ALBERTA OIL SANDS
ENVIRONMENTAL
RESEARCH PROGRAM

Water Quality of the Athabasca Oil Sands Area
Volume 1
Data Collection and Quality

Project WS I.2.I
August 1980

Alberta
ENVIRONMENT

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ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM RESEARCH REPORTS

These research reports describe the results of investigations funded under the Alberta Oil Sands Environmental Research Program. This program was designed to direct and co-ordinate research projects concerned with the environmental effects of development of the Athabasca Oil Sands in Alberta.

A list of research reports published to date is included at the end of this report.

Enquiries pertaining to the reports in the series should be directed to:

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Water Quality of the
Athabasca Oil Sands Area
Volume I
Data Collection and Quality

Project WS 1.2.1

This report may be cited as:

Akena, A.M. 1980. Water quality of the Athabasca Oil Sands area. Volume 1: Data collection and quality. Prep. for the Alberta Oil Sands Environmental Research Program by Pollution Control Division, Alberta Environment. AOSERP Project WS 1.2.1. 100 pp.

The Hon. J.W. (Jack) Cookson
Minister of the Environment
222 Legislative Building
Edmonton, Alberta

Sir:

Enclosed is the report "Water Quality of the Athabasca Oil Sands Area. Volume I: Data Collection and Quality."

This report was prepared for the Alberta Oil Sands Environmental Research Program, through its Water System, under the Canada-Alberta Agreement of February 1975 (amended September 1977).

Respectfully,

W. Solodzuk, P.Eng.
Chairman, Steering Committee, AOSERP
Deputy Minister, Alberta Environment

Water Quality of the Athabasca Oil Sands Area: Volume I: Data Collection and Quality

Descriptive Summary

Water quality sample collection and analysis has been an ongoing activity by various agencies in the Athabasca Oil Sands area since the early 1970's. However, standardization of sampling sites, procedures, and analysis has received minimal attention because of the diverse number of agencies and organizations (each with its own priorities and objectives) who were collecting water quality data. Water quality analysis in the Athabasca Oil Sands area should fulfill the following two objectives:

1. Provide a documentation of baseline states prior to industrial and residential development; and
2. Provide a basis from which water quality parameters can be utilized to evaluate the effect of oil sands development on natural processes.

With these objectives as a background, a regional water quality control program was developed by AOSERP. The initial component of this program has produced three reports:

1. An Intensive Surface Water Quality Study of the Muskeg River Watershed
   Volume I: Water Chemistry
   Prepared by A.M. Akena
2. Volume II: Hydrology
   Prepared by c.R. Froelich
3. Regional Water Quality of the AOSERP Study Area
   Volume II: Discussion of 1976 and 1977 Data
   Prepared by R.T. Seidner

The objectives of this report, "Water Quality of the Athabasca Oil Sands Area; Volume I: Data Collection and Quality", were to review the precision and availability of water quality data of surface water in the AOSERP study area; identify sources and location of all data collected; and describe all quality control measures employed and how they affect the significance and application of the data.

The final report in this series (WS 1.2.1, due in 1981) will include a summary of activities from 1978 to 1980 and will summarize both the natural controls on water quality parameters and the effects of oil sands developments on water quality in the AOSERP study area.

The report, "Water Quality of the Athabasca Oil Sands Area; Volume I: Data Collection and Quality" prepared by A.M. Akena, has been reviewed by external reviewers and the Research Management Division accepts this report and recommends that it be published.

W.R. MacDonald
Director
Research Management Division

WATER QUALITY OF THE ATHABASCA OIL SANDS AREA

VOLUME I

DATA COLLECTION AND QUALITY

by

ANTHONY MARK AKENA

Alberta Environment

for

ALBERTA OIL SANDS

ENVIRONMENTAL RESEARCH PROGRAM

WS 1.2.1

August 1980

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ABSTRACT

This report documents locations of Athabasca Oil Sands area water quality sampling sites; sampling, analytical and quality control methods used; the volume and availability of assembled data; and an extensive appraisal of the quality of the data base. The quality control measures taken proved to be very useful in identifying causes of variations in analytical data and, as far as this water quality data base is concerned, in producing valid and accurate data.

ACKNOWLEDGEMENTS

The following members of staff of Alberta Department of Environment: Randy Chappel, Jim Anderson, and Scott Flett made invaluable contributions to this project by carrying out the sampling and field measurements.

The author is also grateful to Read Seidner for managing the project in 1977; and to Merl Korchinski, Walter Nahulak, and Don LaBerge for their continued involvement in the quality control programs.

This research project WS 1.2.1 was funded by the Alberta Oil Sands Environmental Research Program, established to fund, direct, and co-ordinate environmental research in the Athabasca Oil Sands area of northeastern Alberta.

1. AOSERP STUDY AREA WATER QUALITY STUDIES

1.1 INTRODUCTION

Water quality/quantity studies of rivers and lakes within the Alberta Oil Sands Environmental Research Program (AOSERP) study area have been major components of AOSERP since its inception in 1975. In the first five years, Water System programs emphasized, as a general objective (Smith et al. 1979), the establishment of baseline conditions and the development of a detailed understanding of natural stream and limnological processes.

The regional water quality monitoring program was instituted in February 1976. Initially, a number of groups (Department of Biology, University of Calgary and Inland Waters Directorate researchers) collected and analyzed the water samples. But, from April 1976, Alberta Environment's Environmental Protection Services (EPS) assumed the responsibilities of planning, conducting and managing the collection and storage of AOSERP study area water quality data. Activities relating to the data collection and water quality monitoring were co-ordinated with those of a hydrometric network operated by Water Survey of Canada. Simultaneous operation of water quality stations and streamflow stations is important because it enables the researcher to compute chemical constituent loadings.

The stations in AOSERP water quality studies were selected to suit Water System objectives (Smith et al. 1979). After 1976, standardized collection and analysis procedures were employed in an attempt to generate a quality-controlled data base. This data base helps identify significant naturally occurring water quality parameters--parameters which should be included in procedures for predicting the impact on water quality of oil sands related developments.

1.1.1 Report Objectives

The information collected by the Athabasca Oil Sands area water quality monitoring project WS 1.2.1 (formerly HY 2.8.1) is being published in three volumes. This volume, Volume 1: Data Collection and Quality, documents:

1. Locations of AOSERP water quality sampling sites;
2. Sampling, analytical and quality control methods used;
3. Volume and availability of assembled data; and
4. A comprehensive appraisal of the quality of the data base.

Volume II (Seidner 1980) and Volume III (Akena in prep.) are interpretive reports purposed to establish baseline water quality conditions of the whole study area.

1.2 DESCRIPTION OF THE AOSERP STUDY AREA

The AOSERP study area is located in the northeastern part of Alberta, approximately 450 km from Edmonton (Figure 1). The area is characterized by a northward, gently sloping, flat-to-slightly rolling plain, and upland areas highlighted by the Thickwood Hills and Birch, Stony, and Muskeg mountains. Associated with these landscape features is a myriad of muskeg ponds and upland area lakes drained by the Athabasca River and its tributaries.

The northerly flow of the main stem Athabasca River receives significant discharge contributions from the Clearwater, Hangingstone, and Horse rivers, all of which join the Athabasca River in and around Fort McMurray. Other large rivers, for instance, the Steepbank, Muskeg, Firebag, MacKay, Dover and Ells, join the Athabasca River between Fort McMurray and Lake Athabasca.

1.3 AOSERP WATER QUALITY MONITORING PROGRAM

1.3.1 Administrative Decisions

1.3.1.1 Selection of Locations of Water Quality Sampling Stations. The distribution of AOSERP surface water quality sampling stations and changes in the number of active stations were influenced by the distribution of the hydrometric network and considerations of hydrological zoning of the study area.

The AOSERP study area was divided into drainage basins (Figure 2). At least one water quality station was located within

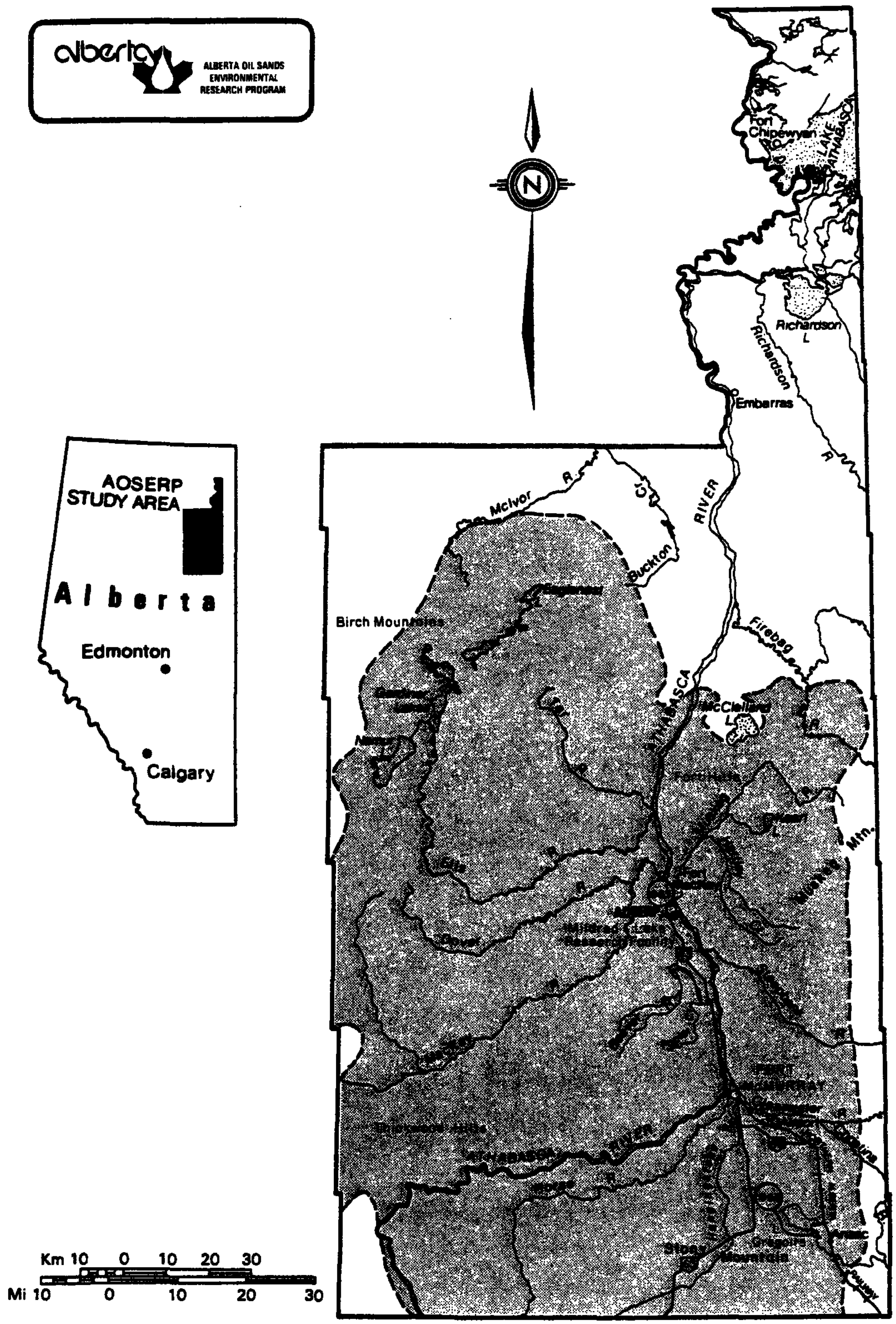

Figure I. The AOSERP study area and Athabasca Oil Sands deposit (shaded gray).

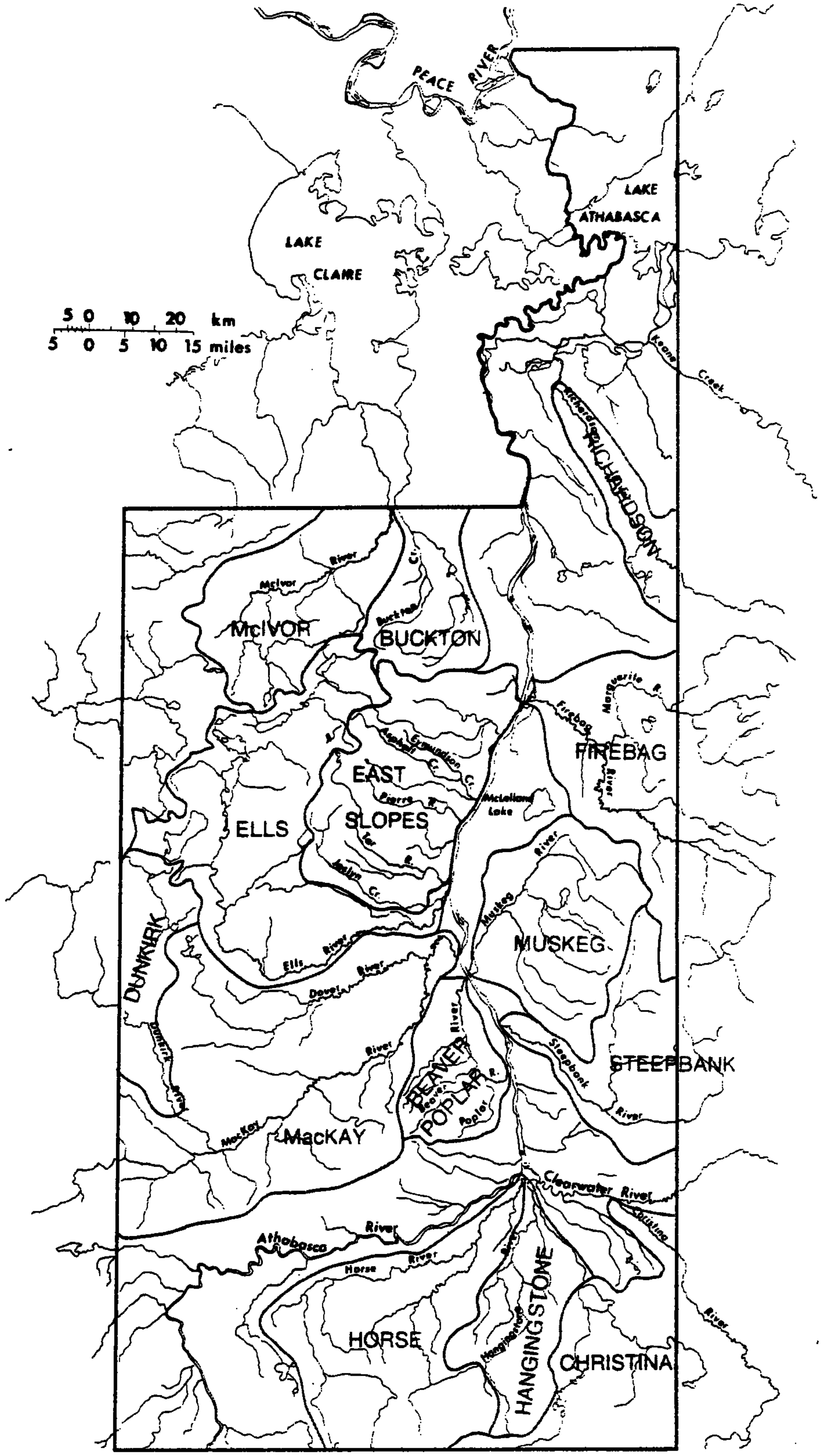

Figure 2. Surface water drainage system.

each basin, provided that a high portion (>50%) of a basin has the potential for oil sands development. If it was discovered, during the semiannual review, that the water quality parameters showed identical or similar levels at stations within the same basin, this was used as a justification for a reduction in the number of stations. Also, it was felt that of two basins, each much different in size but exhibiting similar water quality characteristics and each having a station, the station monitoring the larger basin would be selected for continued operation.

In a large number of cases, water quality stations were operated in conjunction with streamflow stations. The establishment of the streamflow network followed guidelines for minimum streamflow network densities published by the World Meteorological Organization (1974) and the density of stations in Alberta and Saskatchewan. From these considerations and comparison, the existing network [13 (1975), 16 (1976), 30 (1977), 21 (1978), 18 (1979)] was developed (Warner and Spitzer 1978). The general objectives of the hydrometric studies include providing an inventory of information on the hydrologic resources of the study area, determining frequencies and magnitudes of flood flows, water level-discharge rating curves, and determining whether the water supply is adequate to meet the needs of industry, urban development and reclamation (Smith et al. 1979). The adequacy of the hydrometric network and information gathered has recently been assessed by Yaremko and Murray (1979).

Before the water quality sampling stations were established, attempts were made to ensure that each sampling location was truly representative of the water quality of the entire stream. The examination included transecting the stream at the proposed location and analyzing the samples for selected parameters. Where lateral or vertical stratification in the stream/river was suspected and/or observed, a new sampling area was chosen or, as was the case with the Athabasca River, three sampling locations across the river were monitored. The other factors considered in the selection were ease of access for sampling and any abnormal stream conditions.

After the selections were made, all AOSERP water quality monitoring stations (Figure 3) were fixed by detailed physical and biological descriptions, including:

1. Streamflow;
2. Streamflow at locations where the stream is not gauged;
3. Stream gradient;
4. Stream width;
5. Maximum and average depth;
6. Cross-section area and configuration;
7. Pool and/or riffle description;
8. Substrate characteristics and composition;
9. Stream bank height, configuration, characteristics, stability, soil type, composition, etc.;
10. Submergent and emergent vegetation;
11. Shore, stream bank, overstory and surrounding vegetation characteristics and composition;
12. Presence or absence of algae, aquatic invertebrates, fish, and aquatic mammal activity (i.e., beaver dams); and
13. Maps and/or photographs of the sample location and surrounding (upstream and downstream) area; and, by site markers or landmarks in such a way that interested researchers can find the sampling sites without personal guidance.

1.3.1.2 Frequency of Sampling. Sampling frequency is a major consideration in the design of a water quality monitoring network because both the operational costs and the reliability (and utility) of the water quality data derived from the network are related directly to the network. The AOSERP water quality monitoring network was not developed from results of a statistical analysis (elementary or sophisticated) of an existing water quality data bank or aimed at achieving equal information content from each station (Sanders and Adrian 1978). Rather it attempted to:

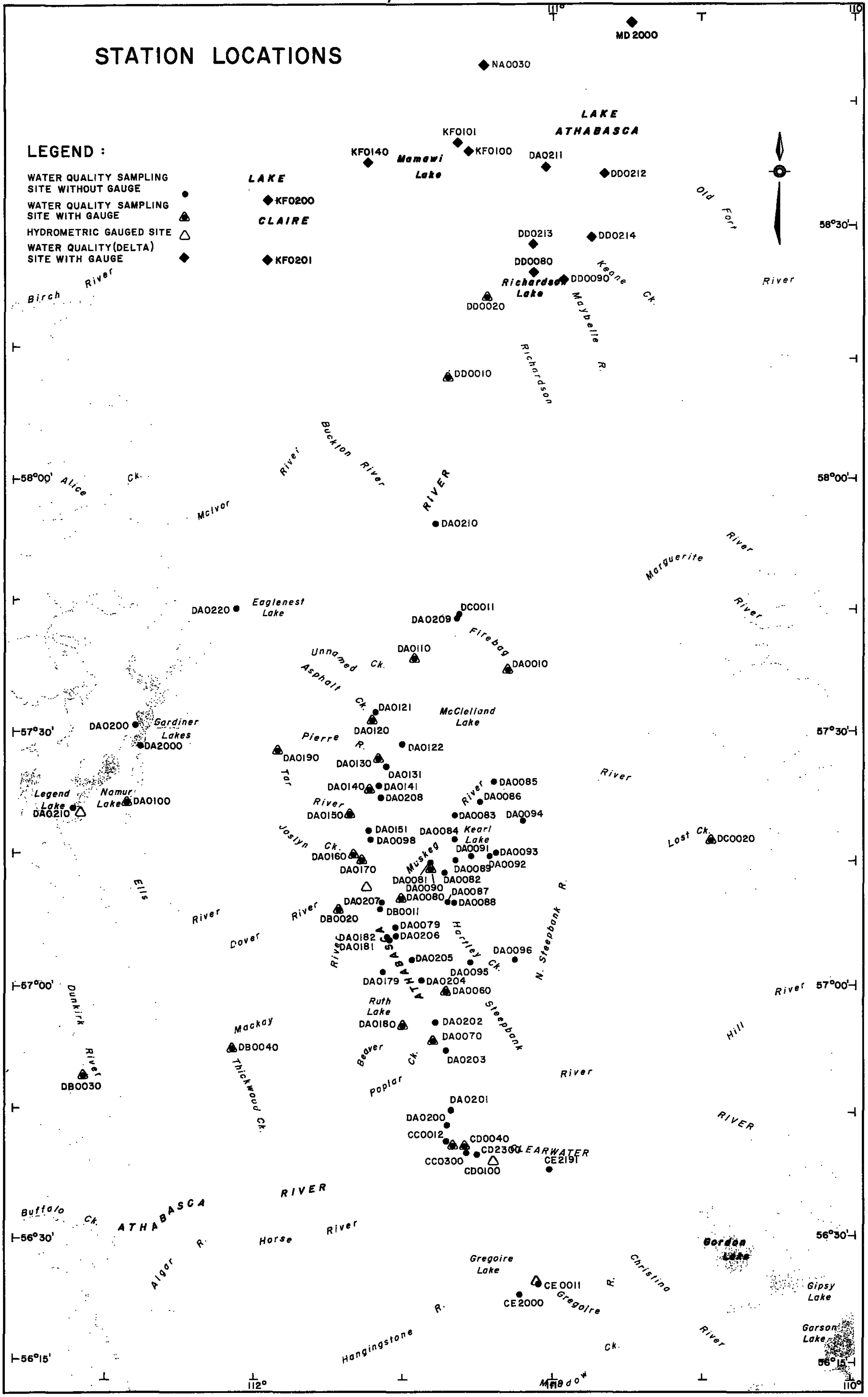

Figure 3. Water quality sampling and gauging station locations.

1. Provide a background assessment;
2. Determine spatial, short-term, and seasonal variations in relevant water quality/quantity parameters, and investigate relationships between the parameters;
3. Assign priorities to areas of concern; and
4. Ascertain potential (or actual) effects of oil sands related developments.

The original plans were to sample the regional sites twice monthly (weekly during high water period) and to sample the remote sites (Birch Mountains region and Peace-Athabasca Delta) monthly. Unfortunately, weight and space restrictions on the helicopter required making extra trips or adjustments to planned sampling frequencies. As a cost saving measure, the Birch Mountains region and Peace-Athabasca Delta sites were sampled every other month on an alternate basis, and the major regional sites were also cut down to once-a-month samplings.

Table 1 gives the sampling frequencies for AOSERP water quality sites. The deviations from planned frequencies of sampling reflect program redirection (see Section 1.3.1.1), cost-saving adjustments, and numerous occasions when sampling trips could not be made because of weather conditions, periods of ice break-up or ice formation. It is unfortunate that the cost-saving adjustments and insurmountable sampling conditions have imposed some limits on the number and kinds of longitudinal correlations that can be obtained from the data base.

Table 1. Water quality stations and sampling history.

Station Code Number	Station Description	Date of first sample	Number of Samplings 1976	1977	1978	1979	Date of last sample
00AT07CC0012	ATHABASCA RIVER 100 METERS ABOVE THE CONFLUENCE WITH THE HORSE RIVER AOSERP	Feb. 1976	14	7	9	10	Oct. 1979
00AT07CC0030	HORSE RIVER AT ABASANDS PARK - 2 MILES ABOVE CONFLUENCE WITH ATHABASCA RIVER - AOSERP	Feb. 1976	3	2	-	-	Mar. 1977
00AT07CC0300	HORSE RIVER NEAR FORT MCMURRAY 100 METERS ABOVE CONFLUENCE WITH ATHABASCA RIVER AOSERP	Jul. 1977	-	4	7	4	Apr. 1979
00AT07CD0040	HANGINGSTONE CREEK - AT HWY 63 -AOSERP	Feb. 1976	8	11	10	10	Oct. 1979
00AT07CD0100	SALINE CREEK - AOSERP	May 1976	5	3	-	-	Jun. 1977
00AT07CD2300	CLEARWATER RIVER APPROXIMATELY 2000 METERS ABOVE WATERWAYS AOSERP	Feb. 1976	10	7	8	10	Oct. 1979
00AT07CE2000	SURMONT CREEK - ABOUT 2 MILES ABOVE GREGOIRE LAKE- AOSERP	May 1978	-	-	8	10	Oct. 1979
00AT07CE2191	CHRISTINA RIVER - ABOVE CONFLUENCE WITH CLEARWATER RIVER	Jun. 1978	-	-	7	3	Mar. 1979
00AT07DA0060	STEEPBANK RIVER - 4.5 MILES UPSTREAM FROM THE MOUTH - AT WSC GAUGE - AOSERP	Feb. 1976	6	12	10	9	Oct. 1979
00AT07DA0070	POPLAR CREEK - 13 MILES NORTH OF FORT MCMURRAY VIA HWY 63 - AOSERP	May 1976	6	9	9	9	Oct. 1979
00AT07DA0079	MUSKEG RIVER NEAR THE MOUTH - AOSERP	Feb. 1976	8	1	1	-	Mar. 1978
00AT07DA0080	MUSKEG RIVER - SITE IS 2.2 MILES NORTH EAST OF FORT MACKAY - AT WSC GAUGE -AOSERP	Jul. 1976	6	12	25	10	Oct. 1979
00AT07DA0081	MUSKEG RIVER - ABOVE SHELL PUMPING STATION ABOVE HARTLEY CREEK - AOSERP	Sep. 1976	2	-	-	-	Oct. 1976
00AT07DA0082	HARTLEY CREEK - 2 MILES ABOVE CONFLUENCE WITH MUSKEG RIVER -AOSERP	Jul. 1976	6	4	-	-	Jul. 1977
00AT07DA0083	STANLEY CREEK - 1.5 MILES ABOVE CONFLUENCE WITH MUSKEG RIVER - AOSERP	Jul. 1976	4	7	-	-	Jul. 1977

Continued ....

Table 1. Continued.

Station Code Number	Station Description	Date of first sample	Number of Samplings 1976	1977	1978	1979	Date of last sample
00AT07DA0084	KEARL LAKE TRIBUTARY TO MUSKEG RIVER 1 MILE ABOVE CONFLUENCE WITH MUSKEG R. - AOSERP	Jul. 1976	4	9	3	-	Apr. 1978
00AT07DA0085	MUSKEG RIVER - 7 MILES UPSTREAM FROM STANLEY CREEK - AOSERP	Jul. 1976	4	11	3	-	May 1978
00AT07DA0086	MUSKEG TRIBUTARY -3.5 MILES UPSTREAM FROM STANLEY CREEK AND .5 MILE UPSTREAM FROM CONFLUENCE WITH MUSKEG RIVER - AOSERP	Sep. 1976	3	7	-	-	Jul. 1977
00AT07DA0087	HARTLEY CREEK - SW FORK - .25 MILES FROM JUNCTION WITH SE FORK - AOSERP	Jul. 1976	4	5	-	-	Oct. 1977
00AT07DA0088	HARTLEY CREEK - SE FORK - .25 MILES FROM JUNCTION WITH SW FORK - AOSERP	Jul. 1976	4	5	-	-	Jul. 1977
00AT07DA0089	TRIBUTARY TO MUSKEG RIVER 3 MILES UPSTREAM FROM HARTLEY CREEK -AOSERP	Jan. 1977	-	7	-	-	Jul. 1977
00AT07DA0090	HARTLEY CREEK - ONE-QUARTER MILE ABOVE CONFLUENCE WITH MUSKEG RIVER GAUGE - AOSERP	Jul. 1976	5	12	15	4	Apr. 1979
00AT07DA0091	TRIBUTARY LEADING TO KEARL LAKE TRIBUTARY FEEDING THE MUSKEG RIVER 4 MILES FROM KEARL LAKE OUTLET -AOSERP	Aug. 1976	6	5	-	-	Oct. 1977
00AT07DA0092	KEARL LAKE OUTLET - AOSERP	Aug. 1976	4	5	1	-	Mar. 1978
00AT07DA0093	KEARL LAKE INLET - AOSERP	Aug. 1976	3	4	-	-	Jul. 1977
00AT07DA0094	MUSKEG RIVER 14 MILES UPSTREAM FROM STANLEY CREEK - AOSERP	Sep. 1976	2	4	-	-	Jul. 1977
00AT07DA0095	HARTLEY CREEK -SW FORK- 10 MILES FROM JUNCTION WITH SE FORK - AOSERP	Jul. 1976	5	5	-	-	Jul. 1977
00AT07DA0096	HARTLEY CREEK - SE FORK - 13 MILES FROM JUNCTION WITH SW FORK - AOSERP	Aug. 1976	3	5	-	-	Jul. 1977
00AT07DA0098	ELLS RIVER NEAR THE MOUTH NO.1 AOSERP	Feb. 1976	2	-	7	4	Apr. 1979
00AT07DA0099	ELLS RIVER NEAR THE MOUTH NO.2 AOSERP	Aug. 1976	1	-	-	-	Aug. 1976

Continued ....

Table 1. Continued.

