

Off-Refuge

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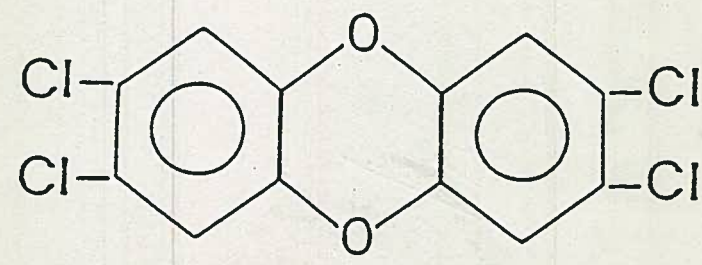
NAES-TR-92-03

November 1992

entered 01/09/95

## Technical Report

### Contaminant Investigation of Fish in Lake Minchumina, Alaska



by

**Elaine Snyder-Conn**

**Fish and Wildlife Service  
U.S. Department of Interior  
Fairbanks, AK**

**November 13, 1992**

### Disclaimer

The mention of trade names or commercial products does not constitute endorsement or recommendation for use by the Federal Government.

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Cover: 2,3,7,8-tetrachlorodibenzo-para-dioxin (2,3,7,8-TCDD), one of the compounds investigated

## Introduction

Lake Minchumina, located 306 km (190 miles) to the southwest of Fairbanks, Alaska, is an important sports fishery lake for Anchorage and Fairbanks residents and also is the base for a subsistence fishery for year-round Lake Minchumina residents. The lake supports large populations of northern pike (*Esox lucius*) and burbot (*Lota lota*). Bald eagles (*Haliaeetus leucocephalus*), lesser sandhill cranes (*Grus canadensis canadensis*), and numerous waterfowl also utilize the area, which is heavily used by duck hunters. The lake is also within the feeding range of endangered American peregrine falcons (*Falco peregrinus anatum*), one of which has nested adjacent to the lake for the past three years (Skip Ambrose, U.S. Fish and Wildlife Service, unpublished data).

Lake Minchumina occupies an alluvial valley of the Tanana Basin, characterized by extensive glaciofluvial sedimentary deposits and large alluvial fans, with eolian contributions. Due to the unconsolidated nature of deposits, consisting of fine gravels, sand, and silt, wells supplying residents are shallow, between 5 and 10 ft below the surface. Recharge of wells occurs from surface water as well as groundwater.

Lake Minchumina lacks road access and is reached primarily by float planes and wheeled fixed-wing aircraft. The Flight Service Station for the lake was established in 1942 and operated until 1969 by the Federal Aviation Administration (FAA). Pesticides, including 2,4,5-T, 2,4-D, DDT, and possibly other defoliants and insecticides, were sprayed at the Lake Minchumina airport runways for weed and mosquito control. Barrels of these materials, some leaking, were found at various locations adjacent to the lake, with primary storage in an area approximately 46 m northwest of the tank farm. In August 1985, the Alaska Department of Environmental Conservation (ADEC) notified the FAA of violations following an inspection. The FAA instituted remedial actions in September 1985, when 22 55-gallon drums and contaminated soil from the pesticide storage area were placed in overpacked drums and transferred to the runway apron. Also placed on the apron were six drums containing PCB-contaminated soil from a local power plant cleanup operation. De-icing wastes, including propanol and ethylene glycol, also were stored in this area. Some 22 drums were left in the original storage area (Alaska Department of Transportation and Public Facilities 1988).

Since 1985, samples have been collected by ADEC and the FAA to characterize the soil and drums located in the storage area. FAA samples revealed that two drums contained 2,4-D at 18,000 to 36,000 mg/L and the liquid in one drum contained 2,4,5-T at 72,000 mg/L. Surface soil collected by ADEC at the site contained 2,4-D at 10,000 mg/kg. A composite soil sample from three drums contained 2,4-D at 23 mg/kg, 2,4,5-T at 17 mg/kg, and PCB's at 33 ppm. As part of the environmental site assessment, additional collections of soil, sediment, surface water and groundwater were made by Ecology and Environment, Inc. in 1987 at the pesticide/drum storage area, suspected "hot spots", at sites downgradient from waste sites, and at a control site (E & E 1987). Soil in the drum storage area contained 4,4'-DDT at up to 1400 mg/kg, and DDT metabolites, 4,4'-DDE and 4,4'-DDD, at 380 and 0.001 mg/kg, respectively, in the same area. The highest concentration of DDT in the runoff area downgradient from the site contained 3.3 mg/kg DDT. Dioxin (2,3,7,8-TCDD) was also

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found at 49 µg/kg in the composite soil sample from the pesticide storage area containing high DDT and DDE residues. Limits of detection for some other pesticides (BHC, heptachlor, aldrin, endosulfan, dieldrin) were poor for this soil sample. Most of the data for water samples was rejected due to poor spike recoveries. However, aldrin was present in the three domestic well and two surface water samples at a concentration of 0.07 - 0.08 µg/L.

