.3 ppm at Site 1 to a low of 100.3 ppm at Site 3. The Hood Creek Site 6 concentration was extremely high at 1603.2 ppm but Site 7, downstream, was in line with Fish Creek values at 105.4 ppm. The airport sites were lowest with 96.5 ppm at the end of the runway and 58.1 ppm at Meadow Lake.

Zinc values on Fish Creek in 1993 showed no significant pattern, though all of the values were twice or more than the control of 57.3 ppm. Values on Hood Creek ranged from 70.0 to 220.5 ppm. The airport site values were 55.2 ppm at the end of the runway and 53.9 ppm at Meadow Lake. These values appear to be low to intermediate between groundwater concentrations found by Donaldson et. al. (1973) on Elmendorf Air Force Base as high as 450 ppm and those found in samples from Anchorage domestic wells ranging from 0 - 20 ppm.

Site Comparison

Comparison of all the values for metals across all the sites between September 1992 and May through August 1993 indicates the following:

Site 1 (Northwood Park on Fish Creek) metals, with the exception of nickel and vanadium, were all measured at significantly greater concentrations in September relative to May through August. Maximum mean concentrations in September range from approximately twice the maximum (As, Cr, Cu, Sr, and Zn) measured in May through August to five times (Cd) up to a maximum of seven times greater (Pb). It appears that the retention basin is performing its intended function through the summer and fall but spring runoff may be flushing the metal accumulations back into the system. Such a high concentration entering the stream in a short time may result in adverse effects downstream.

Site 2 (Barbara Park pond) metals concentrations, with the exception of Cd (seven times higher), were not significantly different from summer to fall. The slight elevation in spring, then trending lower through the summer of 1993, as compared to the previous September, may indicate the same flushing effect as was observed at Northwood Park.

Site 3 (site just above tidal influence on Fish Creek) shows the same pattern. All the metals show some elevation when May - August means are compared to September. Most elevations are slight but those for Sr and Pb range from 1.5 x to 3.6 x higher. Cadmium is at an extreme at 8x higher in September.

Site 4 (outlet of Fish Creek on Knik Arm) repeats the pattern except that Cd is 12x higher in September when compared to May - August concentrations.

Site 5 (Jones Lake) on Hood Creek was only collected in 1993. No comparisons can be made.

Site 6 (pond at Clay Products Drive) shows significant elevations from May - August 1993 when compared to September 1992. All the metals were elevated by at least a factor of 1.2x (Ni) with a midpoint of 3.3x (As) and a maximum of 10x for Cd. This pond is apparently receiving highly metalliferous runoff from the surrounding area.

Site 7 (outlet of Hood Creek to Knik Arm) mean metal values were approximately the same for all the months sampled with the exception of Cr (2x higher in September). It is interesting to note that all the metals except Cr showed maximum concentrations higher in the summer as compared to fall.

Site 8 (pond near end of airport runway) shows a mixed pattern. Maximum concentrations, with the exception of vanadium, were higher in the summer. When the values are averaged, Cu, Pb, Sr, and Zn are 2 to 3 times higher in the fall.

Site 9 (Meadow Lake at the airport) appears to be isolated from the general pattern observed on the creeks and at the runway pond. The values fluctuated very slightly or not at all for all the metals. The pond is also the only one not directly exposed to runoff from residential or urban areas. It does not appear to receiving detectable inputs via atmospheric deposition from the airport.

The control site (North Fork of Campbell Creek), when compared to the Fish/Hood Creek drainage does exhibit the same general type of pattern with maximum values measured in the fall (Pb is particularly high). However, maximum concentrations are again very similar between May - August and September, perhaps indicating a slow accumulation from spring to fall. The exceptions are Pb and Sr which are significantly higher in the fall.

Comparing sample averages for metal concentrations by site from September 1992 to August 1993, many sites have an indication of a bimodal effect with the high values associated with May and September. The high values in May may reveal the combination of snowmelt/runoff plus the effects of frequent heavy rains common to that month. The values in September may again be associated with the effects of runoff associated with the usual rainy season from mid August to mid September.

Aliphatic Hydrocarbons

Aliphatics are one of the major groups of organic compounds, characterized by straight- or branched-chains of the constituent carbon atoms. Aliphatic hydrocarbons are comprised of three subgroups: (1) paraffins (alkanes), all of which are saturated and comparatively unreactive, the branched chain types being much more suitable for gasoline than the straight-chain; (2) olefins (alkenes or alkadienes), which are unsaturated and quite reactive; and (3) acetylenes (alkynes), which contain a triple bond and are highly reactive. In complex structures, the chains may be branched or cross-linked (Lewis, 1997).

Alkanes have the general formula C_nH_{2n+2} and the simplest member of the series is methane. At room temperature and pressure all alkanes up to C4 are gaseous, liquid between C5 and C15, and solid above that. Crude oil contains approximately 15 to 20% of such compounds. Methane is the predominant component of natural gas and alkanes between pentane (C5) and pentadecane (C15) are the chief constituents of straight-run (uncracked) gasoline. Above C17, the alkanes are solid, waxlike substances and crude oil containing a high fraction of these compounds will be cloudy and have a high pour point (Kinghorn, 1983).

Natural gas consists mostly of methane (CH4) with smaller amounts of propane, ethane, and normal and isobutane. Many of the light hydrocarbons, including methane, ethylene, propylene, butylene, and benzene are feedstocks for the chemical industry, being used to make a wide variety of items such as synthetic fibers, plastics, soap, paint, cosmetics and agricultural chemicals. The normal and branched isomers of propane and butane can be liquefied and are used as a fuel. Other normal and branched fractions of pentane and hexane are used for solvents, cleaners, and paint thinners.

Gasoline consists of a mixture of approximately 50% aliphatics and 50% aromatics with the aliphatics in the C7 to C11 range. Kerosene, approximately 70% aliphatics and 30% aromatics with the aliphatics in the C11 to C15 range, was originally used mostly for domestic lighting and heating but is now mainly the major component of jet fuels. The C15 to C25 fraction is used for jet and diesel fuel. Lube oil contains the fraction from C26 to C40 or C50 depending on the refiner. The fraction above C50 is called the residuum and contains asphalts, asphaltenes, and resinous compounds which are used as wood preservatives, roofing asphalts and road asphalts.

Olefins are unsaturated aliphatic hydrocarbons having one or more double bonds and are obtained by cracking naptha or other petroleum fractions at high temperature. One type is used to make medium-biodegradable surfactants. Another type is used to produce synthetic fibers.

Acetylenes are created by cracking petroleum hydrocarbons to create a very flammable gas which is used to manufacture a number of compounds including vinyl chloride and vinyl acetate. It is also common used as a welding gas.

Aliphatics are a natural constituent of crude oil which is generated by the transformation of buried organic matter through pressure, heat, time, certain catalysts and bacterial action. The material is preponderantly of plant origin but may be admixed with a small animal component. Many fractions of petroleum have the ability to rotate the plane of polarized light, a property which is usually found in compounds that have been generated biogenically (Kinghorn, 1983).

The percentages of the various constituents vary with the age and depth of burial of the organic matter but, as a rule, the light hydrocarbons are absent in recent sediments and much in evidence in the ancient ones. Alkane distribution in rocks and sediments is very variable but long-chain alkanes with odd carbon numbers will predominate in most young sediments, especially those which are deposited under terrestrial influence. However, with increasing depth of burial and age, this odd preference disappears by dilution with newly generated alkanes which have no

odd or even carbon preference. It is true that the n-alkanes in plant waxes and recent sediments have a predominance of odd carbon numbered members but work on corals and sponges has shown a ratio of odd to even carbons that is very close to unity. This hypothesis is further supported by the work of Meyers (in Vandermuelen and Hrudey, 1984) who states that the most notable difference between petroleum hydrocarbons and those of plants and animals is the great diversity of molecular structures in petroleum. Included in this complex mixture are a number of homologous series of straight-chain, branched, cyclic, and aromatic hydrocarbons (Farrington and Meyers, 1975) which are the products of long-term geochemical transformations of the original, biological precursors of petroleum components. In contrast, biological hydrocarbons are much simpler in their variety and, in particular, do not commonly contain cyclic or aromatic structures (Douglas and Eglinton, 1966).

Terrestrial versus marine origin also affects the molecular weight range. Alkanes generated in a terrestrial environment tend to have a predominantly C24 to C32 range, which corresponds to plant waxes. Alkanes generated in a marine environment will predominate in the C14 to C22 range, which corresponds to the lipids of marine organisms.

The aliphatics are not considered to be the petroleum fraction which generally produces toxic effects in biota. The toxicity is associated with the aromatic fraction (Anderson, et al, 1974). This explains the greater toxicity of refined oils, which are rich in aromatics, as opposed to crude oil. Also, Peakall and coworkers in an ongoing investigation into the mechanism of embryotoxicity determined that an aromatic fraction prepared from South Louisiana crude oil was substantially more toxic than an aliphatic fraction (Peakall, et al, 1983). This assessment is tempered somewhat by evidence that algae may be affected by the aliphatic fraction of diesel oil. Hutchinson and coworkers (1981) found that hexane did produce toxic effects on the unicellular algae, *Chlorella vulgaris.*

The aliphatics also include a fraction termed the "unresolved complex mixture (UCM)." This fraction, which forms a large hump above baseline on hydrocarbon chromatograms, is composed of a variety of cycloalkanes and branched alkanes which are so similar in boiling point range and polarity that normal gas chromatographic techniques used for analysis cannot separate them (Hoffman, et al. in Vandermeulen and Hrudey, 1984). UCMs have been found to dominate the contents of recent sediments but diminish with sediment depth (Wakeham and Carpenter, 1976) where the aliphatic fraction becomes much less complex. At depth, the aliphatics exhibit a clear preponderance of an odd number of carbons over an even number in the land-plant n-alkane distribution and the UCM virtually disappears. Therefore, the UCM can be used to date sediments and to indicate the possibility of anthropogenic hydrocarbon contributions.

According to Stenstrom, et al, (in Vadermueulen and Hrudey, 1984) aliphatics are generally associated with commercial land use. In their study of the quality of urban runoff in the San Francisco area the percent of the aliphatic fraction composed of n-alkanes of C25 and larger was inversely related to commercial land use. The aromatic fraction was more variable, with samples from non-commercial stations sometimes having very high aromatic fractions.

With regard to potentially toxic concentrations of aliphatics, there is very little in the literature. A few workers, such as Woodward et al (1981) have performed studies which differentiated between the effects of aliphatics and aromatics but in general, research has focused on the aromatic fraction with its know carcinogenic potential. Woodward et al (1991) calculated a bioconcentration factor of 8x for cutthroat trout. This value was much lower than that for the combined aromatics at 163x. Bioavailability is no doubt high, as it is for all the highly lipophilic hydrocarbon fractions. The uptake (absorption) and elimination of a number of aliphatics from contaminated food fed to rainbow trout has been studied by Cravedi and Tulliez (1981). A broad range of aliphatics were found to be readily absorbed through the gastrointestinal mucosa. They became redistributed through out the tissues with the highest levels residing in the adipose tissues (Cravedi and Tulliez, 1981). There was also some evidence that the cyclic compounds were retained over the branched alkanes. Over the range of aliphatics tested (C14 to C24), maximum retention was noted for pentadecane.

The study of hydrocarbons in tissue is further complicated by the fact that hydrocarbons may be very rapidly metabolized into completely different compounds which may not be analyzed for or may not be recognized as derivatives. In addition, there is evidence that the metabolites, rather than the parent compounds, are more persistent in tissue (Vandermuelen in Vandermuelen and Hrudey, 1984) though this attribute may be limited to the aromatic fraction only.

Biological turnover and degradation of hydrocarbons most commonly involves a cytochrome-P450 dependent mixed-function oxidase (MFO), also known as aryl hydrocarbon hydroxylase (AHH). A complex broad-response enzyme system that is more normally involved in steroid catabolism, it essentially acts to degrade aromatic and a number of other hydrocarbons either by hydroxylation or by forming a conjugate with glucuronic acid (Parke, 1975). Either reaction renders these lipophilic compounds more water-soluble, and they therefore are more readily excreted (Neff, 1979). MFO is also thought to be involved in the metabolism of aliphatic (alkane) hydrocarbons through the conversion to fatty acids via lipid oxidation (Durand and Tulliez, 1980).

The aliphatic fractions analyzed for samples collected in September, 1992 ranged from a low of 0.11 ppm dry wt. to a high of 30.4 ppm at Site 8. Sites 6, 8, and 9 (all ponds) were higher

than free flowing stream locations; Sites 1 and 2, also ponds or catchments, were higher than the locations near the mouths of the streams, which averaged 4 ppm or less. The control site, located on a free-flowing stream, is anomalous at 10.84 ppm dry wt.

The same sites, including the new Site 5 at Jones Lake, when sampled and averaged for May through August 1993, were all higher than the September 1992 samplings. The high value was for Site 5 at 131.65 ppm. All other ponded areas (Sites 1, 2, 6, 8, 9) ranged from 10.58 ppm to 65.52 ppm dry wt. The free-flowing streams, including the control, ranged from 3.23 ppm to 6.12 ppm dry wt. All the ponds would be expected to accumulate organic matter [Site 5, Jones Lake, is overgrown with pond lilly (*Knifer polysepalum*)]. Since the aliphatics are known to be associated with decaying organic matter, this finding is expected. Without considerable more work, which may still be inconclusive, it is not possible to say what component may be attributable to anthropogenic sources.

Unresolved complex mixtures (UCMs) were not reported by the Mississippi State University laboratory for samples collected in September, 1992 and May, 1993. Results were reported for the samples sent to GERG at Texas A&M but the results did not meet screening criteria for blanks, except in August 1993 (Appendix E, Table E4). Although one sampling event does not provide reliable data, it provides an indication of the potential complex mixture levels. Concentrations of unresolved complex mixture on this date were above 100 ppm at sites 1 (Northwood Park), 2 (Barbara Park), 4 (Fish Creek outlet), and 6 (Clay Products Drive pond). The highest sample concentration of 817.66 ppm was taken from the Northwood Park retention basin. Sites 2 and 6, with concentrations of 420.09 ppm and 139.46 ppm, respectively, are also ponds which may act as sinks for hydrocarbons washed into the creek via storm-drains. This high concentration of UCM compared to the low identifiable hydrocarbon fractions does suggest that the anthropogenic component to these ponds is very high. However, since all the other samples were rendered unusable by high laboratory blanks, it is possible that these UCM values are a laboratory artifact.

Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) are composed of hydrogen and carbon arranged in the form of two or more fused benzene rings in linear, angular, or cluster arrangements, which may or may not be substituted by groups attached to the rings. These substituted PAHs have greater toxicological effects than does the parent compound. The groups of major concern are those ranging from C10 to C24. The lower molecular weight compounds such as naphthalene, fluorene, phenanthrene, and anthracene have significant acute toxicity to some organisms.

However, all known PAH carcinogens are in the high molecular weight PAH group (Eisler, 1987).

PAHs are ubiquitous in the environment and are naturally produced by vegetal and microbial synthesis, volcanic activities, forest fires and by anthropogenic industrial activities. They reach aquatic environments via domestic and industrial sewage effluents, surface runoff, airborne particulate, and spillage of petroleum and petroleum products (Eisler, 1987).