Station Code Number	Station Description	Date of first sample	Number of Samplings 1976	1977	1978	1979	Date of last sample
00AT07DA0100	UPPER ELLS RIVER - 5 MILES BELOW GARDINER LAKES - AT WSC GAUGE - AOSERP	Oct. 1976	2	11	12	2	Feb. 1979
00AT07DA0110	UNNAMED CREEK 34 AIR MILES NORTH OF FORT MACKAY IMMEDIATELY BELOW SMALL UNNAMED TRIBUTARY WSC SITE AOSERP	Nov. 1976	2	8	5	2	Mar. 1979
00AT07DA0111	SMALL TRIBUTARY TO UNNAMED CREEK 34 AIR MILES NORTH OF FORT MACKAY IMMEDIATELY BEFORE CONFLUENCE WITH UNNAMED CREEK AOSERP	Oct. 1976	1	-	-	-	Oct. 1976
00AT07DA0115	UNAMED CREEK -NEAR THE MOUTH -AOSERP	Feb. 1976	2	-	-	-	May 1976
00AT07DA0120	ASPHALT CREEK NEAR FORT MACKAY - ON RIGHT BANK 30 AIR MILES NORTH OF FORT MACKAY - AT WSC GAUGE - AOSERP	Oct. 1976	2	8	-	-	Nov. 1977
00AT07DA0121	EYMUNDSON CREEK APPROXIMATELY 4000 METERS UPSTREAM OF CONFLUENCE WITH ASPHALT CREEK AOSERP	May 1976	4	7	-	-	Nov. 1977
00AT07DA0122	EYMUNDSON CREEK AT MOUTH AOSERP	Nov. 1976	1	-	-	-	Nov. 1976
00AT07DA0130	PIERRE RIVER - 20 MILES NORTH OF FORT MACKAY - AT WSC GAUGE -AOSERP	Oct. 1976	2	8	1	-	May 1978
00AT07DA0131	PIERRE RIVER NEAR THE MOUTH AOSERP	May 1976	4	-	-	-	Nov. 1976
00AT07DA0140	CALUMET RIVER NEAR FORT MACKAY - ON RIGHT BANK 16 AIR MILES NORTH OF FORT MACKAY - AT WSC GAUGE - AOSERP	Nov. 1976	1	10	2	-	Mar. 1978
00AT07DA0141	CALUMET RIVER NEAR THE MOUTH - AOSERP	Feb. 1976	6	-	-	-	Nov. 1976
00AT07DA0150	LOWER TAR RIVER - 13 AIR MILES NORTH-WEST OF FORT MACKAY GAUGE - AOSERP	Oct. 1976	2	11	2	-	May 1978
00AT07DA0151	TAR RIVER NEAR MOUTH-AOSERP	May 1976	3	1	-	-	Sep. 1977
00AT07DA0160	JOSLYN CREEK - 2 MILES ABOVE CONFLUENCE WITH ELLS RIVER - AT WSC GAUGE - AOSERP	Oct. 1976	2	7	9	4	Apr. 1979
00AT07DA0170	LOWER ELLS RIVER - 2 MILES ABOVE CONFLUENCE WITH JOSLYN CREEK - AT WSC GAUGE - AOSERP	Oct. 1976	2	12	4	-	May 1978

Continued ...

Table 1. Continued.

Station Code Number	Station Description	Date of first sample	Number of Samplings 1976	1977	1978	1979	Date of last sample
00AT07DA0179	BEAVER RIVER INSIDE SYNCRUDE AOSERP	Oct. 1976	2	-	-	-	Nov. 1976
00AT07DA0180	BEAVER RIVER ABOVE SYNCRUDE - .25 MILE BELOW CONFLUENCE WITH CACHE CREEK - AT WSC GAUGE - AOSERP	Sep. 1976	3	11	4	-	May 1978
00AT07DA0181	BEAVER RIVER AT HWY 63 - AOSERP	Aug. 1976	5	10	6	-	Oct. 1978
00AT07DA0182	BRIDGE CREEK DIVERSION - AT HWY 63 - AOSERP	Aug. 1976	4	8	9	10	Oct. 1979
00AT07DA0190	UPPER TAR RIVER - 26 AIR MILES NORTH WEST OF FORT MACKAY - AT WSC GAUGE - AOSERP	Oct. 1976	2	9	1	-	May 1978
00AT07DA0200	ATHABASCA RIVER - OFF MCDONALD ISLAND - AOSERP	Jun. 1976	15	-	-	-	Oct. 1976
00AT07DA0201	ATHABASCA RIVER - SITE 3 - MILE 6.5 - AOSERP	Jun. 1976	5	2	-	-	Feb. 1977
00AT07DA0202	ATHABASCA RIVER ABOVE G.C.O.S. PLANT - AOSERP	Feb. 1976	8	-	-	-	Nov. 1976
00AT07DA0203	ATHABASCA RIVER - SITE 4 - MILE 19 - AOSERP	Aug. 1976	5	2	-	-	Feb. 1977
00AT07DA0204	ATHABASCA RIVER AT OLD AOSERP DOCK MILEAGE = 26.3	Jun. 1976	7	4	-	-	Feb. 1977
00AT07DA0205	ATHABASCA RIVER - SITE 6 - MILEAGE 29.8 - AOSERP	Jun. 1976	5	2	-	-	Feb. 1977
00AT07DA0206	ATHABASCA RIVER UPSTREAM FROM THE CONFLUENCE WITH THE MUSKEG RIVER MILE 34.5 - AOSERP	May 1976	5	2	-	-	Feb. 1977
00AT07DA0207	ATHABASCA RIVER AT FORT MACKAY - AOSERP	Feb. 1976	6	6	12	10	Oct. 1979
00AT07DA0208	ATHABASCA RIVER BELOW CONFLUENCE WITH THE TAR RIVER - MILE 52.4 - AOSERP	Jun. 1976	5	2	-	-	Feb. 1977
00AT07DA0209	ATHABASCA RIVER - ABOVE THE FIREBAG RIVER - MILE 82.4 - AOSERP	Feb. 1976	9	2	-	-	Feb. 1977

Continued ....

Table 1. Continued.

Station Code Number	Station Description	Date of first sample	Number of Samplings 1976	1977	1978	1979	Date of last sample
00AT07DA0210	ATHABASCA RIVER 13 MILES BELOW CONFLUENCE WITH THE FIREBAG RIVER MILE 97-AOSERP	Jul. 1976	5	2	1	-	Feb. 1978
00AT07DA0211	ATHABASCA RIVER - EMBARRAS RIVER	Sep. 1976	1	1	-	-	May 1977
00AT07DB0011	MACKAY RIVER AT HWY. 63 AOSERP	Feb. 1976	7	11	10	10	Oct. 1979
00AT07DB0020	DOVER RIVER - 2 MILES ABOVE CONFLUENCE WITH MACKAY RIVER - AT WSC GAUGE - AOSERP	Oct. 1976	2	11	4	-	May 1978
00AT07DB0030	DUNKIRK RIVER NEAR FORT MACKAY - ON RIGHT BANK 52 AIR MILES NORTH WEST OF FORT MCMURRAY - AT WSC GAUGE - AOSERP	Feb. 1976	4	12	11	2	Feb. 1979
00AT07DB0040	THICKWOOD CREEK - 1 MILE ABOVE CONFLUENCE WITH MACKAY RIVER - AT WSC GAUGE - AOSERP	Sep. 1976	3	10	2	-	Feb. 1978
00AT07DC0010	FIREBAG RIVER WSC SITE AOSERP	Feb. 1976	6	11	11	3	Mar. 1979
00AT07DC0011	FIREBAG RIVER NEAR MOUTH AOSERP	Sep. 1977	-	3	-	-	Nov. 1977
00AT07DC0020	LOST CREEK - ONE-HALF MILE ABOVE THE MOUTH - AT WSC GAUGE - AOSERP	Oct. 1976	1	7	1	-	Jan. 1978
00AT07DD0010	ATHABASCA RIVER AT EMBARRAS AIRPORT - AT WSC GAUGE -AOSERP	Jun. 1977	-	4	6	6	Oct. 1979
00AT07DD0020	RICHARDSON RIVER AT WSC GAUGE - AOSERP	Jun. 1977	-	5	7	3	Mar. 1979
00AT07DD0090	JACKFISH CREEK APPROXIMATELY 500 METERS UP FROM CONFLUENCE WITH THE ATHABASCA RIVER SITE 70 AOSERP	May 1977	-	5	4	3	Mar. 1979
00AT07DD0212	ATHABASCA RIVER - BIG POINT CHANNEL OUTLET - DELTA SITE - AOSERP	Sep. 1976	2	5	4	7	Sep. 1979
00AT07DD0213	ATHABASCA RIVER - FLETCHER CHANNEL NEAR LAKE ATHABASCA - AOSERP	Sep. 1976	1	-	-	-	Oct. 1976
00AT07DD0214	ATHABASCA RIVER - GOOSE ISLAND CHANNEL NEAR LAKE ATHABASCA - AOSERP	Sep. 1976	1	-	-	-	Sep. 1976

Continued ....

Table 1. Continued.

Station Code Number	Station Description	Date of first sample	Number of Samplings 1976	1977	1978	1979	Date of last sample
00AT07KF0100	MAMAWI LAKE CHANNEL - AOSERP	Jun. 1977	-	5	6	2	Mar. 1979
00AT07KF0101	CHENAL DES QUATRE FOURCHERS APPROXIMATELY 6500 METERS DOWNSTREAM FROM FOUR FORKS SITE 75 AOSERP	Jun. 1977	-	5	5	4	Jul. 1979
00AT07KF0140	PRAIRIE RIVER-WSC. SITE -AOSERP	Jun. 1977	-	5	5	2	Mar. 1979
00AT07NA0030	RIVIERE DES ROCHERS 150 METERS UPSTREAM OF REVILLION COUPE	Sep. 1976	1	4	5	7	Oct. 1979
00AT07NA0031	RIVIERE DES ROCHERS AT MILE 217.5 AOSERP	May 1977	-	1	-	-	May 1977
01AT07CD3000	LAKE 16 MILES EAST OF FT. MCMURRY AOSERP	Feb. 1976	1	-	-	-	Feb. 1976
01AT07CE0010	GREGOIRE LAKE - AT WSC GAUGE AT PIER ONE HALF MILE WEST OF ANZAC - AOSERP	Oct. 1976	1	-	-	-	Oct. 1976
01AT07CE0011	GREGOIRE LAKE AT WIER - AOSERP	Oct. 1976	2	11	10	10	Oct. 1979
01AT07DA0200	UPPER GARDNER LAKE IN BIRCH MOUNTAINS - WSC GAUGE ON WEST SHORE - AOSERP	Jan. 1977	-	11	2	-	Mar. 1978
01AT07DA0210	NAMUR LAKE AT BIRCH MOUNTAIN LODGE IN BIRCH MOUNTAINS AOSERP	Jan. 1977	-	11	3	-	Apr. 1978
01AT07DA0220	EAGLENEST LAKE IN BIRCH MOUNTAINS NEAR OUTLET AOSERP	Jan. 1977	-	12	8	-	Nov. 1978
01AT07DA0300	MCCLELLAND LAKE AOSERP	Feb. 1976	1	-	-	-	Feb, 1976
01AT07DA2000	GARDINER LAKE LOWER SITE - AOSERP	Jan. 1977	-	4	2	-	May 1978
01AT07DB0035	BIRCH LAKE IN SNIPE CREEK BASIN AOSERP	Jul. 1977	-	1	-	-	Jul. 1977
01AT07DD0080	RICHARDSON LAKE CENTER - AOSERP	Sep. 1976	1	5	4	-	Dec. 1978

Continued ...

Table 1. Concluded.

Station Code Number	Station Description	Date of first sample	Number of Samplings 1976	1977	1978	1979	Date of last sample
01AT07KF0200	LAKE CLAIRE 10.5 KILOMETERS DUE EAST OF THE NORTH END OF BIRCH RIVER-AOSERP SITE 78 AOSERP	Jul. 1977	-	4	5	3	Mar. 1979
01AT07KF0201	LAKE CLAIRE AT 28TH BASELINE DUE WEST OF WILLOW POINT 2.75 MILES SITE 79 - AOSERP	May 1977	-	5	4	2	Feb. 1979
01AT07MD2000	LAKE ATHABASKA AT SANDY POINT - DUE WEST OF TIP OF SANDY POINT - AOSERP	Jul. 1977	-	4	3	1	Jan. 1979
01AT07MD2300	DORIE LAKE NEAR FORT CHIPEWYAN - AOSERP	Jan. 1978	-	-	1	-	Jan. 1978

2. WATER QUALITY DATA COLLECTION

2.1 INTRODUCTION

To produce reliable water quality data, guidelines and terms of reference were developed to guarantee the two conditions that must be met. Firstly, the sampling procedure employed in the field must produce samples that are truly representative of the water quality of the stream, river, lake, or point source; and these samples must be handled in such a way that they do not deteriorate or become contaminated before they reach the analytical laboratory. Secondly, the analyses of the water for the various parameters must be accurate. To ensure the latter, an analysis contract, patterned after an example in the literature (Edwards et al. 1975; Edwards et al. 1977), and terms of reference requiring compliance with internal and external quality control conditions were drawn up. The external quality control was provided by the participation of Alberta Environment's Pollution Control Laboratory and Environment Canada's Inland Waters Laboratory (Calgary).

2.2 FIELD WORK

Environmental Protection Services personnel in Fort McMurray and Fort Chipewyan were responsible for all the field measurements, samplings, and sample shipment.

Truck, trail bike, snowmobile, jet boat, float plane and/or helicopter were used, as required, to reach sampling sites. During late fall to early spring, a portable ice auger was used to drill through the ice cover.

AOSERP water quality field sheets (Figure 4) were used in the study to enter detailed information and eliminate problems that can arise from improper identification of samples, since constituent levels may vary with stream/river depth, flow, and distance from shore and from one shore to the other. Generally, the pieces of information included:

1. Source and location of site (station number and/or full description as required for data processing), including a cross-section locator;

A.O.S.E.R.P. REGIONAL WATER QUALITY SAMPLING SHEET: PROJECT WS 1.2.1

SAMPLED BY: ____________

STATION DESCRIPTION: ____________

STATION -SAMPLE CODE: 05A0 AT07 . . . . . KKK . . . . MST

D D M M Y Y h h m m
(date) (time)

SAMPLING SITE:

Access:

_____ wading
_____ cableway
_____ boat
_____ ice cover

_____ meters upstream from gauge.
_____ meters downstream from gauge.
_____ 97251F meters from surface.
_____ 97206F meters from right bank facing downstream.
_____ 97202F meters from left bank facing downstream.

Suspended Sediment Sample? _____ Discharge (flow rate) instant. cfs. _____ 97161F.

_____ Stage (lake level).

FIELD PARAMETERS: _____ 02061F temperature (°C) _____ 10301F pH

_____ 02041F specific conductance _____ 08102F dissolved oxygen.

WEATHER CONDITIONS: Air temp. ____°C Barometric Pressure. _____ cm Hg.

Cloud cover _____% Precipitation _____ Wind (speed//direction) _____

NUMBER	SYMBOL	TYPE	PRESERVATION	PARAMETERS TO BE ANALYZED
	R	1 litre plastic	None	☐ All ___B ___Ca, ___Na, ___K, ___Se, ___As ___Mg, ___Cl ___F, ___Silica, ___Sulphate, ___Conductance, ___Alkalinity, ___pH.
	G 1	32 oz glass	None	☐ All ___odor, ___color, ___Turbidity ___Tannin & Lignin, ___Sulfactants ___Dissolved solids*, ___Cr (+6), ___Susp. solids*, ___Humic Acids, ___Fulvic acids. (* total & volatile)
	G 2	1 litre plastic	2.5 ml Conc H_2SO_4	☐ All ___COD, ___Total Kjeldahl, ___NH_3-N, ___Total Phosphorous,
	O G	32 oz glass	2.5 ml Conc H_2SO_4	___ Oil and Greases
	P	32 oz glass	1 gm $CuSO_4$ and 2 ml 85% H_3PO_4	___ Phenols.
	N C	5 oz plastic	None	☐ All ___O-PO_4, ___NO_3-N ___NO_2-N ___Total inorg. C, ___Total org. C, ___Total dissolved org. C,
	M	1 litre plastic	10 ml Conc. HNO_3 (add after sampling)	☐ All ___Cd, ___Cu, ___Fe, ___V, ___Mn, ___Zn, ___Al, ___Pb, ___Ag, ___Co, ___ ___ ___Ti, ___Ni, ___Be, ___ ,
	H G	2 oz Pyrex bottle	2 ml sol. of 0.5% HNO_3 & 0.5% $K_2Cr_2O_7$ (add after sampling)	___ Mercury
	C Y	250 ml plastic	1 ml 6N NaOH	___ Cyanide
	S	5 oz plastic	2 ml 1M ZnAc	___ Sulphide
	C H	32 oz plastic	1 ml 10% $MgCO_3$	___ Chlorophyll "A"
	P H H	40 oz wine bottle	None, (keep cool & out of sun)	___ Total Hydrocarbon

NOTE: FILL BOTTLE TO 90% CAPACITY. Telex Lab prior to or soon after shipping samples (enclose a duplicate copy of each sampling sheet.)

REMARKS - PROBLEMS IN SAMPLING ---- etc. ____________

Figure 4. AOSERP regional water quality sampling sheet.

2. Date and time of sampling;
3. Field data and/or test results, other observations, and sampling technique employed;
4. Markings to indicate parameters to be analyzed; and
5. Sample bottle label numbers.

2.2.1 Field Measurements

The field data collection and analyses included, but were not always limited to the perameters listed in Figure 4. Portable field instruments (a Radiometer pH Meter, a Hydrolab Conductivity-Temperature Meter, and a Hydrolab Dissolved Oxygen Meter) were calibrated in the Mildred Lake laboratory immediately before each sampling round using procedures supplied by the manufacturers. These instruments were used for on-site measurements which, together with other required field data and observations, were recorded on the field sheets. Whenever possible (i.e., where NAQUADAT code numbers are available) these results have been coded and entered on the computer files containing the chemical analyses results from the contractor.

The numerous gaps in field data were a result of instrument failures, freeze-ups, temporary malfunctions and/or breakages caused by means of transportation used or weather conditions.

2.2.2 Sampling

The collection of water samples basically followed Environment Canada's procedures (Water Survey of Canada 1978).

In the case of a shallow stream, an "integrated" sample from top to bottom (in the middle of the stream) was taken in such a way that the sample is made composite according to flow. This is accomplished by lowering the sample container (mouth tilted down) by hand to near the bottom, making sure not to contaminate the sample with bottom sediment or debris, and allowing the container to fill (mouth tilted up and facing upstream) as it is being pulled up.

Samples collected from lakes and large rivers (e.g., Athabasca and Clearwater rivers) generally consisted of surface "grab" samples collected from near midstream. The choice of location, depth, and frequency of sampling of the lakes and large rivers was influenced to a great extent by logistic and fiscal considerations. It is realized, for instance, that taking monthly grab samples from a lake would probably not identify seasonal variations caused by stratification, rainfall, runoff, wind, and biotic processes. Unfortunately, transect, depth-integrated and more frequent samplings, required by an intensive study of the this area, would be time consuming and very costly.

All possible sources of sample contamination were investigated and eliminated. One source of possible lead contamination was found to be the ice drilling equipment used during winter samplings. The ice auger flighting was coated with a lead based paint (see Table 2). The paint layer consequently was removed using a sand blaster. Procedures and other pieces of equipment were routinely checked to identify/eliminate possible sources of contamination.

Another precaution taken during sampling from ice-holes (or stagnant bodies of water) included using a stainless steel bucket or taking the samples in sequence; those that do not require preservatives after sampling were collected first. When those were filled, bottles requiring preservatives after sampling and bottles containing preservatives were then dipped into the water in the sequence:

R G1 NC M Hg PHH CH S Cy G2 OG P

This ensured that overflow did not contain a constituent that would contaminate subsequent samples.

2.2.3 Sample Preservation, Storage, and Shipment

Deterioration of water samples is a concern in any water quality sampling program. Attempts to reduce the effects of physical, chemical, and biological processes which may result in sample deterioration have included the following preventive measures:

Table 2. Analyses of paint sample scrapings from ice drilling equipment[a].

Sample Numbers[b]	Co	Cu	Mn	Ni	Cd	Cr	Pb	Zn
1.	0.002	0.007	0.020	0.004	<0.001	0.010	0.103	0.013
2.	0.002	0.017	0.020	0.004	<0.001	3.750	23.40	0.030
3.	0.002	0.010	0.068	0.063	<0.001	0.250	1.600	0.024
4.	0.006	0.022	0.018	0.006	<0.001	0.350	0.520	0.570
5.	0.001	0.004	0.042	0.004	<0.001	0.150	0.850	0.014

[a] These quantities (mg/L) are relative since scrapings were not weighted. The scrapings were digested and all samples diluted to the same volume prior to analysis.

[b] Sample Numbers:

1. Needle Bar
2. Ice Auger Extension
3. Paint from Ice Auger
4. Slush Remover
5. Ice Chisel

1. Use of specific containers;
2. Use of chemical preservatives; and
3. Minimum transit time.

As shown in Figure 4, some samples required that preservatives be added on-site after sampling, while others had the preservatives in the bottle prior to sampling. The specific containers and preservatives used during the history of this study are documented in Table 3.

Water samples and a set of the completed field sheets were crated, air freighted and generally arrived at the laboratory within 24 h of sampling, for Fort McMurray area samples, and between 30 to 48 h for Peace-Athabasca Delta area samples. The contracted analytical laboratory assumed responsibility for the samples upon arrival at the Calgary International Airport.

2.2.4 Field Work Summary

The above discussions outlined field measurements, sampling procedures, and precautions taken to collect relevant data, minimize sample deterioration, and ensure that the samples were truly representative of the source. The guidelines emphasized:

1. Adhering to established sampling sequence and frequency;
2. Using proper site codes and descriptions;
3. Accuracy and clarity in recording all field data, comments, observations, identification of bottles, sampling time, date, location, etc.,
4. Significance of sampling from the same location;
5. Ensuring that the water samples are truly representative (i.e., employing proper sampling technique and good judgment) of the water quality station (river, lake, industrial effluent, etc.) from which the samples originate;
6. Employing integrated sampling techniques on rivers;

Table 3. A historical summary of sample containers, preservatives, holding times, analysis methods and detection limits.

Parameter	Bottle[a]	Preservative[a]	Analysis Method(s) NAQUADAT CODE(S)[b,c]	Dectection Limits mg/L (except when indicated)	Maximum Holding Time (working days)
Calcium	*R, plastic*	None	20103L	0.01 (to Sep 77) 0.001 (to present)	10
Magnesium	"	"	12102L	0.01 (to Sep 77) 0.05 (to present)	10
Sodium	"	"	11102L (to Aug 78) 11103L (to present)	0.05 (to Aug 78) 0.01 (to present)	10
Potassium	"	"	19102L (to Aug 78) 19103L (to present)	0.05 (to Aug 78) 0.01 (to present)	10
Chloride	"	"	17203L	1.0 (to Sep 77) 0.1 (to Jul 78) 0.01 (to present)	7
Sulphate	"	"	16306L	1.0 (to Jul 79) 0.1 (to present)	7, (to Jun 78) 5, (to present)
Phenolphthalein Alkalinity (as $CaCO_3$)	"	"	10151L	0.5 (to Jun 78) 0.1 (to present)	1
Total Alkalinity (as $CaCO_3$)	"	"	10101L	0.5 (to Jun 78) 0.1 (to present)	1
pH	"	"	10301L	0.01 pH units	1
Fluoride	"	"	09105L (to Jul 78) 09107L (to present)	0.1 (to Sep 76) 0.05 (to present)	7, (to Jun 78) 4, (to present)
Silica	"	"	14102L (to Jun 76) 14101L (to present)	0.02	3
Conductance	"	"	02041L	0.2 µs/cm	1
Colour	*G-1, glass*	"	02011L (to Aug 77) 02021L (to present)	5 (Rel. Units) 5 (Pt Co colour Units)	1,[d] 2,[d]
Tannin & Lignin	"	"	06551L	0.1	1, (to Jul 78)[d] 4, (to present)[d]
Total Filtble Res. (TFR)	"	"	10451L	1.0	7, (to Jul 78) 12, (to Jun 79) 15, (to present)
Total Filtble Res. Fixed (TFRF)	"	"	10551L	1.0	7, (to Jul 78) 12, (to Jun 79) 15, (to present)
Total Non-filtble Res. (TNFR)	"	"	10401L	0.4	7, (to Jul 78) 12, (to Jun 79) 15, (to present)

Continued...

Table 3. Continued.

Parameter	Bottle[a]	Preservative[a]	Analysis Method(s) NAQUADAT CODE(S)[b,c]	Dectection Limits mg/L (except when indicated)	Maximum Holding Time (working days)
Total Non-filtble Res. Fixed (TNFRF)	*G-1, glass*	None	10501L	0.4	7, (to Jul 78) 12, (to Jun 79) 15, (to present)
Turbidity	"	"	02073L	0.1 JTU	7, (to Jun 78) 2, (to present)
Surfactants (MBAS)	"	"	10701L Man. Extr. (to Aug 77) 10701L Aut. Extr. (to present)	0.02	1, (to Sep 77)[d] 3, (to present)[d]
Humic Acids	"	"	06581L (eff. Sep 77)	1.0	12
Fulvic Acids	"	"	93050L (eff. Jun 78)	1.0	12
Total Inorganic Carbon	*NC, plastic*	"	06051L	0.5	1, (to Jun 78)[d] 5, (to present)[d]
Total Organic Carbon	"	"	06001L	0.5	1, (to Jun 78)[d] 2, (to present)[d]
Total Diss. Organic Carbon	"	"	06101L	0.5	1, (to Jun 78)[d] 2, (to present)[d]
Nitrate-Nitrogen	"	"	07300L	0.01 (to Jun 77) 0.003 (to present)	1, (to Jun 78)[d] 2, (to present)[d]
Nitrite-Nitrogen	"	"	07206L	0.01 (to Jun 77) 0.003 (to present)	1, (to Jun 78)[d] 2, (to present)[d]
(Nitrate & Nitrite)-Nitrogen	"	"	07110L 07111L (intermit.)	0.01 (to Jun 77) 0.003 (to present)	1, (to Jun 78)[d] 2, (to present)[d]
Ammonia-Nitrogen	*G-2, plastic*	2.5 mL conc H_2SO_4 per litre of sample	07555L	0.01 (to Jul 79) 0.002 (to present)	5
Total Kjeldahl Nitrogen	"	"	07013L (to Sep 77) 07015L (to present)	0.1 (to Apr 78) 0.02 (to present)	5
Total Phosphate-Phosphorus (as P)	"	"	15406L	0.005 (to Jun 77) 0.003 (to present)	5
Ortho-Phosphate-Phosphorus (as P)	*NC, plastic*	None	15256L	0.005 (to Jun 77) 0.003 (to present)	1, (to Jun 78)[d] 2, (to present)[d]
Phenols	*P, glass*	1 g $CuSO_4$ and 2 mL 85% H_3PO_4 per 32 oz of sample	06532L	0.001	1,[d]

Continued...

Table 3. Continued.

Parameter	Bottle[a]	Preservative[a]	Analysis Method(s) NAQUADAT CODE(S)[b,c]	Dectection Limits mg/L (except when indicated)	Maximum Holding Time (working days)
Oil & Grease	*OG, glass*	2.5 mL conc H_2SO_4 (or 5 mL 1+1 H_2SO_4) per litre of sample	06521L	0.2 (to Sep 77) 0.1 (to present)	12,[d]
Sulphide	*S, plastic*	2 mL 1M ZnAc per 5 oz sample	06101L	0.05 (to Jul 78) 0.01 (to present)	1
Cyanide	*CN, plastic*	5 mL 6N NaOH per litre of sample	06603L (to Jan 78)	0.01 (to Jan 78) 0.002 (to Mar 78) 0.001 (to present)	6 2 (most samples)
Total Hydrocarbon (as C_{10})	*PHH, wine bottle*	None	06500L (eff. Jun 78)	1.0 (to Sep 77)	11, kept cool (≈4°C) out of sunlight
Chlorophyll "a"	*CH, plastic*	1 mL, 10% $MgCO_3$ per litre of sample	06711L	0.005 (to Sep 76) 0.001 (to present)	0 filtered immediately (fiberglass filter), frozen and analyzed within 9 days
Chemical Oxygen Demand	*G-2, plastic*	2.5 mL conc H SO per litre of sample	08301L	1.0	4
Cadmium	*M, plastic*	2 mL conc HNO_3 (to Jun 77) 10 mL conc HNO_3 (to present) added per litre of sample	48302L (Extr.)	0.001	15
Cooper	"	"	29305L (Extr.)	0.001	15
Iron	"	"	26304L (Extr.) (to Sep 77) 26302L (Extr.) (to Jul 79) 26304L (Extr.) (to present)	0.01 (to Apr 78) 0.001 (to present)	15
Lead	"	"	82302L (Extr.)	0.002	15
Manganese	"	"	25304L (Extr.) with preconcen.	0.001	15
Zinc	"	"	30304L (Extr.) (to Oct 76) 30305L (Extr.) (to present)	0.001	15

Continued...

Table 3. Continued.

Parameter	Bottle[a]	Preservative[a]	Analysis Method(s) NAQUADAT CODE(S)[b,c]	Dectection Limits mg/L (except when indicated)	Maximum Holding Time (working days)
Vanadium	"	"	23001L (T) 23002L (T) with preconcen.	0.01 (to Dec 76) 0.001 (to present)	15
Nickel	"	"	28302L (Extr.)	0.002 (to Apr 78) 0.001 (to present)	15
Aluminum	"	"	13302L (Extr.) with preconcen.	0.01	
Cobalt	"	"	27302L (Extr.)	0.002 (to Apr 78) 0.001 (to present)	15
Beryllium	"	"	04301L (Extr.) 04030L (Extr.)	0.001	15
Chromium (+6)	*G-1, glass*	None	24101L (correction for color interference instituted Jun 78)	0.003	2
Mercury (T)[c]	*HG, polypropylene,* (on rare occasions polyethylene)	1 mL HNO_3 per 5 oz sample (to Sep 76) 1 mL 30% HNO_3 + 1 mL 5% $K_2Cr_2O_7$ per 2 oz sample-added after (to present)	80015L (to Oct 76) 80011L (to present)	0.0002 (to Oct 76) 0.0001 (to present)	7 (to Jul 79) 10 (to present)
Boron (Diss.)[c]	*M, plastic*	2 mL conc. HNO_3 (to Jun 77) 10 mL conc. HNO_3 (to Sep 77)	05105L (to Dec 77) 05106L (to present)	0.01	15
	R, plastic	None (to present)			
Silver (Extr.)[c]	*AG, plastic* (to Sep 77)	0.5 g EDTA + 1 mL 1:1 HNO_3 per 5 oz sample-added after (to Sep 77)	47301L (to Jul 77) 47302L (to present)	0.005 (to Mar 77) 0.001 (to present)	15
	M, plastic (to present)	10 mL conc HNO_3 per litre of sample -added after (to present)			

Continued...

Table 3. Concluded.