No samples of biota were obtained by the FAA, EPA, ADEC, or E & E during the environmental site assessment. Such sampling is needed to perform an adequate environmental risk assessment. Therefore, the objective of this study was to measure pesticide and dioxin concentrations in five long-lived predatory fish from Lake Minchumina to determine maximal probable exposure. Northern pike and burbot were selected as the target species.

## Materials and Methods

### *Fish Collection and Handling*

Five whole fish, two burbot and three northern pike, were obtained from Mary Flood, a Lake Minchumina resident. The fish had been collected by hook and line during the winter of 1989 (no dates available), gutted, and frozen whole. The frozen fish were shipped to Fairbanks by air and measured for total length, fork length and weight (Table 1). The fish were then refrozen prior to shipment in a cooler with dry ice to the primary contract analytical laboratory, Mississippi State Chemical Laboratory. Subsamples of whole-fish homogenate from this laboratory were subsequently sent by air courier to Radian Corporation for analysis of dioxins/furans in October 1989.

Table 1. Fish submitted for analysis of organochlorine pesticides and dioxins.

| Sample Number | Species       | Fork Length (mm) | Total Length (mm) | Fish Weight (g) <sup>a</sup> |
|---------------|---------------|------------------|-------------------|------------------------------|
| AMI01F1       | Burbot        | 585 <sup>b</sup> | - <sup>b</sup>    | 5480                         |
| BMI01F1       | Burbot        | 603              | 558               | 2160                         |
| AMI01F2       | Northern Pike | 553              | 545               | 1550                         |
| BMI01F2       | Northern Pike | 612              | 598               | 2040                         |
| CMI01F2       | Northern Pike | 695              | 680               | 2250                         |

<sup>a</sup> Whole fish minus entrails

<sup>b</sup> Fish tail was broken off after the fish was frozen. Measurement of fork length is an estimate; measurement of total length was not possible.

## *Sample Analysis*

### **Organochlorine Pesticides and PCB's**

Organochlorine pesticides and PCB's were determined by Mississippi State Chemical Laboratory, MS. Ten-gram samples were collected from each homogenized whole fish following mixture with anhydrous sodium sulfate and Soxhlet extraction with hexane for seven hours. The extract was concentrated by rotary evaporation, transferred to a tared test tube, and further reduced to dryness for lipid determination. The weighed lipid sample was dissolved in petroleum ether and extracted four times with acetonitrile saturated with petroleum ether. Residues were partitioned into petroleum ether, which was washed, concentrated, and transferred to a glass chromatographic column containing 20 gm Florisil. The column was eluted with 200 mL 6% diethyl ether/94% petroleum ether (Fraction I), followed by 200 mL 15% diethyl ether/85% petroleum ether (Fraction II). Fraction II was concentrated to appropriate volume for residue quantification by packed or capillary column electron capture gas chromatography. Fraction I was concentrated and transferred to a silicic acid chromatographic column for additional cleanup required for separation of PCB's from other organochlorine compounds. Three fractions were eluted from the silicic acid column. Each was concentrated to appropriate volume for quantification by gas chromatography.

### **Dioxin Analysis**

Subsamples of whole-fish homogenate were analyzed for dioxins and furans by Radian Analytical Services, Austin, TX using EPA Method SW 8280 (Revision 0, September 1986) using a Hewlett Packard 5987 Gas Chromatograph/Mass Spectrometer. Surrogate recovery of carbon 13-labeled 2,3,7,8-TCDD spiked into each sample prior to extraction was used to estimate percent recovery. However, no corrections were made to the data based on these estimates. The limit of detection varied from 5.7 - 9.6 picograms/gram (pg/g or parts per trillion) depending on sample. All results were reported in wet weight.