PAHs which accumulate in sediment degrade very slowly in the absence of oxygen and penetrating radiation. Their ultimate fate appears to be biotransformation and biodegradation by benthic organisms (Eisler, 1987). They are metabolized very slowly in molluscs, as compared to fish and mammals, making them the sentinel of choice in monitoring studies.

In order to compare the PAH values found at these sites with concentrations in the literature which are postulated to produce adverse effects on biota, the PAHs were summed (Tables 2 and 4) and compared to the values presented by Long and Morgan (1991). These researchers propose a value of 4 ppm dry weight for the ER-L and 35 ppm for the ER-M for PAHs. The ER-L value was not exceeded at any of the sites at any time. Values ranged in September 1992 from 0.08 ppm dry wt. at Site 4 to 2.82 ppm dry wt. at Site 6. No pattern was discernable. The values from May to August 1993 generally replicated those from September 1992 with the high value at Site 6 (2.49 ppm). The lowest value this time was recorded at Site 8. The isolated ponds and the control were the lowest of the group.

In summary, concentrations of aliphatics and aromatics were elevated in some of the ponds, as would be expected since they are serving as sediment deposition areas. One, Northwood Park, was designed to be a retention basin. Research has shown that retention basins are very effective at removing hydrocarbons from urban runoff (Hoffman and Quinn in Vandermuelen and Hrudey, 1984). Once introduced into a water body, regardless of the source, hydrocarbons from petroleum, biota, and other sources can persist for considerable lengths of time. Two factors account for this. The first is that higher-molecular-weight hydrocarbons tend to become associated with waterborne and eolian particles because of their relatively low water solubility and vapor pressure. The second is that hydrocarbons have decreased chemical or biochemical reactivity because they contain no functional groups (Meyers in Vandernmuelen and Hrudey, 1984). The net effect is that these compounds tend to accumulate in the sediments over time. Therefore, the simple presence of these compounds does not necessarily indicate recent or ongoing anthropogenic inputs although the focus of the sampling points on ponds and catchment areas predisposes the finding of aliphatics associated with refined petroleum which would be transported by runoff. Also, the presence of a fair number of resolved components and the

presence of unresolved complex mixtures (UCMs) of hydrocarbons underlying the resolved individual hydrocarbons chromatogram peaks is considered indicative of contamination by refined petroleum (Meyers in Vandermuelen and Hrudey, 1984). However, since these results consist of one reliable sample, it is difficult to say much beyond the fact that the reported level of UCMs relative to the resolved component indicates that the hydrocarbon source is refined petroleum. What should be noted is that, since the UCMs were not well quantitated and they are a major component of anthropogenic contributions, it is possible that the total hydrocarbon content is actually much greater than reported.

The location of the streams in a heavily urbanized and industrialized area does presuppose that the majority of the hydrocarbons are of anthropogenic origin. It is well known that the combustion of fossil fuels such as coal and wood has greatly increased the amounts of hydrocarbons being deposited in urban environments either by water transport (aliphatics) or by atmospheric transport (aromatics). The ratio of aromatics to aliphatics has also reflected the change to oil and gas from coal and wood as the major source of heating. The percentage of aliphatics continues to rise but the percent of aromatics is decreasing. Evidently coal combustion produces proportionally more aromatics than does the burning of fuel oils. Since the consensus is that aromatics are the more toxic fraction, this change is to be applauded. However, as the sedimentary record shows (Meyers in Vandermuelen and Hrudey, 1984) deposited hydrocarbons, particularly those bound to the clay fractions, remain available for reexposure and release virtually forever.

Organochlorines

Beta BHC, o,p- and p,p-DDD, o,p- and p,p-DDE, o,p- and p,p-DDT, *cis* nonachlor, delta BHC, gamma chlordane, and mirex were detected at very low concentrations in a few samples (Appendices A5, D5, and E5). These values are between 2x and 10x the practical quantitation limit and should be considered as qualitative. In addition, review of the quality assurance data suggests a possibility of laboratory contamination in a number of these samples.

Polycyclic Chlorinated Biphenyls

In June 1993, small amounts of total PCBs were measured in samples from sites 1, 5, 6, and 9 (Appendix C5). In July 1993 small amounts were again detected at sites 1, 2, 4, 5, 6, and 9 (Appendix D5).

Analyses for specific PCB congeners were not conducted on samples collected September 1992 or May 1993. In June - August 1993, concentrations of PCB congeners in samples were, for

the most part, less than 2x the detection limit (Appendices C6, D6, and E6). Similar to the organochlorine data, there is the possibility of lab contamination. This is particularly apparent for the June 1993 data in which concentrations of four PCB congeners at site 5 and two at site 9 were the same to five decimal places. The values, if valid, are low enough that they should be considered qualitative only.

Bioassays

Bioassays were conducted as a method of determining whether there might be adverse biological effects associated with sediments at various sites in these watersheds. In particular, the focus was on the Microtox test as a potentially rapid and accurate means of surveying streams to determine if more intensive studies were needed. The tests with *C. tentans* and *Daphnia* were intended as a check on the Microtox results, since these bioassays have a large body of research associated with them in the literature and are regarded as the benchmark test for predicting biological effects of contaminants in sediment.

Comparison of Microtox Bioassay and Chemical Analyses

The Microtox bioassay was originally developed as a field screening technique for assessing water quality; the procedure was later modified to screen sediment. The Microtox Solid-Phase Test is designed to give a measurement of the effects of toxins bound to solid particles in soil and sediment. It is important to note, however, that "although, the protocol provides quantitative data on the basis of a 'dose-response' curve, interpretation of individual samples is problematic. The test is therefore best suited to ranking multiple samples and identifying toxicity hot-spots." (Microbics Corporation, 1992).

Two variables are of concern with this procedure: 1) a very small sample (0.3 grams) of sediment is tested (note: this amount has been increased in Microbics protocols since this study), and 2) interference (i.e. suspended particles in solution block, absorb and/or reflect light emitted by the luminescent bacteria). While Microtox may be an effective screening technique for water samples, there is doubt about its use for screening sediment. This is due not only to the problems noted above, but to the complex nature of sediment and its multifold interaction with contaminants (M. Henry, USFWS, pers. com.). In addition, these Microtox analyses were conducted on samples which were collected separately from those collected for chemical analyses.

Sediment samples were collected from all the sites available in August, September, and October, 1992. The laboratory technician used them to set up the tests and practice the Microtox procedure. The tests run on August 11, September 8, September 14 and October 13 were

intended to produce reportable results but were inconclusive. The test run on September 29 on samples collected just four days after those collected on September 25 for chemical analysis yielded complete results and is used below to compare with the chemical values.

The Microtox test, when used to rank the sites using the mean EC50 values (Table 5) , identified the "most" contaminated to the "least"contaminated sites as follows: Site 7>Site 4> Site 2> Site 1> Site 3 (note: the value of 3.325 was considered anomalous and dropped from site 3), Site 6> Site 9> Site 8> Control.

If it is assumed that the highest chemical concentrations reported for the same sites equate with the highest potential risk, the correlation with the Microtox test is moderate at best. The site ranking by chemical concentrations from highest to lowest values is Site 4>Site6>Site 1>Site 3>Site 2. Sites 7, 8, 9, and the control were all very low and would not be considered to be " hot spots" on this basis. The ranking was accomplished by selecting the sites which had the majority of the highest values for contaminants.

If the Microtox test was used to select and focus on the "hottest" site, it would have failed completely in this instance. However, if it was used to identify a group of sites requiring further investigation, it would be a qualified success even though Site 6 may also have been overlooked. Site 4 would have been identified as the second most contaminated by both methods.

We recommend that these conclusions be strongly tempered by several considerations. The bioassays were run on samples different from those used for chemical analysis, although they came from the same general vicinity. The Microtox was run by a technician who had limited time to learn and practice the procedure. Only one Microtox test yielded results for all the sample sites. Lastly, the sedimentary materials themselves could be very different, which could strongly influence the results. The samples taken from sites closer to Knik Arm could be considerably higher in marine clays when compared to the materials found in the freshwater sediments in the Anchorage bowl. This could potentially cause problems with Microtox bioassays: clays tend to be highly expansive and have an enormous surface area; as such they could easily block, absorb, and reflect light given off by the bacteria creating erroneous readings.

Comparison of *Chironomus* and Microtox Bioassays

The first three *C. tentans* bioassays were conducted in order to check the sensitivity of the bioassay and to compare to the Microtox Bioassay. For these tests, what was assumed to be the most contaminated site (site 2, the Northwood Park storm drain settling pond) was compared to what was assumed to be the least contaminated site (the control site).

In the first bioassay, the sediment from the control site was "clean" according to Microtox

what was assumed to be the least contaminated site (the control site).

In the first bioassay, the sediment from the control site was "clean" according to Microtox tests, however, over half the *Chironomus* larvae in the 100% control sediment either died or were not found. The cause of this was probably not contaminants, however, but rather the nature of the sediment, which was quite sandy and apparently did not provide an adequate substrate for the larvae. This variable makes interpretation of the test questionable. Temperature, DO and pH measurements taken from a 100% site 2 beaker before and after the test showed little change. Water quality measurements were not taken from the control site beaker.

In the second two bioassays the samples, to make them similar to those used in the Microtox bioassay, were sieved through a stainless steel screen. If the results of the two bioassays are combined the results can be plotted as a bar graph (Fig 1). The graph shows a slight decline in the number of larvae found alive as the concentration of Site 2 sediment increases. Microtox bioassays conducted on the same samples support this - indicating a higher toxicity (lower EC50 value) at Site 2 than at the Control Site. Water quality measurements for the Control site and site 2 were taken before, but not after the tests. DO levels were lower in the 100% site 2 beakers for both tests, but without after test measurements no inferences can be made.

The last bioassay tested unscreened sediments from Sites 1 and 3 (Table 5). The sites appear relatively clean based upon both the *Chironomus* and Microtox bioassays, although with only two replicate tests interpretation is limited. Water quality measurements were again taken before, but not after the test, thus providing limited information.

CONCLUSIONS

Metals

Arsenic, cadmium, copper, and selenium concentrations do not appear to be a concern when compared to values cited by Long and Morgan, 1991.

However, several of the other metals were detected at levels which may warrant further study in the future. Chromium exceeded ER-L values at Sites 1, 2, and 7 but did not exceed the ER-M value. Nickel values exceeded the ER-L value at every site except site 5 and the ER-M value was exceeded at Sites 3, 4, and 7. Lead values exceeded the ER-L at all sites excepting Sites 5 and 9. The ER-M was exceeded at Site 6 in May 1993. Zinc values exceeded the ER-L at least once at every site excepting Sites 5, 9, and Control. The ER-M was exceeded at Sites 1, 2,

and 6 at least once. Mercury exceeded the ER-L once at Site 6 and was twice detected at a value slightly lower than the ER-L at Sites 3 and 7.

Those sites where the ER-M value was exceeded (nickel at Sites 3, 4, and 7; lead at Site 6; zinc at Sites 1, 2, and 6) would definitely seem to warrant further investigation.

The pattern for metals which indicate that there may "flushing" of retention areas on a seasonal basis is a concern. Many of the ponded areas are stable and apparently productive wildlife areas but Site 1, designed as a retention basin, should be dredged on a regular basis. It is definitely receiving runoff from the surrounding residential area and from the parking lot just adjacent to it. Annual creek cleanup activities usually find much discarded trash associated with the pond and wetland.

Hydrocarbons

Concentrations of hydrocarbons are elevated in some of the ponds but the levels measured do not appear to be a concern based on the values available for assessing risk from polycyclic aromatic hydrocarbons. However, since waterfowl are feeding and breeding in these ponds, a better monitoring program may be needed to determine what the actual level of exposure is.

The ponds appear to be functioning as retention basins and retaining contaminants. Those designed and performing as a retention basin should be dredged on a regular basis so that wildlife are not exposed to high concentrations of metals and hydrocarbons. Ponds not specifically designed as retention structures should be monitored for contaminants to determine if they also should be dredged. This would prevent a buildup of contaminants which are then flushed downstream during high runoff events. The contaminants could be redeposited downstream where more wildlife, such as shorebirds and migrating ducks would be exposed.

Organochlorines

Concentrations of organochlorines and PCBs were generally less than 2x the detection limit rendering them qualitative data at best. Concentrations above this level are suspected of being laboratory artifacts. No conclusions can be drawn either on the actual levels which may be found at these sites or the potential impact to biota.

Bioassays

Testing the concept of using a quick bioassay method to determine "hot spots" was a secondary goal under the Urban Contaminants Project. Under the original scope of the project, such a test would make it possible to accomplish rapid screening of the watersheds and focus

samples...(but) it is most appropriate for inclusion in a "battery of tests" where sediment is evaluated based on the results of several different bioassays (Bennett and Cubbage, 1992). The literature reviewed seems to be in general agreement that no one test, biological or chemical, is sufficient for determining toxicity, either to a species or a trophic level (Long and Morgan, 1991; USEPA, 1994; Adams et al 1992). Therefore, as anticipated, the success of the test to use Microtox to identify "hot spots" is mixed but, considering the number of variables in this study, it performed very well. The test succeeded in identifying the half of the sites which have the highest levels of contaminants. It may not have identified the most contaminated site when compared to the chemical data but the chemical data are also incomplete. In future, the chemical analyses should include grain size analysis, organic matter content, clay type, and acid volatile sulfide (AVS) content. Estimates of the efficacy of AVS for identifying toxicity are mixed (Hansen et al 1996; Long et al 1998) but since it is an indicator of bioavailability, the data could be added to the weight of evidence when assessing the risk of toxicity.

The usefulness of the *Chironomus* bioassay cannot be evaluated on this exceedingly limited basis. However, there is no reason, based on the high acceptance of this bioassay method, to doubt that properly conducted *Chironomus* bioassays would greatly improve the confidence in determining the toxicity of the sediments in these watersheds. The confidence would be even greater if other bioassays were also performed, such as with *D.magna* or other organisms such as *Hyalella azteca,* which might be more sensitive.

The concept of a tiered risk assessment process could be useful in future studies of these watersheds. This process is described in Sediment Quality and Aquatic Life Assessment (Adams et al, 1992). They describe the many methods used to determine sediment toxicity but conclude that no one approach is definitive. Sediment quality assessment is considerably more complex than water quality assessment due to the many site-specific parameters that need to be considered that are not a factor for water. These factors include bioavailability, sorption kinetics, sediment characteristics, sediment deposition, erosion, and compaction, bioturbation, and temporal and spatial differences to mention a few. Their tiered assessment approach incorporates a Tier 1 which includes an acute toxicity/chronic (or subchronic) bioassay, a bulk sediment or pore water bioassay, and a bioaccumulation measurement. If there is no toxicity and/or no bioaccumulation, the site is determined to be safe for the species or trophic level of concern. If there is toxicity, Tier 2 begins with a definition of the zone of impact using bulk chemical measurements and another series of chronic/subchronic bulk sediment bioassays. If the zone is determined to be small enough to not present a risk, the investigation is stopped. If the zone is large enough to present a risk, Tier 3 will be implemented. It includes chronic multispecies sediment toxicity

small enough to not present a risk, the investigation is stopped. If the zone is large enough to present a risk, Tier 3 will be implemented. It includes chronic multispecies sediment toxicity testing, spatial and depth toxicity confirmation, infaunal biological measurements, tissue residue analysis to determine bioaccumulation, toxicity identification evaluation, spiked sediment toxicity tests and the Apparent Effects Threshold/Sediment Triad Evaluation. These are all site-specific sediment quality criteria which provide enough data that a sufficient weight of evidence can be generated for making a sound decision on the level of toxicity risk.