Parameter	Bottle[a]	Preservative[a]	Analysis Method(s) NAQUADAT CODE(S)[b,c]	Dectection Limits mg/L (except when indicated)	Maximum Holding Time (working days)
Arsenic	*M, plastic* (to Jan 77)	2 mL Conc HNO_3 per litre of sample (to Jan 77)	33104L (Diss.)	0.005 (to Aug 76) 0.001 (to Mar 77) 0.0005 (to Jun 77) 0.0002 (to present)	15
	G-2, plastic (to Jun 78)	2.5 mL Conc H_2SO_4 per litre of sample (to Jun 78)			
	R, plastic (to present)	No preservative (to present)			
Selenium	*M, plastic* (to Jan 77)	2 mL conc HNO_3 per litre of sample (to Jan 77)	34102L (Diss.)	0.005 (to Aug 76) 0.002 (to Jun 77) 0.0002 (to present)	15
	G-2, plastic (to Jun 78)	2.5 mL Conc H_2SO_4 per litre of sample (to Jun 78)			
	R, plastic (to present)	No preservative (to present)			

OTHER METAL FORMS MONITORED OCCASIONALLY:

Vanadium	(Dissolved)	23101L	Beryllium	(Dissolved)	04101L	Antimony	(Extractable)	51301L
Vanadium	(Dissolved)	23102L	Iron	(Dissolved)	26101L	Antimony	(Dissolved)	51101L
Cadmium	(Dissolved)	48102L	Mercury	(Extractable)	80311L	Barium	(Extractable)	56301L
Nickel	(Dissolved)	28102L	Mercury	(Extractable)	80313L	Strontium	(Extractable)	38301L
Lead	(Dissolved)	82103L	Molybdenum	(Extractable)	42301L	Strontium	(Dissolved)	38101L
Cobalt	(Dissolved)	27101L	Titanium	(Total)	92500L	Boron	(Dissolved)	05102L
Copper	(Dissolved)	29105L	Chromium	(Extractable)	24302L	Boron	(Extractable)	05301L

[a] Refer to Figure 4.

[b] For details of analytical methods and instrumentation, refer to Alberta Environment (1977).

[c] Man. Extr. - Manual Extraction
Aut. Extr. - Automated Extraction
T. - Total
Diss. - Dissolved

[d] at 4°C

7. Adding the right preservative, in the right amount, and into the numbered bottle;
8. Avoiding solutions not used in sample preservation from contaminating samples;
9. Expediency in shipping of properly labelled samples; and
10. Contacting the analytical laboratories to inform them that samples have been shipped.

2.3 LABORATORY ANALYSES

The second criterion for producing dependable water quality data relates to the "quality" of containers and preservative reagents and the accuracy of analyses required to define the natural water quality of the AOSERP study area. An appropriate description of the composition of study area waters required:

1. Results of timely analyses for major ions, nutrients and certain organics;
2. Results of timely determinations of levels of other parameters susceptible to change; and
3. Documentation of concentrations of heavy (and trace) metals that may, in the future, be mobilized by oil sands mining operations and which may have significant effects on aquatic fauna.

Bacteriological samples were collected in containers supplied by, and the analyses (Total Coliform, Fecal Coliform, and Standard Plate Count) performed by the Public Health Laboratory (Edmonton). The chemical analysis contract was awarded yearly to the laboratory that proved to be most competent in an open tender competition.

2.3.1 Chemical Analysis Contract

The Terms of Reference for the chemical analysis contract required the contractor to:

1. Provide all sample bottles, suitably labeled teflon-capped vials, preservative reagents and shipping labels;

2. Provide only new bottles for samples to be analyzed for trace metals;
3. Provide only preservative reagents of the quality recommended by Alberta Environment's Pollution Control Laboratory. The lists of sample containers and preservatives used during the study are shown in Table 3. No deviations from these lists were permitted;
4. Analyze samples for specified parameters taken from those in Table 3, and according to specific directions accompanying each sample. Because several research projects were involved, the analytical requirements varied by project; and in the later parts of the project, parameters showing consistently low levels were dropped when and where project reviews considered that such a move would not compromise the value of the data base;
5. Use the standard methods and detection limits (Table 3) agreed to in the contract. When alternative methods were proposed by the contractor, they were first reviewed with the Pollution Control Laboratory before being approved for the contract;
6. Supply data on punched cards (or high density nine-track tape) compatible with Government of Alberta Computer System and acceptable to the NAQUADAT program;
7. The contractor was required to meet the quality control criteria specified in Section 3; and
8. Persistent gross errors in the analyses reported to EPS were subject to penalties under terms of the contract.

2.4 DATA STORAGE AND RETRIEVAL SYSTEM

The Athabasca Oil Sands area water quality data collected by this AOSERP project are stored in NAQUADAT, the computerized National Water Quality Data Storage and Retrieval System, which is a repository of water quality information designed to store physical, chemical and selected bacteriological and hydrometric data. The insert below gives an example of a NAQUADAT reporting format.

STATION 00AT07DA0090 LATITUDE 57D 15M 34S LONGITUDE 111D 27M 53S

HARTLEY CREEK - ONE-QUARTER MILE ABOVE CONFLUENCE WITH MUSKEG RIVER GAUGE - AOSERP

SAMPLE DATE TIME MST D M Y H M	97202F SAMPLING DIST. FROM LEFT BANK M	97206F SAMPLING DIST. FROM RIGHT BANK M	97251F DEPTH OF SAMPLING FROM SURF. M	02061F TEMPERATURE OF WATER DEG.C.	02061L TEMPERATURE OF WATER DEG.C.	10301F PH PH UNITS	10301L PH PH UNITS
5 6 78 10 30	1.		0.3	15.5		8.1	7.65
21 6 78 10 15	1.5	5.0	0.4	14.5		7.9	7.48
10 7 78 09 15	1.5	2.	0.3	14.5		7.0	7.80
20 7 78 09 00	1.	3.	1.				7.50
15 8 78 10 20	4.	1.	0.3	13.		8.2	7.40

SAMPLE DATE TIME MST D M Y H M	02041F SPECIFIC CONDUCT. US/CM	02041L SPECIFIC CONDUCT. US/CM	08102F OXYGEN DISSOLVED O2 MG/L	20103L CALCIUM DISSOLVED CA MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	11102L SODIUM DISSOLVED NA MG/L	19102L POTASSIUM DISSOLVED K MG/L
5 6 78 10 30	83	130	5.2	20.0	6.0	10.8 03L	0.40 03L
21 6 78 10 15	120	166	9.5	21.9	5.7	10.7 03L	0.20 03L
10 7 78 09 15	120	211	9.9	28.7	7.9	12.4 03L	0.10 03L
20 7 78 09 00		227		30.0	9.0	13.7 03L	L.01 03L
15 8 78 10 20	74	189	8.8	31.3	8.8	14.1 03L	0.50 03L

SAMPLE DATE TIME MST D M Y H M	17203L CHLORIDE DISSOLVED CL MG/L	16306L SULPHATE DISSOLVED SO4 MG/L	10151L ALKALINITY PHENOL - PHTHALEIN CACO3 MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	06301L CARBONATE (CALCD.) CO3 MG/L	06201L BICARBONT. (CALCD.) HCO3 MG/L	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L
5 6 78 10 30	1.3	4.3	L.1	86.0	0.	105.	74.6
21 6 78 10 15	1.9	4.1	L.1	90.4	0.	110.	78.2
10 7 78 09 15	2.1	5.0	L.1	119.4	0.	146.	104.2
20 7 78 09 00	2.4	4.5	L.1	131.7	0.	161.	112.0
15 8 78 10 20	2.0	6.2	L.1	125.8	0.	153.	114.4

For complete information on the capabilities, graphic plots, and all reporting formats of the NAQUADAT system, the reader is requested to contact:

Data and Instrumentation Section
Water Quality Branch
Environment Canada
Place Vincent Massey
Ottawa, Canada
K1A 0E7

2.5 AVAILABILITY OF AOSERP WATER QUALITY DATA

All the data generated by the AOSERP regional water quality monitoring program and the Muskeg River watershed study (Akena 1979) are stored in Alberta Environment's NAQUADAT files. Unfortunately, water quality data collected by other AOSERP studies, for instance, biological and groundwater studies, are not contained in this data bank. Most of these other data are, however, published in AOSERP reports. A list of AOSERP publications is available at the back of this report.

The water quality data stored in Alberta Environment's NAQUADAT files are updated regularly. In order to obtain a retrieval from the data files, it is only necessary to inform

Water Quality Control Branch
Alberta Environment
9820 - 106 Street
Edmonton, Alberta
T5K 2J6
Telephone (403) 427-5828

of the information required from the NAQUADAT files and agree to pay the computer costs (minimal) associated with the request.

2.6 NON-AOSERP WATER QUALITY DATA

In addition to the AOSERP study area surface water quality data collected since February 1976, the project has also assembled some non-AOSERP (including pre-AOSERP) surface water quality data. Most of this latter set of data was abstracted from reports of Federal and Alberta Government Departments, Alberta Research Council, universities, private consulting firms and oil sands industry (Appendix 5.1). Unfortunately, the studies culminating in these reports used a wide variety of collection, storage, and analysis procedures. A majority of the data bases contain:

1. No definition of extent or accuracy;
2. Unclear location of sampling sites;
3. Incomplete field data;

4. Lack of documentation of sampling procedures and sample preservatives used;
5. Unidentified analytical laboratories;
6. Lack of rigorous quality control and quality assurance programs;
7. Inconsistencies in sites and parameters monitored; and
8. Incomplete or lack of documentation of analytical methods, detection limits and precision (see Sections 2 and 3).

Because the available information is incomplete and/or cannot be validated, no attempts will be made to evaluate these data bases in terms of AOSERP's general objectives. The user is advised to place little emphasis on the precision or accuracy of the data and to exercise caution when comparing the results of those studies with AOSERP's. The above remarks should not, however, be misconstrued to mean that previous studies are worthless.

2.7 SUMMARY

The project used trained field technicians, reliable sampling and sample preservation techniques to ensure that the field work was sufficiently free of error.

The quality and accuracy of laboratory analyses were assured by enforcement of conditions of the chemical analysis contract patterned after examples in the literature. Specifically, they prescribed internal and external quality control conditions.

The Athabasca Oil Sands area water quality data generated by this AOSERP project are stored in Alberta Environment's NAQUADAT files; and are readily available in one of the many NAQUADAT reporting formats. Non-AOSERP water quality data have not been entered in the NAQUADAT files because of uncertainties associated with the locations of sampling sites, sampling procedures, analytical methods, data, quality assurance, and quality control measures used by the various groups.

3. QUALITY CONTROL PROGRAMS AND DATA COMPARABILITY

3.1 CONSULTANT CAPABILITY

Consultant laboratories in Alberta were requested to submit proposals detailing their services, equipments, expertise, experiences, and fee schedules. Awarding the analytical service contract to a laboratory depended heavily on analytical performance; and retention of the contract was assured only as long as a high standard of day-to-day performance was reflected in the exhaustive performance evaluations (see Section 3.2).

3.1.1 Consistency of Analytical Data and Internal Quality Control Programs

3.1.1.1 Ion Balance and Data Checks. For analytical data to be acceptable, an ion balance (NAQUADAT method 00103L) within the range 0.90 to 1.10 was required. In the case of a smaller amount of sample being available for analysis and thus insufficient sample to recheck some of the ion analyses, an analysis report containing an ion balance within the range 0.85 to 1.15 was accepted.

The consultant reported an ion balance in the range required by the contract for each set of samples analysed.

The consultant has also recently instituted computer check programs as means of validating analysis data. The programs provided the bilateral checks listed in Table 4 to verify compatibility of analytical data. These checks are based on relative levels and/or proportionality. The ability to spot inconsistencies allowed the consultant to repeat the analyses that produced the conflicting data. As a result, few discrepencies exist in the data base.

3.1.1.2 Precision. The consultant was also required to demonstrate an internal quality control program and to submit documentation of it with monthly invoices to EPS. Such a program included blind duplicates submitted by EPS and replicate analyses of at least one set of samples per 20 sets reported (Appendix 5.2).

Table 4. Bilateral checks used by Chemex Labs (Alberta) Ltd.

Parameter A	Parameter B	Computer Check Criteria
pH	Carbonate (or Phenol-phthalein Alkalinity)	when pH > 8.3, CO_3 > 0.0
Conductance	Total Dissolved Solids	B = 0.65A ± 20%
Turbidity	Total Non-Filterable Residue	A = B ± 20%
Total Organic Carbon	Chemical Oxygen Demand	B >(1 to 4) A
Total Organic Carbon	Dissolved Organic Carbon	A ≥ B
Total Inorganic Carbon	Total Alkalinity	A ≃ (1/5)B
Total Kjeldahl Nitrogen	Ammonia Nitrogen	A > B
Nitrate + Nitrite Nitrogen	Nitrite Nitrogen	A ≥ B
Total Phosphorus	Ortho-Phosphorus	A > B
Total Filterable Residue	Total Filterable Residue Fixed	A > B
Total Non-Filterable Residue	Total Non-Filterable Residue Fixed	A > B

The consultant was informed of results of all duplicate analyses. If there occurred deviations (in either in-lab or blind duplicates) greater than 10% of the mean value on any particular analysis (or that would result in a deviation in mean value greater than ten times the detection limit), the consultant was required to make every effort to discover the source(s) of error and correct the situation. If the deviation greater than 10% of the mean value occurs where the analysis results are less than 10 times the detection limit, the consultant was required to demonstrate an improvement of its precision. Such deviations were considered particularly serious if the parameter monitored was critical and/or showed levels at which improvement of precision is desirable and necessary.

The levels of acceptable deviations specified above (and in American Public Health Association 1976) were based on the understanding that, as the level of any species present in the water sample approaches the detection limit for the particular analytical method, the accuracy of the result for that species decreases. Consequently, higher deviations would be expected at concentrations approaching the detection limit. The concentrations of many trace and heavy metals in AOSERP study area waters tend to be close to the detection limit of the analytical methods used; thus, analysis results would be expected to show significant percentage deviations.

Appendix 5.2 shows that there were minor and very few real variations in the concentrations of the parameters monitored throughout the study period, the only noticeable exception being the set of three duplicate zinc analyses reported for November 1977 samples (see Appendix 5.2). Other parameters exhibiting slight variations appear to be limited to those parameters (see Section 3.2.2.1) which, when particulates are present, are most susceptible to problems of sample duplication. Nevertheless, the tabulated results show that very few analyses differed more than the acceptable coefficients of variation or standard deviations (American Public Health Association 1976). There was amasingly a high percentage of zero deviations produced in these duplicate analyses.

3.1.2 Accuracy and External Quality Control Programs

In addition to demonstrating a rigorous internal quality control program, the consultant was also required to participate in:

1. Federal Quality Control Studies administered by Inland Water Directorate, Burlington, Ontario;
2. Provincial Quality Control Studies administered by Alberta Environment's Pollution Control Laboratory; and
3. Project quality control and tri-laboratory sample exchange programs administered through the project.

3.1.2.1 Federal Quality Control Studies. The results of the series of national Interlaboratory Quality Control Studies, conducted since 1970, have been analyzed and published by Inland Water Directorate, Canada Center for Inland Waters, Burlington (Aspila and Carron 1979 and references therein).

These studies assembled and evaluated the quality of the data obtained by participating laboratories in the analyses of quality control samples for various groups of water quality parameters. Chemex Laboratories (Alberta) Ltd. and Alberta Environment's Pollution Control Laboratory participated in a significant number of the more recent studies.

3.1.2.2 Provincial Quality Control Studies. Six provincial Interlaboratory Quality Control Studies were carried out between October 1976 and December 1979. These studies have been helpful in improving the capabilities of Alberta laboratories.

The list of parameters analyzed and participating laboratories are provided in Table 5. Analyses, with statistical evaluations of data generated by the participating laboratories, are available in published public documents (Nahulak and Paul 1977, 1978; Ramamoorthy 1980).

The need for quality control programs and eventual achievement of data compatibility (interchangeability) is clearly demonstrated by the range of values reported in these quality control studies.

Table 5. A list of parameters analyzed and laboratories involved in provincial Interlaboratory Quality Control Studies.

Study Number	1	2	3	4	5	6
Analytical Laboratories / Parameters Analysed	Na, Mg, Cl, SO_4^{2-}, NH_3-N (in surface waters)	Carbon (total, inorganic and organic), Tannin & Lignin, Total Phosphate-P and Phenol	Phenols and Chemical Oxygen Demand (in synthetic samples and industrial waste waters)	NO_2-N, NO_3-N, NO_2-N + NO_3-N (in synthetic samples and industrial waste waters)	T-PO_4, o-PO_4 (in synthetic samples and industrial waste waters)	Dissolved NH_3-N, Total Kjeldahl Nitrogen (in synthetic samples and industrial waste waters)
Alberta Government's Pollution Control Laboratory Clover Bar	✓	✓	✓	✓	✓	✓
Environment Canada's Inland Water Directorate Lab Calgary		✓	✓	✓	✓	
Chemex Labs (Alberta) Ltd. Calgary	✓	✓	✓	✓	✓	✓
Syncrude Canada Ltd. Edmonton	✓	✓	✓		✓	
Syncrude Canada Ltd. Fort McMurray	✓	✓	✓	✓	✓	
GCOS Fort McMurray	✓	✓	✓			✓
Environment Canada's EPS Lab Edmonton		✓	✓	✓	✓	✓
City of Edmonton Waste Water Treatment Laboratory		✓				✓
Alberta Environment's Earth Sciences and Licencing Division Lethbridge		✓	✓	✓		
Western Industrial Laboratories Edmonton		✓	✓	✓	✓	
Dow Chemicals Fort Saskatchewan			✓			
Celanese (Canada) Inc. Edmonton			✓			
Gulf Oil (Canada) Ltd. Edmonton			✓			✓
Gulf Oil (Canada) Ltd. Calgary			✓			
Texaco (Canada) Ltd. Edmonton			✓			✓
Imperial Oil Edmonton			✓			
Esso Chemical (Canada) Redwater			✓	✓	✓	
Core Laboratories-Canada Ltd. Edmonton			✓			
Core Laboratories-Canada Ltd. Calgary				✓		✓
R M Hardy & Associates Ltd. Edmonton			✓	✓	✓	✓
Chemical & Geological Laboratories Ltd. Edmonton			✓	✓	✓	✓
Chemical & Geological Laboratories Ltd. Calgary			✓	✓	✓	✓
Renewable Resources Consulting Services Ltd. Edmonton			✓	✓	✓	
Western Co-operative Fertilizers Ltd. Calgary					✓	
Canadian Fertilizers Co. Medicine Hat				✓	✓	
Cominco Carseland Fertilizers Calgary				✓	✓	✓
Powell Analytical & Consulting Services Calgary				✓	✓	✓
Western Co-op Fertilizers Ltd. Medicine Hat				✓	✓	
Cominco Ltd., Carseland Plant. Calgary				✓	✓	✓

3.2 PROJECT QUALITY CONTROL AND AN EVALUATION OF THE QUALITY OF AOSERP WATER QUALITY DATA

The project quality control and interlaboratory sample exchange programs were designed to provide external checks on the effectiveness of the consultant laboratory's internal quality control program and a way of identifying areas where improvement in analytical methods would be desirable. For these sample exchange programs, agents of EPS submitted:

1. Replicate bulk water samples from the field;
2. "Design samples", solutions of known chemical composition; or
3. "Spiked samples", natural water or industrial effluent samples to which known amounts of one or more chemicals have been added.

3.2.1 Sample Exchange Program

Triplicate sample sets distributed in the program were obtained from water samples (bulk, design, or spiked) collected in a 20 L polypropylene (or polyethylene) bottle with a spigot at the bottom. To ensure uniformity of sub-samples, each replicate set of bottles was filled from the spigot while the sample was being gently stirred with a long glass rod.

Various factors affect a laboratory's comparative performance in such sample exchange programs, including:

1. Manner of splitting and/or preparation of samples for exchange;
2. Analytical methodology;
3. Coefficients of variation for a particular method at different concentration levels;
4. Detection limits attainable;
5. Application of internal quality control programs to increase probability of accurate test results;
6. Sample contamination;

7. Deterioration or change in parameter concentration as a result of time lapsing before samples were analyzed; and
8. Amount of suspended matter present.

3.2.2 Results of Sample Exchange Program

The tri-laboratory sample exchange analysis results are tabulated in Tables 6 to 14 and Appendix 5.3. The program found significant agreement in analyses of most design samples (Tables 7 to 10) but numerous analytical discrepancies for bulk water (Appendix 5.3) and spiked samples (Tables 11 to 14). The parameters identified as problem areas are those whose values differed more than the acceptable coefficient of variation, relative or standard deviation at the measured parameter level; and where such variations appeared in several sample exchanges. These parameters are listed in Table 15 together with the most probable reasons for their variations.

The parameters discussed in the following sections are chosen because they help illustrate variable analyses and quality control or because the parameters are particularly critical to the water quality of the region.

3.2.2.1 Effects of Holding Times and/or Particulates on Data Quality

3.2.2.1.1 Particulate Materials. Study area surface waters frequently carry suspensions of fine organic debris, calcereous materials and clay minerals. It is therefore not surprising that the parameters showing the most frequent and significant deviations were those influenced by particulate materials and effects of microbial processes.

The project attempted to improve sample duplication and minimize the variations (caused by the changes in temperature, medium, pH, dissolved gases, and holding time) in the concentrations of dissolved major ions, major ion-related parameters, metals and nutrients. For instance, variations in dissolved carbon dioxide affect both the pH and the specific conductance. These variations could also explain

Table 6. Tri-laboratory analyses of design samples (June 1977).

Parameter	Design Concentration	Chemex Lab	Pollution Control Lab	Inland Waters Lab
pH	-	7.9	7.9	7.9
Conductivity	301.5	305	350	309
Total Dissolved Solids	159.15	158.8	178	-
Total Hardness (as $CaCO_3$)	85.1	84.6	94	93.9
Calcium	22.25	22	25	24.9
Magnesium	7.2	7.2	8	7.7
Sodium	19.85	20	20	20
Potassium	4.2	4.4	4.2	4.3
Total Alkalinity (as $CaCO_3$)	17.85	18.8	33	17.8
Chloride	43.2	43.3	46	46
Fluoride	0.55	0.59	0.56	-
Sulphate	51.2	50	55	49
Ammonia Nitrogen	0.23	0.22	0.28	-
Kjeldahl Nitrogen	0.41	0.39	1.72	0.37
Total Phosphorus	0.20	0.13	0.23	-
Cadmium	0.017	0.016	0.015	0.018
Lead	0.050	0.020	0.014	0.024
Iron	0.15	0.15	0.15	0.11
Manganese	0.08	0.08	0.08	0.085
Chromium	0.05	0.045	0.035	0.04
Silver	0.040	0.025	0.038	0.04
Copper	0.01	0.021	0.017	0.017
Cobalt	0.04	0.037	0.039	0.043
Phenol	0.008	0.007	0.006	-
Total Organic Carbon	50	77	82	96
Total Inorganic Carbon	30	27	22	27
Total Carbon	80	104	104	123

Table 7. Analyses of design samples (July 1977).

Parameter	Design Concentration	Chemex Lab	Pollution Control Lab
Conductivity	603.	644.	550.
Total Dissolved Solids	318.3	368.0	280.0
Total Hardness (as $CaCO_3$)	170.2	168.4	172
Calcium	44.5	44.0	44.0
Magnesium	14.4	14.2	16.0
Sodium	39.7	41.0	40.0
Potassium	8.4	8.8	8.4
Total Alkalinity (as $CaCO_3$)	35.7	39.0	58.0
Chloride	86.4	97.4	76.0
Fluoride	1.1	1.28	1.1
Sulphate	102.4	98.4	62.0
Kjeldahl Nitrogen (#3)	0.41	0.14	0.39
Phosphorus (#3)	0.20	0.185	0.22
Kjeldahl Nitrogen (#4)	3.51	3.90	3.05
Phosphorus (#4)	0.66	0.61	0.67
Ammonia Nitrogen (as N) (#7)	0.23	0.26	0.24
Ammonia Nitrogen (as N) (#8)	1.59	1.10	1.64
Chemical Oxygen Demand (#2)	231.	316.	212.
Cadmium	0.073	0.075	0.060
Copper	0.102	0.100	0.106
Iron	0.678	0.80	-
Lead	0.352	0.400	0.340
Manganese	0.397	0.40	0.422
Zinc	0.174	0.165	0.170
Vanadium	0.157	0.070	0.196
Selenium	0.044	0.030	0.0415
Arsenic	0.154	0.160	0.140
Nickel	0.152	0.190	0.155
Aluminum	0.904	1.00	0.880
Cobalt	0.396	0.400	0.371
Chromium	0.209	0.25	0.182
Mercury	0.0094	0.020	0.0077
Ortho Phosphate (#9)	0.19	0.185	0.15
Ortho Phosphate (#10)	0.052	0.055	0.040
Nitrate + Nitrite (as N) (#9)	0.38	0.29	0.41
Nitrate + Nitrite (as N) (#10)	0.11	0.11	0.11
Total Organic Carbon (#2)	90.0	90.0	89.9

Table 8. Analyses of design samples (April 1977)

	Design Concentration	Chemex Lab
Cadmium	0.012	0.016
Chromium (+6)	0.03	0.75
Copper	0.015	0.017
Iron	0.09	0.12
Lead	0.03	0.175
Manganese	0.06	0.07
Silver	0.03	0.028
Zinc	0.03	0.040
Vanadium	NIL	<0.001
Nickel	NIL	0.002
Aluminum	NIL	0.01
Cobalt	0.024	0.031

Table 9. Analyses of design samples (July 1977)

Parameter	Design Concentration	P.C.L. July 7	P.C.L. July 12	P.C.L. July 13	Chemex
Alkalinity (as $CaCO_3$)	-	33.	33.	33.	32.5
pH	-	7.6	7.5	7.7	8.2
Conductivity	-	300	280	285	257
Calcium	12.8	11.0	12.0	10.0	11.4
Magnesium	9.3	10.0	10.0	10.0	9.2
Total Hardness	-	71	72	68	-
Sodium	30.9	28.0	29.0	27.0	27.2
Potassium	0.687	1.5	1.2	1.2	2.05
Silica	0.57	0.5	0.8	0.5	0.66
Nitrate + Nitrite (as N)	.271	0.3	0.3	0.3	0.325
Chloride	49.7	50	50	48	47.4
Sulphate	30	28	22	24	22.6
Fluoride	0.8	0.83	0.79	0.76	0.75
Bicarbonate	39.9	40.0	40.0	40.0	39.6
Surfactants	0.2	-	0.19	-	0.20
Tannin and Lignin	0.833	-	0.1	-	0.5
Hexavalent Chromium	0.66	-	0.54	-	0.35
Ammonia Nitrogen	0.42	-	0.39	0.44	0.50
Total Phosphorus	0.14	-	0.11	0.12	0.105
Total Kjeldahl Nitrogen	-	-	-	-	-
Nitrogen (as N)	0.42	-	0.59	0.64	0.51
Arsenic	0.004	-	-	-	0.0006
Selenium	0.008	-	-	-	0.0014
Total Organic Carbon	30	-	36	24	33
Total Carbon	70	-	73	63	69.0
Total Inorganic Carbon	40	-	37	39	36.0
Ortho Phosphorus (as P)	-	-	-	-	-
Nitrate + Nitrite (L.L.)	0.026	-	0.005	0.015	0.003
Phenols	0.008	-	0.008	-	0.010
Mercury	0.0005	0.0005	0.0006	0.0005	0.00045
Iron	0.7	0.725	0.73	0.73	0.72
Cobalt	0.008	0.008	0.009	0.007	0.008
Copper	0.003	0.004	0.004	0.005	0.005
Manganese	0.020	0.022	0.022	0.022	0.022
Nickel	0.005	0.006	0.006	0.008	0.007
Cadmium	0.004	0.004	0.004	0.004	0.003
Chromium	0.008	0.008	0.008	0.008	0.008
Lead	0.011	0.012	0.010	0.012	0.014
Total Dissolved Solids	-	151	145	142	-
Zinc	0.02	0.023	0.025	0.024	0.021
Beryllium	0.005	0.004	0.005	0.003	0.005
Silver	0.009	0.009	0.009	0.010	0.009
Vanadium	0.020	0.021	0.002	0.02	0.038
Molybdenum	0.008	0.008	0.007	-	0.006
Aluminum	0.08	0.082	0.078	0.086	0.09
Carbonate	-	-	-	-	10.5

Table 10. Analyses of design samples (September 1977).

	Design Concentration	Chemex Lab
Cadmium	0.010	0.009
Chromium (+6)	0.025	0.015
Copper	0.012	0.008
Iron	0.075	0.08
Lead	0.025	0.005
Manganese	0.050	0.039
Silver	0.025	0.015
Zinc	0.025	0.028
Vanadium	NIL	<0.001
Nickel	NIL	<0.002
Aluminum	NIL	<0.01
Cobalt	0.020	0.020
Titanium	NIL	<0.05
Mercury	0.050	0.043

Table 11. Analyses of spiked samples (Conn Creek, April 1977).

Parameter	Design Addition (Minimum Present)	Chemex Lab
Zinc	0.02	0.039
Cadmium	0.008	0.004
Lead	0.02	0.018
Iron	0.06	2.95
Manganese	0.04	0.15
Chromium +6	0.02	0.02
Silver	0.02	0.009
Copper	0.01	0.015
Cobalt	0.016	0.018
Mercury	0.002	<0.0001

Table 12. Analyses of spiked samples (Poplar Creek, August 1977).

Parameter	Design Addition (minimum present)	Pollution Control Lab	Chemex Lab
Silver	0.03	<0.001	0.028
Iron	0.09	-	0.12
Cobalt	0.024	0.032	0.031
Lead	0.03	0.48	0.175
Manganese	0.06	0.076	0.07
Copper	0.015	0.017	0.017
Cadmium	0.012	0.013	0.016
Zinc	0.03	0.041	0.040
Mercury	0.003	<0.0001	<0.0001

Table 13. Analyses of unspiked and spiked samples (September 1977).

Parameter	Chemex Lab Unspiked	Chemex Lab Spiked	Difference Chemex Lab	Difference Expected
Ammonia Nitrogen	0.03	0.02	-0.01	0
Total Kjeldahl Nitrogen	1.01	0.91	-0.10	0
Total Phosphate	0.024	0.025	+0.001	0
Chemical Oxygen Demand	38	32	-6	0
Selenium[a]	<0.0002	<0.002	NIL	+0.001
Arsenic[a]	0.0002	0.0040	+0.0038	+0.01

[a] Spiked sample has 0.01 ppm As and 0.001 ppm Se added.

Table 14. Analyses of disguised design samples (July 1979).

Parameter	Design Addition (minimum present)	Pollution Control Lab	Chemex Lab
Sodium	75.6	75.0	75.0
Cobalt	0.05	0.055	0.050
Copper	0.05	0.049	0.053
Nickel	0.1	0.096	0.097
Cadmium	0.05	0.049	0.053
Lead	0.05	0.056	0.050
Zinc	0.05	0.053	0.051
Manganese	0.05	0.396	0.34
Chromium	0.05	0.064	-
Vanadium	0.05	0.046	0.063
Molybdenum	0.1	0.001	-
Aluminum	0.1	0.290	0.022
Nitrate + Nitrite	18.0	18.05	-
Nitrite	1.0	1.00	-
Chloride	50.0	52.0	50.0
Calcium	28.5	25.0	24.2
Potassium	-	11.7	11.8
Fluoride	1.0	1.16	1.07
Sulfate	100	112	110

Table 15. Most probable reasons for lack of agreement in the values of certain parameters.