## *Quality Assurance/Quality Control*

### **Organochlorine Pesticides and PCB's**

Spike recoveries were performed on all compounds except toxaphene and PCB's (although not all pesticide congeners were examined). Recovery was low for HCB (65%), but was high for all other compounds (85-100%), indicating high accuracy. However, no duplicate analysis was performed, so precision cannot be estimated. Both a reagent blank and a matrix blank were run to estimate contamination resulting from the analytical procedure. No pesticides were recovered from the reagent blank, but the matrix blank for fish showed 0.01 mg/kg

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 $\alpha$ -chlordane, dieldrin, and 4,4'-DDD, as well as 0.02 mg/kg 4,4'-DDT, indicating that positive results of these analytes at these concentration levels could be attributable to laboratory contamination. In addition to these steps to assure quality, mass spectrometry was performed on one of the five fish samples to confirm gas chromatograph results. These results agreed with gas chromatograph results.

## Dioxins

Surrogate carbon-13 spike recoveries of 2,3,7,8-TCDD for the five fish were 81, 35, 82, 43, and 74%, respectively, indicating adequate recovery in three of the five analyses. Recovery in a matrix spike was 106%, also indicating adequate recovery. One sample was duplicated. Both samples were below detection limits (<5.9 and <3.6 pg/g). Thus, an estimate of precision was not possible. Surrogate spike recovery on the duplicate was 140%, exceeding control limits. Two reagent blanks contained <7.0 and <8.6 pg/g, indicating lack of laboratory dioxin contamination. Surrogate spike recovery on the blanks were 73 and 66%, again suggesting adequate recovery of dioxin.

## Results and Discussion

Many of the pesticides detected at the pesticide storage site at Lake Minchumina could pose a serious threat to fish and wildlife. The 2,3,7,8-TCDD isomer of dioxin, found in soils at the site, "is the most toxic synthetic chemical ever tested under laboratory conditions," and has resulted in numerous mammal and bird deaths and reproductive failures elsewhere (Eisler 1986: P. 1). The effects of DDE, a DDT metabolite, also present at the site, are also profound and include massive reproductive failures among certain bird species, especially raptors, due to egg-shell thinning (Stickel 1975). DDT and its metabolites are also slightly to severely toxic to invertebrates and fish depending on species (EPA 1980; Mayer and Ellersieck 1986).

No pesticides or dioxins were detected in any of burbot or northern pike examined (see Appendix), with the exception of a trace amount, 0.02 mg/kg 4,4'-DDE, in one fish. A similar amount of matrix blank contamination occurred, suggesting that even this small concentration was due to laboratory contamination and not actually present in the northern pike. Deficiencies in laboratory quality assurance do not enable an estimate of precision of these results. Also, lack of spike recovery data do not allow any conclusions regarding PCB or toxaphene concentrations of the fish. However, accuracy during spike recoveries was, for the most part, adequate to high for the remaining compounds examined. Although only five fish were examined, all findings were negative, suggesting that Lake Minchumina fish are not contaminated with organochlorine compounds. Apparently, contamination of the lake itself has been minimal. Alternately, dilution and degradation processes have been sufficient to minimize recent fish exposures to organochlorine compounds. These results agree with those

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obtained by E & E (1987), which showed no organochlorine contamination of lake sediments, with the exception of low-level contamination by 2,4,5-T (0.033 - 0.260 mg/kg). Our analyses did not include analysis of this herbicide. When 2,4,5-T is not contaminated by dioxin, it is of low toxicity to invertebrates and only slightly toxic to fish (Mayer and Ellersieck 1986).

Additional terrestrial studies are needed to assess extent and amount of contamination of terrestrial biota by organochlorine compounds. Since the endangered peregrine falcon is present in the area, collection of several surrogate raptor eggs, preferably addled eggs, is recommended to perform this assessment.

### References

Alaska Department of Transportation and Public Facilities. 1988. Draft environmental assessment: Lake Minchumina Airport Improvements. Northern Region Environmental Section, Alaska Department of Transportation and Public Facilities. 17 pp.

Ecology and Environment, Inc. 1987. Technical assessment team site assessment final report for: Lake Minchumina FAA Flight Service Station Lake Minchumina, Alaska. Technical Direction Document T10-8705-008 submitted to the U.S. Environmental Protection Agency Region X Superfund Removal and Emergency Section, Seattle, WA. 20 pp.

Eisler, R. 1986. Dioxin hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish Wildl. Biol. Rep. 85(1.8). 37 pp.

EPA. 1980. Ambient water quality criteria for DDT. Office of Water Regulations and Standards, U.S. Environmental Protection Agency PB81-117491. Washington, D.C.

Mayer, F.L., Jr. and M.R. Ellersieck. 1986. Manual of acute toxicity: interpretation and data base for 410 chemicals and 66 species of freshwater animals. U.S. Fish and Wildlife Service Resource Publication 160. 506 pp.