The Urban Contaminants Project has been discontinued to allow limited staff to focus on refuge issues. While a need can be demonstrated for collecting more data on the interactions between contaminants and wildlife in the Anchorage area, the project objectives should be refocused on specific, answerable questions, such as selecting a particular species of concern and attempting to assess the impact of a specific contaminant or suite of contaminants in the sediments on the growth, survival, and reproductive success of that species. Statistically valid study designs are necessary. Water quality data such as pH, hardness, etc. must be collected since these parameters affect both biological organisms and bioavailability of contaminants from sediment. The methods for sample collection must be standardized, better characterization of the sediments must be performed, and appropriate bioassay species and techniques selected.

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APPENDIX A

Chemical Analyses September 1992

A1. QUALITY ASSURANCE SCREENING OF ALL ANALYTES TESTED FOR IN FISH CREEK SEDIMENT SAMPLES, ANCHORAGE ALASKA. SEPTEMBER 1992.

Metals	<2x	duplicates	blanks
Al		ok	ok
As		ok	ok
B		ok	ok
Ba		ok	ok
Be		ok	ok
Cd		ok	ok
Cr		ok	ok
Cu		ok	ok
Fe		ok	ok
Hg	x	ok	ok
Mg		ok	ok
Mn		ok	ok
Mo	x	N/A	ok
Ni		ok	ok
Pb		ok	ok
Se		N/A	ok
Sr		ok	ok
V		ok	ok
Zn		ok	ok

Aliphatics	<2x	duplicates	blanks
n-decane	x	N/A	ok
n-docosane		ok	ok
n-dodecane		ok	ok
n-dotriacontane		NO	ok
n-eicosane		ok	ok
n-heneicosane		ok	ok
n-hentriacontane		NO	ok
n-heptacosane		ok	ok
n-heptadecane		ok	ok
n-hexacosane		ok	ok
n-hexadecane		ok	ok
n-nonacosane		ok	ok
n-nonadecane		ok	ok
n-octacosane		NO	ok
n-octadecane		ok	ok
n-pentacosane		ok	ok
n-pentadecane		ok	ok
n-tetracosane		ok	ok
n-tetradecane		ok	ok
n-tetratriacontane		NO	ok
n-triacontane		NO	ok
n-tricosane		ok	ok
n-tridecane		ok	ok
n-tritriacontane		NO	ok
n-undecane		N/A	ok
phytane		ok	ok
pristane		ok	ok

Aromatics	<2x	duplicates	blanks
1,2,5,6-dibenzanthracene	x	N/A	ok
1,2-benzanthracene		NO	ok
1-methylnaphthalene	x	ok	ok
1-methylphenanthrene		ok	ok
2,3,5-trimethylnaphthalene	x	NO	ok
2,6-dimethylnaphthalene		ok	ok
2-methylnaphthalene		ok	ok
acenaphthalene	x	N/A	ok
acenaphthene	x	ok	ok
anthracene		ok	ok
benzo(a)pyrene		N/A	ok
benzo(b)fluoranthene		ok	ok
benzo(e)pyrene		ok	ok
benzo(g,h,i)perylene		N/A	ok
benzo(k)fluoranthene		N/A	ok
biphenyl	x	N/A	ok
C1-chrysenes	x	N/A	ok
C1-dibenzothiophenes	x	N/A	ok
C1-Fluoranthenes & Pyrenes	x	N/A	ok
C1-fluorenes	x	N/A	ok
C1-naphthalenes		ok	ok
C1-phenanthrenes		ok	ok
C2-chrysenes	x	N/A	ok
C2-dibenzothiophenes	x	N/A	ok
C2-fluorenes	x	N/A	ok
C2-naphthalenes		ok	ok
C2-phenanthrenes		ok	ok
C3-chrysenes	x	N/A	ok
C3-dibenzothiophenes	x	N/A	ok
C3-fluorenes	x	N/A	ok
C3-naphthalenes		NO	ok
C3-phenanthrenes	x	N/A	ok
C4-chrysenes	x	N/A	ok
C4-naphthalenes	x	N/A	ok
C4-phenanthrenes		NO	ok
chrysene		ok	ok
dibenzothiophene	x	ok	ok
fluoranthene		NO	ok
fluorene	x	ok	ok
indeno(1,2,3-cd)pyrene		N/A	ok
naphthalene		ok	ok
perylene		ok	ok
phenanthrene		ok	ok
pyrene		ok	ok

Organochlorines	<2x	duplicates	blanks
alpha BHC	x	N/A	ok
alpha chlordane	x	N/A	ok
beta BHC		N/A	ok
cis-nonachlor	x	N/A	ok
delta BHC	x	N/A	ok
dieldrin	x	N/A	ok
endrin	x	N/A	ok
gamma BHC	x	N/A	ok
gamma chlordane	x	N/A	ok
HCB	x	N/A	ok
heptachlor epoxide	x	N/A	ok
mirex	x	N/A	ok
o,p'-DDD	x	N/A	ok
o,p'-DDE	x	N/A	ok
o,p'-DDT	x	N/A	ok
oxychlordane	x	N/A	ok
p,p'-DDD		N/A	ok
p,p'-DDE		N/A	ok
p,p'-DDT	x	N/A	ok
PCB-TOTAL	x	N/A	ok
toxaphene	x	N/A	ok
trans-nonachlor	x	N/A	ok

KEY

<2x:
x concentrations were less than 2x the detection limit in all the samples.

duplicates:
ok relative percent differences were less than 20%.
NO relative percent differences were greater than 20%.
N/A test(s) were invalid; concentrations were below the detection limit.

blanks:
ok concentrations in procedural blanks were less than 2x the detection limit.
NO concentrations in procedural blanks were greater than 2x the detection limit.

A2. METALS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. SEPTEMBER 1992.

Site	Sample #	% Moisture	Al	As	B	Ba	Be	Cd	Cr	Cu	Fe	Mg	Mn	Ni	Pb	Se	Sr	V	Zn
1	09259211	37.23	24430.00	13.10	21.70	182.50	-	0.42	203.30	37.57	35510.00	10170.00	682.30	47.23	90.37	-	65.44	82.82	365.90
1	09259212	86.12	14530.00	41.06	28.94	257.90	-	1.67	45.03	67.75	74820.00	6879.00	1790.00	38.92	57.61	-	90.21	57.98	734.30
1	09259213	41.17	18790.00	19.00	16.65	201.30	-	0.43	92.94	40.54	32440.00	7310.00	930.00	35.73	35.65	-	66.78	56.46	282.70
1	09259214	25.39	18220.00	5.11	13.03	50.25	-	0.54	49.31	23.28	27200.00	9301.00	482.20	31.10	14.90	-	31.64	52.15	85.71
2	09259221	51.92	17120.00	17.33	0.00	108.60	-	0.62	59.84	30.15	27840.00	6381.00	257.40	31.91	19.40	-	40.69	69.75	78.92
2	09259222	42.99	18800.00	16.17	11.54	113.00	-	0.80	47.75	28.99	28940.00	7404.00	468.40	31.23	40.92	-	38.44	67.88	198.80
3	09259231	22.79	27250.00	15.26	17.75	97.54	-	0.82	64.24	51.42	39800.00	14080.00	951.70	52.33	30.76	-	64.64	78.57	107.50
3	09259232	28.17	22050.00	12.58	15.57	92.74	-	0.75	52.32	48.00	35280.00	12390.00	670.60	47.58	26.19	-	50.30	65.56	93.09
4	09259241	40.88	28200.00	27.94	22.16	201.70	0.44	1.32	55.62	63.09	42640.00	14620.00	951.80	48.63	37.71	-	66.01	79.85	178.20
4	09259242	41.70	27830.00	27.15	19.85	194.70	0.41	1.09	53.66	62.36	41980.00	14330.00	919.60	47.06	37.07	-	65.36	77.87	208.70
6	09259261	57.14	19440.00	19.30	20.46	111.50	-	1.50	61.62	47.94	55290.00	7809.00	760.10	41.61	55.12	-	45.11	70.01	857.40
6	09259262	71.08	17050.00	19.81	11.82	121.50	-	0.78	40.62	62.91	47320.00	7130.00	1015.00	50.05	116.90	-	42.96	64.62	2349.00
7	09259271	38.28	22570.00	18.63	12.59	114.50	-	-	89.63	49.00	34330.00	12390.00	673.40	44.27	15.70	-	45.71	65.70	105.40
8	09259281	71.19	15580.00	6.07	-	99.57	-	-	28.16	51.26	19210.00	5144.00	377.70	27.85	20.61	-	32.29	42.72	102.80
8	09259282	70.38	18500.00	5.45	-	109.90	-	-	43.51	49.41	24820.00	7220.00	390.90	35.15	28.35	-	45.29	54.77	90.23
9	09259291	52.47	13490.00	5.68	-	76.58	-	-	30.97	33.02	18260.00	5232.00	295.20	23.76	18.97	-	21.95	44.83	58.06
Control	092992C1	57.19	19920.00	9.40	11.40	128.20	-	-	57.51	29.27	21950.00	5764.00	690.40	24.79	9.94	1.35	116.40	56.18	50.97
Control	092992C2	49.16	19040.00	7.51	-	90.53	-	-	63.49	24.16	21120.00	5949.00	524.70	23.83	42.52	-	93.56	50.86	66.92

(-) Concentration less than 2x the detection limit.

A3 EXTENDED...

Site	Sample #	% Moisture	n-octadecane	n-pentacosane	n-pentadecane	n-tetracosane	n-tetradecane	n-tricosane	n-tridecane	n-undecane	phytane	pristane	Total
1	09259211	31.5	0.161	1.080	0.073	0.102	-	0.365	-	-	0.219	0.365	6.380
1	09259212	89.5	0.476	3.810	0.381	0.762	-	1.810	-	-	0.571	1.714	35.619
1	09259213	44.0	0.143	1.661	0.089	0.304	0.054	0.929	-	-	0.125	0.679	12.464
1	09259214	24.0	0.039	-	-	-	-	-	-	-	0.039	0.053	0.395
2	09259221	52.5	0.084	2.105	-	0.421	-	1.116	-	-	0.084	0.232	12.695
2	09259222	41.5	0.137	1.282	0.103	0.239	0.085	0.547	0.051	-	0.274	0.530	9.350
3	09259231	21.0	0.089	0.544	0.076	0.152	0.076	0.291	0.063	0.038	-	0.114	4.278
3	09259232	23.5	0.092	0.575	0.092	0.170	0.092	0.327	0.078	-	-	0.131	4.627
4	09259241	40.0	0.050	0.267	0.083	-	0.050	0.083	-	-	0.150	0.300	3.483
4	09259242	41.0	0.068	0.356	0.119	0.051	0.068	0.119	-	-	0.153	0.356	4.763
6	09259261	47.0	0.189	3.019	0.170	0.283	0.132	1.434	0.057	0.075	0.377	0.774	17.075
6	09259262	67.0	0.576	6.061	0.394	0.697	0.273	2.000	0.121	-	1.182	2.242	36.152
7	09259271	26.5	-	0.231	0.041	-	-	0.068	-	-	-	-	0.762
8	09259281	69.0	0.194	6.129	0.129	0.742	-	2.742	0.097	-	0.097	0.097	42.613
8	09259282	60.5	0.127	2.253	-	0.278	-	0.709	-	-	-	-	18.228
9	09259291	51.5	0.186	4.124	0.082	0.392	0.082	1.567	-	-	0.103	0.557	21.010
Control	092992C1	53.5	-	2.366	-	0.258	-	0.860	-	-	-	-	12.495
Control	092992C2	43.5	-	1.611	-	0.142	-	0.637	-	-	-	-	9.186

A4. AROMATIC HYDROCARBONS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. SEPTEMBER 1992.

Site	Sample #	% Moisture	1-methylphenanthrene	2,6-dimethylnaphthalene	2-methylnaphthalene	anthracene	benzo(a)pyrene	benzo(b)fluoranthene	benzo(e)pyrene
1	09259211	31.5	-	-	-	-	-	0.044	-
1	09259212	89.5	-	-	-	-	-	0.571	0.286
1	09259213	44.0	-	-	-	-	-	0.071	-
1	09259214	24.0	-	-	-	-	-	-	-
2	09259221	52.5	-	-	-	-	-	-	-
2	09259222	41.5	-	0.051	-	-	-	0.051	-
3	09259231	21.0	-	0.038	0.063	-	-	-	-
3	09259232	23.5	0.039	0.039	0.052	-	-	-	-
4	09259241	40.0	-	-	-	-	-	-	-
4	09259242	41.0	-	-	-	-	-	-	-
6	09259261	47.0	0.075	-	-	-	0.151	0.151	0.132
6	09259262	67.0	-	0.303	0.091	0.091	0.212	0.152	0.152
7	09259271	26.5	-	-	0.041	-	-	-	-
8	09259281	69.0	-	-	-	-	-	-	-
8	09259282	60.5	-	-	-	-	-	-	-
9	09259291	51.5	-	-	-	-	-	-	-
Control	092992C1	53.5	-	-	-	-	-	-	-
Control	092992C2	43.5	-	-	-	-	-	-	-

(-) Concentration less than 2x the detection limit.

A4. EXTENDED...

Site	Sample #	% Moisture	benzo(g,h,i)perylene	benzo(k)fluoranthene	C1-naphthalenes	C1-phenanthrenes	C2-naphthalenes	C2-phenanthrenes	chrysene
1	09259211	31.5	-	-	0.044	-	-	-	0.044
1	09259212	89.5	0.381	-	0.286	-	-	-	0.476
1	09259213	44.0	0.054	-	0.054	-	-	-	0.071
1	09259214	24.0	-	-	0.039	-	-	-	0.039
2	09259221	52.5	-	-	-	-	-	-	-
2	09259222	41.5	-	-	0.051	-	0.051	0.085	0.051
3	09259231	21.0	-	-	0.101	-	0.038	0.051	-
3	09259232	23.5	-	-	0.078	0.039	0.039	0.052	-
4	09259241	40.0	-	-	0.050	-	-	-	-
4	09259242	41.0	-	-	0.051	-	-	-	-
6	09259261	47.0	0.113	0.170	0.075	0.075	0.094	0.132	0.226
6	09259262	67.0	0.152	0.152	0.152	0.212	0.424	0.273	0.242
7	09259271	26.5	-	-	0.068	-	-	-	-
8	09259281	69.0	-	0.097	-	-	-	-	-
8	09259282	60.5	-	-	0.076	-	-	-	-
9	09259291	51.5	-	-	0.062	-	-	-	-
Control	092992C1	53.5	-	-	0.065	-	-	-	0.086
Control	092992C2	43.5	-	-	0.053	-	-	-	-

A4. EXTENDED...