Parameter	Amount of Particulate in Sample	Differences in Analytical Methods (or phase Analysed)	Sampling and/or Preservation	Analytical Instrument and Parameters subject to uncontrollable fluctuations	Effects of Holding Time and Microbial Processes
Alkalinity (as $CaCO_3$)	X				X
pH	X				X
Conductivity	X			X	X
Calcium	X				
Total Hardness	X				
Silica	X				X
Sulphate					X
Bicarbonate	X				X
Surfactants					X
Color				X	X
Turbidity	X			X	X
Total Kjeldahl Nitrogen	X				X
Ammonia Nitrogen			X		X
Nitrate + Nitrite (as N)					X
Total Organic Carbon	X				X
Total Inorganic Carbon	X				X
Total Phosphorus (as P)	X				X
Ortho Phosphorus			X		X
Chemical Oxygen Demand				X	X
Phenols					X
Mercury			X		X
Iron	X	X			
Copper	X	X			
Selenium & Arsenic	X	X			
Zinc	X	X			
Nickel	X	X			
Aluminum	X	X			
Filterable Residue Fixed	X				X
Non-Filterable Residue Fixed	X				X

why the ratio of the concentrations of total inorganic carbon (holding time 5 days) to bicarbonate (holding time 1 day) frequently deviated from the 1:5.2 expected from a theoretical consideration.

In one study, the project conducted time series analyses of field-filtered samples. The participating laboratories had agreed to standardize holding times, sample bottles and preservatives. The analyses showed few significant variations for heavy metals (see Section 3.2.3.2.2).

3.2.2.1.2 Organic Compounds and Nutrients. Organic compounds and other nutrients are utilized by micro-organisms inhabiting most natural waters. While the rates may be altered, the activities of the biotic components (algae, bacteria, fungi, etc.) do not, however, stop after samples are removed from their sources. So that biochemical redox reactions (including processing of organic material), utilization/ sedimentation of nutrients (especially C, N, P and Si), and bacterial respiration could be major factors influencing the variations in the concentrations of these parameters and others affected by medium change. (American Public Health Association 1976; Riemann and Schierup 1978).

The parameters most affected by holding times and microbial processes are listed in Table 15. The list suggests a need to develop sample treatments that will allow researchers, who cannot conduct on-site analyses, to generate consistently accurate data.

Phenol. The results of provincial Interlaboratory Quality Control Study No. 2 (Nahulak and Paul 1977) and No. 3 (Nahulak and Paul 1978) showed significant disagreements, in terms of precision and accuracy, for the analyses of phenol. The range and significance of these variations, at the measured parameter level, raise concern in the abilities of most laboratories to produce accurate analyses. The AOSERP water quality project conducted a quality control study (Table 16) of phenol. The samples were analyzed by the Pollution Control and Chemex laboratories and produced impressive agreement with

Table 16. Analyses of design samples (May 1977).

Parameter	Design Concentration	Chemex Lab	Pollution Control Lab
Phenol (#1)	0.010	0.012	0.010
Phenol (#2)	0.015	0.012	0.016
Surfactant (#1)	0.030	0.029	0.028
Surfactant (#2)	0.050	0.053	0.045

each other and with the design concentrations. It appears that, for phenol and other refractory parameters, the success in the project was in promptness in the analyses of water samples.

Nutrients. Utilization and/or sedimentation of nutrients by organisms have major influences on sample nutrient concentrations.

The provincial Interlaboratory Quality Control Study (Ramamoorthy 1980) investigated the parameters NO_2-N, NO_3-N, total PO_4-P, ortho PO_4-P, NH_3-N and total Kjeldahl nitrogen (TKN). Variations attributable to differences in holding times were evident in the analyses for nutrients (Table 17). Laboratory #1 is Chemex Labs.

In the study of NO_2-N and NO_3-N, half of the laboratories (specifically, laboratories #1, 5, 6, 8, 9, 11, 16, and 17) showed an adequate degree of accuracy and precision in their results, and some measure of agreement with the design concentrations; while the rest (specifically, laboratories, #2, 7, 15, 18, 22, 23, 24, 25, 26, and 28) did not.

In the study of total PO_4-P and ortho PO_4-P, most laboratories (except laboratories #2, 3, and 26) reported slightly higher, but satisfactory, analyses for total PO_4-P compared to the design concentrations. But analyses for these parameters in industrial effluent samples (Samples #3, 4, 5, and 6) produced significantly variable results. It appears that the presence of sediments and/or variations of sample holding times was responsible for the variations in the results. This observation is supported by AOSERP sample exchange studies (Tables 6 and 7, and Appendix 5.3) conducted between Chemex, Pollution Control and Inland Waters laboratories, which showed only slight variations. The significance of holding times on changes in concentrations are particularly evident in the study of total PO_4-P and ortho PO_4-P where spiked industrial samples (samples #5 and 6) showed lower values than expected by consideration of the spike concentrations alone.

The Interlaboratory Quality Control Study also investigated NH_3-N and TKN. Although samples #3 and 5 are supposed to be identical, the TKN values (reported by laboratories #10, 22, and 26) and the NH_3-N values (reported by laboratory #22) showed no agreement.

Table 17. Analyses of river water samples for nutrients.

Parameter	Sample Number	Laboratory Number 1	2	5	6	7	8	9	11	15	16	17	18	22	23	24	25	26	28	Design[a] Value (in mg/L)
NITRATE-NITROGEN	1	0.235	1.500	0.16	0.16			0.19	0.35	0.04	0.15	0.35		<0.005	0.215	0.54	0.83		1.13	0.2
	2	0.225	0.800	0.15	0.13			0.19	0.22	<0.01	0.19	0.25		0.050	0.090	0.54	0.10		0.67	0.19
	3	3.780	7.500	2.92	3.58			3.27	3.30	2.54	3.43	1.98		3.500	3.480	4.05	3.68		44.50	A
	4	3.600	7.500	2.75	3.37			3.08	3.40	3.39	3.83	1.85		2.930	4.040	4.05	3.43		22.60	0.95 A
	5	4.600	9.500	3.08	3.89			3.53	3.70	4.17	4.62	1.88		4.050	4.200	5.18	4.08		25.60	0.95(A+0.5)
	6	4.750	9.500	3.66	4.06			3.80	3.80	2.78	4.85	1.96		4.100	3.880	5.33	4.24		28.70	(A+0.5)
NITRITE-NITROGEN	1	0.210	0.256	0.24	0.18			0.19		0.22	0.21	0.20	0.20	2.500			0.22			0.2
	2	0.200	0.244	0.21	0.18			0.18		0.20	0.19	0.20	0.20	1.400			<0.01			0.19
	3	0.320	0.365	0.33	0.28			0.30		0.30	0.37	0.32	0.36	4.900			0.32			B
	4	0.300	0.295	0.33	0.28			0.27		0.29	0.35	0.29	0.36	5.800			0.31			0.95 B
	5	0.800	1.900	0.84	0.71			0.78		0.75	0.88	0.79	0.84	13.800			0.50			0.95(B+0.5)
	6	0.850	2.400	0.89	0.75			0.85		0.80	0.93	0.84	0.84	15.700			0.85			(B+0.5)
NITRATE-NITROGEN + NITRITE-NITROGEN	1	0.445	1.756	0.40	0.34	1.70	0.46	0.38		0.26	0.36	0.55	0.09				1.05	1.12		0.4
	2	0.425	1.044	0.36	0.31	1.52	0.44	0.37		0.20	0.38	0.46	0.11				0.10	1.12		0.38
	3	4.100	7.865	3.25	3.86	5.68	3.70	3.57		2.84	3.80	2.30	3.20				4.00	4.06		C
	4	3.900	7.795	3.08	3.65	5.18	3.50	3.35		3.68	4.18	2.14	3.00				3.74	4.06		0.95 C
	5	5.400	11.400	3.92	4.60	9.20	4.50	4.31		4.91	5.50	2.66	3.50				4.58	5.04		0.95(C+1)
	6	5.600	11.900	4.55	4.81	9.20	4.80	4.65		3.58	5.78	2.80	3.70				5.09	5.39		(C+1)

Parameter	Sample Number	Laboratory Number 1	2	3	5	7	8	9	11	15	16	17	18	23	25	26	27	Design[a] Value (in mg/L)
TOTAL PHOSPHORUS (as P)	1	0.260	0.3377	0.287	0.29	0.30	0.260	0.27	0.23	0.30	0.300	0.25	0.246	0.310	0.26	0.4	0.28	0.24
	2	0.280	0.3408	0.319	0.29	0.28	0.280	0.27	0.31	0.27	0.270	0.24	0.262	0.310	0.26	0.4	0.33	0.25
	3	0.019	0.2578	0.109	0.06	<0.15	0.065	0.04	0.01	0.02	0.048	<0.02	0.032	0.007	0.04	0.6	0.02	0.95 D
	4	0.016	0.2857	0.156	0.05	<0.15	0.065	0.03	0.01	0.03	0.040	<0.02	0.040	0.007	0.02	0.6	0.04	D
	5	0.430	0.8758	0.584	0.43	0.57	0.580	0.47	0.39	0.40	0.420	0.34	0.422	0.460	0.41	1.1	0.47	0.95(D+0.5)
	6	0.470	0.8405	0.603	0.48	0.61	0.600	0.51	0.41	0.49	0.400	0.39	0.365	0.500	0.44	1.1	0.49	D+0.5
ORTHO PHOSPHATE (as P)	1	0.260	0.4700				0.260	0.25		0.29	0.270	0.25		0.290	0.26	0.3		0.24
	2	0.280	0.4000				0.270	0.26		0.27	0.260	0.24		0.310	0.26	0.3		0.25
	3	0.006	0.1800				0.025	0.02		<0.01	0.005	<0.02		0.000	0.02	0.6		0.95 E
	4	0.008	0.1800				0.022	0.01		<0.01	0.006	<0.02		0.000	0.01	0.6		E
	5	0.410	0.5800				0.440	0.44		0.40	0.360	0.33		0.290	0.41	1.1		0.95(E+0.5)
	6	0.460	0.6500				0.480	0.43		0.45	0.380	0.36		0.330	0.43	1.1		(E+0.5)

Continued...

Similarly, samples #1 and 6 were also supposed to be identical, but results for NH_3-N (e.g., laboratories #4, 10, and 22) and TKN (e.g., laboratories #4, 10, 22, 24, and 26) gave results that showed no measure of agreement. A significant lack of agreement also occurred in the analyses of identical samples #2 and 4 for NH_3-N (e.g., laboratories #4, 9, 10, and 26) and for TKN (e.g., laboratories #4, 10, 16 and 26).

It is important to note that in the above comparisons the available information was evaluated in terms of data compatability or interchangeability and no attempts were made to generate any statistical distribution.

Project Quality Control Studies. The following Chemex Laboratory's nutrients analyses, on design samples, showed deviations greater than the acceptable standard deviation:

Table Number	Date	Parameters
7	February 1977	TKN, NH_3-N, NO_2-N + NO_3-N
6	June 1977	total PO_4-P
9	July 1977	NH_3-N, total PO_4-P, NO_2-N + NO_3-N

Rather surprisingly, the Chemex duplicate nutrient analyses (Appendix 5.2) of bulk water samples collected for the regional water quality program showed occassional variations in TKN values only.

The frequency and size of the variations in the concentrations of the five nutrients increase significantly when the tri-laboratory sample exchange data (Appendix 5.3) are considered.

A time series study, similar to that conducted for heavy metals (See Section 3.2.3.2.2), is being planned for nutrients. The study will investigate NO_3-N, NO_2-N, NH_3-N, total PO_4-P and ortho PO_4-P.

3.2.3 Variations Attributable to Significant Differences in Analytical Methods

3.2.3.1 Oil and Grease. The extraction procedures employed in the determination of oil and grease do not separate (and quantify) a specific substance; rather groups of substances (e.g., fatty acids, fats, waxes, oils, hydrocarbons, soaps etc.) that have similar physical properties. These properties include their mutual solubility in the extracting solvent. No solvent is known that will selectively dissolve only oil and grease. The Pollution Control Laboratory uses Freon 112 (1,1,2 trichloro-1,2,2-trifluoroethane), while Chemex Labs and Inland Waters Laboratory both use low boiling petroleum ether.

Because of their specific extractive properties, certain solvents may extract other soluble compounds in addition to oil and grease. For instance, Freon 112 will extract organic dyes and elemental sulphur. Thus, the extraction of other compounds, the possibility of differential recovery of others (e.g., lubricants and emulsifiers), the difference in temperatures used to evaporate the solvents (e.g., petroleum ether, 47°C; Freon 112, 105°C), and the effects of bacterial degradation introduce variations to the analysis results. Low boiling fractions (e.g., kerosene and gasoline) may also be lost at the temperature necessary to remove the last trace of the extraction solvent.

Analysis results reported by the Pollution Control Laboratory frequently showed significantly higher values than those reported by either Chemex or Inland Waters laboratories. It is most probable that the difference is in the analytical methods employed.

3.2.3.2 Heavy and Trace Metals Forms and Concentrations

3.2.3.2.1 Arsenic. An accurate determination of trace amounts of arsenic in water and wastewater is crucial because of its toxic nature.

A review of tri-laboratory sample exchange data (Table 18 and Appendix 5.3) for arsenic shows that the values reported by the Pollution Control Laboratory were consistently higher than those reported by both Chemex and Inland Waters laboratories. It appears that the difference is in the analytical procedures. Chemex and Inland Waters laboratories analyze for dissolved arsenic and dissolved selenium. In the procedure for dissolved arsenic, the water samples are pretreated with conc. HCl and $K_2S_2O_8$ and then reacted (95°C) with

Table 18. Analyses of river water samples for arsenic and selenium (April 1978).

	Selenium (mg/L)						
	Chemex	P.C.L.	I.W.L.			Sample Source	Cond
Date of Analyses	9 May	30 May	15 Mar	2 May	27 Jun		
Sample No.							
1	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002	IWL (Sample #40)	-
2	0.0006	0.0002	<0.0005	0.0002	<0.0002	Frenchman River	1680
3[a]	0.0005	0.0002	-	0.0003	<0.0002	Composite Sample	410
4	0.0008	0.0004	0.0005	0.0005	0.0004	Qu'appelle R., Sask.	1850
5	0.0005	<0.0002	<0.0005	0.0002	<0.0002	Qu'appelle R., Sask.	1550
6	0.0012	0.0008	0.0008	0.0009	0.0007	Oldman R., Alta.	350
7	0.0015	0.0010	0.0020	0.0014	0.0008	Moose Jaw R., Sask.	2480
8	0.0004	0.0003	<0.0005	0.0003	<0.0002	Swift Current Cr., Sask.	1890

	Arsenic (mg/L)						
	Chemex	P.C.L.	I.W.L.			Sample Source	Cond (Chemex)
Date of Analyses	9 May	30 May	15 Mar	2 May	27 Jun		
Sample No.							
1	0.44	0.77	0.53	0.52	0.55	IWL (Sample #40)	-
2	0.0011	0.0022	0.0009	0.0012	0.0011	Frenchman R.	1680
3[a]	0.0051	0.0079	-	0.0054	0.0060	Composite Sample	410
4	0.0032	0.0052	0.0034	0.0030	0.0009	Qu'appelle R.,Sask.	1850
5	0.0071	0.0122	0.0072	0.0062	0.0067	Qu'appelle R.,Sask	1550
6	<0.0002	<0.0002	<0.0005	0.0002	0.0003	Oldman R. , Alta.	350
7	0.0028	0.0045	0.0024	0.0023	0.0026	Moose Jaw R., Sask.	2480
8	0.0015	0.0021	0.0013	0.0015	0.0014	Swift Current Cr., Sask.	1890

[a] 0.25 mL of 50 mg/L As in 200 mL sample was added (thus As - 0.00625 mg/L).

a $HCl-SnCl_2$ and KI solutions. The Pollution Control Laboratory, on the other hand, analyzed for total arsenic (and total selenium) and used conc. HCl and conc. H_2SO_4 in the pre-digestion of its arsenic samples.

In addition to the above differences, it was noted that the NO_3^- ion, from nitric acid used as a sample preservative (up to January 1977), interfered with the analytical methods for Se and As employed by Chemex and Inland Waters laboratories; while only selenium was interfered with in the method used by Pollution Control Laboratory. The pre-digestion step employed by the Pollution Control Laboratory removed both NO_3^- ion and Se; thus, requiring Se and As to be analyzed by individual procedures.

When the three laboratories used identical no-digestion methods, there was interference in all cases.

After June 1978, samples for Se and As were collected in the *R* bottle (no preservative added) and no, or very little, difference remained in the analytical data (see Appendix 5.3) for arsenic.

3.2.3.2.2 Other Metals. It should be apparent from the above discussions that problems of metal analyses, especially in quality control studies, are hard ones to control because of variability in sample sediment contents; and, because laboratories are either not analyzing these metals routinely or are using different analytical procedures. Different procedures employ different sample preparation techniques (e.g., preconcentration, digestion or solvent extraction) to improve sensitivity, recovery, and/or lower the detection limits.

Metal-Organic Interactions. A large number of the procedures (especially those for atomic absorption) in common use utilize one or more properties of metal-organic (or metal complex-organic) solvent interactions to help in determining the concentrations of metals in water samples (Stein and McClellan 1980 and references therein).

Unfortunately, a consideration of:

1. Choice of organic solvent [i.e., selectivity of the solvent for the specific metal(s)];
2. Solvent medium (including masking agents and effective pH range);
3. Relative stabilities of the complex(es) formed in the organic extract;
4. Completeness of extraction of the complex(es) by the organic solvent;
5. Solution uptake rate;
6. Effects of varying concentrations of common ions or complexing agents on percent recovery; and
7. Combustibility aspects of the solvent;

mean that, unless analytical procedures are standardized to the smallest detail, recurrent disagreements in quality control studies will remain.

In addition to the factors outlined above, AOSERP study area waters contain significant concentrations of humic acids Unless these acids are destroyed (e.g., by UV irradiation), the analytical procedures, using solvent extraction or complexiometric techniques, may be determining only a portion of the "dissolved" or "extractable" metal concentration. It is also possible that, for samples containing humic acids, volatile organo-metallic compounds are lost in the carbon rod atomic absorption technique.

The project attempted to eliminate humic acid interference by ensuring that, for "dissolved" or "extractable" metals, sample pH's were lowered to approximately pH 1 to 2 during storage (preservation with 10 mL conc. HNO_3 per litre of sample) and filtration prior to analysis. This, however, created new problems because, at these low pH's, a significant amount of sedimentary (mineral) metal forms (e.g., sulphides and aluminosilicates) can be dissolved. Furthermore, the humic acid precipitates filtered and discarded prior to analysis generally contained significant amounts of strongly bound metal ions.

Korchinski (personal communication) recently conducted some experiments in which the humic acid precipitates were washed with 1:1 HNO_3, distilled water and redissolved in NH_4OH solutions and the pH adusted to 7.5 prior analysis. Analyses of the solutions showed that Cr^{+3} (11%), Co^{+3} (16%), Fe^{+3} (38%) and V^{+4} (7%) were precipitated with the humic acids; while for Cd, Mn, Cu, Al, Pb, Ni, and Zn, only 0 to 3% of the metals (by weight) were precipitated.

The discussions above indicate that dissolution of sedimentary metal forms could significantly increase the "dissolved" or organic solvent "extractable" metal concentrations; and that, depending on the sediment (mineral) content, preservation and analytical procedures may over-estimate the concentrations of the measured metal form (e.g., aluminum) and probably produce non-duplicatable results on duplicate bulk water samples. Results of the analyses of water samples from Eymundson Creek and Hartley Creek (Tables 19 and 20) showed that aluminum, copper, nickel, zinc and possibly lead were problem areas. Consequently, the project conducted a few studies in which some of the pre-analysis procedures (e.g., digestion, preconcentration, and extraction) were standardized. In one study field, filtered samples were used and the analysis results showed drastic improvements in data compatibility. Specifically, analyses of filtered (and spiked) water samples from Poplar Creek (Table 21) showed excellent agreements between laboratories in the analyses of Fe, Co, Pb, Cu, Cd, Zn and V. The study found no evidence of time-dependent deterioration or recovery problems. The agreements are significant considering that the total organic carbon content in the filtered water was 60 mg/L, mostly as humic acids. The problems associated with humic acid interferences would therefore prevail. Specifically, unless all the laboratories filtered out the humic acid precipitates (which contain metal-humate complexes) formed during the sample preservation with HNO_3, it is probable that the pH-dependent solvent extraction procedures would dissolve varying amounts of the precipitates.

Table 19. Analyses of Eymundson Creek samples (1978).

Parameter	Nickel mg/L			Lead Mg/L			Vanadium mg/L			Zinc mg/L		
Sample Number												
Lab	IWD	PCL	CHEMEX	IWD	PCL	CHEMEX	IWD	PCL	CHEMEX	IWD	PCL	CHEMEX
3046	0.18	0.10	0.15	0.001	0.006	0.003	3.1	-	3.0	0.35	0.320	0.30
3047	0.19	0.10	0.12	0.001	0.003	0.003	3.2	-	3.0	0.35	0.320	0.30
3048	0.16	0.10	0.15	0.001	0.003	0.002	3.2	-	3.0	0.35	0.325	0.30
3049	0.17	0.10	0.06	0.001	0.003	0.002	3.2	-	1.5	0.35	0.325	0.30
3050	0.22	0.10	0.14	0.001	0.004	0.002	3.2	-	3.0	0.35	0.325	0.30
3051	0.18	0.10	0.14	0.001	0.004	0.002	3.1	-	3.0	0.34	0.325	0.30
3052	0.23	0.10	0.14	0.001	0.003	0.002	3.1	-	3.0	0.34	0.320	0.30
3053	0.23	0.10	0.15	0.001	0.003	0.002	3.3	-	3.0	0.35	0.320	0.30
3054	0.27	0.10	0.14	0.001	0.003	0.002	3.2	-	3.0	0.35	0.320	0.30
3055	0.20	0.10	0.15	0.001	0.003	0.002	3.0	-	3.0	0.35	0.320	0.31
Mean, $\bar{X}$	0.20	0.10	0.13	0.001	0.0035	0.002	3.2	-	2.9	0.35	0.322	0.30
S.D., σ	0.034	0.00	0.028	0.000	0.0010	0.0001	0.003	-	0.47	0.004	0.024	0.003
Date Analyzed	23 Nov.	26 Oct.	27 Nov.	16 Nov.	26 Oct.	24 Nov.	14 Nov.	-	27 Nov.	14 Nov.	26 Oct.	27 Nov.

Parameter	Nickel mg/L			Lead Mg/L			Vanadium mg/L			Zinc mg/L		
Sample Number												
Lab	IWD	PCL	CHEMEX	IWD	PCL	CHEMEX	IWD	PCL	CHEMEX	IWD	PCL	CHEMEX
3046	0.035	0.018	0.016	-	< 0.003	0.004	< 0.001	< 0.002	< 0.001	0.016	0.012	0.022
3047	0.041	0.018	0.017	-	< 0.003	0.004	< 0.001	< 0.002	< 0.001	0.013	0.011	0.019
3048	0.037	0.018	0.016	-	< 0.003	0.004	< 0.001	< 0.002	< 0.001	0.018	0.010	0.021
3049	0.034	0.018	0.016	-	< 0.003	0.003	< 0.001	< 0.002	< 0.001	0.017	0.013	0.018
3050	0.036	0.018	0.018	-	< 0.003	0.004	< 0.001	< 0.002	< 0.001	0.017	0.013	0.022
3051	0.035	0.018	0.016	-	< 0.003	0.005	< 0.001	< 0.002	< 0.001	0.015	0.013	0.019
3052	0.033	0.018	0.016	-	< 0.003	0.004	< 0.001	< 0.002	< 0.001	0.016	0.011	0.022
3053	0.035	0.018	0.016	-	< 0.003	0.003	< 0.001	< 0.002	< 0.001	0.016	0.013	0.018
3054	0.033	0.018	0.016	-	< 0.003	0.002	< 0.001	< 0.002	< 0.001	0.018	0.013	0.018
3055	0.033	0.019	0.016	-	< 0.003	0.005	< 0.001	< 0.002	< 0.001	0.018	0.012	0.020
Mean, $\bar{X}$	0.035	0.018	0.016	-	< 0.003	0.003	< 0.001	< 0.002	< 0.001	0.016	0.012	0.020
S.D., σ	0.0021	0.0003	0.00067	-	0.000	0.0018	0.00	0.00	0.00	0.0017	0.0012	0.0017
Date Analyzed	27 Nov.	23 Oct.	24 Nov.	-	6 Nov.	24 Nov.	27 Nov.	6 Nov.	24 Nov.	23 Oct.	6 Nov.	24 Nov.

Table 20. Analyses of Hartley Creek samples (August 1978).

Parameter	Aluminum mg/L			Copper mg/L			Iron mg/L			Lead mg/L		
Sample Number												
Lab	IWD	PCL	CHEMEX	IWD	PCL	CHEMEX	IWD	PCL	CHEMEX	IWD	PCL	CHEMEX
2058	0.16	0.020	0.06	< 0.001	< 0.001	< 0.001	0.54	-	0.57	< 0.004	< 0.003	0.007
2059	0.20	0.020	0.09	< 0.001	< 0.001	< 0.001	0.54	-	0.57	< 0.004	< 0.003	0.002
2060	0.11	0.021	0.08	< 0.001	< 0.001	< 0.001	0.53	-	0.56	< 0.004	< 0.003	< 0.001
Mean, $\bar{X}$	0.157	0.0203	0.076	-	-	-	0.537	-	0.567	< 0.004	< 0.003	0.0045
S.D., σ	0.0451	0.0006	0.0153	0.00	0.00	0.00	0.0058	-	0.0058	0.00	0.00	0.0025
Date Analyzed	22 Nov.			13 Oct.			18 Sept.			13 Oct.		

Parameter	Manganese mg/L			Nickel mg/L			Vanadium mg/L			Zinc mg/L		
Sample Number												
Lab	IWD	PCL	CHEMEX	IWD	PCL	CHEMEX	IWD	PCL	CHEMEX	IWD	PCL	CHEMEX
2058	0.029	0.035	0.075	0.016	< 0.001	< 0.001	< 0.001	< 0.002	< 0.001	0.022	0.004	0.002
2059	0.026	0.032	0.025	0.016	< 0.001	< 0.001	< 0.001	< 0.002	< 0.001	0.043	0.001	0.002
2060	0.027	0.035	0.028	0.015	< 0.001	< 0.001	< 0.001	< 0.002	< 0.001	0.015	0.005	0.003
Mean, $\bar{X}$	0.0273	0.034	0.0427	0.0157	< 0.001	< 0.001	< 0.001	< 0.002	< 0.001	0.0267	0.045	0.0023
S.D., σ	0.0015	0.0017	0.028	0.0006	0.00	0.00	0.00	0.00	0.00	0.0146	0.0030	0.0006
Date Analyzed	18 Sept.			13 Oct.								

Table 21. Time series analyses of Poplar Creek samples (22 January 1979).[a]

SAMPLE NUMBER		BLANK			M-1			M-2			M-3		
DATE ANALYZED		A	B	C	A	B	C	A	B	C	A	B	C
IRON	PCL	<0.02	<0.02	—	1.21	1.47	1.44	1.20	1.42	1.38	1.20	1.43	1.40
	CH	<0.01	<0.01	<0.01	1.34	1.33	1.35	1.33	1.35	1.33	1.34	1.35	1.35
	INL	<0.02	<0.02	<0.02	1.34	1.36	1.35	1.34	1.37	1.36	1.34	1.36	1.36
COBALT	PCL	<0.001	<0.001	—	0.002	0.002	<0.001	0.002	0.002	<0.001	0.030	0.031	0.026
	CH	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.025	0.027	<0.001
	INL	<0.002	—	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	0.002	0.029	0.029	0.029
NICKEL	PCL	<0.001	<0.001	—	0.005	0.004	0.005	0.006	0.004	0.005	0.033	0.030	0.033
	CH	<0.001	<0.001	<0.001	0.005	0.006	0.006	0.005	0.006	0.006	0.030	0.032	0.031
	INL	<0.002	—	<0.002	0.005	0.006	0.005	0.006	0.007	0.006	0.035	0.035	0.032
LEAD	PCL	<0.003	<0.003	—	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.028	0.028	0.028
	CH	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.029	0.027	0.029
	INL	<0.003	—	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.028	0.028	0.027
MANGANESE	PCL	<0.008	<0.008	—	0.580	0.580	0.590	0.580	0.580	0.580	0.580	0.580	0.570
	CH	<0.001	<0.001	<0.001	0.500	0.500	0.500	0.500	0.520	0.500	0.510	0.510	0.510
	INL	<0.001	<0.001	<0.001	0.620	0.630	0.610	0.620	0.630	0.600	0.610	0.630	0.600
ALUMINUM	PCL	<0.020	—	—	<0.020	—	—	<0.020	—	—	<0.020	—	—
	CH	<0.010	<0.001		0.10	0.06	—	0.09	0.06	—	0.06	0.06	—
	INL	<0.02	—	—	0.017	0.020	0.024	0.015	0.017	0.020	0.017	0.022	0.021
COPPER	PCL	<0.001	<0.001	—	0.006	0.008	0.007	0.004	0.005	0.004	0.037	0.038	0.038
	CH	<0.002	<0.001	<0.001	0.004	0.004	0.004	0.004	0.004	0.004	0.034	0.035	0.034
	INL	<0.001	—	<0.001	0.005	0.005	0.007	0.005	0.004	0.006	0.039	0.042	0.037
CADMIUM	PCL	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.026	0.029
	CH	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.028	0.028
	INL	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.018	0.021	0.029
ZINC	PCL	0.008	0.006	—	0.007	0.009	0.006	0.008	0.008	0.006	0.028	0.033	0.033
	CH	<0.001	<0.001	<0.001	0.006	0.008	0.008	0.006	0.008	0.008	0.034	0.035	0.035
	INL	<0.001	—	<0.001	0.004	0.004	0.005	0.002	0.005	0.004	0.021	0.026	0.020
VANADIUM	PCL	<0.002	—	—	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	CH	0.001	0.001	—	0.002	0.002	—	0.002	0.002	—	0.002	0.002	—
	INL	<0.002	—	—	0.002	0.001	0.002	0.001	0.001	0.002	0.002	0.002	0.002

Continued...

Table 21. Continued.