Stickel, W.H. 1975. Some effects of pollutants in terrestrial ecosystems. Pages 25-74 in A.D. McIntyre and C.F. Mills, editors. Ecological toxicology research. Plenum Press, N.Y.

the same way as the other two, but the first is the only one that is not a simple case of the other two.

The first case is the only one that is not a simple case of the other two, and the second case is the only one that is not a simple case of the other two.

The second case is the only one that is not a simple case of the other two, and the third case is the only one that is not a simple case of the other two.

### CONCLUSION

The first case is the only one that is not a simple case of the other two, and the second case is the only one that is not a simple case of the other two.

The second case is the only one that is not a simple case of the other two, and the third case is the only one that is not a simple case of the other two.

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The sixth case is the only one that is not a simple case of the other two, and the seventh case is the only one that is not a simple case of the other two.



SAMPLE TYPE: Fish

CAT NO. 5891  
BATCH NO. NR012-89-R7  
ORDER NO. 85800-89-08059

MISSISSIPPI STATE CHEMICAL LABORATORY  
BOX CR  
MISSISSIPPI STATE, MS 39762  
REPORT FORM  
USDI/FWS

ORGANOCHLORINES

DATE RECEIVED 02/12/90

PARTS PER MILLION AS RECEIVED (WET WT)

| FWS #               | AM101F1 | BM101F1 | AM101F2       | BM101F2       | CM101F2       | Blank   | Matrix Blank |
|---------------------|---------|---------|---------------|---------------|---------------|---------|--------------|
| LAB #               | 776574  | 776575  | 776576        | 776577        | 776578        | 776579  | for          |
| MATRIX              | Burbot  | Burbot  | Northern Pike | Northern Pike | Northern Pike | Reagent | Fish         |
| COMPOUND            |         |         |               |               |               |         |              |
| HCB                 | ND*     | ND      | ND            | ND            | ND            | ND      | ND           |
| $\alpha$ -BHC       | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| $\gamma$ -BHC       | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| $\beta$ -BHC        | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| $\delta$ -BHC       | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| Oxychlorane         | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| Hept. Epox.         | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| $\gamma$ -Chlordane | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| $\gamma$ -Nonachlor | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| Toxaphene           | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| PCB's (total)       | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| o, p'-DDE           | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| $\alpha$ -Chlordane | ND      | ND      | ND            | ND            | ND            | ND      | 0.01         |
| p, p'-DDE           | ND      | ND      | ND            | 0.02          | ND            | ND      | 0.02         |
| Dieldrin            | ND      | ND      | ND            | ND            | ND            | ND      | 0.01         |
| o, p'-DDD           | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| Endrin              | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| cis-nonachlor       | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| o, p'-DDT           | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| p, p'-DDD           | ND      | ND      | ND            | ND            | ND            | ND      | 0.01         |
| p, p'-DDT           | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| Mirex               | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| OTHER:              |         |         |               |               |               |         |              |
|                     |         |         |               |               |               |         |              |
|                     |         |         |               |               |               |         |              |
| WEIGHT (g)          | 5480    | 2160    | 1550          | 2040          | 2250          | -       | -            |
| MOISTURE (%)        | 80.4    | 81.2    | 78.4          | 78.4          | 77.8          | -       | 71.0         |
| LIPID (%)           | 2.63    | 2.58    | 1.70          | 2.24          | 1.55          | -       | 8.53         |

Lower Level of Detection = 0.01 ppm for Tissue, Soil, Etc. 0.05 for Toxaphene and PCBs.  
For Water, LLD= 0.005 ppm for OCs, Tox, PCBs

\*\*Spike = ppm for

\* = Confirmed by GC/Mass Spectrometry

\*ND = None Detected

\*\*\*NS = Not Spiked

Signature

*Larry A. Lane*

SAMPLE TYPE: Fish

CAT NO. 5891  
BATCH NO. NR012-89-R7  
ORDER NO. 85800-89-08059

MISSISSIPPI STATE CHEMICAL LABORATORY  
BOX CR  
MISSISSIPPI STATE, MS 39762  
REPORT FORM  
USD1/FWS

ORGANOCHLORINES

DATE RECEIVED 02/12/90

PARTS PER MILLION AS RECEIVED (WET WT)