Site	Sample #	% Moisture	indeno(1,2,3-cd)pyrene	naphthalene	perylene	phenanthrene	pyrene	Total
1	09259211	31.5	-	-	0.058	-	-	0.190
1	09259212	89.5	0.381	-	-	0.286	0.476	3.143
1	09259213	44.0	0.054	0.054	0.179	0.054	0.071	0.661
1	09259214	24.0	-	-	-	-	-	0.079
2	09259221	52.5	-	-	0.063	-	-	0.063
2	09259222	41.5	-	-	0.051	0.068	0.068	0.530
3	09259231	21.0	-	-	0.063	0.038	-	0.392
3	09259232	23.5	-	-	0.052	0.039	-	0.431
4	09259241	40.0	-	-	-	-	-	0.050
4	09259242	41.0	-	-	-	-	0.051	0.102
6	09259261	47.0	0.113	-	0.057	0.283	0.396	2.245
6	09259262	67.0	0.121	-	-	0.273	0.394	3.394
7	09259271	26.5	-	-	-	-	-	0.109
8	09259281	69.0	-	-	0.097	0.129	0.097	0.419
8	09259282	60.5	-	-	-	-	-	0.076
9	09259291	51.5	-	-	-	0.082	-	0.144
Control	092992C1	53.5	-	-	0.065	-	-	0.215
Control	092992C2	43.5	-	-	0.053	-	-	0.106

A5. ORGANOCHLORINES (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. SEPTEMBER 199

Site	Sample #	% Moisture	beta BHC	p,p'-DDD	p,p'-DDE
1	09259211	31.5	-	-	-
1	09259212	89.5	-	-	-
1	09259213	44.0	-	-	-
1	09259214	24.0	-	-	-
2	09259221	52.5	-	-	-
2	09259222	41.5	-	0.017	-
3	09259231	21.0	-	-	-
3	09259232	23.5	-	-	-
4	09259241	40.0	-	-	-
4	09259242	41.0	-	-	-
6	09259261	47.0	-	0.019	-
6	09259262	67.0	0.030	0.061	0.030
7	09259271	26.5	-	-	-
8	09259281	69.0	-	-	-
8	09259282	60.5	-	-	-
9	09259291	51.5	-	-	-
Control	092992C1	53.5	-	-	-
Control	092992C2	43.5	-	-	-

(-) Concentration less than 2x the detection limit.

APPENDIX B

Chemical Analyses May 1993

B1. QUALITY ASSURANCE SCREENING OF ALL ANALYTES TESTED FOR IN FISH CREEK SEDIMENT SAMPLES, ANCHORAGE ALASKA. MAY 1993

Metals	<2x	duplicates	blanks
Al		ok	ok
As		ok	ok
B		ok	ok
Ba		ok	ok
Be		ok	ok
Cd		ok	ok
Cr		ok	ok
Cu		ok	ok
Fe		ok	ok
Hg		ok	ok
Mg		ok	ok
Mn		ok	ok
Mo	x	N/A	ok
Ni		ok	ok
Pb		ok	ok
Se	x	N/A	ok
Sr		ok	ok
V		ok	ok
Zn		ok	ok

Aliphatics	<2x	duplicates	blanks
n-decane		N/A	ok
n-docosane		ok	ok
n-dodecane		ok	ok
n-dotriacontane		NO	ok
n-eicosane		ok	ok
n-heneicosane		ok	ok
n-hentriacontane		NO	ok
n-heptacosane		ok	ok
n-heptadecane		ok	ok
n-hexacosane		ok	ok
n-hexadecane		ok	ok
n-nonacosane		ok	ok
n-nonadecane		ok	ok
n-octacosane		NO	ok
n-octadecane		ok	ok
n-pentacosane		ok	ok
n-pentadecane		ok	ok
n-tetracosane		ok	ok
n-tetradecane		ok	ok
n-tetratriacontane		NO	ok
n-triacontane		NO	ok
n-tricosane		ok	ok
n-tridecane		ok	ok
n-tritriacontane		NO	ok
n-undecane		N/A	ok
phytane		ok	ok
pristane		ok	ok

Aromatics	<2x	duplicates	blanks
1,2,5,6-dibenzanthracene	x	N/A	ok
1,2-benzanthracene		NO	ok
1-methylnaphthalene		ok	ok
1-methylphenanthrene		ok	ok
2,3,5-trimethylnaphthalene	x	NO	ok
2,6-dimethylnaphthalene		ok	ok
2-methylnaphthalene		ok	ok
acenaphthalene	x	N/A	ok
acenaphthene		ok	ok
anthracene		ok	ok
benzo(a)pyrene		N/A	ok
benzo(b)fluoranthene		ok	ok
benzo(e)pyrene		ok	ok
benzo(g,h,i)perylene		N/A	ok
benzo(k)fluoranthene		N/A	ok
biphenyl	x	N/A	ok
C1-chrysenes	x	N/A	ok
C1-dibenzothiophenes	x	N/A	ok
C1-Fluoranthenes & Pyrenes	x	N/A	ok
C1-fluorenes	x	N/A	ok
C1-naphthalenes		ok	ok
C1-phenanthrenes		ok	ok
C2-chrysenes	x	N/A	ok
C2-dibenzothiophenes	x	N/A	ok
C2-fluorenes	x	N/A	ok
C2-naphthalenes		ok	ok
C2-phenanthrenes		ok	ok
C3-chrysenes	x	N/A	ok
C3-dibenzothiophenes	x	N/A	ok
C3-fluorenes	x	N/A	ok
C3-naphthalenes		NO	ok
C3-phenanthrenes	x	N/A	ok
C4-chrysenes	x	N/A	ok
C4-naphthalenes	x	N/A	ok
C4-phenanthrenes		NO	ok
chrysene		ok	ok
dibenzothiophene		ok	ok
fluoranthene		NO	ok
fluorene		ok	ok
indeno(1,2,3-cd)pyrene		N/A	ok
naphthalene	x	ok	ok
perylene		ok	ok
phenanthrene		ok	ok
pyrene		ok	ok

Organochlorines	<2x	duplicates	blanks
alpha BHC	x	N/A	ok
alpha chlordane	x	N/A	ok
beta BHC	x	N/A	ok
cis-nonachlor	x	N/A	ok
delta BHC	x	N/A	ok
dieldrin	x	N/A	ok
endrin	x	N/A	ok
gamma BHC	x	N/A	ok
gamma chlordane	x	N/A	ok
HCB	x	N/A	ok
heptachlor epoxide	x	N/A	ok
mirex	x	N/A	ok
o,p'-DDD	x	N/A	ok
o,p'-DDE	x	N/A	ok
o,p'-DDT	x	N/A	ok
oxychlordane	x	N/A	ok
p,p'-DDD	x	N/A	ok
p,p'-DDE	x	N/A	ok
p,p'-DDT	x	N/A	ok
PCB-TOTAL	x	N/A	ok
toxaphene	x	N/A	ok
trans-nonachlor	x	N/A	ok

KEY

<2x:
x concentrations were less than 2x the detection limit in all the samples.

duplicates:
ok relative percent differences were less than 20%.
NO relative percent differences were greater than 20%.
N/A test(s) were invalid; concentrations were below the detection limit.

blanks:
ok concentrations in procedural blanks were less than 2x the detection limit.
NO concentrations in procedural blanks were greater than 2x the detection limit.

B2. METALS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. MAY 1993

Site	Sample #	% Moisture	Al	As	B	Ba	Be	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Ni	Pb	Sr	V	Zn
1	05049311	46.22	20910.00	12.49	16.95	95.03	-	-	104.10	29.54	33410.00	-	10510.00	655.30	37.36	17.48	52.85	71.58	406.20
2	05049321	36.15	17550.00	13.76	10.61	87.27	-	-	72.99	30.35	33280.00	-	8348.00	658.20	34.88	52.83	27.34	60.00	217.20
2	05049322	36.79	18070.00	14.12	13.31	90.46	-	-	91.62	29.77	32490.00	-	8557.00	647.00	38.14	40.51	29.05	60.59	184.40
3	05039331	20.03	22710.00	11.23	13.60	81.67	-	-	57.38	50.85	37660.00	-	13250.00	641.10	53.58	17.00	40.29	67.99	97.60
4	05039341	40.62	21980.00	24.67	-	165.10	0.65	0.55	47.96	56.61	37160.00	-	12640.00	794.00	44.35	21.44	48.34	67.01	153.70
5	05109351	84.92	9539.00	9.08	-	69.42	-	-	17.22	16.02	12410.00	-	2133.00	190.00	15.85	-	35.19	30.56	67.36
6	05049361	71.68	21510.00	23.26	22.74	155.70	-	1.45	46.33	64.94	67440.00	0.22	7279.00	1319.00	48.15	131.90	54.88	73.91	2015.00
7	05049371	32.09	23900.00	16.91	19.91	107.60	-	-	48.43	53.27	36420.00	-	14070.00	780.60	47.12	18.00	59.74	68.73	104.10
8	05049381	34.19	16700.00	6.24	-	69.09	0.82	0.80	64.77	22.19	19420.00	-	5567.00	353.40	27.33	14.31	23.22	46.42	53.58
9	05049391	46.67	20540.00	6.61	-	96.42	-	-	48.99	32.69	24080.00	-	7577.00	373.10	29.82	18.49	27.34	56.80	83.93
Control	051093C1	24.03	16910.00	6.38	13.39	69.88	-	-	77.91	20.42	30380.00	-	9531.00	644.70	31.30	11.52	27.71	56.42	54.77

(-) Concentration less than 2x the detection limit.

113. ALIPHATIC HYDROCARBONS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. MAY 1993.

Site	Sample #	% Moisture	n-decane	n-docosane	n-dodecane	n-eicosane	n-heneicosane	n-heptacosane	n-heptadecane	n-hexacosane	n-hexadecane	n-nonacosane	n-nonadecane
1	05049311	40.5	0.067	0.084	-	0.118	0.235	3.025	0.353	0.252	0.185	1.849	0.269
2	05049321	36.0	-	0.047	-	0.063	0.094	1.094	0.078	0.219	0.063	1.078	0.266
2	05049322	36.5	0.047	0.094	0.047	0.094	0.205	2.677	0.551	0.772	0.142	3.150	0.504
3	05039331	17.5	0.036	0.121	0.061	0.109	0.121	0.170	0.085	0.073	0.073	0.170	0.109
4	05039341	39.5	-	-	-	0.083	0.760	0.463	0.165	0.050	0.050	0.446	0.099
5	05109351	82.0	-	1.556	-	0.944	4.722	8.333	8.333	1.667	-	12.222	1.056
6	05049361	71.0	-	1.931	0.276	1.138	2.103	11.034	1.483	3.793	1.103	9.655	2.207
7	05049371	30.5	0.043	0.101	0.058	0.086	0.978	0.273	0.101	0.058	0.086	0.245	0.129
8	05049381	38.0	-	0.258	-	0.226	0.532	5.000	0.048	0.516	-	6.290	0.194
9	05049391	39.5	-	0.149	-	0.132	0.463	6.116	0.165	0.314	0.066	3.636	0.198
Control	051093C1	33.0	-	0.045	-	-	0.104	2.090	-	0.075	-	0.806	-

(-) Concentration less than 2x the detection limit.

B3. EXTENDED...

Site	Sample #	% Moisture	n-octadecane	n-pentacosane	n-pentadecane	n-tetracosane	n-tetradecane	n-tricosane	n-tridecane	n-undecane	phytane	pristane	Total
1	05049311	40.5	0.218	1.613	0.134	0.151	0.067	0.504	-	0.084	0.403	0.605	10.218
2	05049321	36.0	0.078	0.563	0.063	0.094	0.047	0.188	-	-	0.203	0.313	4.547
2	05049322	36.5	0.142	1.244	0.079	0.268	0.094	0.394	0.079	-	0.362	0.614	11.559
3	05039331	17.5	0.073	0.170	0.073	0.097	0.061	0.133	0.061	0.048	-	0.145	1.988
4	05039341	39.5	0.066	0.298	0.066	0.066	0.050	0.099	-	-	0.083	0.231	3.074
5	05109351	82.0	0.278	6.667	0.167	1.444	0.222	7.222	-	-	0.500	-	55.333
6	05049361	71.0	1.069	7.241	0.897	2.586	0.690	4.138	0.345	0.172	2.310	4.828	59.000
7	05049371	30.5	0.086	0.230	0.086	0.115	0.072	0.158	0.072	0.058	-	0.144	3.180
8	05049381	38.0	0.065	2.097	-	0.403	-	0.935	-	-	-	-	16.565
9	05049391	39.5	0.116	4.132	0.050	0.281	0.083	1.570	-	-	0.083	0.314	17.868
Control	051093C1	33.0	-	0.896	-	0.075	-	0.328	-	-	-	-	4.418

B4. AROMATIC HYDROCARBONS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. MAY 1993.

Site	Sample #	% Moisture	1-methylnaphthalene	1-methylphenanthrene	2,6-dimethylnaphthalene	2-methylnaphthalene	acenaphthene	anthracene	benzo(a)pyrene
1	05049311	40.5	-	-	-	-	-	-	-
2	05049321	36.0	0.047	0.063		0.063	0.047	0.078	
2	05049322	36.5	0.047	0.079	0.047	0.063	0.063	0.110	-
3	05039331	17.5	0.036	0.036	0.036	0.048	-	-	-
4	05039341	39.5	-	-	-	-	-	-	-
5	05109351	82.0	-	-	-	-	-	-	0.167
6	05049361	71.0	-	-	0.276	0.103	-	0.103	0.552
7	05049371	30.5	0.043	0.043	0.043	0.072	-	-	-
8	05049381	38.0	-	-	-	-	-	-	-
9	05049391	39.5	-	-	-	-	-	-	0.050
Control	051093C1	33.0	-	-	-	-	-	-	-

(-) Concentration less than 2x the detection limit.

B4. EXTENDED...

Site	Sample #	% Moisture	benzo(b)fluoranthene	benzo(e)pyrene	benzo(g,h,i)perylene	benzo(k)fluoranthene	C1-naphthalenes	C1-phenanthrenes	C2-naphthalenes
1	05049311	40.5	0.050	-	-	-	0.050	-	-
2	05049321	36.0	0.063				0.109	0.063	-
2	05049322	36.5	0.063	-	-	-	0.110	0.079	0.047
3	05039331	17.5	-	-	-	-	0.085	0.036	0.036
4	05039341	39.5	0.050	-	-	-	0.050	-	-
5	05109351	82.0	0.167	-	-	-	-	-	-
6	05049361	71.0	0.621	0.414	0.621	0.483	0.138	-	0.276
7	05049371	30.5	-	-	-	-	0.115	0.043	0.158
8	05049381	38.0	-	-	-	-	-	-	-
9	05049391	39.5	-	-	-	0.050	-	-	-
Control	051093C1	33.0	-	-	-	-	0.045	-	-

B4. EXTENDED...