SAMPLE NUMBER		M-4			M-5			M-6			M-7		
DATE ANALYZED		A	B	C	A	B	C	A	B	C	A	B	C
IRON	PCL	1.20	1.42	1.40	1.21	1.42	1.37	1.20	1.43	1.36	1.21	1.38	1.37
	CH	1.34	1.33	1.37	1.34	1.35	1.33	1.34	1.35	1.33	1.36	1.40	1.33
	INL	1.34	1.36	1.38	1.34	1.36	1.37	1.34	1.36	1.37	1.33	1.35	1.37
COBALT	PCL	<0.001	<0.002	<0.001	0.002	0.002	<0.001	0.002	0.002	<0.001	0.002	0.002	<0.001
	CH	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	INL	<0.02	<0.02	<0.002	<0.02	<0.02	0.002	<0.02	<0.02	0.002	<0.002	<0.002	<0.002
NICKEL	PCL	0.005	0.004	0.004	0.005	0.004	0.005	0.008	0.003	0.005	0.006	0.004	0.004
	CH	0.005	0.007	0.005	0.005	0.006	0.006	0.005	0.006	0.006	0.005	0.006	0.006
	INL	0.006	0.006	0.006	0.007	0.006	0.006	0.007	0.007	0.006	0.007	0.005	0.005
LEAD	PCL	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	CH	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	INL	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
MANGANESE	PCL	0.580	0.570	0.580	0.580	0.580	0.570	0.590	0.580	0.580	0.590	0.580	0.580
	CH	0.500	0.510	0.500	0.510	0.510	0.500	0.520	0.500	0.500	0.510	0.510	0.510
	INL	0.620	0.630	0.610	0.620	0.630	0.600	0.610	0.630	0.600	0.610	0.630	0.600
ALUMINUM	PCL	<0.020	–	–	<0.020	–	–	<0.020	–	–	<0.020	–	–
	CH	0.130	0.060	–	0.100	0.060	–	0.090	0.060	–	0.120	0.060	–
	INL	0.017	0.017	0.021	0.017	0.019	0.018	0.014	0.019	0.019	0.014	0.020	0.018
COPPER	PCL	0.004	0.005	0.005	0.004	0.005	0.004	0.005	0.005	0.004	0.005	0.005	0.004
	CH	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	INL	0.004	0.004	0.008	0.005	0.005	0.006	0.006	0.005	0.007	0.004	0.005	0.006
CADMIUM	PCL	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	CH	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	INL	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
ZINC	PCL	0.008	0.008	0.006	0.008	0.008	0.006	0.008	0.008	0.007	0.008	0.009	0.006
	CH	0.007	0.009	0.008	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
	INL	0.005	0.005	0.004	0.003	0.005	0.005	0.003	0.004	0.004	0.004	0.005	0.004
VANADIUM	PCL	<0.002	0.002	<0.002	<0.002	0.002	<0.002	<0.002	0.002	<0.002	<0.002	0.002	<0.002
	CH	0.002	0.002	–	<0.001	0.001	–	0.001	0.001	–	<0.001	0.001	–
	INL	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.002	0.001	0.002	0.002	0.001

Continued...

Table 21. Continued.

SAMPLE NUMBER		M-8			M-9			M-10		
DATE ANALYZED		A	B	C	A	B	C	A	B	C
IRON	PCL	1.21	1.40	1.37	1.21	1.41	1.37	1.20	1.38	1.36
	CH	1.34	1.33	1.35	1.34	1.35	1.33	1.34	1.35	1.35
	INL	1.34	1.37	1.36	1.33	1.37	1.37	1.32	1.37	1.37
COBALT	PCL	0.002	0.002	<0.001	0.002	0.002	<0.001	0.002	0.002	<0.001
	CH	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
	INL	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	0.002
NICKEL	PCL	0.006	0.005	0.005	0.006	0.003	0.005	0.006	0.008	0.005
	CH	0.005	0.006	0.006	0.004	0.006	0.006	0.004	0.006	0.006
	INL	0.007	0.007	0.005	0.008	0.006	0.005	0.007	0.005	0.006
LEAD	PCL	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	CH	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	INL	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
MANGANESE	PCL	0.590	0.580	0.580	0.600	0.580	0.570	0.600	0.580	0.580
	CH	0.510	0.500	0.500	0.500	0.500	0.500	0.510	0.510	0.510
	INL	0.610	0.630	0.600	0.620	0.630	0.600	0.620	0.630	0.610
ALUMINUM	PCL	<0.020	–	–	<0.020	–	–	<0.020	–	–
	CH	0.100	0.060	–	0.070	0.060	–	0.070	0.060	–
	INL	0.016	0.019	0.018	0.015	0.017	0.019	0.015	0.020	0.019
COPPER	PCL	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.004
	CH	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	INL	0.006	0.005	0.004	0.005	0.005	0.006	0.005	0.005	0.007
CADMIUM	PCL	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	CH	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	INL	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
ZINC	PCL	0.008	0.008	0.006	0.008	0.008	0.006	0.007	0.010	0.006
	CH	0.007	0.008	0.007	0.007	0.008	0.007	0.007	0.007	0.007
	INL	0.005	0.005	0.004	0.005	0.005	0.005	0.005	0.006	0.006
VANADIUM	PCL	<0.002	0.002	<0.002	<0.002	0.002	<0.002	<0.002	0.002	<0.002
	CH	<0.001	0.001	–	<0.001	<0.001	–	0.002	0.002	–
	INL	0.002	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.002

Continued...

Table 21. Continued.

SAMPLE NUMBER			SPIKED SAMPLE #1			SPIKED SAMPLE #2			WATER - CONTROL		
DATE ANALYZED	SPIKE ADDED (mg/L)		A	B	C	A	B	C	A	B	C
IRON		PCL	1.20	1.41	1.38	1.20	1.41	1.36	1.20	1.42	1.38
		CH	1.36	1.40	1.35	1.34	1.33	1.35	1.34	1.35	1.35
		INL	1.34	1.36	1.38	1.34	1.37	1.37	1.32	1.36	1.37
COBALT	0.028	PCL	0.029	0.029	0.026	0.030	0.030	0.029	0.002	0.002	<0.001
		CH	0.027	0.027	<0.001	0.027	0.025	<0.001	<0.001	<0.001	<0.001
		INL	0.029	0.029	0.029	0.029	0.029	0.030	<0.002	<0.002	0.002
NICKEL	0.028	PCL	0.033	0.030	0.033	0.033	0.030	0.034	0.006	0.004	0.005
		CH	0.030	0.032	0.032	0.030	0.032	0.032	0.006	0.006	0.006
		INL	0.035	0.035	0.033	0.037	0.034	0.034	0.006	0.007	0.005
LEAD	0.028	PCL	0.027	0.028	0.028	0.027	0.027	0.027	<0.003	<0.003	<0.003
		CH	0.029	0.030	0.030	0.029	0.030	0.029	<0.002	<0.002	<0.002
		INL	0.028	0.028	0.027	0.028	0.028	0.026	<0.003	<0.003	<0.003
MANGANESE		PCL	0.580	0.580	0.580	0.590	0.580	0.580	0.580	0.580	0.580
		CH	0.510	0.500	0.500	0.510	0.500	0.510	0.510	0.510	0.500
		INL	0.620	0.630	0.610	0.620	0.630	0.600	0.620	0.630	0.600
ALUMINUM		PCL	<0.020	—	—	<0.020	—	—	<0.020	—	—
		CH	0.080	0.060	—	—	0.060	—	0.110	0.06	—
		INL	0.017	0.025	0.024	0.018	0.023	0.025	0.014	0.017	0.020
COPPER	0.028	PCL	0.037	0.037	0.037	0.038	0.038	0.038	0.004	0.004	0.004
		CH	0.034	0.035	0.035	0.034	0.035	0.034	0.004	0.004	0.004
		INL	0.040	0.041	0.039	0.040	0.041	0.036	0.006	0.006	0.006
CADMIUM	0.028	PCL	0.028	0.026	0.028	0.028	0.026	0.028	<0.001	<0.001	<0.001
		CH	0.027	0.028	0.028	0.027	0.028	0.028	<0.001	<0.001	<0.001
		INL	0.016	0.028	0.026	0.020	0.028	0.022	<0.001	<0.001	<0.001
ZINC	0.028	PCL	0.030	0.033	0.031	0.030	0.033	0.033	0.007	0.008	0.006
		CH	0.034	0.034	0.035	0.033	0.033	0.034	0.007	0.007	0.007
		INL	0.023	0.021	0.027	0.023	0.025	0.022	0.004	0.005	0.004
VANADIUM		PCL	<0.002	0.002	<0.002	<0.002	0.002	<0.002	<0.002	0.002	<0.002
		CH	<0.001	0.001	—	<0.001	0.001	—	<0.001	0.001	—
		INL	0.002	0.002	0.001	0.001	0.001	0.001	0.002	0.002	0.001

Continued...

Table 21. Concluded.

[a] Key

		A	B	C
COBALT	Chemex	26 Jan	22 Feb	22 Mar
	Inland W.	2 Feb	22 Feb	27 Mar
	P.C.L.	25 Jan	21 Feb	21 Mar
NICKEL	"	"	"	"
LEAD	"	"	"	"
COPPER	"	"	"	"
CADMIUM	"	"	"	"
ZINC	"	"	"	"
MANGANESE	Chemex	29 Jan	26 Feb	23 Mar
	Inland W.	5 Feb	23 Feb	26 Mar
	P.C.L.	25 Jan	21 Feb	21 Mar
VANADIUM	Chemex	22 Feb	23 Feb	-
	Inland W.	30 Jan	1 Mar	2 Apr
	P.C.L.	25 Jan	21 Feb	21 Mar
IRON	Chemex	26 Jan	22 Feb	29 Mar
	Inalnd W.	5 Feb	23 Feb	26 Mar
	P.C.L.	25 Jan	21 Feb	21 Mar
ALUMINUM	Chemex	5 Feb	-	-
	Inland	30 Jan	28 Feb	-
	P.C.L.	25 Jan	21 Feb	21 Mar

Factors Related to Procedures. The variations in nickel results have an added dimension. All three laboratories used the most widely used, although not necessarily the most efficient (Stein and McClellan 1980), extraction system for metal ions--ammonium pyrolidine dithiocarbonate dissolved in methyl isobutyl ketone. In the procedure, the sampel pH is adjusted prior to buffering with a sodium acetate solution. It is believed that the observed variations in nickel data are caused, in part, by the use of nickel contaminated NaOH solutions used to adjust the sample pH. The label on commercial reagent grade sodium hydroxide solutions (e.g., "Baker Analysed" REAGENT) frequently report 5 mg/L Ni as an impurity.

The lack of agreement in aluminum analysis results is probably caused by differences in analytical methods (Table 22).

3.2.3.3 Variations Between Measuring Instruments. AOSERP water quality data have, on occasions, shown significant variations between field measured and laboratory pH and specific conductance values. One possible reason is a lack of agreement among instruments. Figure 5 illustrates observed variations between four commercial conductivity meters. This does not mean that the instruments were faulty or generally improperly operated, but merely that correlations between instruments are sometimes poor. Human error cannot, however, be overlooked. Field technicians have on occasions forgotten to apply multiplying factors required to instrument readings.

3.3 SUMMARY

An exhaustive performance evaluation of the consultant laboratory was instituted and maintained by the project leader to ensure the quality of the data base. External checks of the consultant laboratory's internal quality control program were provided by interlaboratory sample exchange programs. These programs also investigated and identified causes of variations in analytical data; and areas where improvements in preservation and analytical methods were desirable. The program clearly demonstrated the usefulness of quality control programs and the reliability of AOSERP water quality data base; since valid and accurate data are needed for interpretive and predictive evaluations of the water quality of the AOSERP study area.

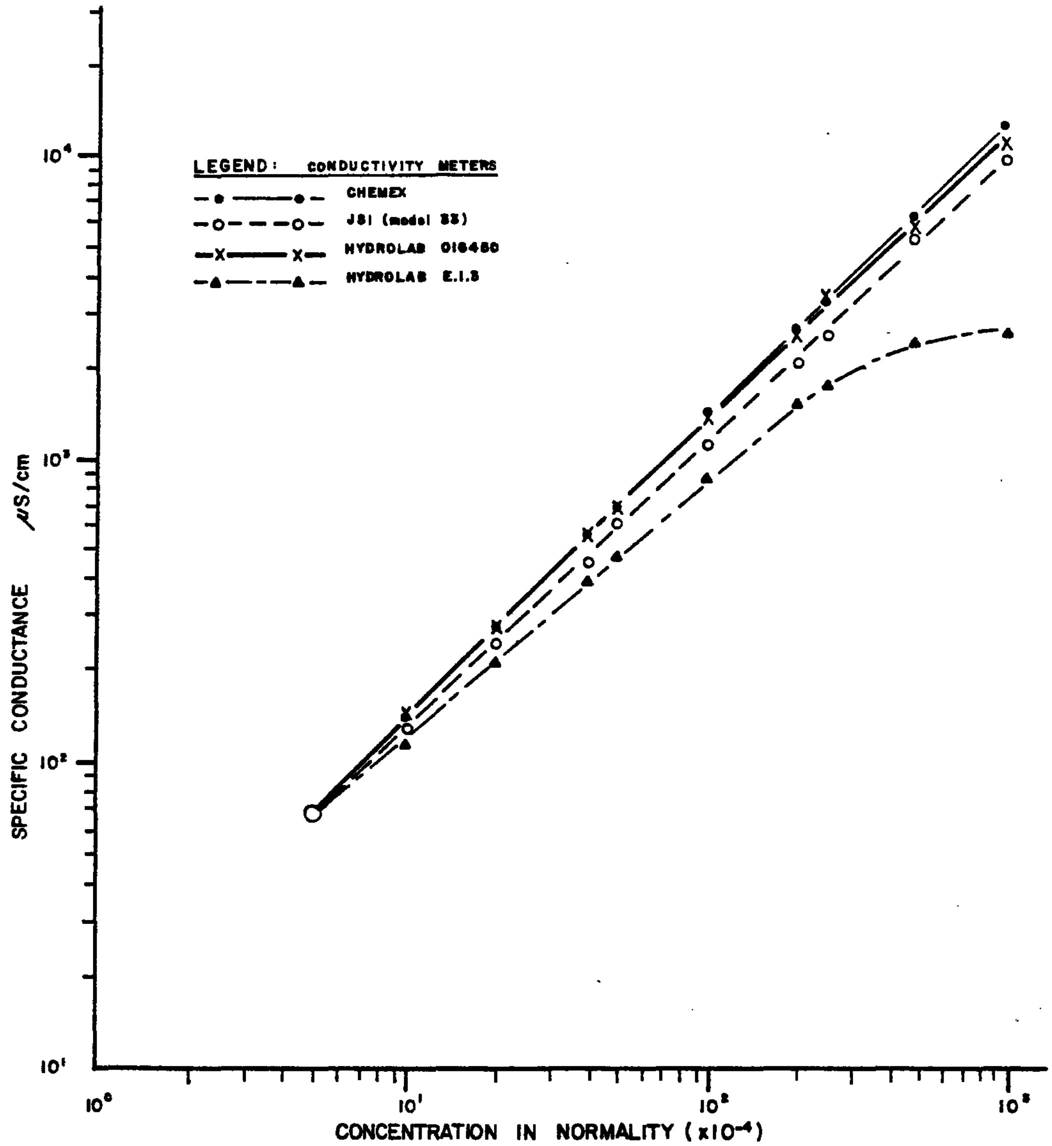

Figure 5. A comparison of specific conductance readings obtained from four instruments.

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Table 22. Procedures used to analyze for aluminum.

Laboratory	Analysis Methods: NAQUADAT Code Number	Analysis Methods: Description
Chemex	13302L	Aluminum is analyzed by atomic absorption-direct aspiration method. The sample is acidified with a dilute mineral acid, shaken, and left overnight. The solution is then preconcentrated and aspirated, and the absorbance measured spectrophotometrically at 309.3 nm and compared with those of standard aluminum solutions.
Inland Waters	13303L	Aluminum is analyzed by the solvent extraction-atomic absorption method. The sample is acidified with a dilute mineral acid, shaken, and left overnight. An 8-hydroxyquinoline solution and a buffer (pH 8) solution are added to the sample solution, then the pH is adjusted to between 7.5 and 8.5. This solution is extracted twice with $CHCl_3$. The extracts are combined and then aspirated. The absorbance, of the combined extracts, is measured spectrophotometrically at 309.3 nm, and compared with those of identically prepared standard aluminum solutions.
Pollution Control	13306L	Aluminum is analyzed by the solvent extraction-atomic absorption method. The sample is acidified with a dilute mineral acid, shaken, and left overnight. An aliquot is titrated with NH_4OH to the blue end point of bromophenol blue, then back-titrated with H_2SO_4 until the blue color disappears. The pH is adjusted to 6.0 ± 0.1 with a buffer. An aliquot is extracted with ethyl propionate containing 8-hydroxyquinoline and the solvent layer aspirated. The absorbance is measured at 237.3 nm and compared with those of identically prepared standard aluminum solutions.

5. APPENDIX

5.1 SOURCES OF NON-AOSERP ATHABASCA OIL SANDS AREA SURFACE WATER QUALITY DATA CATALOGUED BY WATER QUALITY CONTROL BRANCH (Table 23)

Table 23. Sources of non-AOSERP Athabasca oil sands area surface water quality data catalogued by water quality control branch.

Title of Report and Year	Author or Affiliation	Brief Summary of Report Content
Investigation of Oil Spill in Athabasca River 4 April 1968	Alberta Department of Health Environmental Health Services Division	Counteractive measures to restrict oil pollution of the Athabasca River from the contaminated slough area on the G.C.O.S property were discussed in a meeting on 26 March 1968 in Edmonton. Subsequently a trip was made on 4 April 1968 to observe the waste water treatment facilities, the site of the oil spill and the condition of the river.
Water Quality Summary - Athabasca River 1966-71	Alberta Department of the Environment Division of Standards and Approvals	This report is concerned with data compilation and evaluation of water quality of the Athabasca River during the last five years (1966-1971). This data has been reviewed in relation to existing water quality criteria and water quality standards for the Athabasca River.
Fort McKay Water Supply Report 7 May 1969	H.A. Kerr, P.Eng. Soils, Geology and Groundwater Branch D.A. Shillabeer, P.Eng. Environmental Health Services Division, Alberta Department of Health	An investigation of all potential water supplies for the settlement was conducted on 7 May 1969. Various sources of water were analysed in the lab: school well, Hudson Bay Company well, Athabasca River, McKay River, Beaver River, muskeg runoff (north and south of settlement) and the school cistern.
Monthly Analyses of Athabasca River Water Sampled at and near Fort McMurray, Alberta September 1957-58	K.A. Clark Alberta Research Council	Samples were collected on a once-a-month basis for an entire year in response to requests from parties interested in the development of the tar sands.
1977 Break-up and Subsequent Ice Jam at Fort McMurray June 1977	P.F. Doyle, Transportation and Surface Water Engineering Division Alberta Research Council	This report documents the 1977 spring breakup and subsequent ice jam on the Athabasca River below Fort McMurray which produced the highest flood levels in Fort McMurray and neighboring Waterways since 1936.
1978 Breakup in the Vicinity of Fort McMurray and Investigation of Two Athabasca River Ice Jams December 1978	P.F. Doyle, Transportation and Surface Water Engineering Division Alberta Research Council D.D. Andres, River Engineering Branch Alberta Environment	The work presented in this report is a part of continuing research program to study breakup and related phenomena in Alberta rivers. The report presents field documentation and a partial data analysis of the 1978 spring breakup and two major ice jams on the Athabasca River.

Continued...

Table 23. Continued.

Title of Report and Year	Author / Affiliation	Brief Summary of Report Content
Toxicity of Wastewater Discharges and their Effects on Receiving Water and Northwest Pulp and Power Co., Ltd., Hinton, Alberta. January 1975	Environment Canada Environmental Protection Service	Samples of wastewater discharges from Northwest Pulp and Power Ltd. were collected in August 1974, for bacteriological and chemical analysis and toxicity testing. All samples bioassayed exhibited acute lethal toxicity to Rainbow Trout which can be attributed to toxic components in the waste water.
A Study of Current Pulp Mill Loadings in the Athabasca River September 1967	Alberta Department of Health Environmental Health Services Division	The report covers 3 areas: Athabasca River flow distribution, average loadings from Northwest Pulp and Power Ltd., and assimilation of biochemical oxygen demand on the Athabasca River.
Disposal of Waste Waters from Bleached Kraft Pulp Mills to the Athabasca River. April 1965	Department of Public Health Division of Sanitary Engineering	An assessment of the water quality of the Athabasca River in order to facilitate more pulp and paper plants in the Hinton area.
Aquatic Studies on Various Rivers in the Fort McMurray Region: Clearwater River, Horse River, Hangingstone River, Gregoire Lake and Tributaries. September 1972	Department of Natural Resources Fish and Wildlife Division	The report covers geographical and geological characteristics of each river plus biological and chemical characteristics of various sample sites in each river system.
Gregoire Lake Study May 1969	Department of Natural Resources Fish and Wildlife Division	The report covers morphometry, physical and chemical data, inflow and outflow, plankton, bottom fauna, and fish fauna including catch records from 1944/45 to 1965/66.
Water Quality Study - Athabasca River 1966	Bryant F. Bidgood Fish and Wildlife Division	The report covers biological and chemical characteristics of the Athabasca River above and below the G.C.O.S. plant site.
Summary Report - Athabasca River Winter 1966-67	Alberta Department of Health Environmental Health Services Division	The Athabasca River was sampled on 5 occasions during the winter of 1966-67, to study the effects of the pollutional load from the Kraft pulp mill at Hinton, Alberta. Samples were taken in 6 locations; from Hinton to Fort McMurray.

Continued...

Table 23. Continued.

Title of Report and Year	Author / Affiliation	Brief Summary of Report Content
Hydrologic and Hydraulic Characteristics of the Athabasca River from Fort McMurray to Embarras December 1977	P.F. Doyle, Transportation and Surface Water Engineering Division Alberta Research Council	A dessemination of the data which has been collected between Fort McMurray and Embarras by the Alberta Research Council and other agencies. It also provides some insight into the river's behavior along this reach.
New Town of Fort McMurray Sewage Sampling Program August 1974	D.E. Morrison, Municipal Engineering Branch Department of Environment	This report is a summary of the sampling and analyses conducted on the sewage from the Fort McMurray lagoons. The program began 19 August and continued until 21 August.
Water Quality Monitoring Athabasca River 1968, 1969, 1970 - 1980	Syncrude Canada Limited Research Department	These are excerpts from Syncrude's Annual Documentation (Internal Report); they discuss the types of studies done in that particular year, results of the studies and the changes with repect to water quality.
Environmental Impact Assessment Lease 13 Mining Project Alberta Oil Sands June 1975	Shell Canada Limited	One chapter in the report discusses water quality studies conducted within the Shell Lease (Lease 13) area. The studies date back to spring 1973 and involves the lower Muskeg River drainage basin.
Water Sample Analysis Water Treatment Plant Fort McMurray January - October 1979	Pollution Control Lab Pollution Control Division Alberta Environment	These are monthly laboratory results not publicized or put in report form.
Records of Daily Water Analysis Tests at the Fort McMurray Water Treatment Plant	Town of Fort McMurray	These are records of water analysis done before and after treatment in the Fort McMuray Water Treatment Plant. These are daily record sheets are not publish or put in report form.
Birch River December 1969 - November 1973	Water Survey of Canada	These samples were taken by the Water Survey of Canada crew whenever they were at the Birch River Site. Routine analyses were conducted and the results are put on the NAQUADAT Computer System, but not in a report form.

Continued...

Table 23. Continued.

Title of Report and Year	Author / Affiliation	Brief Summary of Report Content
Summary Report - Athabasca River Pollution Survey 1967-68	Alberta Department of Health Environmental Health Services Division	The Athabasca River was sampled on 6 occasions during the winter of 1967-68. Surveys are made during the winter of each year when low river flows and ice cover concentrate the problem of pollution. Samples were collected from 9 locations starting in Hinton and ending in Fort McMurray.
Athabasca River Water Survey 8 July 1968 29 July 1968 8 August 1968	Alberta Department of Health Environmental Health Services Division	On 8 July 1968, water samples of the Athabasca River were obtained at 5 mile intervals between Tar Island and Fort McKay, the survey was repeated on 29 July and 8 August. This survey was done in an effort to derive an explanation for the excessive oil concentrations (10.5 and 11.9 mg/L) observed at Fort McKay at an earlier date.
Summary Report - Athabasca River Pollution Survey 1969-70	Alberta Department of Health Environmental Health Services Division	Five sampling surveys were conducted on the waters of the Athabasca River and its tributaries during the winter 1969-70. Samples were taken to analyze the river waters for chemical composition and bacteriological constituents on a regular basis.
Pollution Survey Summary: Athabasca River 1970-71	Alberta Department of the Environment Pollution Control Division	A total of 6 surveys were conducted on the Athabasca River during the winter of 1970-71. Tests for chemical and bacteriological constituents were run on samples from 5 sites on the river from Hinton to Tar Island.
Water Quality - Athabasca River 1971-72	Alberta Department of the Environment Pollution Control Division	Water quality surveys of the Athabasca River were conducted during winter of 1971-72. November through February. To evaluate the loadings into the river, the analyses of industrial and municipal discharges were also performed.
Summary Report - G.C.O.S. Process Waste Effluent Winter 1967-68	Department of Health Environmental Health Services Division	The effluent from the G.C.O.S. plant at Tar Island is discharged into the Athabasca River approximately 20 miles downstream from the town of Fort McMurray. The effluent consists of three streams: process waste, sludge setting pond, and lagoon waste. The Process waste is a continuous flow and is the topic of this report. The rate of discharge ranges from 7-12 million I.G.P.D. The effluent was sampled six times during the winter survey. All samples were grab and were tested according to procedures set forth by Standard Methods.

Continued...

Table 23. Concluded.

Title of Report and Year	Author / Affiliation	Brief Summary of Report Content
Water Sample Analysis of the Athabasca River	Department of Energy and Natural Resources, Fish and Wildlife Division	Eight water samples collected from sites on the Athabasca River (22 March 1968) were analysed by the Alberta Department of Agriculture, Veterinary Service Division. These results are not publicized or put into any report.
Water Quality Data, Alberta, 1961-1973 (Published 1975)	Inland Waters Directorate Water Quality Branch Ottawa, Canada	The report presents a summary of water samples collected (within Alberta) and analysed between 1961 and 1973. The water quality data (chemical physical and biological) were collected by Water Quality Branch laboratories as part of the National Water Quality monitoring program. The Athabasca River (at Fort McMurray) and the Clearwater River (at Fort McMurray) were monitored between October 1967 and December 1973. The detailed information on these and other sites is reportedly available in the water survey of Canada NAQUADAT files.
Detailed Surface Water Quality Data, Alberta 1974-1976 (Published 1980)	Inland Waters Directorate, Western and Northern Region, Water Quality Branch, Calgary, Alberta	The report represents detailed chemical, physical and biological data from short term special studies and/or surveys or long term monitoring of selected surface waters in Alberta during the period 1974-1976. Among the stations monitored were, the Athabasca River at Fort McMurray (12 February 1974 to 21 November 1976), the Athabasca River at Fort McKay (7 August 1974 to 17 November 1976), and the Clearwater River above Fort McMurray (12 February 1974 to 21 November 1976).

5.2 DUPLICATE ANALYSES REPORTED BY CHEMEX LABS (ALBERTA) LTD. (Table 24)

Table 24. Duplicate analyses reported by Chemex Labs (Alberta) Ltd.

PARAMETERS	00AT07CC0012 ORIGINAL	00AT07CC0012 DUPLICATE	00AT07DA0080 ORIGINAL	00AT07DA0080 DUPLICATE	00AT07CD0100 ORIGINAL	00AT07CD0100 DUPLICATE	00AT07DA0096 ORIGINAL	00AT07DA0096 DUPLICATE	00AT07DA0205 ORIGINAL	00AT07DA0205 DUPLICATE	00AT07DA0090 ORIGINAL	00AT07DA0090 DUPLICATE
Calcium	29.5	29.5	57.0	55.0	22.0	22.0	27.0	27.0	21.0	21.5	25.0	24.5
Magnesium	7.7	7.8	13.0	13.2	7.5	8.1	7.6	7.7	5.7	5.8	8.2	7.9
Sodium	6.5	6.0	12.0	12.0	16.0	18.0	5.9	6.0	7.4	7.2	13.0	13.0
Potassium	1.2	1.1	1.0	0.7	0.9	1.3	0.2	0.2	1.5	1.6	0.6	0.5
Chloride	3.0	3.0	5.1	5.2	1.5	1.8	2.2	2.0	1.4	1.3	1.2	1.3
Sulphate	26.0	28.5	0.5	1.0	9.5	11.0	1.3	2.1	11.0	13.5	NA	0.5
Total Alkalinity	103.0	94.0	228.4	236.3	101.0	97.3	101.6	96.5	86.6	92.7	113.4	117.4
PH	8.2	8.1	7.8	8.0	7.0	7.2	7.8	7.8	7.6	7.8	7.7	7.8
Carbonate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bicarbonate	125.6	114.6	278.4	288.1	123.1	118.6	123.9	117.6	105.6	113.0	138.2	143.1
Total Hardness	105.4	105.8	195.9	191.7	85.8	88.3	98.7	99.1	75.9	77.6	96.2	93.7
Fluoride	0.11	0.10	0.14	0.12	0.09	0.08	0.06	L 0.05	0.09	0.09	0.08	0.07
Silica	5.3	5.5	25.0	24.2	7.5	7.3	7.8	7.9	6.2	6.1	9.0	9.2
Conductance	240	250	380	400	194	179	195	210	200	207	190	205
Threshold Odor Number	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	4	NA
Color	30	25	35	30	100	90	50	60	120	135	70	70
Tannin & Lignin	0.80	0.85	0.08	0.07	2.45	2.30	1.25	1.40	2.60	2.45	1.65	1.60
Total Filtble. Res.	160	144	276	264	142	136	117	112	110	118	123	138
Total Filtble. Res. Fixed	104	96	256	244	127	121	96	90	64	78	96.0	92
Total Non-Filtble. Res.	468	433	0.8	1.2	215	200	4.0	4.8	2602	2387	14.4	13.6
Total Non-Filtble. Res. Fixed	384	397	L 0.04	0.4	200	194	2.8	2.4	2456	2302	9.2	8.8
Turbidity	NA	NA	NA	NA	128	NA	NA	NA	675	NA	21.0	NA
Surfactants	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02
Humic Acids	NA	18	9.0	NA	7.0	6.5	8.0	7.5	11.5	10.0	8.5	7.5
Fulvic Acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	18	19	17.5	17	37	35	20.5	20.0	57	56	24.5	24
Total Inorganic Carbon	27	27	46.5	45	19	19	27.0	27.0	23	23	29	27
Total Diss. Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate Nitrogen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrite Nitrogen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate & Nitrite Nitrogen	0.64	0.66	0.02	0.02	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	0.01	L 0.01
Ammonia Nitrogen	0.08	0.09	0.05	0.06	0.16	0.15	0.12	0.11	0.04	0.04	0.03	0.02
Total Kjeldahl Nitrogen	2.82	3.19	1.66	1.89	1.50	1.72	1.40	1.29	3.20	3.45	1.20	1.09
Total Phosphorus	NA	0.125	L 0.01	L 0.01	0.33	0.31	0.04	0.04	1.85	1.83	0.05	0.05
Ortho Phosphorus	L 0.01	L 0.01	L 0.01	L 0.01	0.22	0.18	L 0.01	L 0.01	0.03	0.02	0.02	0.02
Cyanide	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01
Chemical Oxygen Demand	39.6	37.1	49.5	54.6	123.7	116.5	58.6	61.6	267	282	40.0	44.4
Cadmium	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Hexavalent Chromium	0.004	0.006	0.016	0.013	0.006	0.004	0.190	0.175	0.018	0.015	L 0.003	L 0.003
Copper	0.012	0.014	0.026	0.023	0.009	0.007	0.002	0.002	0.059	0.060	0.002	0.002
Iron	8.70	9.0	3.85	3.80	5.3	5.6	0.50	0.46	63.0	61.5	0.94	0.91
Lead	0.006	0.008	L 0.002	L 0.002	0.008	0.008	L 0.002	L 0.002	0.019	0.020	L 0.002	L 0.002
Manganese	0.280	0.290	0.26	0.255	0.100	0.096	0.07	0.10	1.70	1.65	0.030	0.032
Silver	L 0.005	L 0.005	L 0.005	L 0.005	L 0.005	L 0.005	L 0.005	L 0.005	L 0.005	L 0.005	L 0.005	L 0.005
Zinc	0.049	0.047	0.013	0.015	0.038	0.040	0.010	0.008	0.331	0.349	0.001	L 0.001
Vanadium	L 0.01	L 0.01	L 0.01	L 0.01	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Selenium	L 0.002	L 0.002	0.002	L 0.002	0.0025	L 0.002	L 0.002	L 0.002	L 0.0005	L 0.0005	L 0.0005	L 0.0005
Mercury	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002
Arsenic	L 0.005	L 0.005	L 0.005	L 0.005	0.006	L 0.005	0.015	0.012	0.015	0.008	L 0.005	L 0.005
Nickel	0.018	0.022	L 0.002	L 0.002	0.005	0.004	L 0.002	L 0.002	0.071	0.068	L 0.001	L 0.002
Aluminum	1.60	1.75	L 0.05	L 0.05	3.20	3.10	0.09	0.08	10.60	10.30	0.08	0.07
Cobalt	0.006	0.006	0.006	0.044	L 0.002	L 0.002	L 0.002	L 0.002	0.043	0.044	L 0.001	L 0.002
Boron	0.05	0.06	0.08	0.09	0.30	0.27	0.01	0.03	1.51	1.46	0.48	0.41
Titanium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jun/76		Jul/76		Aug/76		Aug/76		Aug/76		Sept/76	

Continued...