| FWS #         | Spike** | % Recovery |  |  |  |  |  |
|---------------|---------|------------|--|--|--|--|--|
| LAB #         | 776580  |            |  |  |  |  |  |
| MATRIX        | Fish    |            |  |  |  |  |  |
| COMPOUND      |         |            |  |  |  |  |  |
| HCB           | 0.065   | 65         |  |  |  |  |  |
| α-BHC         | NS***   |            |  |  |  |  |  |
| γ-BHC         | 0.095   | 95         |  |  |  |  |  |
| β-BHC         | 0.098   | 98         |  |  |  |  |  |
| δ-BHC         | NS      |            |  |  |  |  |  |
| Oxychlordane  | 0.10    | 100        |  |  |  |  |  |
| Hept. Epox.   | 0.10    | 100        |  |  |  |  |  |
| γ-Chlordane   | NS      |            |  |  |  |  |  |
| t-Nonachlor   | 0.10    | 100        |  |  |  |  |  |
| Toxaphene     | NS      |            |  |  |  |  |  |
| PCB's (total) | NS      |            |  |  |  |  |  |
| o, p'-DDE     | 0.10    | 100        |  |  |  |  |  |
| α-Chlordane   | 0.10    | 100        |  |  |  |  |  |
| p, p'-DDE     | 0.095   | 95         |  |  |  |  |  |
| Dieldrin      | 0.099   | 99         |  |  |  |  |  |
| o, p'-DDD     | NS      |            |  |  |  |  |  |
| Endrin        | 0.10    | 100        |  |  |  |  |  |
| cis-nonachlor | 0.10    | 100        |  |  |  |  |  |
| o, p'-DDT     | 0.095   | 95         |  |  |  |  |  |
| p, p'-DDD     | 0.095   | 95         |  |  |  |  |  |
| p, p'-DDT     | 0.10    | 100        |  |  |  |  |  |
| Mirex         | 0.091   | 91         |  |  |  |  |  |
| OTHER:        |         |            |  |  |  |  |  |
|               |         |            |  |  |  |  |  |
|               |         |            |  |  |  |  |  |
| WEIGHT (g)    | -       |            |  |  |  |  |  |
| MOISTURE (%)  | 72.0    |            |  |  |  |  |  |
| LIPID (%)     | 8.70    |            |  |  |  |  |  |

Lower Level of Detection = 0.01 ppm for Tissue, Soil, Etc. 0.05 for Toxaphene and PCBs.  
For Water, LLD= 0.005 ppm for OCs, Tox, PCBs

\*\*Spike = 0.10 ppm for Fish.

\* = Confirmed by GC/Mass Spectrometry

\*\*ND = None Detected

\*\*\*NS = Not Spiked

*Larry A Lane*  
Signature

SAMPLE TYPE: Fish

CAT NO. 5891  
BATCH NO. NR012-89-R7  
ORDER NO. 85800-89-08059

MISSISSIPPI STATE CHEMICAL LABORATORY  
BOX CR  
MISSISSIPPI STATE, MS 39762  
REPORT FORM  
USD1/FWS

ORGANOCHLORINES (SUPPLEMENTAL)

DATE RECEIVED 02/12/90

PARTS PER MILLION AS RECEIVED (WET WT)

| FWS #         | AM101F1 | BM101F1 | AM101F2       | BM101F2       | CM101F2       | Blank   | Matrix Blank |
|---------------|---------|---------|---------------|---------------|---------------|---------|--------------|
| LAB #         | 776574  | 776575  | 776576        | 776577        | 776578        | 776579  | for          |
| MATRIX        | Burbot  | Burbot  | Northern Pike | Northern Pike | Northern Pike | Reagent | Fish         |
| COMPOUND      |         |         |               |               |               |         |              |
| Endosulfan I  | ND*     | ND      | ND            | ND            | ND            | ND      | ND           |
| Endosulfan II | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| Endo. Sulfate | ND      | ND      | ND            | ND            | ND            | ND      | ND           |
| OTHER:        |         |         |               |               |               |         |              |
|               |         |         |               |               |               |         |              |
|               |         |         |               |               |               |         |              |
| WEIGHT (g)    | 5480    | 2160    | 1550          | 2040          | 2250          | -       | -            |
| MOISTURE (%)  | 80.4    | 81.2    | 78.4          | 78.4          | 77.8          | -       | 71.0         |
| LIPID (%)     | 2.63    | 2.58    | 1.70          | 2.24          | 1.55          | -       | 8.53         |

Lower Level of Detection = 0.01 ppm for Tissue, Soil, Etc. 0.05 for Toxaphene and PCB For Water, LLD= 0.005 ppm for OCs, Tox, PCBs