Site	Sample #	% Moisture	C2-phenanthrenes	chrysene	dibenzothiophene	fluorene	indeno(1,2,3-cd)pyrene	perylene	phenanthrene	pyrene	Total
1	05049311	40.5	0.084	0.067	-	-	-	0.067	0.050	0.067	0.437
2	05049321	36.0	0.125	0.063		0.078			0.375	0.109	1.281
2	05049322	36.5	0.157	0.063	0.047	0.110	-	-	0.520	0.126	1.732
3	05039331	17.5	0.036	-	-	-	-	0.036	-	-	0.388
4	05039341	39.5	-	-	-	-	-	-	-	-	0.099
5	05109351	82.0	-	-	-	-	-	0.889	-	-	1.222
6	05049361	71.0	0.517	0.828	0.103	0.103	0.586	0.207	1.103	1.138	8.172
7	05049371	30.5	0.058	-	-	-	-	0.043	0.043	-	0.662
8	05049381	38.0	-	-	-	-	-	-	-	-	0.000
9	05049391	39.5	-	-	-	-	-	-	0.050	0.050	0.198
Control	051093C1	33.0	-	-	-	-	-	-	-	-	0.045

APPENDIX C

Chemical Analyses June 1993

C1. QUALITY ASSURANCE SCREENING OF ALL ANALYTES TESTED FOR IN FISH CREEK SEDIMENT SAMPLES, ANCHORAGE ALASKA JUNE 1993

Metal	<2x	duplicates	blanks
Al		ok	ok
As		ok	ok
B		ok	NO
Ba		ok	ok
Be		ok	ok
Cd	x	N/A	ok
Cr		ok	ok
Cu		ok	ok
Fe		ok	ok
Hg	x	ok	ok
Mg		ok	ok
Mn		N/A	ok
Mo	x	ok	ok
Ni		ok	ok
Pb		ok	ok
Se	x	N/A	ok
Sr		ok	ok
V		ok	ok
Zn		ok	ok

Aliphatics	<2x	duplicates	blanks
n-decane		ok	ok
n-docosane		ok	ok
n-dodecane		ok	ok
n-dotriacontane		ok	ok
n-eicosane		ok	ok
n-heneicosane		ok	ok
n-hentriacontane		ok	ok
n-heptacosane		ok	ok
n-heptadecane		ok	ok
n-hexacosane		ok	ok
n-hexadecane		ok	ok
n-nonacosane		ok	ok
n-nonadecane		ok	ok
n-octacosane		ok	ok
n-octadecane		ok	ok
n-pentacosane		ok	ok
n-pentadecane		ok	ok
n-tetracosane		ok	ok
n-tetradecane		ok	ok
n-tetratriacontane		N/A	ok
n-triacontane		ok	ok
n-tricosane		ok	ok
n-tridecane		ok	ok
n-tritriacontane		ok	ok
n-undecane		ok	ok
phytane		ok	ok
pristane		ok	ok

Aromatic	<2x	duplicates	blanks
1,2,5,6-dibenzanthracene	x	N/A	ok
1,2-benzanthracene		N/A	ok
1,6,7-Trimethyl-naphthalene		ok	ok
1-methylnaphthalene		ok	ok
1-methylphenanthrene	x	ok	ok
2,6-dimethylnaphthalene		ok	ok
2-methylnaphthalene		ok	ok
acenaphthalene	x	N/A	ok
acenaphthene	x	N/A	ok
anthracene	x	N/A	ok
benzo(a)pyrene		N/A	ok
benzo(b)fluoranthene		N/A	ok
benzo(e)pyrene		N/A	ok
benzo(g,h,i)perylene		N/A	ok
benzo(k)fluoranthene		N/A	ok
biphenyl	x	ok	ok
C1-chrysenes		ok	ok
C1-dibenzothiophenes	x	N/A	ok
C1-Fluoranthenes & Pyrenes		ok	ok
C1-fluorenes		ok	ok
C1-naphthalenes		ok	ok
C1-Phenanthrenes & Anthracenes		NO	ok
C2-chrysenes		ok	ok
C2-dibenzothiophenes	x	N/A	ok
C2-fluorenes		NO	ok
C2-naphthalenes		NO	ok
C2-Phenanthrenes & Anthracenes		NO	ok
C3-chrysenes		N/A	ok
C3-dibenzothiophenes	x	N/A	ok
C3-fluorenes		NO	ok
C3-naphthalenes		ok	ok
C3-Phenanthrenes & Anthracenes		ok	ok
C4-chrysenes	x	N/A	ok
C4-naphthalenes		ok	ok
C4-Phenanthrenes & Anthracenes		NO	ok
chrysene		ok	ok
dibenzothiophene	x	N/A	ok
fluoranthene		N/A	ok
fluorene	x	ok	ok
indeno(1,2,3-cd)pyrene		N/A	ok
naphthalene		ok	ok
perylene		N/A	ok
phenanthrene		ok	ok
pyrene		N/A	ok
unresolved complex mixture		NO	ok

Organochlorines	<2x	duplicates	blanks
Aldrin	x	N/A	ok
alpha BHC	x	N/A	ok
alpha chlordane	x	N/A	ok
beta BHC	x	N/A	ok
cis-nonachlor	x	N/A	ok
delta BHC	x	N/A	ok
dieldrin	x	N/A	ok
endrin	x	N/A	ok
gamma BHC	x	N/A	ok
gamma chlordane	x	N/A	ok
HCB	x	N/A	ok
Heptachlor	x	N/A	ok
heptachlor epoxide	x	N/A	ok
mirex	x	N/A	ok
o,p'-DDD	x	N/A	ok
o,p'-DDE	x	N/A	ok
o,p'-DDT	x	N/A	ok
oxychlordane	x	N/A	ok
p,p'-DDD	x	N/A	ok
p,p'-DDE	x	N/A	ok
p,p'-DDT	x	N/A	ok
PCB-TOTAL		N/A	ok
toxaphene	x	N/A	ok
trans-nonachlor	x	N/A	ok

PCBs	<2x	duplicates	blanks
PCB# 7	x	N/A	ok
PCB# 8	x	N/A	ok
PCB# 15	x	N/A	ok
PCB# 16/32	x	N/A	ok
PCB# 18	x	N/A	ok
PCB# 22	x	N/A	ok
PCB# 24	x	N/A	ok
PCB# 25	x	N/A	ok
PCB# 26	x	N/A	ok
PCB# 28	x	N/A	ok
PCB# 29	x	N/A	ok
PCB# 31	x	N/A	ok
PCB# 33	x	N/A	ok
PCB# 37/42	x	N/A	ok
PCB# 40	x	N/A	ok
PCB# 41/64	x	N/A	ok
PCB# 44	x	N/A	ok
PCB# 45	x	N/A	ok
PCB# 46	x	N/A	ok
PCB# 47/48	x	N/A	ok
PCB# 49	x	N/A	ok
PCB# 50	x	N/A	ok
PCB# 52	x	N/A	ok
PCB# 60/56	x	N/A	ok
PCB# 66	x	N/A	ok
PCB# 70	x	N/A	ok
PCB# 74	x	N/A	ok
PCB# 82	x	N/A	ok
PCB# 83	x	N/A	ok
PCB# 84	x	N/A	ok
PCB# 85	x	N/A	ok
PCB# 87	x	N/A	ok
PCB# 88	x	N/A	ok
PCB# 92	x	N/A	ok
PCB# 97	x	N/A	ok
PCB# 99	x	N/A	ok
PCB# 100	x	N/A	ok
PCB# 101	x	N/A	ok
PCB# 105	x	N/A	ok
PCB# 107/108/144	x	N/A	ok
PCB# 110/77	x	N/A	ok
PCB# 118/108/149	x	N/A	ok
PCB# 126	x	N/A	ok
PCB# 128	x	N/A	ok
PCB# 129	x	N/A	ok
PCB# 136	x	N/A	ok
PCB# 137	x	N/A	ok
PCB# 138		N/A	ok
PCB# 141	x	N/A	ok
PCB# 146	x	N/A	ok
PCB# 149	x	N/A	ok
PCB# 151	x	N/A	ok
PCB# 153	x	N/A	ok
PCB# 156/171/202	x	N/A	ok
PCB# 158	x	N/A	ok
PCB# 167	x	N/A	ok
PCB# 170	x	N/A	ok
PCB# 172	x	N/A	ok
PCB# 174	x	N/A	ok
PCB# 177	x	N/A	ok
PCB# 178	x	N/A	ok
PCB# 180	x	N/A	ok
PCB# 183	x	N/A	ok
PCB# 185	x	N/A	ok
PCB# 187/182/159	x	N/A	ok
PCB# 188	x	N/A	ok
PCB# 189	x	N/A	ok
PCB# 191	x	N/A	ok
PCB# 194	x	N/A	ok
PCB# 195		N/A	ok
PCB# 196	x	N/A	ok
PCB# 200	x	N/A	ok
PCB# 201	x	N/A	ok
PCB# 205	x	N/A	ok
PCB# 206		N/A	ok
PCB# 209		N/A	ok

KEY

<2x:
x concentrations were less than 2x the detection limit in all the samples.

duplicates:
ok relative percent differences were less than 20%.
NO relative percent differences were greater than 20%.
N/A test(s) were invalid; concentrations were below the detection limit.

blanks:
ok concentrations in procedural blanks were less than 2x the detection limit.
NO concentrations in procedural blanks were greater than 2x the detection limit

C2. METALS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. JUNE 1993.

Site	Sample #	% Moisture	Al	As	Ba	Be	Cr	Cu	Fe	Mg	Mn	Ni	Pb	Sr	V	Zn
1	06099311	32.90	13266.71	4.89	58.99	0.89	27.59	17.88	26060.69	7466.20	482.15	30.44	-	29.61	46.62	125.20
2	06099321	30.46	15389.87	12.08	74.70	0.97	32.12	22.15	30551.82	7875.00	559.41	35.15	26.28	26.78	57.05	143.03
2	06099322	31.00	14589.49	9.13	63.34	0.77	33.31	20.49	27733.04	7524.21	436.92	32.31	17.97	21.45	51.88	107.08
3	06099331	27.69	21119.90	10.67	76.72	1.11	47.98	40.53	37873.69	12755.72	760.16	57.94	-	45.27	64.88	92.16
4	06099341	45.24	20973.54	21.39	154.04	1.38	48.39	48.46	39662.81	12756.93	911.91	48.05	14.57	48.08	67.39	154.41
5	06099351	69.65	7104.70	5.92	48.40	-	11.29	14.54	13702.67	1599.82	198.28	14.07	-	29.38	26.84	59.50
6	06099361	34.41	10087.17	5.46	42.85	0.60	24.98	20.83	26400.58	6719.00	376.74	31.54	-	20.34	36.64	168.97
7	06099371	28.44	21504.80	10.87	67.31	1.10	46.66	41.13	37916.58	14114.47	812.67	50.51	-	54.16	69.01	90.94
8	06109381	37.56	12066.02	4.89	53.50	0.58	22.90	18.50	18453.98	5402.16	299.61	25.87	-	12.62	39.16	39.51
9	06109391	46.01	14393.03	4.73	78.28	0.66	27.33	23.09	20124.19	5338.49	316.77	26.00	-	20.08	47.60	49.74
Control	060993C1	43.09	15740.09	8.06	134.71	0.83	53.16	27.63	23084.16	7683.06	394.35	36.00	-	63.18	63.16	66.75

(-) Concentration less than 2x the detection limit.

C3. ALIPHATIC HYDROCARBONS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. JUNE 1993.

Site	Sample #	% Moisture	n-decane	n-docosane	n-dodecane	n-dotriacontane	n-eicosane	n-heneicosane	n-hentriacontane	n-heptacosane	n-heptadecane	n-hexacosane
1	06099311	35.96	-	0.123	-	0.263	0.140	0.274	0.970	1.680	0.252	0.225
2	06099321	30.48	-	0.185	-	0.268	0.309	0.302	1.078	2.047	0.154	0.305
2	06099322	32.35	-	0.194	-	0.191	0.259	0.312	0.978	2.065	0.156	0.340
3	06099331	30.48	0.060	0.135	0.075	0.033	0.142	0.135	0.287	0.803	0.145	0.149
4	06099341	45.45	-	0.098	-	0.367	0.116	0.163	0.620	0.851	0.406	0.219
5	06099351	78.50	-	3.641	-	1.824	1.042	8.499	14.508	23.287	6.776	5.135
6	06099361	37.60	0.043	0.179	0.054	0.399	0.203	0.314	3.845	2.076	0.236	0.347
7	06099371	28.57	0.107	0.123	0.125	-	0.155	0.115	0.094	0.204	0.162	0.099
8	06109381	39.67	-	0.272	-	0.396	0.148	0.437	6.903	3.458	0.040	0.499
9	06109391	43.10	-	0.405	-	0.706	0.223	0.930	13.429	9.338	0.428	0.825
Control	060993C1	53.06	-	0.394	-	0.313	0.157	0.625	4.123	9.758	0.072	0.699

(-) Concentration less than 2x the detection limit.

C3. EXTENDED...

Site	Sample #	% Moisture	n-hexadecane	n-nonacosane	n-nonadecane	n-octacosane	n-octadecane	n-pentacosane	n-pentadecane	n-tetracosane	n-tetradecane
1	06099311	35.96	0.047	1.130	0.100	0.238	0.073	1.299	0.044	0.229	-
2	06099321	30.48	0.040	1.452	0.110	0.358	0.063	1.391	0.038	0.229	-
2	06099322	32.35	0.039	1.532	0.111	0.346	0.064	1.293	0.034	0.290	-
3	06099331	30.48	0.085	0.543	0.097	0.134	0.086	0.434	0.097	0.137	0.087
4	06099341	45.45	0.054	0.678	0.094	0.213	0.067	0.682	0.064	0.140	0.028
5	06099351	78.50	-	33.433	1.260	4.203	0.722	19.491	0.130	4.547	-
6	06099361	37.60	0.071	4.673	0.145	0.360	0.098	1.608	0.073	0.245	0.036
7	06099371	28.57	0.121	0.148	0.119	0.076	0.114	0.178	0.140	0.118	0.129
8	06109381	39.67	-	5.194	0.119	0.568	0.056	1.712	-	0.423	-
9	06109391	43.10	0.064	8.870	0.289	0.715	0.150	7.243	0.056	0.703	-
Control	060993C1	53.06	-	4.807	0.138	0.636	0.055	4.137	-	0.700	-

C3. EXTENDED...

Site	Sample #	% Moisture	n-tetratriacontane	n-triacontane	n-tricosane	n-tridecane	n-tritriacontane	n-undecane	phytane	pristane	Total
1	06099311	35.96	0.388	0.298	0.639	-	0.563	-	0.205	0.272	9.453
2	06099321	30.48	0.343	0.334	0.646	-	0.604	-	0.189	0.312	10.758
2	06099322	32.35	0.288	0.297	0.663	-	0.477	-	0.179	0.278	10.386
3	06099331	30.48	-	0.066	0.239	0.085	0.118	0.076	-	0.129	4.375
4	06099341	45.45	0.488	0.398	0.291	-	0.496	-	0.114	0.142	6.791
5	06099351	78.50	0.347	2.486	18.461	-	4.190	-	0.302	-	154.283
6	06099361	37.60	0.375	0.626	0.712	-	0.810	0.092	0.172	0.280	18.073
7	06099371	28.57	-	0.044	0.147	0.136	0.038	0.129	-	0.162	2.983
8	06109381	39.67	-	0.593	0.923	-	1.759	-	-	-	23.499
9	06109391	43.10	0.064	0.765	2.759	-	3.222	-	0.071	0.119	51.375
Control	060993C1	53.06	0.048	0.290	1.619	-	1.508	-	-	-	30.080

C4. AROMATIC HYDROCARBONS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. JUNE 1993.

Site	Sample #	% Moisture	1,2-benzanthracene	1,6,7-Trimethyl-naphthalene	1-methylnaphthalene	2,6-dimethylnaphthalene	2-methylnaphthalene	benzo(a)pyrene
1	06099311	35.96	-	-	-	-	-	-
2	06099321	30.48	-	-	-	-	-	-
2	06099322	32.35	-	-	-	-	-	-
3	06099331	30.48	-	-	-	0.030	0.033	-
4	06099341	45.45	-	-	-	-	-	-
5	06099351	78.50	-	-	-	-	-	-
6	06099361	37.60	0.073	-	-	-	-	0.092
7	06099371	28.57	-	0.042	0.036	0.071	0.066	-
8	06109381	39.67	-	-	-	-	-	-
9	06109391	43.10	-	-	-	-	-	-
Control	060993C1	53.06	-	-	-	-	-	-

(-) Concentration less than 2x the detection limit.