Table 24. Continued.

PARAMETERS	00AT07DB0030 [illegible] ORIGINAL	DUPLICATE	00AT07DB0040 [illegible] ORIGINAL	DUPLICATE	00AT07DA0205 [illegible] ORIGINAL	DUPLICATE	00AT07DA0181 [illegible] ORIGINAL	DUPLICATE	00AT07DA0089 [illegible] ORIGINAL	DUPLICATE	00AT07DB0011 [illegible] ORIGINAL	DUPLICATE
Calcium	28.5	29.0	20.0	21.0	30.0	26.0	74.5	73.8	28.5	28.5	39.0	39.0
Magnesium	7.5	7.3	5.5	5.8	7.8	6.8	22.0	22.0	10.7	10.7	14.0	14.0
Sodium	10.0	9.8	2.5	2.8	7.5	8.0	162.5	161.0	22.0	22.0	28.0	28.0
Potassium	1.0	0.9	0.5	0.4	0.5	0.40	3.8	4.2	0.6	0.6	1.5	1.4
Chloride	0.4	0.5	0.3	0.2	5.8	1.4	217.5	215.0	3.1	3.1	7.6	7.6
Sulphate	9.2	10.6	0.8	1.5	17.8	14.6	53.5	55.0	6.7	6.7	21.9	21.3
Total Alkalinity	106.1	111.4	72.9	77.4	97.0	84.0	268.0	264.0	139.6	139.6	168.1	164.0
PH	7.6	7.6	7.3	7.4	7.7	7.55	7.7	7.7	7.8	7.5	7.8	7.5
Carbonate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bicarbonate	129.3	135.8	88.9	94.4	118.2	102.4	326.7	321.8	170.2	170.2	204.9	199.9
Total Hardness	102.0	102.5	72.6	76.3	107.0	92.9	276.6	274.9	115.2	115.2	155.0	155.0
Fluoride	0.10	0.10	0.06	L 0.05	0.07	0.10	0.18	0.17	0.07	0.07	0.17	0.16
Silica	6.2	6.3	4.8	4.7	5.9	5.9	8.4	8.5	13.6	13.6	8.9	8.9
Conductance	220	205	120	135	215	193	1330	1350	270	270	350	350
Threshold Odor Number	NA	NA	8	NA	2	2	2	2	2	2	2	2
Color	150	165	160	170	35	100	60	60	110	105	130	125
Tannin & Lignin	1.40	1.35	2.55	2.45	1.00	2.20	0.60	0.55	1.80	1.45	2.3	2.1
Total Filtble. Res.	132	145	75.9	88.0	155	114	730	740	134	134	230	238
Total Filtble. Res. Fixed	124	128	68.0	65.0	122.5	97.0	645	660	76.0	76	216	224
Total Non-Filtble. Res.	4.0	2.8	6.4	5.8	36.4	50.8	40.4	43.5	1.2	0.8	4.4	4.0
Total Non-Filtble. Res. Fixed	2.8	2.4	2.8	2.8	29.2	43.6	24.8	24.0	L 0.4	L 0.4	2.8	2.8
Turbidity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.1	4.9
Surfactants	L 0.02	L 0.02	L 0.02	L 0.002	L 0.02	L 0.02	0.05	NA	L 0.02	L 0.02	L 0.02	L 0.02
Humic Acids	11.5	11.0	14.0	14.0	2.5	6.5	2.0	2.0	6.5	6.0	6.0	6.0
Fulvic Acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	37	39	32	31	22	15.0	46	45	33	32	39	38
Total Inorganic Carbon	21	20	15	16	21	19.0	34	34	23	22	36	36
Total Diss. Organic Carbon	NA	NA	NA	NA	19	18.5	34	34	32	32	37	37
Nitrate Nitrogen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrite Nitrogen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate & Nitrite Nitrogen	L 0.01	L 0.01	L 0.01	L 0.01	0.02	L 0.01	L 0.01	L 0.01	0.01	0.01	0.01	0.01
Ammonia Nitrogen	0.06	0.06	0.04	0.04	0.04	0.10	0.49	0.46	0.06	0.06	0.12	0.12
Total Kjeldahl Nitrogen	0.65	0.73	0.66	0.73	0.68	0.40	0.65	0.71	1.30	1.40	0.69	0.72
Total Phosphorus	0.09	0.09	0.13	0.12	0.07	0.10	0.12	0.12	0.42	0.42	0.09	0.07
Ortho Phosphorus	0.02	0.02	0.02	0.02	0.03	0.01	0.02	0.02	L 0.01	L 0.01	0.02	0.02
Cyanide	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01
Chemical Oxygen Demand	97.8	97.8	92.2	90.6	29	64	38	42	134	134	82	78
Cadmium	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	0.001	L 0.001	L 0.001	L 0.001	L 0.001
Hexavalent Chromium	0.007	0.005	L 0.003	L 0.003	L 0.003	L 0.003	0.004	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003
Copper	0.001	L 0.001	0.001	L 0.001	0.006	0.009	0.007	0.007	0.001	0.001	0.003	0.004
Iron	1.82	1.78	1.80	1.85	0.85	2.10	2.0	2.0	0.51	0.51	1.60	1.62
Lead	L 0.004	L 0.002	L 0.002	L 0.002	0.003	0.012	0.006	0.007	L 0.002	L 0.002	0.005	0.004
Manganese	0.041	0.042	0.072	0.065	0.045	0.063	0.355	0.350	0.115	0.115	0.025	0.026
Silver	L 0.005	L 0.005	L 0.005	L 0.005	L 0.005	L 0.005	L 0.005	NA	L 0.005	L 0.005	L 0.005	L 0.005
Zinc	L 0.001	0.004	0.004	0.004	0.008	0.015	0.046	0.051	0.003	0.003	0.004	0.004
Vanadium	L 0.001	L 0.001	L 0.001	L 0.001	0.003	0.003	0.002	L 0.002	L 0.001	L 0.001	L 0.001	L 0.001
Selenium	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005
Mercury	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001
Arsenic	L 0.005	L 0.005	L 0.005	L 0.005	0.008	0.009	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Nickel	L 0.002	L 0.002	0.003	L 0.002	L 0.002	0.002	L 0.002	0.006	L 0.002	L 0.002	L 0.002	L 0.002
Aluminum	0.06	0.06	0.07	0.06	0.27	0.62	0.48	0.59	0.04	0.04	0.06	0.04
Cobalt	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002
Boron	0.25	0.26	0.08	0.07	0.08	0.16	0.22	0.24	0.02	0.02	0.10	0.10
Titanium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Sept/76		Sept/76		Sept/76		Oct/76		Nov/76		Nov/76	

Continued...

Table 24. Continued.

PARAMETERS	00AT07DA0209 [illegible]		00AT07DA0086 [illegible]		00AT07DA0085 [illegible]		00AT07DC0010 [illegible]		00AT07DA0121 [illegible]		00AT07DB0030 [illegible]	
	ORIGINAL	DUPLICATE	ORIGINAL	DUPLICATE	ORIGINAL	DUPLICATE	ORIGINAL	DUPLICATE	ORIGINAL	DUPLICATE	ORIGINAL	DUPLICATE
Calcium	36.0	36.0	69.0	69.0	87.0	87.0	32.5	32.5	8.5	8.5	21.0	21.0
Magnesium	9.6	9.6	16.4	16.4	24.5	24.5	10.2	10.2	3.7	3.7	6.5	6.5
Sodium	30.0	30.0	10.0	10.0	10.5	10.5	4.0	4.0	9.7	9.6	7.5	7.5
Potassium	1.9	1.9	1.5	1.6	1.8	1.8	1.2	1.2	4.1	4.1	2.0	2.0
Chloride	35.7	35.7	2.7	2.7	3.6	3.6	2.1	2.1	3.5	3.3	0.7	0.6
Sulphate	24.7	26.0	6.0	5.9	4.5	4.1	4.5	4.0	17.8	18.0	18.2	19.0
Total Alkalinity	121.6	122.0	250.0	254.0	326.8	326.0	124.0	124.0	36.0	38.0	74.6	74.6
PH	7.5	7.5	7.3	7.3	7.6	7.6	8.3	8.2	6.6	6.7	7.7	8.4
Carbonate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4
Bicarbonate	148.2	148.7	304.8	309.6	398.4	397.4	151.2	151.2	43.9	46.3	90.9	86.1
Total Hardness	129.4	129.4	239.8	239.8	318.1	318.1	123.1	123.1	36.5	36.5	79.2	79.2
Fluoride	0.08	0.08	0.10	0.10	0.19	0.20	0.11	0.12	0.17	0.17	0.10	0.08
Silica	8.3	8.3	14.0	14.0	16.0	16.0	16.7	17.0	2.8	2.9	3.4	3.4
Conductance	390	390	460	460	590	590	233	233	119	119	182	182
Threshold Odor Number	2	2	4	4	4	4	2	2	2	2	8	8
Color	15	25	85	85	35	40	L 5	L 5	90	85	50	60
Tannin & Lignin	0.40	0.40	1.60	1.55	0.70	0.75	0.4	0.3	1.6	1.6	1.20	1.20
Total Filtble. Res.	251	255	289	294	369	362	166	162	77	79	110	113
Total Filtble. Res. Fixed	208	214	206	211	331	324	149	146	49	48	63.0	66.0
Total Non-Filtble. Res.	4.4	5.6	59.0	63.0	7.6	9.6	5.6	6.0	38.8	43.6	16.4	NA
Total Non-Filtble. Res. Fixed	1.6	2.8	26.0	27.0	4.8	6.0	3.6	3.6	30.8	30.0	6.8	NA
Turbidity	3.9	3.7	180	NA	5.5	5.7	1.1	1.3	29	31	4.8	5.1
Surfactants	L 0.02	L 0.02	L 0.02	NA	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	0.07	NA
Humic Acids	L 1.0	L 1.0	2.0	NA	L 1.0	L 1.0	L 1.0	L 1.0	4.5	4.0	L 1.0	L 1.0
Fulvic Acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	6.5	6.5	34	35	10.0	10.5	L 1	1	15	15	24	25
Total Inorganic Carbon	25.5	25	45	45	52.0	52.5	20	19	7	7	12	11
Total Diss. Organic Carbon	6.0	6.0	31	31	9.5	9.0	L 1	L 1	12	13	24	24
Nitrate Nitrogen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrite Nitrogen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate & Nitrite Nitrogen	0.04	0.04	0.02	0.02	0.03	0.02	0.08	0.09	L 0.01	L 0.01	L 0.01	L 0.01
Ammonia Nitrogen	0.12	0.16	1.40	1.36	0.47	0.47	0.09	0.10	0.15	0.10	0.01	L 0.01
Total Kjeldahl Nitrogen	0.88	0.89	2.40	2.25	1.34	1.27	0.57	0.49	2.31	2.20	1.30	1.23
Total Phosphorus	0.04	0.03	0.34	0.36	0.09	0.10	0.05	0.05	0.36	0.38	0.10	0.10
Ortho Phosphorus	L 0.01	L 0.01	0.02	0.02	0.03	0.03	0.02	0.02	0.03	0.03	0.02	0.02
Cyanide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chemical Oxygen Demand	35	37	86	91	59	66	14	17	82	76	51	46
Cadmium	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Hexavalent Chromium	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003
Copper	0.004	0.007	0.120	0.120	0.002	0.002	0.026	0.029	0.005	0.005	0.002	0.003
Iron	0.52	0.54	19.0	18.5	2.45	2.35	0.61	0.62	8.55	8.70	1.50	1.46
Lead	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	0.009	0.007	L 0.002	L 0.002	L 0.002	L 0.002
Manganese	0.022	0.021	0.72	0.73	0.19	0.18	0.028	0.029	0.76	0.77	0.046	0.048
Silver	L 0.005	L 0.005	L 0.005	NA	L 0.005	L 0.005	L 0.005	L 0.005	L 0.001	L 0.001	L 0.001	L 0.001
Zinc	0.029	0.027	0.006	0.006	0.043	0.048	0.008	0.006	0.028	0.028	0.008	0.009
Vanadium	0.003	0.002	0.002	0.002	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Selenium	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005
Mercury	0.0004	0.0003	0.0003	0.0003	L 0.0001	L 0.0001	L 0.0001	L 0.0001	0.0003	0.0002	L 0.0001	L 0.0001
Arsenic	L 0.001	L 0.001	L 0.001	L 0.001	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005	L 0.0005
Nickel	L 0.002	L 0.002	0.008	0.008	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	0.003	L 0.002	L 0.002
Aluminum	0.04	0.05	0.02	0.03	0.03	0.02	0.04	0.07	0.21	0.21	0.23	0.20
Cobalt	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002
Boron	0.12	0.14	0.18	0.16	0.23	0.24	0.03	0.04	0.10	0.09	0.16	0.14
Titanium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jan/77		Feb/77		Mar/77		Apr/77		Apr/77		May/77	

Continued...

Table 24. Continued.

PARAMETERS	00AT07DA0100 UPPER ELLS RIVER - 3 MILES BELOW [illegible] ORIGINAL	DUPLICATE	00AT07DB0030 [illegible] ORIGINAL	DUPLICATE	00AT07DB0040 [illegible] ORIGINAL	DUPLICATE	00AT07DA0090 [illegible] ORIGINAL	DUPLICATE	00AT07DA0080 [illegible] ORIGINAL	DUPLICATE	00AT07DA0082 [illegible] ORIGINAL	DUPLICATE
Calcium	13.0	13.0	26.5	26.5	12.5	12.5	32.5	32.5	32.5	32.5	23.5	23.5
Magnesium	3.7	3.7	8.0	8.0	4.5	4.5	9.5	9.5	9.5	9.5	7.0	7.0
Sodium	2.7	2.7	9.0	9.0	2.2	2.2	22.0	22.0	22.0	22.0	10.5	10.5
Potassium	0.9	0.9	1.4	1.5	0.3	0.3	0.7	0.7	0.7	0.7	0.2	0.2
Chloride	0.3	0.4	1.6	1.8	1.6	2.0	14.4	14.5	14.4	14.5	1.0	1.0
Sulphate	6.8	6.8	14.3	13.8	8.3	7.8	8.2	7.3	8.2	7.3	5.1	5.2
Total Alkalinity	48.8	48.4	96.8	97.0	44.1	43.5	142.9	143.5	142.9	143.5	100.0	99.2
PH	7.4	8.1	8.3	8.2	7.8	7.9	7.8	7.8	7.8	7.8	7.7	7.7
Carbonate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bicarbonate	59.5	59.8	118.0	118.2	53.8	53.0	174.2	174.9	174.2	174.9	121.9	120.9
Total Hardness	47.7	47.7	99.1	99.1	49.7	49.7	120.3	120.3	120.3	120.3	87.5	87.5
Fluoride	0.07	0.07	0.12	0.14	L 0.05	L 0.05	0.16	0.15	0.16	0.15	NA	NA
Silica	3.7	3.6	2.7	2.7	2.6	2.6	5.4	5.4	5.4	5.4	4.1	4.1
Conductance	108	108	217	216	89.0	88.5	320	320	320	320	196	198
Threshold Odor Number	2	2	4	4	4	4	4	4	4	4	2	2
Color	25	25	90	100	170	170	110	110	110	110	110	110
Tannin & Lignin	0.60	0.60	1.5	1.6	2.75	2.80	1.6	1.5	1.6	1.5	1.6	1.5
Total Filtble. Res.	72.0	66.0	130	132	60.0	57.5	192	194	192	194	118	120
Total Filtble. Res. Fixed	47.0	48.0	83.0	78.0	23.0	28.0	157	149	157	149	78.0	81.0
Total Non-Filtble. Res.	6.0	NA	3.6	NA	1.2	1.6	6.0	NA	6.0	NA	2.8	NA
Total Non-Filtble. Res. Fixed	2.4	NA	L 0.4	NA	L 0.4	L 0.4	1.6	NA	1.6	NA	1.6	NA
Turbidity	1.3	1.2	2.1	2.0	1.9	2.0	3.3	3.5	3.3	3.5	1.0	0.9
Surfactants	0.09	NA	0.06	NA	0.06	NA	0.02	0.02	0.02	0.02	NA	NA
Humic Acids	L 1.0	L 1.0	1.5	1.0	2.5	2.5	1.5	1.5	1.5	1.5	NA	NA
Fulvic Acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	14	14	27	27.5	28	28	27	26.5	27	26.5	29	29
Total Inorganic Carbon	9	8	18	17.5	8	8	35	35	35	35	23	24
Total Diss. Organic Carbon	14	13	25.5	25.5	26	27	24.5	24	24.5	24	27	27
Nitrate Nitrogen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrite Nitrogen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate & Nitrite Nitrogen	L 0.01	L 0.01	0.005	L 0.003	L 0.003	L 0.003	0.014	0.014	0.014	0.014	0.020	0.020
Ammonia Nitrogen	0.01	0.01	0.06	0.05	0.05	0.05	0.01	0.01	0.01	0.01	L 0.01	0.01
Total Kjeldahl Nitrogen	0.55	0.61	1.06	1.13	1.02	1.00	1.00	1.02	1.00	1.02	1.00	1.09
Total Phosphorus	0.06	0.05	0.076	0.092	0.050	0.048	0.033	0.031	0.033	0.031	0.026	0.029
Ortho Phosphorus	0.01	0.01	0.013	0.015	0.016	0.016	0.006	0.006	0.006	0.006	0.006	0.006
Cyanide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chemical Oxygen Demand	43	47	59	49	87	98	55	56	55	56	78	81
Cadmium	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Hexavalent Chromium	L 0.003	L 0.003	L 0.003	0.004	L 0.003	L 0.003	L 0.003	0.003	L 0.003	0.003	NA	NA
Copper	0.002	0.001	0.001	0.001	L 0.001	0.001	0.001	L 0.001	0.001	L 0.001	L 0.001	L 0.001
Iron	0.41	0.38	1.10	1.10	0.64	[illegible]	0.80	0.71	0.80	0.71	0.42	0.41
Lead	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002
Manganese	0.058	0.056	0.145	0.145	0.026	0.026	0.028	0.026	0.028	0.026	0.022	0.019
Silver	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	NA	NA
Zinc	0.005	0.004	0.007	0.007	0.018	0.017	0.048	0.044	0.048	0.044	NA	NA
Vanadium	L 0.001	L 0.001	0.001	0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Selenium	L 0.0005	L 0.0005	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002
Mercury	0.0002	0.0002	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001
Arsenic	0.0016	0.0013	L 0.0002	L 0.0002	0.0009	0.0007	0.0003	0.0004	0.0003	0.0004	0.0004	0.0004
Nickel	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002
Aluminum	0.16	0.14	0.11	0.09	L 0.01	0.04	0.03	0.04	0.03	0.04	NA	NA
Cobalt	0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	NA	NA
Boron	0.07	0.06	0.08	NA	0.11	0.09	0.18	0.18	0.18	0.18	0.10	0.12
Titanium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May/77		Jun/77		Jun/77		Jul/77		Jul/77		Jul/77	

Continued...

Table 24. Continued.

PARAMETERS	00AT07BC0020 ORIGINAL	00AT07BC0020 DUPLICATE	00AT07DA0070 ORIGINAL	00AT07DA0070 DUPLICATE	00AT07DA0181 ORIGINAL	00AT07DA0181 DUPLICATE	01AT07DA0200 ORIGINAL	01AT07DA0200 DUPLICATE	00AT07DB0030 ORIGINAL	00AT07DB0030 DUPLICATE	00AT07DA0085 ORIGINAL	00AT07DA0085 DUPLICATE
Calcium	24.5	24.5	29.0	28	64.0	64.0	15.5	15.5	28.5	28.5	39.5	39.5
Magnesium	6.5	6.5	9.5	10	17.2	17.2	4.5	4.5	8.0	8.0	15.0	14.5
Sodium	1.5	1.4	35.5	33	26.5	26.5	3.0	3.0	8.7	8.7	6.3	6.3
Potassium	0.04	0.04	2.40	1.7	3.90	3.90	1.30	1.30	1.20	1.20	1.10	1.10
Chloride	0.4	0.4	23.2	20	20.8	22.0	0.4	0.4	0.7	0.8	1.2	1.2
Sulphate	4.7	4.6	6.6	10	55.0	55.0	6.2	6.0	15.8	15.8	0.1	0.1
Total Alkalinity	86.4	86.4	154.4	154	186.2	187.8	53.8	53.1	101.9	102.0	164.4	165.6
PH	8.00	8.00	8.05	7.9	7.90	7.95	7.47	7.45	7.87	7.89	7.91	7.95
Carbonate	0.0	0.0	0.0	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bicarbonate	105.3	105.3	188.2	187	227.0	228.9	65.6	64.7	124.2	124.3	200.4	201.9
Total Hardness	87.9	87.9	111.5	111	230.6	230.6	57.2	57.2	104.1	104.1	160.4	158.3
Fluoride	0.09	0.09	0.12	0.14	0.23	0.24	0.09	0.08	0.11	0.12	0.10	0.10
Silica	6.1	6.1	5.6	7.5	4.1	4.1	1.2	1.2	3.0	3.0	10.0	10.0
Conductance	138	138	315	365	490	488	115	114	211	211	275	274
Threshold Odor Number	4	4	2	NA	2	2	4	4	2	2	2	2
Color	80	70	80	96	25	25	30	30	130	125	80	80
Tannin & Lignin	1.0	1.15	1.3	1.1	1.15	1.20	0.7	0.7	1.4	1.3	1.2	1.2
Total Filtble. Res.	97.6	94.4	204	262	294	292	69.0	66.0	127	129	177	172
Total Filtble. Res. Fixed	68.0	68.0	161	160	271	266	51.0	50.0	83.0	86.0	126	121
Total Non-Filtble. Res.	L 0.4	L 0.4	4.4	NA	7.6	NA	8.0	8.8	3.2	3.6	1.2	2.0
Total Non-Filtble. Res. Fixed	L 0.4	L 0.4	2.4	NA	3.6	NA	4.0	4.0	0.8	0.8	L 0.4	L 0.4
Turbidity	0.6	0.6	4.35	5	3.35	3.50	4.15	4.00	4.35	4.15	2.70	2.65
Surfactants	0.04	0.035	0.05	0.27	0.12	0.13	0.09	0.07	0.15	0.15	0.12	0.12
Humic Acids	L 1.0	L 1.0	1.5	NA	L 1.0	L 1.0	L 1.0	NA	1.5	1.5	1.5	1.5
Fulvic Acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	15.5	14.5	29.5	22	13.5	15.5	12.0	12.0	22.5	22.5	27.5	26.5
Total Inorganic Carbon	15.0	16.0	27.0	36	42.5	42.5	13.5	13.0	23.5	23.5	28.5	28.0
Total Diss. Organic Carbon	15.0	14.5	27.0	NA	11.5	13.5	11.5	12.0	22.5	22.0	23.5	24.5
Nitrate Nitrogen	NA	NA	NA	NA	NA	NA	NA	NA	L 0.003	L 0.003	NA	NA
Nitrite Nitrogen	NA	NA	NA	NA	0.032	0.032	L 0.003	L 0.003	L 0.003	L 0.003	NA	NA
Nitrate & Nitrite Nitrogen	0.008	0.008	0.010	0.018	0.091	0.089	0.007	0.007	L 0.003	L 0.003	0.012	0.011
Ammonia Nitrogen	0.03	0.03	0.14	0.11	0.18	0.20	0.06	0.06	0.13	0.15	0.06	0.06
Total Kjeldahl Nitrogen	5.98	6.26	1.08	2.13	1.50	1.63	0.58	0.53	1.35	1.42	1.36	1.33
Total Phosphorus	0.051	0.051	0.040	L 0.05	0.073	0.068	0.036	0.036	0.091	0.086	[illegible]	[illegible]
Ortho Phosphorus	0.022	0.022	0.005	0.10	0.011	0.011	0.003	0.003	0.015	0.015	0.009	0.010
Cyanide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chemical Oxygen Demand	85.0	84.0	59.0	60.0	38.0	41.0	41.0	40.0	75.0	77.0	49	52
Cadmium	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Hexavalent Chromium	L 0.003	L 0.003	0.004	0.004	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003
Copper	0.002	0.001	0.004	L 0.001	0.002	0.002	L 0.001	L 0.001	0.003	0.002	0.002	0.002
Iron	0.63	0.67	0.36	0.33	0.45	0.45	0.32	0.33	1.48	1.46	0.47	0.46
Lead	L 0.002	L 0.002	L 0.002	L 0.003	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002
Manganese	0.023	0.024	0.067	0.076	0.145	0.155	0.065	0.066	0.036	0.036	0.034	0.034
Silver	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Zinc	0.005	0.006	0.044	0.067	0.014	0.011	0.005	0.005	0.008	0.007	0.009	0.006
Vanadium	L 0.001	L 0.001	L 0.001	L 0.01	L 0.001	L 0.001	0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Selenium	L 0.0002	L 0.0002	L 0.0002	NA	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002
Mercury	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001
Arsenic	0.0003	0.0003	0.0005	NA	0.0005	0.0006	L 0.0002	L 0.0002	0.0006	0.0008	L 0.0002	L 0.0002
Nickel	L 0.002	L 0.002	0.008	0.005	L 0.002	0.003	0.006	0.008	0.006	0.006	L 0.002	L 0.002
Aluminum	0.03	0.02	0.09	NA	0.13	0.15	0.02	0.02	0.06	0.05	0.04	0.04
Cobalt	L 0.002	L 0.002	L 0.002	L 0.001	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002
Boron	0.15	0.16	0.21	NA	0.13	0.12	0.12	0.12	0.28	0.26	0.11	0.11
Titanium	NA	NA	NA	NA	L 0.01	L 0.01	NA	NA	NA	NA	L 0.05	L 0.05
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul/77		Jul/77		Aug/77		Aug/77		Aug/77		Oct/77	

Continued...

Table 24. Continued.