\*\*Spike = ppm for

\* = Confirmed by GC/Mass Spectrometry

\*ND = None Detected

\*\*\*NS = Not Spiked

*Larry A. Lane*  
Signature

12  
SAMPLE TYPE: Fish

CAT NO. 5891  
BATCH NO. NR012-89-R7  
ORDER NO. 85800-89-08059

MISSISSIPPI STATE CHEMICAL LABORATORY  
BOX CR  
MISSISSIPPI STATE, MS 39762  
REPORT FORM  
USD1/FWS

ORGANOCHLORINES (SUPPLEMENTAL)

DATE RECEIVED 02/12/90

PARTS PER MILLION AS RECEIVED (WET WT)

| FWS #         | Spike Level | Spike  | % Recovery |  |  |  |  |
|---------------|-------------|--------|------------|--|--|--|--|
| LAB #         |             | 776580 |            |  |  |  |  |
| MATRIX        | Fish        | Fish   |            |  |  |  |  |
| COMPOUND      |             |        |            |  |  |  |  |
| Endosulfan I  | 0.040       | 0.034  | 85         |  |  |  |  |
| Endosulfan II | 0.10        | 0.087  | 87         |  |  |  |  |
| Endo. Sulfate | 0.20        | 0.18   | 90         |  |  |  |  |
| OTHER:        |             |        |            |  |  |  |  |
|               |             |        |            |  |  |  |  |
|               |             |        |            |  |  |  |  |
|               |             |        |            |  |  |  |  |
|               |             |        |            |  |  |  |  |
|               |             |        |            |  |  |  |  |

Lower Level of Detection = 0.01 ppm for Tissue, Soil, Etc. 0.05 for Toxaphene and PCB  
For Water, LLD= 0.005 ppm for OCs, Tox, PCBs

\*\*Spike = ppm for  
\* = Confirmed by GC/Mass Spectrometry  
\*ND = None Detected  
\*\*\*NS = Not Spiked

*Larry A Lane*

Signature



Analytical Data Summary

US FISH AND WILDLIFE SERVICE  
Radian Work Order: 89-10-223

|                                                                                                                |         |         |         |         |         |       |
|----------------------------------------------------------------------------------------------------------------|---------|---------|---------|---------|---------|-------|
| Method:SW8280-Dioxins/Furans (1)                                                                               |         |         |         |         |         |       |
| List:Dioxin Analyte List                                                                                       |         |         |         |         |         |       |
| Sample ID:                                                                                                     | AM101F1 | BM101F1 | AM101F2 | BM101F2 | CM101F2 | MS    |
| Factor:                                                                                                        | 1       | 1       | 1       | 1       | 1       | 0     |
| Results in:                                                                                                    | pg/g    | pg/g    | pg/g    | pg/g    | pg/g    | %     |
|                                                                                                                | 01A     | 02A     | 03C     | 04A     | 05A     | 06A   |
| Matrix:                                                                                                        | biota   | biota   | biota   | biota   | biota   | biota |
| 2,3,7,8-TCDD                                                                                                   | <5.9    | <5.4    | <5.7    | <9.6    | <6.4    | 106   |
| Surrogate Recovery(%)                                                                                          |         |         |         |         |         |       |
| C13-2,3,7,8-TCDD                                                                                               | 81      | 35 Q    | 82      | 43      | 74      | 76    |
| Control Limits: 40 to 120                                                                                      |         |         |         |         |         |       |
| Q Outside control limits                                                                                       |         |         |         |         |         |       |
| (1) For a detailed description of flags and technical terms in this report refer to Appendix A in this report. |         |         |         |         |         |       |

**RADIAN**  
CORPORATION

Analytical Data Summary

US FISH AND WILDLIFE SERVICE  
Radian Work Order: 89-10-223

Method:SW8280-Dioxins/Furans (1)

List:Dioxin Analyte List

| Sample ID:  | AM101F1 DUP | REAGENT BLANK | REAGENT BLANK |
|-------------|-------------|---------------|---------------|
| Factor:     | 1           | 1             | 1             |
| Results in: | pg/g        | pg/g          | pg/g          |
|             | 07A         | 08A           | 09A           |
| Matrix:     | biota       | biota         | biota         |

2,3,7,8-TCDD

<3.6

<7.0

<8.6

Surrogate Recovery(%)

C13-2,3,7,8-TCDD

140 q

73

66

Control Limits: 40 to 120

Q Outside control limits

(1) For a detailed description of flags and technical terms in this report refer to Appendix A in this report.