C4. EXTENDED...

Site	Sample #	% Moisture	benzo(b)fluoranthene	benzo(e)pyrene	benzo(g,h,i)perylene	benzo(k)fluoranthene	C1-chrysenes	C1-Fluoranthenes & Pyrenes	C1-fluorenes
1	06099311	35.96	-	-	-	-	0.061	-	-
2	06099321	30.48	-	-	-	-	0.063	0.031	-
2	06099322	32.35	-	-	-	-	0.061	0.032	-
3	06099331	30.48	-	-	-	-	0.030	-	-
4	06099341	45.45	-	-	-	-	0.048	-	-
5	06099351	78.50	-	-	-	-	-	-	-
6	06099361	37.60	0.102	0.070	0.084	0.102	0.097	0.105	-
7	06099371	28.57	-	-	-	-	0.047	0.032	0.040
8	06109381	39.67	-	-	-	-	-	-	-
9	06109391	43.10	-	-	-	-	-	-	-
Control	060993C1	53.06	-	-	-	-	-	-	-

C4. EXTENDED...

Site	Sample #	% Moisture	C1-naphthalenes	C2-chrysenes	C3-chrysenes	C3-naphthalenes	C3-Phenanthrenes & Anthracenes	C4-naphthalenes	chrysene
1	06099311	35.96	-	0.139	-	-	0.041	-	0.031
2	06099321	30.48	-	0.087	-	0.058	0.054	0.052	-
2	06099322	32.35	-	0.085	-	0.050	0.077	0.048	-
3	06099331	30.48	0.054	0.029	-	0.134	0.039	0.068	-
4	06099341	45.45	-	0.066	-	0.037	0.041	0.035	-
5	06099351	78.50	-	-	-	-	-	-	-
6	06099361	37.60	-	0.097	-	0.062	0.089	0.055	0.133
7	06099371	28.57	0.102	0.050	-	0.162	0.067	0.071	-
8	06109381	39.67	-	-	-	-	-	-	-
9	06109391	43.10	-	-	-	-	-	-	-
Control	060993C1	53.06	-	-	-	-	-	-	-

C4. EXTENDED...

Site	Sample #	% Moisture	fluoranthene	indeno(1,2,3-cd)pyrene	naphthalene	perylene	phenanthrene	pyrene	Total
1	06099311	35.96	-	-	-	-	-	0.039	0.310
2	06099321	30.48	-	-	-	-	-	0.038	0.383
2	06099322	32.35	-	-	-	-	-	0.038	0.390
3	06099331	30.48	-	-	-	-	-	-	0.418
4	06099341	45.45	-	-	-	-	-	0.038	0.265
5	06099351	78.50	-	-	-	1.101	-	-	1.101
6	06099361	37.60	0.351	0.090	-	-	0.189	0.290	2.081
7	06099371	28.57	-	-	-	-	0.045	-	0.310
8	06109381	39.67	-	-	-	-	-	-	0.000
9	06109391	43.10	0.043	-	-	-	-	0.038	0.081
Control	060993C1	53.06	-	-	-	0.138	-	-	0.138

C5. TOTAL POLYCHLORINATED BIPHENYLS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. JUNE 1993.

Site	Sample #	% Moisture	PCB-TOTAL
1	06099311	35.96	0.031
2	06099321	30.48	-
2	06099322	32.35	-
3	06099331	30.48	-
4	06099341	45.45	-
5	06099351	78.50	0.326
6	06099361	37.60	0.016
7	06099371	28.57	-
8	06109381	39.67	-
9	06109391	43.10	0.053
Control	060993C1	53.06	-

(-) Concentration less than 2x the detection limit.

C6. POLYCHLORINATED BIPHENYL CONGENERS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. JUNE 1993.

Site	Sample #	% Moisture	PCB# 138	PCB# 195	PCB# 206	PCB# 209
1	06099311	35.96	-	-	-	-
2	06099321	30.48	-	-	-	-
2	06099322	32.35	-	-	-	-
3	06099331	30.48	-	-	-	-
4	06099341	45.45	-	-	-	-
5	06099351	78.5	0.047	0.047	0.047	0.047
6	06099361	37.6	-	-	-	-
7	06099371	28.57	-	-	-	-
8	06109381	39.67	-	-	-	-
9	06109391	43.1	-	-	0.018	0.018
Control	060993C1	53.06	-	-	-	-

(-) Concentration less than 2x the detection limit.

APPENDIX D

Chemical Analyses July 1993

QUALITY ASSURANCE SCREENING OF ALL ANALYTES TESTED FOR IN FISH CREEK SEDIMENT SAMPLES, ANCHORAGE ALASKA JULY 1993

Metal	<2x	duplicates	blanks
Al		ok	ok
As		ok	ok
B		ok	ok
Ba		ok	ok
Be		ok	ok
Cd	x	ok	ok
Cr		ok	ok
Cu		ok	ok
Fe		ok	ok
Hg	x	ok	ok
Mg		ok	ok
Mn		ok	ok
Mo	x	N/A	ok
Ni		ok	ok
Pb		ok	ok
Se	x	N/A	ok
Sr		ok	ok
V		ok	ok
Zn		ok	ok

Aliphatics	<2x	duplicates	blanks
n-decane		ok	ok
n-docosane		ok	ok
n-dodecane		ok	ok
n-dotriacontane		NO	ok
n-eicosane		ok	ok
n-heneicosane		ok	ok
n-hentriacontane		ok	ok
n-heptacosane		ok	ok
n-heptadecane		ok	ok
n-hexacosane		ok	ok
n-hexadecane		ok	ok
n-nonacosane		ok	ok
n-nonadecane		ok	ok
n-octacosane		ok	ok
n-octadecane		ok	ok
n-pentacosane		ok	ok
n-pentadecane		ok	ok
n-tetracosane		ok	ok
n-tetradecane		ok	ok
n-tetratriacontane		NO	ok
n-triacontane		ok	ok
n-tricosane		ok	ok
n-tridecane		ok	ok
n-tritriacontane		ok	ok
n-undecane		ok	ok
phytane		ok	ok
pristane		ok	ok

Aromatics	<2x	duplicates	blanks
1,2,5,6-dibenzanthracene	x	N/A	ok
1,2 benzanthracene		N/A	ok
1,6,7-Trimethyl-naphthalene	x	N/A	ok
1-methylnaphthalene	x	N/A	ok
1-methylphenanthrene	x	N/A	ok
2,6-dimethylnaphthalene	x	ok	ok
2-methylnaphthalene	x	ok	ok
acenaphthalene	x	N/A	ok
acenaphthene	x	N/A	ok
anthracene	x	N/A	ok
benzo(a)pyrene		N/A	ok
benzo(b)fluoranthene		N/A	ok
benzo(e)pyrene		N/A	ok
benzo(g,h,i)perylene		N/A	ok
benzo(k)fluoranthene		N/A	ok
biphenyl	x	N/A	ok
C1-chrysenes		N/A	ok
C1-dibenzothiophenes	x	N/A	ok
C1-Fluoranthenes & Pyrenes		N/A	ok
C1-fluorenes	x	N/A	ok
C1-naphthalenes		ok	ok
C1-Phenanthrenes & Anthracenes		ok	ok
C2-chrysenes		ok	ok
C2-dibenzothiophenes	x	N/A	ok
C2-fluorenes		N/A	ok
C2-naphthalenes		ok	ok
C2-Phenanthrenes & Anthracenes		ok	ok
C3-chrysenes		N/A	ok
C3-dibenzothiophenes		N/A	ok
C3-fluorenes		N/A	ok
C3-naphthalenes		ok	ok
C3-Phenanthrenes & Anthracenes		ok	ok
C4-chrysenes	x	N/A	ok
C4-naphthalenes		ok	ok
C4-Phenanthrenes & Anthracenes		ok	ok
chrysene		N/A	ok
dibenzothiophene	x	N/A	ok
fluoranthene		N/A	ok
fluorene	x	N/A	ok
indeno(1,2,3-cd)pyrene		N/A	ok
naphthalene	x	N/A	ok
perylene		N/A	ok
phenanthrene		ok	ok
pyrene		N/A	ok
unresolved complex mixture		NO	ok

Organochlorines	<2x	duplicates	blanks
Aldrin	x	N/A	ok
alpha BHC	x	N/A	ok
alpha chlordane	x	N/A	ok
beta BHC	x	N/A	ok
cis-nonachlor		N/A	ok
delta BHC		N/A	ok
dieldrin	x	N/A	ok
endrin	x	N/A	ok
gamma BHC	x	N/A	ok
gamma chlordane		N/A	ok
HCB	x	N/A	ok
Heptachlor	x	N/A	ok
heptachlor epoxide	x	N/A	ok
mirex		N/A	ok
o,p'-DDD		N/A	ok
o,p'-DDE		N/A	ok
o,p'-DDT		N/A	ok
oxychlordane	x	N/A	ok
p,p'-DDD		N/A	ok
p,p'-DDE		N/A	ok
p,p'-DDT		N/A	ok
PCB-TOTAL		N/A	ok
toxaphene	x	N/A	ok
trans-nonachlor			

PCBs	<2x	duplicates	blanks
PCB# 7	x	N/A	ok
PCB# 8	x	N/A	ok
PCB# 15	x	N/A	ok
PCB# 16/32	x	N/A	ok
PCB# 18	x	N/A	ok
PCB# 22	x	N/A	ok
PCB# 24	x	N/A	ok
PCB# 25	x	N/A	ok
PCB# 26	x	N/A	ok
PCB# 28	x	N/A	ok
PCB# 29	x	N/A	ok
PCB# 31	x	N/A	ok
PCB# 33	x	N/A	ok
PCB# 37/42	x	N/A	ok
PCB# 40	x	N/A	ok
PCB# 41/64	x	N/A	ok
PCB# 44	x	N/A	ok
PCB# 45	x	N/A	ok
PCB# 46	x	N/A	ok
PCB# 47/48	x	N/A	ok
PCB# 49	x	N/A	ok
PCB# 50	x	N/A	ok
PCB# 52		N/A	ok
PCB# 60/56	x	N/A	ok
PCB# 66		N/A	ok
PCB# 70	x	N/A	ok
PCB# 74	x	N/A	ok
PCB# 82		N/A	ok
PCB# 83	x	N/A	ok
PCB# 84	x	N/A	ok
PCB# 85	x	N/A	ok
PCB# 87	x	N/A	ok
PCB# 88		N/A	ok
PCB# 92	x	N/A	ok
PCB# 97	x	N/A	ok
PCB# 99	x	N/A	ok
PCB# 100	x	N/A	ok
PCB# 101		N/A	ok
PCB# 105		N/A	ok
PCB# 107/108/144	x	N/A	ok
PCB# 110/77	x	N/A	ok
PCB# 118/108/149		N/A	ok
PCB# 126		N/A	ok
PCB# 128		N/A	ok
PCB# 129	x	N/A	ok
PCB# 136	x	N/A	ok
PCB# 137	x	N/A	ok
PCB# 138		N/A	ok
PCB# 141	x	N/A	ok
PCB# 146	x	N/A	ok
PCB# 149	x	N/A	ok
PCB# 151	x	N/A	ok
PCB# 153		N/A	ok
PCB# 156/171/202	x	N/A	ok
PCB# 158	x	N/A	ok
PCB# 167	x	N/A	ok
PCB# 170	x	N/A	ok
PCB# 172	x	N/A	ok
PCB# 174	x	N/A	ok
PCB# 177	x	N/A	ok
PCB# 178	x	N/A	ok
PCB# 180		N/A	ok
PCB# 183	x	N/A	ok
PCB# 185	x	N/A	ok
PCB# 187/182/159		N/A	ok
PCB# 188	x	N/A	ok
PCB# 189	x	N/A	ok
PCB# 191	x	N/A	ok
PCB# 194		N/A	ok
PCB# 195		N/A	ok
PCB# 196	x	N/A	ok
PCB# 200		N/A	ok
PCB# 201	x	N/A	ok
PCB# 205	x	N/A	ok
PCB# 206		N/A	ok
PCB# 209		N/A	ok

KEY

<2x:
x concentrations were less than 2x the detection limit in all the samples.

duplicates:
ok relative percent differences were less than 20%.
NO relative percent differences were greater than 20%.
N/A test(s) were invalid; concentrations were below the detection limit.

blanks:
ok concentrations in procedural blanks were less than 2x the detection limit.
NO concentrations in procedural blanks were greater than 2x the detection limit.

D2. METALS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. JULY 1993.

Site	Sample #	% Moisture	Al	As	B	Ba	Be	Cr	Cu	Fe	Mg	Mn	Ni	Pb	Sr	V	Zn
1	07079311	38.60	9837.90	6.32	-	66.79	0.61	23.65	20.66	23491.25	7187.81	493.69	35.34	-	28.56	38.84	103.20
2	07079321	37.64	12958.89	7.69	-	55.67	0.82	24.90	16.91	31102.03	7809.74	401.49	29.86	12.35	19.50	45.42	162.83
3	07079331	23.71	18513.78	7.14	-	72.49	0.96	39.44	32.43	32667.94	11257.03	657.81	48.74	-	35.14	60.75	86.06
4	07079341	43.67	19813.32	19.78	23.80	136.68	1.09	43.80	48.01	38210.43	12123.93	773.98	45.01	14.01	42.61	63.67	155.14
5	07089351	80.89	7849.66	6.80	-	53.60	-	11.83	15.96	10595.14	1723.15	131.66	17.25	-	27.75	34.18	73.36
6	07079361	35.71	14897.22	5.68	29.15	56.19	0.94	34.49	22.07	33215.43	8721.54	512.80	37.27	12.46	29.50	53.66	224.79
7	07079371	38.37	20826.63	15.86	31.01	109.22	1.14	47.80	48.34	39006.82	14161.66	873.20	56.38	11.12	49.20	66.78	115.13
8	07089381	30.64	19816.14	7.37	-	93.35	0.92	36.24	19.76	27747.04	8518.99	383.28	39.40	-	18.18	66.77	56.71
9	07089391	49.37	10898.42	3.54	-	61.16	0.49	22.40	20.62	15879.35	4229.93	251.76	20.58	-	15.32	37.06	41.79
9	07089392	50.85	14782.44	5.04	-	79.18	0.66	28.36	24.99	20196.04	5372.62	321.02	26.20	10.23	21.06	49.89	51.29
Control	070793C1	29.84	8121.24	3.99	-	59.78	0.46	25.99	12.48	18560.28	5107.78	468.03	23.64	-	26.85	31.04	44.07

(-) Concentration less than 2x the detection limit.

D3. ALIPATIC HYDROCARBONS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. JULY 1993.

Site	Sample #	% Moisture	n-decane	n-docosane	n-dodecane	n-eicosane	n-heneicosane	n-hentriacontane	n-heptacosane	n-heptadecane	n-hexacosane
1	07079311	39.42	-	-	-	0.182	0.593	2.206	4.614	0.546	0.469
2	07079321	48.62	-	0.138	-	0.097	0.251	1.295	1.620	0.238	0.310
3	07079331	25.49	0.045	0.091	0.056	0.137	0.091	0.252	0.343	0.118	0.095
4	07079341	44.44	-	0.083	-	0.082	0.192	0.552	0.919	0.515	0.211
5	07089351	83.84	-	2.434	-	0.915	6.152	10.061	19.640	2.441	4.158
6	07079361	39.81	0.064	0.184	0.084	0.341	0.379	1.613	2.253	0.338	0.341
7	07079371	39.22	0.036	0.073	0.040	0.097	0.103	0.220	0.548	0.532	0.087
8	07089381	31.36	-	0.040	-	0.034	0.081	0.279	0.599	0.056	0.058
9	07089391	51.43	-	0.662	-	0.300	1.398	18.760	11.934	0.701	1.194
9	07089392	48.57	-	0.559	-	0.271	1.233	16.458	12.482	0.528	1.085
Control	070793C1	37.19	-	0.053	-	-	0.076	0.607	1.269	-	0.086

(-) Concentration less than 2x the detection limit.