PARAMETERS	01AT07DA0220 ORIGINAL	01AT07DA0220 DUPLICATE	00AT07DA0120 ORIGINAL	00AT07DA0120 DUPLICATE	00AT07DA0150 ORIGINAL	00AT07DA0150 DUPLICATE	00AT07DA0140 ORIGINAL	00AT07DA0140 DUPLICATE	00AT07DA0060 ORIGINAL	00AT07DA0060 DUPLICATE	00AT07DD0010 ORIGINAL	00AT07DD0010 DUPLICATE
Calcium	12.5	12.5	50.5	50.0	38.0	NA	39.0	NA	32.0	NA	40.0	40.0
Magnesium	4.6	4.6	17.0	17.0	13.2	NA	14.0	NA	11.0	NA	11.7	11.7
Sodium	2.9	2.9	28.0	28.0	21.5	NA	46.0	NA	17.5	NA	26.1	26.3
Potassium	0.63	0.64	2.90	2.90	1.85	NA	2.60	NA	0.98	NA	1.50	1.50
Chloride	0.4	0.4	4.7	4.8	3.1	NA	18.7	NA	3.0	NA	26.4	26.3
Sulphate	3.4	3.4	185.0	176.0	35.3	NA	20.0	NA	6.8	NA	27.2	25.0
Total Alkalinity	49.6	49.0	69.6	69.0	158.0	NA	201.0	NA	148.0	NA	144.0	144.4
PH	7.36	7.37	7.43	7.44	7.68	NA	7.79	NA	8.04	NA	7.87	7.88
Carbonate	0.0	0.0	0.0	0.0	0.0	NA	0.0	NA	0.0	NA	0.0	0.0
Bicarbonate	60.5	59.7	84.8	84.1	192.6	NA	245.0	NA	180.4	NA	175.5	176.0
Total Hardness	50.2	50.2	196.1	194.8	149.2	NA	155.0	NA	125.2	NA	148.0	148.0
Fluoride	0.12	0.12	0.34	0.34	0.22	NA	0.19	NA	0.14	NA	0.18	0.18
Silica	1.32	1.32	13.0	12.9	8.7	NA	9.2	NA	7.4	NA	7.9	7.9
Conductance	94.0	94.5	475	475	370	NA	460	NA	256	NA	385	383
Threshold Odor Number	4	4	2	2	2	NA	2	NA	2	NA	1	1
Color	35	35	45	45	70	NA	130	NA	110	NA	25	25
Tannin & Lignin	0.8	0.8	1.0	1.0	0.8	NA	1.4	NA	0.9	NA	0.7	0.6
Total Filtble. Res.	60.2	62.5	330	320	244	NA	306	NA	169	NA	252	258
Total Filtble. Res. Fixed	41.0	39.0	288	283	208	NA	218	NA	126	NA	221	223
Total Non-Filtble. Res.	5.2	4.0	19.2	20.4	10.8	NA	0.8	NA	2.8	NA	3.2	3.6
Total Non-Filtble. Res. Fixed	L 0.4	L 0.4	14.0	14.4	7.2	NA	0.4	NA	0.8	NA	1.2	1.6
Turbidity	5.00	5.15	17.3	17.9	6.9	NA	2.30	NA	2.95	NA	1.5	1.6
Surfactants	0.11	0.11	0.13	0.13	0.20	NA	0.18	NA	0.10	NA	0.05	0.05
Humic Acids	L 1.0	L 1.0	L 1.0	L 1.0	L 1.0	NA	2.5	NA	L 1.0	NA	L 1.0	L 1.0
Fulvic Acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	12.5	12.5	8.5	10.5	18.5	NA	35.5	NA	14.5	NA	12.5	12.0
Total Inorganic Carbon	10.0	10.0	16.5	15.0	34.0	NA	42.5	NA	28.0	NA	31.5	31.5
Total Diss. Organic Carbon	12.0	12.5	7.5	8.5	15.5	NA	35.5	NA	14.5	NA	12.0	12.0
Nitrate Nitrogen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrite Nitrogen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate & Nitrite Nitrogen	0.246	0.247	0.033	0.036	0.025	NA	0.049	NA	0.040	NA	0.083	0.086
Ammonia Nitrogen	0.20	0.23	0.02	0.02	0.02	NA	0.05	NA	0.02	L 0.01	0.06	0.06
Total Kjeldahl Nitrogen	1.35	1.25	0.61	0.67	1.10	NA	1.75	NA	0.70	0.87	1.13	1.10
Total Phosphorus	0.135	0.130	0.049	0.051	0.079	NA	0.076	NA	0.030	0.033	0.032	0.027
Ortho Phosphorus	0.061	0.062	0.003	0.004	0.009	NA	0.031	NA	0.006	NA	0.007	0.008
Cyanide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chemical Oxygen Demand	47	49	57	60	68	NA	108	NA	51	44	51	45
Cadmium	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	0.004	L 0.001	L 0.001
Hexavalent Chromium	L 0.003	L 0.003	L 0.003	L 0.003	0.005	L 0.003	L 0.003	L 0.003	L 0.003	0.004	0.003	0.003
Copper	0.002	0.001	0.004	0.004	0.009	0.034	0.004	0.006	0.002	0.005	0.004	0.004
Iron	0.80	0.80	3.25	3.25	2.30	2.30	0.76	0.62	0.90	[illegible]	0.85	0.85
Lead	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002
Manganese	0.046	0.046	0.352	0.355	0.101	0.116	0.067	0.062	0.054	0.073	0.079	0.078
Silver	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	0.005	L 0.001	L 0.001
Zinc	0.005	0.005	0.027	0.029	0.006	0.035	0.007	0.017	0.006	0.058	0.011	0.010
Vanadium	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Selenium	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	NA	L 0.0002	NA	L 0.0002	L 0.0002	L 0.0002	L 0.0002
Mercury	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	NA	L 0.0001	NA	L 0.0001	NA	L 0.0001	L 0.0001
Arsenic	L 0.0002	L 0.0002	0.0009	0.0010	0.0009	NA	0.0011	NA	0.0003	0.0036	L 0.0002	L 0.0002
Nickel	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002
Aluminum	0.06	0.04	0.27	0.28	0.07	0.09	0.02	L 0.01	0.03	0.04	0.17	0.17
Cobalt	L 0.002	L 0.002	L 0.002	NA	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	0.005	L 0.002	L 0.002
Boron	0.06	0.05	0.16	0.15	0.14	NA	0.20	NA	0.17	NA	0.06	0.05
Titanium	L 0.05	L 0.05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Oct/77		Nov/77		Nov/77		Nov/77		Nov/77		Nov/77	

Continued...

Table 24. Continued.

PARAMETERS	00AT07DA0207 ORIGINAL	00AT07DA0207 DUPLICATE	00AT07DC0020 ORIGINAL	00AT07DC0020 DUPLICATE	00AT07CD2300 ORIGINAL	00AT07CD2300 DUPLICATE	00AT07DB0040 ORIGINAL	00AT07DB0040 DUPLICATE	00AT07DD0010 ORIGINAL	00AT07DD0010 DUPLICATE	00AT07DA0140 ORIGINAL	00AT07DA0140 DUPLICATE
Calcium	52.5	52.5	47.5	47.5	16.5	16.0	44.0	44.0	37.5	38.0	97.0	97.0
Magnesium	15.0	15.0	15.6	15.6	5.8	5.6	15.7	15.7	11.0	11.2	39.4	38.8
Sodium	20.0	20.1	4.5	4.5	32.0	32.0	10.9	10.7	26.2	26.9	55.5	55.5
Potassium	1.70	1.80	0.70	0.70	1.80	1.80	1.50	1.50	1.50	1.50	6.50	6.50
Chloride	14.5	14.5	0.7	0.8	41.8	43.0	1.5	1.5	28.3	28.5	18.0	17.4
Sulphate	27.8	29.0	1.6	1.6	5.6	5.2	10.2	10.2	25.0	25.8	23.5	23.0
Total Alkalinity	177.0	177.2	200.0	200.4	62.6	63.6	172.6	172.8	128.2	129.4	447.2	444.8
PH	7.79	7.80	7.9	7.88	7.47	7.47	7.35	7.35	7.65	7.60	7.90	7.90
Carbonate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bicarbonate	215.8	216.0	243.8	244.3	76.3	77.5	210.4	210.6	156.3	157.7	545.1	542.2
Total Hardness	192.8	192.8	182.8	182.8	65.1	63.0	174.5	174.5	138.9	141.0	404.4	401.9
Fluoride	0.12	0.12	0.11	0.12	0.10	0.10	0.10	0.10	0.11	0.11	0.31	0.32
Silica	7.5	7.5	12.8	12.7	11.7	11.7	17.1	17.1	8.0	8.0	18.6	18.6
Conductance	422	420	355	355	255	255	318	318	390	390	800	805
Threshold Odor Number	4	4	4	4	2	2	2	2	2	2	2	2
Color	20	20	10	10	20	20	200	200	15	15	65	65
Tannin & Lignin	0.25	0.20	0.1	0.1	0.4	0.4	2.4	2.4	0.4	0.5	1.8	2.0
Total Filtble. Res.	260	255	238	233	168	170	215	210	240	243	528	524
Total Filtble. Res. Fixed	227	231	197	199	159	157	163	168	191	186	446	439
Total Non-Filtble. Res.	2.4	2.8	6.4	5.6	5.6	6.4	3.6	4.0	5.2	5.2	76.8	80.0
Total Non-Filtble. Res. Fixed	0.8	0.8	2.8	2.4	3.2	4.0	0.4	0.4	1.2	0.8	36.0	37.0
Turbidity	1.8	1.7	3.10	3.20	3.0	2.8	5.4	5.8	2.4	2.7	60.0	56.5
Surfactants	0.08	0.08	0.11	0.10	0.07	0.07	0.23	0.23	0.10	0.09	0.42	0.41
Humic Acids	L 1.0	L 1.0	L 1.0	L 1.0	L 1.0	L 1.0	5.0	4.5	L 1.0	L 1.0	L 1.0	L 1.0
Fulvic Acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	12.5	12.5	7.5	7.5	1.6	1.0	31.5	31.0	5.0	5.5	55.0	54.5
Total Inorganic Carbon	31.5	31.0	23.5	23.0	17.0	18.0	34.5	34.0	31.5	31.0	100.0	98.5
Total Diss. Organic Carbon	12.0	12.5	7.0	7.5	0.5	1.0	31.0	31.0	5.0	5.0	43.0	42.0
Nitrate Nitrogen	NA	NA	NA	NA	NA	NA	0.075	0.075	0.182	0.182	0.186	0.191
Nitrite Nitrogen	NA	NA	NA	NA	NA	NA	0.007	0.007	0.003	0.003	0.006	0.007
Nitrate & Nitrite Nitrogen	0.13	0.13	0.138	0.149	0.145	0.145	0.082	0.082	0.185	0.185	0.192	0.198
Ammonia Nitrogen	0.07	0.07	0.08	0.08	0.08	0.08	0.38	0.40	0.03	0.03	0.88	0.88
Total Kjeldahl Nitrogen	0.59	0.67	1.25	1.17	0.45	0.44	1.90	1.90	0.92	0.87	3.70	3.75
Total Phosphorus	0.021	0.021	0.058	0.063	0.039	0.037	0.160	0.165	0.021	0.020	0.72	0.72
Ortho Phosphorus	0.010	0.010	0.007	0.007	0.008	0.008	0.021	0.021	0.007	0.006	0.018	0.017
Cyanide	NA	NA	NA	NA	L 0.002	L 0.002	L 0.002	L 0.002	NA	NA	0.002	0.002
Chemical Oxygen Demand	30	33.5	47	47	20	24	94	99	24	24	108	98
Cadmium	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Hexavalent Chromium	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003	0.019	0.020	0.003	0.003	0.003	0.003
Copper	0.003	0.003	0.001	0.001	0.001	0.002	0.007	0.006	0.007	0.009	0.005	0.005
Iron	0.35	0.37	0.77	0.77	0.69	0.69	4.40	4.40	0.40	0.40	21.0	21.0
Lead	L 0.002	L 0.002	0.007	0.008	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	0.014	0.011
Manganese	0.015	0.016	0.22	0.22	0.027	0.027	0.750	0.760	0.029	0.028	4.85	4.81
Silver	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Zinc	0.010	0.009	0.005	0.006	0.003	0.003	0.012	0.011	0.012	0.012	0.026	0.030
Vanadium	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Selenium	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	0.0005	0.0004	L 0.0002	L 0.0002	L 0.0002	L 0.0002
Mercury	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001
Arsenic	L 0.0002	0.0002	0.0002	0.0003	0.0004	0.0004	0.0004	0.0006	0.0004	0.0003	0.0039	0.0031
Nickel	L 0.002	L 0.002	L 0.002	L 0.002	0.002	0.002	0.004	0.003	L 0.002	L 0.002	0.004	0.003
Aluminum	0.04	0.03	0.04	0.04	0.07	0.07	0.23	0.10	0.07	0.08	0.21	0.22
Cobalt	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	0.009	0.007	0.002	0.002
Boron	0.02	0.02	L 0.01	L 0.01	L 0.01	L 0.01	0.21	0.22	0.05	0.04	0.26	0.25
Titanium	NA	NA	L 0.05	L 0.05	L 0.05	L 0.05	L 0.05	L 0.05	L 0.05	L 0.05	L 0.01	L 0.01
Beryllium	NA	NA	NA	NA	NA	NA	NA	JA	NA	NA	NA	NA
	Dec/77		Jan/78		Jan/78		Feb/78		Mar/78		Mar/78	

Continued...

Table 24. Continued.

	00AT07DA0070		00AT07KF0140		00AT07DA0182		00AT07CC0012		00AT07DD0010		00AT07DA0100	
PARAMETERS	ORIGINAL	DUPLICATE	ORIGINAL	DUPLICATE	ORIGINAL	DUPLICATE	ORIGINAL	DUPLICATE	ORIGINAL	DUPLICATE	ORIGINAL	DUPLICATE
Calcium	29.7	29.8	33.200	32.700	33.500	32.000	19.400	19.400	25.500	NA	14.600	14.100
Magnesium	8.1	8.3	9.40	9.70	10.30	10.70	5.40	5.40	7.50	NA	4.50	4.50
Sodium	49.0	48.0	36.00	36.00	23.50	23.50	6.60	6.50	8.20	NA	1.40	1.20
Potassium	1.70	1.60	1.70	1.60	1.10	1.10	0.80	0.80	0.60	NA	0.50	0.50
Chloride	29.5	30.0	47.00	47.00	8.10	8.70	2.40	2.40	6.80	NA	0.70	0.70
Sulphate	9.7	9.8	49.5	49.0	15.5	14.5	14.0	12.5	15.0	NA	6.1	6.6
Total Alkalinity	144.6	144.0	84.7	82.2	136.9	137.3	64.3	NA	87.6	NA	50.1	49.5
PH	7.85	7.85	7.77	7.86	7.60	7.65	7.62	NA	7.75	NA	7.32	7.25
Carbonate	0.0	0.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bicarbonate	176.3	175.5	103.5	100.0	167.0	167.5	78.5	NA	107.0	NA	61.0	60.5
Total Hardness	107.5	108.6	122.0	122.0	126.0	124.0	71.0	NA	95.0	NA	55.0	54.0
Fluoride	0.15	0.15	L 0.5	L 0.5	0.16	0.15	L 0.05	L 0.05	0.08	NA	0.07	0.07
Silica	3.5	3.5	1.40	1.40	4.80	4.80	6.00	6.00	6.20	NA	1.80	1.60
Conductance	300	300	410.0	411.0	323.0	315.0	173.0	171.0	165.0	NA	90.0	90.0
Threshold Odor Number	2	2	4	4	2	2	2	2	2	NA	2	2
Color	80	80	35	35	50	50	190	190	60	NA	30	30
Tannin & Lignin	0.9	0.9	0.5	0.6	1.9	1.8	3.1	3.0	1.0	NA	0.6	0.6
Total Filtble. Res.	198	198	229	226	197	207	113	112	108	NA	59	59
Total Filtble. Res. Fixed	NA	NA	187	193	183	188	77	73	70	NA	39	37
Total Non-Filtble. Res.	12.4	12.0	48.0	49.0	17.2	14.4	139.0	119.0	32.4	NA	4.8	4.4
Total Non-Filtble. Res. Fixed	8.4	8.4	25.0	33.0	10.8	8.8	139.0	116.0	24.8	NA	4.4	4.4
Turbidity	5.3	5.1	59.0	61.5	27.0	25.5	63.0	61.0	21.0	NA	3.2	3.0
Surfactants	0.21	0.20	0.07	0.09	0.19	0.19	0.20	NA	0.30	NA	0.13	0.13
Humic Acids	L 1.0	L 1.0	L 1.0	L 1.0	3	2	5	5	L 1.0	NA	L 1.0	L 1.0
Fulvic Acid	NA	NA	NA	NA	NA	NA	34	36	6	NA	7	9
Total Organic Carbon	25.0	25.5	15.5	17.0	38.0	38.0	11.0	11.0	18.0	NA	15.5	15.0
Total Inorganic Carbon	27.5	28.5	12.5	13.0	28.0	27.5	12.5	12.5	17.5	NA	10.5	10.5
Total Diss. Organic Carbon	24.5	24.0	15.5	16.0	36.5	37.0	10.5	11.0	15.0	NA	15.0	15.0
Nitrate Nitrogen	0.120	0.115	0.006	0.004	NA	NA	NA	NA	NA	NA	NA	NA
Nitrite Nitrogen	L 0.003	L 0.003	0.003	0.003	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate & Nitrite Nitrogen	0.120	0.115	0.009	0.007	0.087	0.087	0.015	0.014	0.009	NA	0.003	0.003
Ammonia Nitrogen	0.025	0.025	0.340	0.340	0.090	0.090	NA	NA	NA	NA	NA	NA
Total Kjeldahl Nitrogen	1.17	0.97	1.93	1.98	1.64	1.59	0.74	0.72	1.94	NA	0.67	0.64
Total Phosphorus	0.032	0.028	0.081	0.086	0.037	0.035	0.042	0.060	0.057	NA	0.036	0.039
Ortho Phosphorus	0.015	0.016	0.003	0.003	0.007	0.007	0.017	0.019	0.013	NA	0.022	0.021
Cyanide	L 0.001	L 0.001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chemical Oxygen Demand	121	126	48	45	85	92	164	162	107	NA	105	115
Cadmium	L 0.001	L 0.001	NA	NA	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	NA	NA
Hexavalent Chromium	0.005	0.005	0.006	0.006	0.018	0.018	0.010	NA	0.004	NA	L 0.003	L 0.003
Copper	L 0.001	L 0.001	0.003	0.002	0.001	L 0.001	0.002	0.002	0.001	0.001	L 0.001	NA
Iron	0.70	0.72	1.840	1.840	1.620	1.620	4.350	4.500	1.030	NA	0.300	0.300
Lead	0.002	L 0.002	L 0.002	L 0.002	0.003	0.002	L 0.002	L 0.002	0.005	0.005	0.003	NA
Manganese	0.201	0.196	0.440	0.046	0.098	0.100	0.093	0.092	0.037	0.038	0.021	NA
Silver	L 0.001	L 0.001	NA	NA	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	NA	NA
Zinc	0.002	0.001	0.005	0.006	0.014	0.012	0.012	0.013	0.007	0.006	0.001	NA
Vanadium	L 0.001	L 0.001	0.002	0.002	0.002	0.001	0.003	0.004	L 0.001	L 0.001	L 0.001	NA
Selenium	L 0.0002	L 0.0002	0.0003	0.0004	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002	NA
Mercury	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	NA
Arsenic	0.0007	0.0005	0.0051	0.0055	0.0007	0.0009	0.0006	0.0008	0.0016	0.0013	0.0007	NA
Nickel	L 0.001	L 0.001	0.003	0.003	0.002	0.002	0.008	NA	0.002	0.003	L 0.001	NA
Aluminum	0.29	0.27	0.52	0.57	0.28	0.31	1.24	1.17	0.25	0.22	0.07	NA
Cobalt	L 0.001	L 0.001	NA	NA	NA	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	NA	NA
Boron	0.18	0.17	0.05	0.04	0.26	0.27	0.13	0.12	0.05	NA	NA	NA
Titanium	L 0.01	L 0.01	NA	NA	NA	NA	NA	NA	L 0.01	L 0.01	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	L 0.001	L 0.001	L 0.001	L 0.001	NA	NA
	May/78		Jun/78		Jul/78		Sept/78		Oct/78		Oct/78	

Continued...

Table 24. Concluded.

PARAMETERS	00AT07DA0060 ORIGINAL (Nov/78)	00AT07DA0060 DUPLICATE (Nov/78)	00AT07DA0160 ORIGINAL (Dec/78)	00AT07DA0160 DUPLICATE (Dec/78)	00AT07DA0070 ORIGINAL (Dec/78)	00AT07DA0070 DUPLICATE (Dec/78)	00AT07DC0010 ORIGINAL (Jan/79)	00AT07DC0010 DUPLICATE (Jan/79)	00AT07CD004C ORIGINAL (Feb/79)	00AT07CD004C DUPLICATE (Feb/79)	00AT07DA009E ORIGINAL (Mar/79)	00AT07DA009E DUPLICATE (Mar/79)
Calcium	38.500	38.500	70.000	70.000	45.000	NA	35.000	35.000	59.000	59.000	22.000	22.000
Magnesium	12.40	13.00	23.00	23.50	23.00	NA	10.80	11.00	19.50	19.60	6.70	6.70
Sodium	20.50	20.50	47.00	50.00	120.00	NA	4.50	4.50	58.00	58.00	11.00	11.00
Potassium	0.90	0.90	2.70	2.80	1.75	NA	0.70	0.70	3.10	2.90	1.00	1.10
Chloride	3.80	3.80	5.00	5.00	160.00	NA	2.40	2.40	31.50	31.00	1.80	1.80
Sulphate	11.0	11.5	130.0	125.0	30.5	NA	5.2	5.2	46.0	46.0	18.0	18.0
Total Alkalinity	171.8	172.0	250.6	249.6	240.0	NA	126.0	126.0	301.0	301.0	77.8	77.0
PH	7.35	7.30	8.10	8.10	8.30	NA	7.40	7.45	8.40	8.40	7.70	7.80
Carbonate	NA	NA	NA	NA	NA	NA	NA	NA	14.0	14.0	NA	NA
Bicarbonate	209.5	210.0	306.0	304.5	293.0	NA	154.0	154.0	339.0	339.0	95.0	94.0
Total Hardness	147.0	150.0	269.5	272.0	207.0	NA	132.0	133.0	228.0	228.0	83.0	83.0
Fluoride	0.11	0.12	0.25	0.24	L 0.05	NA	0.05	0.06	0.08	0.09	1.00	0.90
Silica	11.00	11.00	12.50	12.50	12.00	NA	15.80	15.60	15.50	15.50	3.30	3.30
Conductance	300.0	300.0	700.0	700.0	900.0	NA	240.0	240.0	600.0	600.0	200.0	195.0
Threshold Odor Number	2	2	2	2	2	NA	8	8	2	2	2	2
Color	110	110	45	45	110	NA	20	20	40	40	30	30
Tannin & Lignin	1.1	1.1	1.0	1.0	1.5	NA	0.4	0.5	0.9	0.9	0.6	0.6
Total Filtble. Res.	198	198	462	459	594	NA	158	149	396	396	120	117
Total Filtble. Res. Fixed	141	144	317	313	407	NA	112	113	277	277	77	81
Total Non-Filtble. Res.	34.0	36.0	17.2	16.8	7.2	NA	6.4	6.0	11.2	10.8	4.4	4.0
Total Non-Filtble. Res. Fixed	23.0	23.0	10.0	10.0	2.8	NA	1.6	1.2	6.0	5.6	0.8	0.4
Turbidity	19.0	18.0	36.0	35.0	7.5	NA	4.0	4.3	10.6	10.4	9.6	10.0
Surfactants	0.18	0.16	0.20	0.19	0.31	NA	0.16	0.14	0.09	0.09	0.19	0.19
Humic Acids	L 1.0	L 1.0	L 1.0	L 1.0	L 1.0	NA	L 1.0	L 1.0	L 1.0	L 1.0	1.0	1.0
Fulvic Acid	26	25	9	10	27	NA	4	5	10	12	7	6
Total Organic Carbon	27.0	27.0	7.5	7.5	27.0	NA	6.0	6.5	13.0	13.5	12.5	12.0
Total Inorganic Carbon	39.0	39.5	17.5	18.5	53.0	NA	31.5	31.5	71.5	71.0	18.5	18.[illegible]
Total Diss. Organic Carbon	22.0	22.5	6.0	6.0	27.0	NA	6.0	6.0	12.0	13.0	12.0	12.[illegible]
Nitrate Nitrogen	NA	NA	NA	NA	NA	NA	0.094	0.099	0.468	0.468	0.22[illegible]	0.226
Nitrite Nitrogen	NA	NA	NA	NA	NA	NA	0.010	0.009	0.012	0.012	0.01[illegible]	0.0[illegible]
Nitrate & Nitrite Nitrogen	0.100	0.100	0.042	0.045	0.097	NA	0.104	0.108	0.480	0.480	0.230	0.230
Ammonia Nitrogen	0.079	0.077	L 0.002	0.002	0.122	NA	0.050	0.047	0.043	0.045	0.007	0.004
Total Kjeldahl Nitrogen	1.00	0.90	3.88	3.79	1.08	NA	0.44	0.50	0.70	0.60	1.02	0.96
Total Phosphorus	0.088	0.089	0.097	0.097	0.047	NA	0.048	0.051	0.045	0.044	0.030	0.030
Ortho Phosphorus	0.046	0.046	L 0.003	L 0.003	0.023	NA	0.032	0.033	0.016	0.018	0.009	0.009
Cyanide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chemical Oxygen Demand	59	61	70	70	72	NA	12	10	21	23	32	30
Cadmium	NA	NA	NA	NA	L 0.001	L 0.001	NA	NA	NA	NA	NA	NA
Hexavalent Chromium	0.007	0.007	0.006	NA	0.005	0.005	0.004	0.004	L 0.003	L 0.003	L 0.003	L 0.003
Copper	0.001	0.001	0.006	NA	0.001	0.002	0.003	L 0.001	0.002	0.002	0.005	0.005
Iron	2.150	2.150	4.000	NA	2.550	NA	0.700	0.700	0.700	0.750	0.650	0.650
Lead	L 0.002	L 0.002	L 0.002	NA	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002	L 0.002
Manganese	0.067	0.066	0.099	NA	0.140	0.130	0.029	0.031	0.050	0.055	0.011	0.011
Silver	NA	NA	NA	NA	L 0.001	L 0.001	NA	NA	NA	NA	NA	NA
Zinc	0.007	0.006	0.021	NA	0.003	0.004	0.013	0.012	0.004	0.003	0.026	0.023
Vanadium	L 0.001	L 0.001	L 0.001	NA	L 0.001	L 0.001	L 0.001	L 0.001	0.001	0.001	L 0.001	L 0.001
Selenium	L 0.0002	L 0.0002	L 0.0002	NA	L 0.0002	L 0.0002	0.0002	0.0002	L 0.0002	L 0.0002	L 0.0002	L 0.0002
Mercury	L 0.0001	L 0.0001	L 0.0001	NA	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001	L 0.0001
Arsenic	0.0007	0.0007	0.0005	NA	0.0002	0.0003	0.0012	0.0012	L 0.0003	L 0.0002	NA	0.0005
Nickel	L 0.001	L 0.001	0.008	NA	0.002	0.002	L 0.001	L 0.001	0.003	0.002	L 0.001	L 0.001
Aluminum	0.34	0.30	0.17	NA	0.06	0.06	0.05	0.07	0.06	0.05	0.04	0.04
Cobalt	NA	NA	NA	NA	L 0.001	L 0.001	NA	NA	NA	NA	NA	NA
Boron	NA	NA	0.28	0.28	0.23	0.23	0.03	0.04	0.26	0.25	NA	NA
Titanium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	L 0.001	L 0.001	NA	NA	NA	NA	NA	NA

5.3 TRI-LABORATORY SAMPLE EXCHANGE ANALYSIS RESULTS (Table 25)

Table 25. Tri-laboratory sample exchange analysis results.

PARAMETERS	00AT07CD0040 HANGINGSTONE CREEK - AT HWY 63 - AOSERP			00AT07DA0181 BEAVER RIVER AT HWY 63 - AOSERP			00AT07DA0085 MUSKEG RIVER - 7 MILES UPSTREAM FROM STANLEY CREEK - AOSERP			00AT07DA0181 BEAVER RIVER AT HWY 63 - AOSERP		
	Chemex Lab	Pollution Control Lab	Inland Waters Lab	Chemex Lab	Pollution Control Lab	Inland Waters Lab	Chemex Lab	Pollution Control Lab	Inland Waters Lab	Chemex Lab	Pollution Control Lab	Inla[nd] Wate[rs Lab]
Calcium	24.5	23.7		60.0	56.8		62.5	62.0		56.5	49	
Magnesium	8.0	7.6		15.6	18.2		20.3	20.7		16.2	18	
Sodium	25.0	9.7		98.0	97.6		9.0	12.8		31.0	31.0	
Potassium	1.1	2.1		3.0	3.0		1.1	7.9		2.8	3.0	
Chloride	19.9	19.0		124.0	115.6		3.4	19.4		31.8	21.0	
Sulphate	16.9	16.0		49.8	53.6		4.5	0.71		37.2	46.0	
Total Alkalinity	92.6	93.8		204.6	223.6		241	302		190.0	203	
PH	7.2	7.3		7.6	7.8		7.1	7.1		7.7	8.1	
Carbonate	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Bicarbonate	112.9	109.3		249.4	255.6		294.5	283.4		231.6	247.0	
Total Hardness	54.1	90.2		214.0	211.3		239.6	257.9		207.8	198.0	
Fluoride	0.11	0.20		0.13	18		0.11	NA		0.12	0.19	
Silica	7.6	7.2		8.1	8.0		17.0	19.8		8.4	8.4	
Conductance	230	210		830	850		430	450		510	520	
Threshold Odor Number	4	3		2	1		2	2		2	1	
Color	70	81		70	70		60	NA		35	35	
Tannin & Lignin	2.35	2.36		0.95	0.27		0.45	1.08		0.70	0.6	
Total Filtble. Res.	169	NA		496	509		241	223		306	328	
Total Filtble. Res. Fixed	144	NA		468	427		200	209		265	202	
Total Non-Filtble. Res.	19.2	18.7		52.4	22.0		5.6	5.9		5.20	15	
Total Non-Filtble. Res. Fixed	16.8	NA		43.6	29.2		2.0	2.2		1.60	10	
Turbidity	32.0	33.5		NA	4.3		NA	3		4.1	4.1	
Surfactants	L 0.02	L 0.02		L 0.02	L 0.02		L 0.02	0.15		L 0.02	0.17	
Humic Acids	5.5	NA		6.0	0.87		1.0	NA		L 1.0	L 1.0	
Fulvic Acid	NA	NA		NA	NA		NA	NA		NA	NA	
Total Organic Carbon	24.5	24.0		22.5	20.3		30	28		18	15	
Total Inorganic Carbon	20.5	21.0		38.5	56.7		53	55		36	40	
Total Diss. Organic Carbon	NA	NA		NA	NA		27	NA		18	16	
Nitrate Nitrogen	NA	0.01		NA	0.10		NA	NA		NA	NA	
Nitrite Nitrogen	NA	NA		NA	0.03		NA	NA		NA	NA	
Nitrate & Nitrite Nitrogen	0.02	0.02		0.36	0.13		0.02	0.018		0.08	0.082	
Ammonia Nitrogen	0.04	0.04		0.19	0.28		0.26	0.24		0.37	0.45	
Total Kjeldahl Nitrogen	0.90	0.88		0.90	0.88		0.50	0.50		1.44	1.38	
Phenol	0.004	0.020		L 0.001	L 0.002		0.014	0.009		L 0.001	0.024	
Oil & Grease	L 0.1	0.2		0.7	0.3		L 0.1	0.3		0.8	3.9	
Sulphide	L 0.05	L 0.02		L 0.05	L 0.02		L 0.05	L 0.02		L 0.05	L 0.02	
Total Phosphorus	0.08	NA		0.11	0.13		0.07	NA		0.03	1.38	
Ortho Phosphorus	0.03	L 0.02		0.02	L 0.02		0.01	0.02		L 0.001	L 0.05	
Cyanide	L 0.01	L 0.002		L 0.01	L 0.002		L 0.01	NA		L 0.01	L 0.01	
Chlorophyll "A"	0.001	NA		L 0.001	NA		L 0.001	NA		L 0.001	L 0.001	
Chemical Oxygen Demand	73.6	78.3		92.0	NA		81.0	78.0		29	38.6	
Cadmium	L 0.001	L 0.001		L 0.001	L 0.001		L 0.001	L 0.001		L 0.001	L 0.001	
Hexavalent Chromium	L 0.003	NA		L 0.003	L 0.002		L 0.003	L 0.002		L 0.003	L 0.001	
Copper	0.005	L 0.002		0.003	L 0.001		0.004	0.002		0.003	L 0.001	
Iron	1.00	0.96		3.05	8.7		1.88	NA		0.45	0.50	
Lead	0.013	0.008		0.013	0.02		0.004	L 0.003		L 0.002	L 0.003	
Manganese	0.045	NA		0.242	0.4		0.445	0.423		0.12	0.13	
Silver	L 0.005	NA		L 0.005	NA		L 0.005	L 0.001		L 0.005	L 0.001	
Zinc	0.029	0.026		0.023	0.015		0.010	0.010		0.019	0.019	
Vanadium	L 0.001	L 0.002		L 0.001	L 0.002		L 0.001	L 0.002		L 0.001	L 0.01	
Selenium	L 0.002	NA		L 0.0005	NA		L 0.0005	L 0.0002		L 0.0005	L 0.0002	
Mercury	L 0.0002	L 0.001		L 0.0002	L 0.0001		0.0001	0.0002		L 0.0001	L 0.0001	
Arsenic	L 0.005	NA		0.010	NA		L 0.001	L 0.0002		L 0.001	L 0.0003	
Nickel	0.013	0.010		0.008	0.003		L 0.002	0.001		L 0.002	L 0.001	
Aluminum	0.19	0.26		0.54	0.040		0.015	0.021		0.07	0.07	
Cobalt	0.005	L 0.02		L 0.002	L 0.001		L 0.002	L 0.001		L 0.002	L 0.001	
Boron	0.22	NA		0.17	NA		0.18	NA		0.09	0.09	
Titanium	NA	NA		NA	NA		NA	NA		NA	NA	
Beryllium	NA	NA		NA	NA		NA	L 0.001		NA	NA	
	Aug/76			Sept/76			Nov/76			Jan/77		

Continued...