D3. EXTENDED...

Site	Sample #	% Moisture	n-hexadecane	n-nonacosane	n-nonadecane	n-octacosane	n-octadecane	n-pentacosane	n-pentadecane	n-tetracosane	n-tetradecane
1	07079311	39.42	0.084	2.860	0.179	0.475	0.126	2.996	0.065	0.487	-
2	07079321	48.62	0.068	1.214	0.116	0.300	0.065	1.356	0.059	0.243	0.038
3	07079331	25.49	0.065	0.351	0.070	0.078	0.061	0.254	0.070	0.092	0.065
4	07079341	44.44	0.043	0.619	0.084	0.158	0.048	0.771	0.058	0.197	-
5	07089351	83.84	-	21.000	1.033	2.869	0.382	15.363	-	3.355	-
6	07079361	39.81	0.078	1.824	0.148	0.396	0.097	1.908	0.077	0.312	0.040
7	07079371	39.22	0.062	0.312	0.088	0.067	0.053	0.396	0.127	0.077	0.046
8	07089381	31.36	-	0.336	0.061	0.054	-	0.260	-	0.056	-
9	07089391	51.43	0.068	12.597	0.397	1.199	0.190	8.195	0.061	1.050	-
9	07089392	48.57	0.059	11.045	0.353	1.001	0.164	7.690	0.053	0.915	-
Control	070793C1	37.19	-	0.627	-	0.072	-	0.511	-	0.080	-

D3. EXTENDED...

Site	Sample #	% Moisture	n-triacontane	n-tricosane	n-tridecane	n-tritriacontane	n-undecane	phytane	pristane	Total
1	07079311	39.42	0.360	1.373	-	1.054	-	0.265	0.388	19.323
2	07079321	48.62	0.523	0.601	-	0.811	-	0.166	0.255	9.764
3	07079331	25.49	0.055	0.154	0.061	0.105	0.053	-	0.102	2.863
4	07079341	44.44	0.426	0.303	-	0.594	-	0.126	0.151	6.132
5	07089351	83.84	1.879	13.928	-	3.243	-	0.156	-	109.010
6	07079361	39.81	0.506	0.780	0.047	0.725	0.145	0.242	0.384	13.305
7	07079371	39.22	0.047	0.190	0.044	0.093	0.037	-	0.091	3.466
8	07089381	31.36	-	0.092	-	0.073	-	-	-	2.079
9	07089391	51.43	1.123	3.893	-	4.636	-	0.076	0.136	68.570
9	07089392	48.57	0.974	3.367	-	4.106	-	0.072	0.058	62.474
Control	070793C1	37.19	0.032	0.202	-	0.227	-	-	-	3.843

04. AROMATIC HYDROCARBONS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. JULY 1993.

Site	Sample #	% Moisture	1,2-benzanthracene	benzo(a)pyrene	benzo(b)fluoranthene	benzo(e)pyrene	benzo(g,h,i)perylene	benzo(k)fluoranthene	C1-chrysenes	C1-Fluoranthenes & Pyrenes
1	07079311	39.42	-	-	-	-	-	-	0.040	-
2	07079321	48.62	-	-	0.049	0.055	-	0.053	0.071	0.050
3	07079331	25.49	-	-	-	-	-	-	-	-
4	07079341	44.44	-	-	-	-	-	-	0.050	-
5	07089351	83.84	-	-	-	-	-	-	-	-
6	07079361	39.81	0.080	0.107	0.131	0.114	0.078	0.141	0.088	0.117
7	07079371	39.22	-	-	-	-	-	-	-	-
8	07089381	31.36	-	-	-	-	-	-	-	-
9	07089391	51.43	-	-	-	-	-	-	-	-
9	07089392	48.57	-	-	-	-	-	-	-	-
Control	070793C1	37	-	-	-	-	-	-	-	-

(-) Concentration less than 2x the detection limit.

D4. EXTENDED...

Site	Sample #	% Moisture	C1-naphthalenes	C1-Phenanthrenes & Anthracenes	C2-chrysenes	C2-fluorenes	C2-naphthalenes	C2-Phenanthrenes & Anthracenes	C3-chrysenes
1	07079311	39.42	-	-	0.080	-	-	0.044	-
2	07079321	48.62	-	-	0.112	-	-	0.067	-
3	07079331	25.49	0.038	0.043	-	-	0.048	0.056	-
4	07079341	44.44	-	0.039	0.089	-	-	0.079	0.036
5	07089351	83.84	-	-	-	-	-	-	-
6	07079361	39.81	-	0.095	0.093	0.035	0.040	0.110	-
7	07079371	39.22	0.036	-	-	-	0.041	0.042	-
8	07089381	31.36	-	-	-	-	-	-	-
9	07089391	51.43	-	-	-	-	-	-	-
9	07089392	48.57	-	-	-	-	-	-	-
Control	070793C1	37	-	-	-	-	-	-	-

D4. EXTENDED...

Site	Sample #	% Moisture	C3-dibenzothiophenes	C3-fluorenes	C3-naphthalenes	C3-Phenanthrenes & Anthracenes	C4-naphthalenes	C4-naphthalenes	C4-Phenanthrenes & Anthracenes
1	07079311	39.42	-	-	-	0.051	-	-	0.040
2	07079321	48.62	-	0.041	-	0.079	-	-	0.079
3	07079331	25.49	-	-	0.069	0.032	-	-	0.042
4	07079341	44.44	-	-	-	0.072	-	-	0.053
5	07089351	83.84	-	-	-	-	-	-	-
6	07079361	39.81	0.035	0.051	0.051	0.100	0.044	0.044	0.100
7	07079371	39.22	-	-	0.060	-	-	-	-
8	07089381	31.36	-	-	-	-	-	-	-
9	07089391	51.43	-	-	-	-	-	-	-
9	07089392	48.57	-	-	-	-	-	-	-
Control	070793C1	37	-	-	-	-	-	-	-

D4. EXTENDED...

Site	Sample #	% Moisture	C4-naphthalenes	C4-Phenanthrenes & Anthracenes	chrysene	fluoranthene	indeno(1,2,3-cd)pyrene	perylene	phenanthrene	pyrene	Total
1	07079311	39.42	-	0.040	-	-	-	0.051	-	0.039	0.346
2	07079321	48.62	-	0.079	0.083	0.107	-	-	0.047	0.129	1.022
3	07079331	25.49	-	0.042	-	-	-	-	-	-	0.327
4	07079341	44.44	-	0.053	-	0.047	-	-	-	0.055	0.518
5	07089351	83.84	-	-	-	-	-	1.139	-	-	1.139
6	07079361	39.81	0.044	0.100	0.194	0.410	0.078	0.041	0.223	0.343	2.899
7	07079371	39.22	-	-	-	-	-	-	-	-	0.180
8	07089381	31.36	-	-	-	-	-	-	-	-	0.000
9	07089391	51.43	-	-	-	0.069	-	-	0.049	0.063	0.182
9	07089392	48.57	-	-	-	0.069	-	-	0.055	0.064	0.188
Control	070793C1	37	-	-	-	-	-	-	-	-	0.000

D5. ORGANOCHLORINES AND TOTAL PCB (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. JULY 1993.

Site	Sample #	% Moisture	cis-nonachlor	delta BHC	gamma chlordane	mirex	o,p'-DDD	o,p'-DDE	o,p'-DDT	p,p'-DDD	p,p'-DDE	p,p'-DDT	PCB-TOTAL
1	07079311	39.42	-	-	-	-	-	-	-	-	-	-	0.037
2	07079321	48.62	-	-	-	-	-	-	-	-	-	-	0.008
3	07079331	25.49	-	-	-	-	-	-	-	-	-	-	-
4	07079341	44.44	-	-	-	-	-	-	-	-	-	-	0.006
5	07089351	83.84	-	-	-	-	-	-	-	-	-	-	0.010
6	07079361	39.81	-	-	-	-	-	-	-	-	-	-	0.012
7	07079371	39.22	-	-	-	-	-	-	-	-	-	-	-
8	07089381	31.36	-	-	-	-	-	-	-	-	-	-	-
9	07089391	51.43	0.008	0.004	0.005	0.008	0.007	0.005	0.008	0.024	0.008	0.006	0.338
9	07089392	48.57	-	-	-	-	-	-	-	-	-	-	0.046
Control	070793C1	37.19	-	-	-	-	-	-	-	-	-	-	-

(-) Concentration less than 2x the detection limit.

D6. POLYCHLORINATED BIPHENYL CONGENERS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. JULY 1993.

Sample #	% Moisture	PCB# 52	PCB# 66	PCB# 77	PCB# 87	PCB# 101	PCB# 105	PCB# 118/108/149	PCB# 126	PCB# 128	PCB# 138	PCB# 153	PCB# 180	PCB# 187/182/159	PCB# 194	PCB# 195	PCB# 200	PCB# 206	PCB# 209
07079311	39.42	0.004	-	-	-	-	-	-	-	-	0.004	-	-	-	-	0.005	-	0.008	0.004
07079321	48.62	0.006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07079331	25.49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07079341	44.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07089351	83.84	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07079361	39.81	0.009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07079371	39.22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07089381	31.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07089391	51.43	0.004	0.007	0.008	0.013	0.005	0.032	0.015	0.032	0.025	0.023	0.010	-	0.007	0.005	0.031	0.012	0.041	0.041
07089392	48.57	-	-	-	-	-	-	-	-	-	-	-	0.004	-	-	0.006	-	0.013	0.012
070793C1	37.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

( ) Concentration less than 2x the detection limit.

APPENDIX E

Chemical Analyses August 1993

E1 QUALITY ASSURANCE SCREENING OF ALL ANALYTES TESTED FOR IN FISH CREEK SEDIMENT SAMPLES, ANCHORAGE ALASKA AUGUST 1993

Metal	<2x	duplicates	blanks
Al		ok	ok
As		ok	ok
B		ok	NO
Ba		ok	ok
Be		ok	ok
Cd		ok	ok
Cr		ok	ok
Cu		ok	ok
Fe		ok	ok
Hg		N/A	ok
Mg		ok	ok
Mn		ok	ok
Mo	x	N/A	ok
Ni		ok	ok
Pb		ok	ok
Se	x	N/A	ok
Sr		ok	ok
V		ok	ok
Zn		ok	ok

Aliphatics	<2x	duplicates	blanks
n-decane		-	ok
n-docosane		-	ok
n-dodecane		-	ok
n-dotriacontane		-	ok
n-eicosane		-	ok
n-heneicosane		-	ok
n-hentriacontane		-	ok
n-heptacosane		-	ok
n-heptadecane		-	ok
n-hexacosane		-	ok
n-hexadecane		-	ok
n-nonacosane		-	ok
n-nonadecane		-	ok
n-octacosane		-	ok
n-octadecane		-	ok
n-pentacosane		-	ok
n-pentadecane		-	ok
n-tetracosane		-	ok
n-tetradecane		-	ok
n-tetratriacontane		-	ok
n-triacontane		-	ok
n-tricosane		-	ok
n-tridecane		-	ok
n-tritriacontane		-	ok
n-undecane		-	ok
phytane		-	ok
pristane		-	ok

Aromatics	<2x	duplicates	blanks
1,2,5,6-dibenzanthracene	x	N/A	ok
1,2-benzanthracene		N/A	ok
1,6,7-Trimethyl-naphthalene	x	N/A	ok
1-methylnaphthalene	x	N/A	ok
1-methylphenanthrene	x	N/A	ok
2,6-dimethylnaphthalene	x	N/A	ok
2-methylnaphthalene	x	N/A	ok
acenaphthalene	x	N/A	ok
acenaphthene	x	N/A	ok
anthracene	x	N/A	ok
benzo(a)pyrene		N/A	ok
benzo(b)fluoranthene		N/A	ok
benzo(e)pyrene		N/A	ok
benzo(g,h,i)perylene		N/A	ok
benzo(k)fluoranthene		N/A	ok
biphenyl	x	N/A	ok
C1-chrysenes		ok	ok
C1-dibenzothiophenes	x	N/A	ok
C1-Fluoranthenes & Pyrenes		N/A	ok
C1-fluorenes	x	N/A	ok
C1-naphthalenes		N/A	ok
C1-Phenanthrenes & Anthracenes		ok	ok
C2-chrysenes		ok	ok
C2-dibenzothiophenes	x	N/A	ok
C2-fluorenes	x	N/A	ok
C2-naphthalenes		N/A	ok
C2-Phenanthrenes & Anthracenes		NO	ok
C3-chrysenes	x	N/A	ok
C3-dibenzothiophenes		ok	ok
C3-fluorenes		ok	ok
C3-naphthalenes		ok	ok
C3-Phenanthrenes & Anthracenes		ok	ok
C4-chrysenes	x	N/A	ok
C4-naphthalenes		ok	ok
C4-Phenanthrenes & Anthracenes		ok	ok
chrysene		N/A	ok
dibenzothiophene	x	N/A	ok
fluoranthene		ok	ok
fluorene	x	N/A	ok
Indeno(1,2,3-cd)pyrene		N/A	ok
naphthalene	x	N/A	ok
perylene		N/A	ok
phenanthrene		ok	ok
pyrene		ok	ok
unresolved complex mixture		-	ok

Organochlorines	<2x	duplicates	blanks
Aldrin	x	N/A	ok
alpha BHC	x	N/A	ok
alpha chlordane	x	N/A	ok
beta BHC	x	N/A	ok
cis-nonachlor	x	N/A	ok
delta BHC	x	N/A	ok
dieldrin	x	N/A	ok
endrin	x	N/A	ok
gamma BHC	x	N/A	ok
gamma chlordane	x	N/A	ok
HCB	x	N/A	ok
Heptachlor	x	N/A	ok
heptachlor epoxide	x	N/A	ok
mirex	x	N/A	ok
o,p'-DDD	x	N/A	ok
o,p'-DDE	x	N/A	ok
o,p'-DDT	x	N/A	ok
oxychlordane	x	N/A	ok
p,p'-DDD		N/A	ok
p,p'-DDE	x	N/A	ok
p,p'-DDT	x	N/A	ok
PCB-TOTAL		ok	NO
toxaphene	x	N/A	ok
trans-nonachlor			

PCBs	<2x	duplicates	blanks
PCB# 7	x	N/A	ok
PCB# 8	x	N/A	ok
PCB# 15	x	N/A	ok
PCB# 16/32	x	N/A	ok
PCB# 18	x	N/A	ok
PCB# 22	x	N/A	ok
PCB# 24	x	N/A	ok
PCB# 25	x	N/A	ok
PCB# 26	x	N/A	ok
PCB# 28	x	N/A	ok
PCB# 29	x	N/A	ok
PCB# 31	x	N/A	ok
PCB# 33	x	N/A	ok
PCB# 37/42	x	N/A	ok
PCB# 40	x	N/A	ok
PCB# 41/64	x	N/A	ok
PCB# 44	x	N/A	ok
PCB# 45	x	N/A	ok
PCB# 46	x	N/A	ok
PCB# 47/48	x	N/A	ok
PCB# 49	x	ok	ok
PCB# 50	x	N/A	ok
PCB# 52		ok	ok
PCB# 60/56	x	N/A	ok
PCB# 66	x	N/A	ok
PCB# 70	x	N/A	ok
PCB# 74	x	N/A	ok
PCB# 82	x	N/A	ok
PCB# 83	x	N/A	ok
PCB# 84	x	N/A	ok
PCB# 85	x	N/A	ok
PCB# 87	x	N/A	ok
PCB# 88		N/A	ok
PCB# 92	x	N/A	ok
PCB# 97	x	N/A	ok
PCB# 99	x	N/A	ok
PCB# 100	x	N/A	ok
PCB# 101	x	N/A	ok
PCB# 105	x	N/A	ok
PCB# 107/108/144	x	N/A	ok
PCB# 110/77	x	N/A	ok
PCB# 118/108/149		N/A	ok
PCB# 126		N/A	ok
PCB# 128		N/A	ok
PCB# 129	x	N/A	ok
PCB# 136	x	N/A	ok
PCB# 137	x	N/A	ok
PCB# 138		N/A	ok
PCB# 141	x	N/A	ok
PCB# 146	x	N/A	ok
PCB# 149	x	N/A	ok
PCB# 151	x	N/A	ok
PCB# 153	x	N/A	ok
PCB# 156/171/202	x	N/A	ok
PCB# 158	x	N/A	ok
PCB# 167	x	N/A	ok
PCB# 170		ok	ok
PCB# 172	x	N/A	ok
PCB# 174	x	N/A	ok
PCB# 177	x	N/A	ok
PCB# 178	x	N/A	ok
PCB# 180		N/A	ok
PCB# 183	x	N/A	ok
PCB# 185	x	N/A	ok
PCB# 187/182/159	x	N/A	ok
PCB# 188	x	N/A	ok
PCB# 189	x	N/A	ok
PCB# 191	x	N/A	ok
PCB# 194	x	N/A	ok
PCB# 195		N/A	ok
PCB# 196	x	N/A	ok
PCB# 200		N/A	ok
PCB# 201	x	N/A	ok
PCB# 205	x	N/A	ok

KEY

<2x:
x concentrations were less than 2x the detection limit in all the samples.

duplicates:
ok relative percent differences were less than 20%.
NO relative percent differences were greater than 20%.
N/A test(s) were invalid; concentrations were below the detection limit.
- not duplicated

blanks:
ok concentrations in procedural blanks were less than 2x the detection limit.
NO concentrations in procedural blanks were greater than 2x the detection limit

E2. METALS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. AUGUST 1993.

Site	Sample #	% Moisture	Al	As	Ba	Be	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Ni	Pb	Sr	V	Zn
1	08029311	45.02	16556.56	9.01	95.05	1.01	0.26	35.57	26.36	35256.30	0.10	9227.90	687.52	37.67	11.83	43.33	62.61	212.01
2	08029321	53.91	15534.89	13.64	100.20	1.35	0.40	37.04	21.65	53205.37	-	8506.36	659.27	38.26	23.80	35.87	58.79	307.05
3	08029331	25.51	11087.55	9.71	67.44	0.92	0.28	24.22	16.32	39603.35	0.12	7029.32	496.02	28.77	15.96	22.23	39.84	219.67
4	08029341	41.44	22313.03	20.76	152.07	1.32	0.25	52.79	51.53	41864.06	-	13631.77	895.72	50.74	16.08	46.17	71.05	175.72
5	08039351	79.63	9069.78	5.46	75.90	0.40	-	14.09	12.81	13315.71	-	2048.50	175.38	17.18	-	34.28	33.69	72.71
6	08039361	35.16	12213.53	5.56	47.97	0.77	-	30.40	22.61	29719.77	-	7873.50	455.07	34.80	10.14	21.00	44.02	216.18
7	08039371	64.33	26781.23	21.06	146.70	1.52	0.38	57.52	60.13	46692.99	0.12	16675.24	908.82	60.21	15.42	51.65	78.52	158.38
8	08039381	65.73	20914.72	4.72	101.44	1.02	0.34	50.11	59.98	27704.14	-	7912.04	512.44	43.46	51.61	41.78	67.69	214.89
9	08039391	44.80	17320.39	4.14	87.17	0.79	-	32.06	26.51	22040.23	-	6165.10	337.99	29.42	11.75	27.42	56.21	56.69
9	08039392	50.26	15156.63	4.33	79.79	0.76	-	28.56	29.57	20396.34	-	5628.18	322.89	26.84	12.17	24.94	51.14	56.43
Control	080293C1	38.99	13175.82	5.46	101.92	0.94	-	39.48	16.47	25048.94	-	7604.83	575.60	32.28	-	38.86	50.47	59.84

(-) Concentration less than 2x the detection limit.

L3 ALIPHATIC HYDROCARBONS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. AUGUST 1993.

Site	Sample #	% Moisture	n-decane	n-docosane	n-dodecane	n-dotriacontane	n-eicosane	n-heneicosane	n-hentriacontane	n-heptacosane	n-heptadecane	n-hexacosane
1	08029311	61.39	-	0.570	-	0.803	1.665	1.018	3.491	6.449	1.536	0.800
2	08029321	44.44	-	0.128	-	0.495	0.675	0.230	1.066	1.638	0.355	0.295
3	08029331	28.70	0.043	0.140	0.059	0.065	0.163	0.154	0.526	1.149	0.129	0.163
4	08029341	42.16	-	0.069	-	0.353	0.086	0.123	0.558	0.757	0.541	0.178
5	08039351	84.91	-	3.638	-	1.981	1.060	8.204	13.903	25.142	8.423	5.282
6	08039361	36.11	-	0.130	0.033	0.255	0.213	0.260	1.130	1.349	0.213	0.246
7	08039371	64.39	-	-	-	-	-	-	0.188	0.430	0.199	-
8	08039381	68.93	-	0.740	-	0.550	0.257	1.011	5.958	36.836	0.782	1.770
9	08039391	52.38	-	0.607	-	0.834	0.309	1.501	20.384	11.604	0.655	1.151
9	08039392	48.00	-	0.554	-	0.908	0.265	1.350	18.967	12.306	0.702	1.140
Control	080293C1	42.86	-	0.100	-	0.081	0.040	0.137	1.055	2.335	0.035	0.152

(-) Concentration less than 2x the detection limit.

E3. EXTENDED...

Site	Sample #	% Moisture	n-hexadecane	n-nonacosane	n-nonadecane	n-octacosane	n-octadecane	n-pentacosane	n-pentadecane	n-tetracosane	n-tetradecane
1	08029311	61.39	0.352	3.763	0.591	0.645	0.614	4.903	0.290	0.686	0.098
2	08029321	44.44	0.052	1.143	0.115	0.299	0.065	1.429	0.077	0.202	0.045
3	08029331	28.70	0.070	0.971	0.088	0.161	0.073	0.635	0.081	0.170	0.072
4	08029341	42.16	0.040	0.605	0.073	0.171	0.043	0.626	0.050	0.118	-
5	08039351	84.91	-	31.246	1.246	3.950	0.683	20.530	-	4.513	-
6	08039361	36.11	0.042	1.152	0.103	0.224	0.069	1.197	0.049	0.222	-
7	08039371	64.39	-	0.334	0.056	-	-	0.258	0.087	-	-
8	08039381	68.93	-	11.368	0.267	1.744	0.113	10.589	-	1.352	-
9	08039391	52.38	0.069	13.051	0.420	1.132	0.191	8.809	0.065	1.016	-
9	08039392	48.00	0.062	12.344	0.369	1.008	0.171	9.069	0.060	0.954	-
Control	080293C1	42.86	-	1.111	-	0.133	-	0.861	-	0.126	-

E3. EXTENDED...

Site	Sample #	% Moisture	n-tetratriacontane	n-triacontane	n-tricosane	n-tridecane	n-tritriacontane	n-undecane	phytane	pristane	Total
1	08029311	61.39	1.147	1.000	2.064	0.062	1.554	0.065	1.414	1.922	37.503
2	08029321	44.44	0.716	0.599	0.484	0.038	0.688	-	0.193	0.236	11.262
3	08029331	28.70	-	0.087	0.330	0.070	0.151	0.053	-	0.109	5.712
4	08029341	42.16	0.417	0.370	0.268	-	0.380	-	0.126	0.157	6.110
5	08039351	84.91	0.298	2.445	18.383	-	4.168	-	0.351	-	155.447
6	08039361	36.11	0.321	0.305	0.595	-	0.466	0.050	0.153	0.258	9.036
7	08039371	64.39	-	-	0.135	-	-	-	-	0.062	1.750
8	08039381	68.93	0.315	0.753	3.560	-	1.880	-	-	-	79.846
9	08039391	52.38	0.115	1.144	4.286	-	4.853	-	0.088	0.069	72.356
9	08039392	48.00	0.173	1.046	4.038	-	4.579	-	0.085	0.115	70.265
Control	080293C1	42.86	-	0.068	0.354	-	0.350	-	-	-	6.937

14. AROMATIC HYDROCARBONS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. AUGUST 1993.

Site	Sample #	% Moisture	1,2-benzanthracene	benzo(a)pyrene	benzo(b)fluoranthene	benzo(e)pyrene	benzo(g,h,i)perylene	benzo(k)fluoranthene	C1-chrysenes
1	08029311	61.390	0.124	-	-	-	-	0.052	0.119
2	08029321	44.440	0.155	0.049	0.063	0.067	0.036	0.083	0.090
3	08029331	28.700	-	-	-	-	-	-	-
4	08029341	42.160	-	-	-	-	-	-	-
5	08039351	84.910	-	-	-	-	-	-	-
6	08039361	36.110	0.077	0.045	0.053	0.044	-	0.069	0.045
7	08039371	64.390	-	-	-	-	-	-	-
8	08039381	68.930	0.180	0.116	0.116	0.087	-	0.151	0.064
9	08039391	52.380	-	-	-	-	-	-	-
9	08039392	48.000	-	-	-	-	-	-	-
Control	080293C1	42.860	-	-	-	-	-	-	-

(-) Concentration less than 2x the detection limit.

E4. EXTENDED...

Site	Sample #	% Moisture	C1-Fluoranthenes & Pyrenes	C1-naphthalenes	C1-Phenanthrenes & Anthracenes	C2-chrysenes	C2-naphthalenes	C3-dibenzothiophenes
1	08029311	61.390	0.065	-	0.062	0.249	-	0.098
2	08029321	44.440	0.059	-	-	0.139	-	0.050
3	08029331	28.700	-	0.041	0.049	0.028	0.058	-
4	08029341	42.160	-	-	-	0.045	-	-
5	08039351	84.910	-	-	-	-	-	-
6	08039361	36.110	0.059	-	0.056	0.053	0.034	-
7	08039371	64.390	-	-	-	-	-	-
8	08039381	68.930	0.122	-	0.077	-	-	-
9	08039391	52.380	-	-	-	-	-	-
9	08039392	48.000	-	-	-	-	-	-
Control	080293C1	42.860	-	-	-	-	-	-

E4. EXTENDED...

Site	Sample #	% Moisture	C3-fluorenes	C3-naphthalenes	C3-Phenanthrenes & Anthracenes	C4-naphthalenes	C4-Phenanthrenes & Anthracenes	chrysene	fluoranthene
1	08029311	61.390	0.085	-	0.130	0.085	0.137	0.124	0.075
2	08029321	44.440	-	-	0.086	-	0.097	0.157	0.126
3	08029331	28.700	-	0.086	0.042	0.041	0.048	-	-
4	08029341	42.160	-	0.047	0.043	-	0.036	-	-
5	08039351	84.910	-	-	-	-	-	-	-
6	08039361	36.110	0.038	0.077	0.069	0.059	0.089	0.078	0.174
7	08039371	64.390	-	0.065	-	-	-	-	-
8	08039381	68.930	-	-	-	-	-	0.183	0.409
9	08039391	52.380	-	-	-	-	-	-	0.086
9	08039392	48.000	-	-	-	-	-	-	0.085
Control	080293C1	42.860	-	-	-	-	-	-	-

E4. EXTENDED...

Site	Sample #	% Moisture	indeno(1,2,3-cd)pyrene	perylene	phenanthrene	pyrene	Total	unresolved complex mixture
1	08029311	61.390	-	0.073	0.052	0.104	1.634	817.664
2	08029321	44.440	0.036	-	0.059	0.158	1.510	420.086
3	08029331	28.700	-	0.035	-	-	0.426	40.673
4	08029341	42.160	-	-	-	-	0.171	190.353
5	08039351	84.910	-	1.034	-	-	1.034	23.194
6	08039361	36.110	-	-	0.099	0.150	1.370	139.458
7	08039371	64.390	-	-	-	-	0.065	22.185
8	08039381	68.930	0.074	-	0.267	0.360	2.208	88.832
9	08039391	52.380	-	-	0.063	0.071	0.220	54.809
9	08039392	48.000	-	-	0.069	0.073	0.227	51.538
Control	080293C1	42.860	-	-	-	-	0.000	0.700

E5. ORGANOCHLORINES (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. AUGUST 1993.

Site	Sample #	% Moisture	p,p'-DDD
1	08029311	61.39	0.008
2	08029321	44.44	-
3	08029331	28.70	0.008
4	08029341	42.16	-
5	08039351	84.91	0.017
6	08039361	36.11	0.009
7	08039371	64.39	-
8	08039381	68.93	-
9	08039391	52.38	-
9	08039392	48.00	-
Control	080293C1	42.86	-

(-) Concentration less than 2x the detection limit.

E6. POLYCHLORNATED BIPHENYL CONGENERS (ppm Dry Wt.) IN FISH CREEK SEDIMENT, ANCHORAGE, ALASKA. AUGUST 1993.

Site	Sample #	% Moisture	PCB# 52	PCB# 87	PCB# 118/108/149	PCB# 126	PCB# 128	PCB# 138	PCB# 170	PCB# 180	PCB# 195	PCB# 200	PCB# 206	PCB# 209
1	08029311	61.39	0.021	0.005	0.005	-	0.007	-	0.129	0.006	0.008	-	0.007	0.006
2	08029321	44.44	0.008	-	-	-	-	-	0.119	-	-	-	-	-
3	08029331	28.70	-	-	-	-	-	-	0.036	-	-	-	-	-
4	08029341	42.16	0.004	0.005	-	-	-	-	0.112	-	-	-	-	-
5	08039351	84.91	-	0.023	0.025	0.032	0.026	0.031	0.084	0.018	0.030	0.011	0.030	0.029
6	08039361	36.11	0.005	0.004	-	-	-	0.008	0.095	-	-	-	-	-
7	08039371	64.39	-	-	-	-	-	0.012	0.022	-	-	-	-	-
8	08039381	68.93	-	-	-	-	-	-	0.056	-	-	-	-	-
9	08039391	52.38	-	-	-	-	-	-	0.027	-	-	-	-	-
9	08039392	48.00	0.004	0.006	-	-	-	-	0.028	0.004	-	-	0.005	0.008
Control	080293C1	42.86	-	-	-	-	-	-	0.019	-	-	-	-	-

(-) Concentration less than 2x the detection limit.

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