Table 25. Continued.

PARAMETERS	00AT07DA0070 [illegible] Chemex Lab	Pollution Control Lab	Inland Waters Lab	00AT07DA0080 [illegible] Chemex Lab	Pollution Control Lab	Inland Waters Lab	00AT07DA0070 [illegible] Chemex Lab	Pollution Control Lab	Inland Waters Lab	00AT07DA0120 [illegible] Chemex Lab	Pollution Control Lab	Inland Waters Lab
Calcium	30.0	38		33	37		29.0	28.0	31.9	40.0	44	47.4
Magnesium	9.8	10		NA	NA		9.5	10.0	10.0	15.0	15.0	14.8
Sodium	30.0	30.0		NA	NA		35.5	33.0	37.0	22.5	23.0	21.0
Potassium	2.6	2.4		NA	NA		2.4	1.7	1.9	2.50	1.8	1.7
Chloride	19.5	18		2.0	1.0		23.2	20	20	2.7	2.0	2.4
Sulphate	7.0	L 10		NA	NA		6.6	L 10.0	4.2	146	134	134
Total Alkalinity	145	161		NA	NA		154.4	154.0	155.0	63	65	65
PH	7.7	7.9		NA	NA		8.05	7.9	8.8	7.50	7.1	7.8
Carbonate	0.0	0.0		NA	NA		0.0	0.0	0.0	0.0	0.0	0.0
Bicarbonate	176.8	196.0		NA	NA		188.2	187.0	NA	76.8	79.0	NA
Total Hardness	115.3	138.0		119.5	135		111.5	111.0	121.0	161.6	173.0	179.0
Fluoride	0.10	0.13		0.09	0.12		0.12	0.14	0.12	0.41	0.41	0.36
Silica	6.3	12.7		5.2	4.4		5.6	7.5	6.0	9.4	9.0	9.1
Conductance	330	355		250	200		315	365	362	398	435	411
Threshold Odor Number	2	NA		4	1		2	NA	NA	2	1	NA
Color	130	NA		NA	NA		80	NA	70	45	NA	NA
Tannin & Lignin	2.1	NA		1.45	1.1		1.3	1.1	NA	1.25	0.4	NA
Total Filtble. Res.	208	NA		150	198		204	NA	NA	278	353	NA
Total Filtble. Res. Fixed	170	NA		NA	NA		161	NA	NA	251	298	NA
Total Non-Filtble. Res.	36.0	NA		NA	NA		4.4	NA	3	38	47	NA
Total Non-Filtble. Res. Fixed	27.2	NA		NA	NA		2.4	NA	NA	32.5	45	NA
Turbidity	12.0	NA		NA	NA		4.35	5	6.2	68	NA	32
Surfactants	L 0.02	NA		0.03	0.15		0.05	0.27	NA	0.08	0.09	NA
Humic Acids	4.0	NA		NA	NA		1.5	NA	NA	L 1.0	NA	NA
Fulvic Acid	NA	NA		NA	NA		NA	NA	NA	NA	NA	NA
Total Organic Carbon	17	24		NA	NA		29.5	22.0	28.0	13.5	17.0	18.0
Total Inorganic Carbon	25	33		17.5	31		27.0	36.0	34.0	14.5	11	13.0
Total Diss. Organic Carbon	17	NA		NA	NA		27.0	NA	24.0	12.0	NA	17.0
Nitrate Nitrogen	NA	NA		NA	NA		NA	NA	NA	L 0.003	NA	NA
Nitrite Nitrogen	NA	NA		NA	NA		NA	NA	NA	0.005	NA	NA
Nitrate & Nitrite Nitrogen	L 0.01	0.02		0.028	0.539		0.010	0.018	NA	0.005	0.008	0.02
Ammonia Nitrogen	0.23	0.53		0.03	0.07		0.14	NA	NA	0.08	0.06	0.01
Total Kjeldahl Nitrogen	1.36	2.40		1.32	2.19		1.08	2.13	1.1	2.00	10.54	0.6
Phenol	L 0.001	0.012		L 0.001	0.004		L 0.001	0.008	0.003	L 0.001	0.010	0.002
Oil & Grease	L 0.1	1.2		0.4	1.3		0.2	1.2	L 1.0	1	4	NA
Sulphide	NA	NA		NA	NA		NA	NA	NA	NA	NA	NA
Total Phosphorus	0.24	0.25		NA	NA		0.040	L 0.05	0.032	0.108	0.10	0.054
Ortho Phosphorus	0.02	0.02		0.006	NA		0.005	0.010	NA	0.005	0.015	0.005
Cyanide	NA	NA		NA	NA		NA	NA	NA	NA	NA	NA
Chlorophyll "A"	NA	NA		NA	NA		NA	NA	NA	NA	NA	NA
Chemical Oxygen Demand	87	72		NA	NA		59.0	60	NA	52	32	NA
Cadmium	0.016	0.013		NA	NA		L 0.001	L 0.001	NA	L 0.001	L 0.001	NA
Hexavalent Chromium	0.075	0.075		NA	NA		0.004	0.003	NA	L 0.003	L 0.002	NA
Copper	0.017	0.017		0.006	0.004		0.004	L 0.001	L 0.001	0.004	0.003	NA
Iron	0.12	3.64		1.10	1.3		0.36	0.33	0.38	4.10	3.29	NA
Lead	0.175	0.48		L 0.002	0.004		L 0.002	L 0.003	L 0.001	L 0.002	L 0.003	NA
Manganese	0.070	0.076		NA	NA		0.067	0.076	0.38	0.135	0.163	NA
Silver	0.028	L 0.001		NA	NA		L 0.001	L 0.001	0.005	L 0.001	L 0.001	L 0.004
Zinc	0.040	0.041		0.004	0.013		0.044	0.067	0.020	0.018	0.029	NA
Vanadium	L 0.001	L 0.01		NA	NA		L 0.001	L 0.01	L 0.004	L 0.001	L 0.01	0.002
Selenium	L 0.0005	L 0.005		NA	NA		L 0.0002	NA	L 0.001	L 0.0002	NA	L 0.0005
Mercury	L 0.0001	L 0.0001		NA	NA		L 0.0001	L 0.0001	L 0.001	L 0.0001	L 0.0001	0.0000[illegible]
Arsenic	L 0.0005	0.0008		NA	NA		0.0005	NA	0.0005	L 0.0002	NA	L 0.0005
Nickel	0.002	0.002		NA	NA		0.038	0.005	NA	0.006	0.017	NA
Aluminum	0.01	0.01		0.06	0.025		0.09	NA	0.043	0.52	0.372	NA
Cobalt	0.031	0.032		NA	NA		L 0.002	L 0.001	0.003	L 0.002	0.002	NA
Boron	0.23			NA	NA		0.21	0.16	0.15	0.16	NA	0.18
Titanium	NA	NA		NA	NA		NA	NA	NA	NA	NA	NA
Beryllium	NA	NA		NA	NA		NA	NA	NA	NA	NA	NA
	Apr/77			Jun/77			Jul/77			Aug/77		

Continued...

Table 25. Continued.

PARAMETERS	00AT07DB0011 MACKAY RIVER AT HWY. 63 ABSEPP Chemex Lab	Pollution Control Lab	Inland Waters Lab	00AT07CD2300 CLEARWATER RIVER APPROXIMATELY 2000 METERS ABOVE WATERWAYS ADSEPP Chemex Lab	Pollution Control Lab	Inland Waters Lab	00AT07DA0150 Chemex Lab	Pollution Control Lab	Inland Waters Lab	00AT07DA0160 Chemex Lab	Pollution Control Lab	Inland Waters Lab
Calcium	32.0	32.0	35.2	12.0	15.8		38.0	35.3		46.0	51.0	
Magnesium	11.2	12.0	12.1	4.7	5.0		13.2	14.3		12.5	15.0	
Sodium	25.0	24.0	26.0	19.0	19.2		21.5	22.8		26.5	26.0	
Potassium	1.48	1.2	1.1	0.87	0.88		1.85	1.7		2.50	2.2	
Chloride	7.4	7.0	6.4	24.0	24.9		3.1	12.4		1.8	2.0	
Sulphate	14.8	23	25	6.5	6.0		35.3	35.2		70.0	57.0	
Total Alkalinity	143.0	133.0	139.0	53	87		158.0	NA		163.0	NA	
PH	8.36	7.7	8.4	7.46	7.6		7.68	7.6		7.88	7.7	
Carbonate	1.2	NA	NA	0.0	0.0		0.0	0.0		0.0	0.0	
Bicarbonate	171.9	162.0	NA	64.6	62.8		192.6	194.2		198.7	196.0	
Total Hardness	126.0	128.0	138	19.3	NA		149.2	141.3		166.3	190.0	
Fluoride	0.12	0.13	NA	0.09	NA		0.22	0.14		0.22	0.23	
Silica	1.0	2.5	1.0	7.2	7.2		8.7	8.4		7.3	5.0	
Conductance	291	330	316	165	172		370	392		385	440	
Threshold Odor Number	2	NA	NA	2	1		2	1		2	1	
Color	120	NA	80	35	NA		70	62		60	95	
Tannin & Lignin	1.4	1.5	NA	0.50	0.62		0.8	0.7		1.0	0.6	
Total Filtble. Res.	175	NA	234.0	108	110		244	230		255	220.0	
Total Filtble. Res. Fixed	118	NA	156.0	89.0	88		208	196		203	322.0	
Total Non-Filtble. Res.	2.0	NA	2.0	11.2	12.0		10.8	9.4		20.0	23.0	
Total Non-Filtble. Res. Fixed	0.4	NA	1.0	4.8	4.2		7.2	7.7		14.8	11	
Turbidity	0.9	13	5.5	3.10	6.9		6.9	5.2		21.6	0.13	
Surfactants	0.15	0.15	NA	0.08	L 0.05		0.20	0.26		0.18	NA	
Humic Acids	L 1.0	NA	NA	L 1.0	NA		L 1.0	NA		1.0	NA	
Fulvic Acid	NA	NA	NA	NA	NA		NA	NA		NA	NA	
Total Organic Carbon	24.0	14.0	30.0	9.0	22.7		18.5	19.0		22.0	17.0	
Total Inorganic Carbon	26.5	34.0	31.0	12.0	18.3		34.0	34.0		27.0	31.0	
Total Diss. Organic Carbon	24.0	NA	27.0	9.0	10.2		15.5	NA		21.5	NA	
Nitrate Nitrogen	0.003	NA	NA	NA	0.011		NA	NA		NA	NA	
Nitrite Nitrogen	0.009	NA	NA	NA	NA		NA	0.003		NA	NA	
Nitrate & Nitrite Nitrogen	0.012	0.011	L 0.01	0.080	0.093		0.025	NA		0.033	0.022	
Ammonia Nitrogen	0.02	0.06	L 0.1	L 0.01	0.03		0.02	0.028		0.03	0.06	
Total Kjeldahl Nitrogen	0.92	2.00	0.8	1.20	1.20		1.10	1.1		0.63	1.45	
Phenol	NA	0.008	0.002	NA	0.006		L 0.001	0.004		L 0.001	0.006	
Oil & Grease	0.5	NA	NA	0.6	2.9		L 0.1	0.3		0.7	2.7	
Sulphide	NA	NA	NA	NA	NA		NA	L 0.02		NA	NA	
Total Phosphorus	0.029	L 0.05	NA	0.038	0.036		0.079	0.062		0.112	0.13	
Ortho Phosphorus	L 0.003	0.017	NA	0.011	NA		0.009	0.007		0.007	NA	
Cyanide	NA	NA	NA	NA	NA		NA	NA		NA	NA	
Chlorophyll "A"	NA	NA	NA	NA	NA		NA	NA		NA	NA	
Chemical Oxygen Demand	65.0	81.5	NA	28	26		68.0	90.0		50.0	59.8	
Cadmium	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001		L 0.001	L 0.001		L 0.001	L 0.001	
Hexavalent Chromium	L 0.003	L 0.002	NA	L 0.003	L 0.002		0.005	L 0.0002		L 0.003	L 0.002	
Copper	0.002	L 0.001	L 0.001	0.002	0.32		0.009	0.010		0.005	L 0.001	
Iron	0.59	0.60	0.48	0.72	1.37		2.30	2.30		4.00	3.74	
Lead	L 0.002	L 0.003	L 0.004	L 0.002	L 0.003		L 0.002	L 0.003		L 0.002	L 0.003	
Manganese	0.015	0.018	NA	0.034	0.028		0.101	0.1		0.050	0.050	
Silver	L 0.001	L 0.001	L 0.004	L 0.001	L 0.001		L 0.001	NA		L 0.001	NA	
Zinc	0.005	0.009	0.010	0.031	0.007		0.006	0.005		0.013	0.006	
Vanadium	L 0.001	L 0.01	L 0.001	L 0.001	L 0.002		L 0.001	L 0.002		0.002	L 0.002	
Selenium	L 0.0002	L 0.0002	L 0.0005	L 0.0002	0.0003		L 0.0002	L 0.0002		L 0.0002	0.0003	
Mercury	L 0.0001	L 0.0001	0.00013	L 0.0001	L 0.0001		L 0.0001	L 0.0001		L 0.0001	L 0.0001	
Arsenic	0.0003	0.0005	L 0.0005	0.0006	0.0027		0.0009	0.0013		0.0015	0.0022	
Nickel	L 0.002	L 0.002	0.005	L 0.002	0.008		L 0.002	0.002		0.002	0.006	
Aluminum	0.05	L 0.02	0.033	0.15	0.110		0.07	0.11		0.20	0.100	
Cobalt	L 0.002	L 0.001	L 0.002	L 0.002	L 0.001		L 0.002	0.004		L 0.002	L 0.001	
Boron	0.18	NA	0.31	0.02	0.20		0.14	NA		0.20	0.20	
Titanium	NA	NA	NA	L 0.05	NA		L 0.05	NA		L 0.05	NA	
Beryllium	NA	NA	NA	NA	NA		NA	NA		NA	NA	
	Sept/77			Oct/77			Nov/77			Nov/77		

Continued...

Table 25. Continued.

PARAMETERS	00AT07CC0012 ATHABASCA RIVER 100 METERS ABOVE THE CONFLUENCE WITH THE HORSE RIVER ADSEPP			00AT07DA0207 ATHABASCA RIVER AT FORT MACKAY - ADSEPP			00AT07DA0080 MUSKEG RIVER - SITE 19, 2.2 MILES NORTH EAST OF FORT MACKAY - AT HSC [illegible] - ADSEPP			00AT07DA0181 BEAVER RIVER AT HWY 63 - ADSEPP		
	Chemex Lab	Pollution Control Lab	Inland Waters Lab	Chemex Lab	Pollution Control Lab	Inland Waters Lab	Chemex Lab	Pollution Control Lab	Inland Waters Lab	Chemex Lab	Pollution Control Lab	Inland Waters Lab
Calcium	55.0			52.5	55.0	56.3	77.5	76.0	80.9	77.5	63	
Magnesium	16.0			15.0	16.0	15.6	18.2	19.0	22.3	18.2	17	
Sodium	14.0			20.0	20.0	19.0	14.4	14.0	15.0	14.4	68	
Potassium	2.00			1.70	2.1	2.0	1.4	1.4	1.5	1.4	2.8	
Chloride	4.1			14.5	14.0	15.0	5.6	6.0	5.4	5.6	23	
Sulphate	28.5			27.8	35.0	32.0	1.0	L 10	3.9	L 1.0	163	
Total Alkalinity	195.0			177.0	176.0	185.0	273.2	283.0	281.0	273.2	147	
PH	8.15			7.79	7.6	7.8	7.89	7.1	7.1	7.89	8.0	
Carbonate	0.0			0.0	NA	NA	0.0	0.0	0.0	NA	NA	
Bicarbonate	237.7			215.8	214.0	NA	333.0	345.0	NA	NA	180	
Total Hardness	203.2			192.8	NA	NA	268.4	268.0	NA	NA	226	
Fluoride	0.13			0.12	0.11	0.12	0.15	0.12	0.16	0.15	0.29	
Silica	6.1			7.5	8.0	8.3	12.9	13.4	13.0	12.9	7.3	
Conductance	382.0			422	446	442	455.0	533.0	523.0	455	684	
Threshold Odor Number	4			4	NA	NA	2	1	NA	2	1	
Color	20			20	NA	20	40	96	75	40	98	
Tannin & Lignin	0.30			0.25	NA	NA	0.4	0.4	NA	0.4	0.3	
Total Filtble. Res.	251			260	NA	248.0	301.0	338.0	335.0	301	484	
Total Filtble. Res. Fixed	203			227.0	NA	173.0	263.0	NA	211.0	263	380	
Total Non-Filtble. Res.	0.6			2.4	NA	2.0	6.0	NA	7.0	6.0	NA	
Total Non-Filtble. Res. Fixed	L 0.4			0.8	NA	L 1.0	2.4	NA	3.0	62.4	NA	
Turbidity	1.5			1.8	NA	6.5	5.3	12.0	10.0	5.3	13.0	
Surfactants	0.09			0.08	NA	NA	0.10	0.15	NA	0.10	0.30	
Humic Acids	L 1.0			L 1.0	NA	2.0	L 1.0	NA	L 1.0	NA	NA	
Fulvic Acid	NA			NA	NA	10.0	NA	NA	23.0	NA	NA	
Total Organic Carbon	12.0			12.5	12.0	10.0	38.0	22.0	15.0	38.0	15.0	
Total Inorganic Carbon	34.0			31.5	56.0	38.0	69.0	71.0	72.0	69.0	33.0	
Total Diss. Organic Carbon	12.0			12.0	68.0	9.0	37.0	NA	16.0	37.0	NA	
Nitrate Nitrogen	NA			NA	NA	NA	NA	NA	NA	0.272	NA	
Nitrite Nitrogen	NA			NA	NA	NA	NA	NA	NA	0.005	NA	
Nitrate & Nitrite Nitrogen	0.082			0.13	0.200	0.10	0.015	0.24	0.010	0.277	0.444	
Ammonia Nitrogen	0.06		L 0.01	0.07	NA	L 0.1	0.49	0.60	L 0.1	0.12	0.31	
Total Kjeldahl Nitrogen	0.58			0.59	NA	NA	1.95	2.24	1.1	0.95	1.25	
Phenol	NA			L 0.001	NA	NA	NA	NA	NA	NA	NA	
Oil & Grease	2.4			[illegible]	[illegible]	[illegible]	[illegible]	NA	NA	NA	NA	
Sulphide	NA			NA	NA	NA	NA	NA	NA	NA	NA	
Total Phosphorus	0.018		0.02	0.021	NA	0.02	0.035	0.10	0.02	0.024	0.06	
Ortho Phosphorus	0.004			0.010	0.005	0.005	0.006	0.029	L 0.003	0.009	0.025	
Cyanide	NA			NA	NA	NA	L 0.002	0.011	L 0.005	L 0.002	0.011	
Chlorophyll "A"	NA			NA	NA	NA	NA	NA	NA	NA	NA	
Chemical Oxygen Demand	62			30	NA	NA	34	50.8	NA	NA	NA	
Cadmium	L 0.001			L 0.001	L 0.001	L 0.001	0.003	NA	L 0.001	L 0.002	L 0.001	
Hexavalent Chromium	L 0.003			L 0.003	L 0.002	L 0.015	0.004	L 0.002	NA	L 0.003	0.33	
Copper	0.003			0.003	0.011	0.001	0.003	0.002	L 0.001	0.003	0.003	
Iron	0.26			0.35	0.31	0.32	1.87	2.10	1.80	1.87	0.23	
Lead	L 0.002			L 0.002	L 0.003	0.004	L 0.002	L 0.003	L 0.004	L 0.002	L 0.003	
Manganese	0.008			0.015	0.012	0.020	0.705	0.720	0.90	0.705	1.620	
Silver	L 0.001			L 0.001	L 0.001	L 0.004	L 0.001	L 0.001	L 0.004	L 0.001	L 0.001	
Zinc	0.005			0.010	0.005	0.008	0.002	0.004	0.007	0.002	0.038	
Vanadium	L 0.001			L 0.001	L 0.002	L 0.001	L 0.001	L 0.002	L 0.001	L 0.001	L 0.002	
Selenium	L 0.0002			L 0.0002	NA	L 0.0005	L 0.0002	L 0.0002	L 0.0005	NA	NA	
Mercury	L 0.0001			L 0.0001	L 0.0001	0.04	L 0.0001	L 0.0001	0.10	L 0.0002	L 0.0001	
Arsenic	0.0002		0.0059	L 0.0002	NA	L 0.0005	0.0002	L 0.0002	L 0.0005	NA	NA	
Nickel	L 0.002			L 0.002	0.002	0.017	L 0.002	L 0.001	0.010	L 0.002	L 0.001	
Aluminum	0.05			0.04	0.034	0.11	0.05	0.125	L 0.15	NA	NA	
Cobalt	L 0.002			L 0.002	L 0.001	L 0.002	L 0.002	L 0.001	L 0.002	NA	NA	
Boron	0.05			0.02	NA	0.07	0.03	NA	0.14	NA	NA	
Titanium	L 0.05			L 0.05	NA	L 0.05	NA	L 0.05	NA	NA	NA	
Beryllium	NA			NA	L 0.001	0.005	NA	NA	NA	NA	NA	
	Dec/77			Dec/77			Jan/78			Jan/78		

Continued...

Table 25. Continued.

PARAMETERS	00AT07DA0060 Steepbank River - 4.5 miles upstream from the mouth - at HBC Gauge - AOSERP Chemex Lab	Pollution Control Lab	Inland Waters Lab	00AT07CD0040 Hangingstone Creek - at Hwy 63 - AOSERP Chemex Lab	Pollution Control Lab	Inland Waters Lab	00AT07CD0040 Hangingstone Creek - at Hwy 63 - AOSERP Chemex Lab	Pollution Control Lab	Inland Waters Lab	00AT07DA0207 Athabasca River at Fort MacKay - AOSERP Chemex Lab	Pollution Control Lab	Inland Waters Lab
Calcium	70.0	68.0	73.6	35.5	39	40.5	22.8	23.0	26.2	29.0	28.0	26.4
Magnesium	23.8	23.0	23.8	12.0	12.0	11.8	6.8	8.0	8.1	6.60	8.0	11.4
Sodium	55.0	52.0	54.0	43.0	42.0	43.0	18.5	18.0	18.0	5.30	6.0	5.6
Potassium	2.2	2.1	2.2	2.70	3.0	3.0	0.9	1.1	1.1	0.60	0.80	0.9
Chloride	7.1	7.0	7.3	36.0	36.0	36.0	11.50	12.0	12.0	1.80	3.0	1.5
Sulphate	13.5	L 10	12.0	28.5	21.0	30.0	14.90	25.0	14.0	15.5	17.0	16.0
Total Alkalinity	362.0	366.0	335.0	147.8	157.0	156.0	89.2	86.0	87.0	103.1	91.0	96.0
PH	7.70	7.6	7.8	7.85	7.8	8.1	7.95	7.5	8.1	7.90	7.5	8.1
Carbonate	0.0	0.0	0.0	0.0	0.0	0.0	NA	NA	NA	0.0	0.0	0.0
Bicarbonate	441.3	446.0	NA	180.2	192.0	190.2	109.5	105.0	NA	126.0	111.0	NA
Total Hardness	272.8	263.0	NA	138.0	148.0	149.7	85.0	88.0	NA	100.0	102.0	NA
Fluoride	0.31	0.3	NA	0.18	0.20	0.18	0.05	0.12	NA	0.11	0.13	0.13
Silica	13.8	13.9	14.0	8.5	9.2	9.8	4.90	5.2	5.1	4.50	2.5	4.5
Conductance	625	690	685.0	410	480	462	185.0	243.0	212.0	191.0	221.0	215.0
Threshold Odor Number	2	1	NA	2	NA	NA	2	1	NA	2	1	NA
Color	15	99	30	70	95	75	110	91	100	30.0	NA	50.0
Tannin & Lignin	0.2	0.2	NA	0.9	0.6	NA	1.5	1.5	NA	0.4	0.3	NA
Total Filtble. Res.	413.0	450.0	377.0	270	324	230.0	122.0	216.0	NA	125.0	NA	NA
Total Filtble. Res. Fixed	337.0	398.0	285.0	244.0	254.0	354.0	88.0	158.0	NA	103.0	NA	NA
Total Non-Filtble. Res.	2.0	NA	NA	23.2	27.0	21.0	11.2	NA	16.0	584.0	540.0	254.0
Total Non-Filtble. Res. Fixed	L 0.4	NA	NA	16.0	27.0	30.0	7.2	NA	NA	502.0	NA	NA
Turbidity	1.5	4.0	10.0	10.2	NA	10	9.8	6	5.8	320.0	NA	188
Surfactants	0.15	0.11	NA	0.14	0.19	NA	0.19	0.15	NA	0.10	0.09	NA
Humic Acids	L 1.0	NA	NA	NA	NA	NA	L 1.0	NA	NA	NA	NA	NA
Fulvic Acid	NA	NA	NA	NA	NA	NA	23.0	NA	NA	NA	NA	NA
Total Organic Carbon	20.5	4.0	15.0	15.0	11.0	12.0	17.5	20.0	20.0	13.5	11.0	NA
Total Inorganic Carbon	58.5	98.0	93.0	32.5	43.0	38.0	36.5	23.0	20.0	21.5	33.0	NA
Total Diss. Organic Carbon	20.0	NA	7.0	11.0	NA	10.0	36.0	NA	NA	NA	NA	NA
Nitrate Nitrogen	0.272	NA	NA	NA	NA	NA	0.005	NA	NA	0.074	NA	NA
Nitrite Nitrogen	0.005	NA	NA	NA	0.019	NA	0.002	L 0.05	NA	0.003	L 0.001	NA
Nitrate & Nitrite Nitrogen	0.277	0.293	0.27	0.152	1.61	0.10	0.005	L 0.05	0.01	0.007	0.008	0.05
Ammonia Nitrogen	0.12	0.1	NA	NA	0.08	NA	0.020	0.25	NA	0.120	0.05	NA
Total Kjeldahl Nitrogen	0.95	0.87	0.6	0.095	0.14	0.4	0.62	5.38	0.07	1.58	0.94	1.1
Phenol	NA	NA	NA	NA	NA	NA	L 0.001	0.006	0.02	L 0.001	L 0.001	L 0.001
Oil & Grease	NA	NA	NA	NA	NA	NA	0.8	L 1.0	0.35	0.1	L 1.0	L 0.1
Sulphide	NA	NA	NA	NA	NA	NA	L 1.0	L 0.02	NA	L 0.01	L 0.02	NA
Total Phosphorus	0.24	L 0.05	0.020	0.095	0.14	0.068	0.032	0.09	0.044	0.035	0.42	0.38
Ortho Phosphorus	0.009	0.029	L 0.003	0.018	0.036	0.014	0.015	NA	0.022	0.008	L 0.001	NA
Cyanide	L 0.002	0.006	L 0.005	L 0.001	0.004	0.003	NA	NA	NA	0.001	L 0.002	0.002
Chlorophyll "A"	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chemical Oxygen Demand	NA	NA	NA	NA	NA	NA	NA	NA	NA	278.0	71.0	NA
Cadmium	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	NA	NA	NA	L 0.001	NA	L 0.001
Hexavalent Chromium	L 0.003	L 0.002	NA	0.003	L 0.002	NA	0.010	0.0150	NA	0.010	NA	NA
Copper	0.019	0.008	L 0.001	L 0.001	0.003	L 0.001	L 0.001	L 0.001	L 0.001	0.010	0.010	0.003
Iron	0.46	0.49	0.46	1.37	1.42	1.43	1.02	0.64	1.12	3.90	2.58	0.54
Lead	L 0.002	L 0.003	L 0.004	L 0.002	L 0.004	0.007	L 0.002	L 0.003	L 0.004	0.008	0.008	L 0.004
Manganese	0.022	0.026	0.028	0.106	0.115	0.117	0.037	0.044	0.067	0.281	0.285	0.30
Silver	L 0.001	L 0.001	L 0.004	L 0.001	L 0.001	L 0.004	NA	NA	NA	0.001	L 0.001	NA
Zinc	0.009	0.021	0.007	0.001	0.006	0.009	0.001	0.003	0.006	0.029	0.028	0.14
Vanadium	L 0.001	L 0.002	L 0.001	L 0.001	0.003	0.002	L 0.001	L 0.002	NA	0.003	0.007	0.010
Selenium	L 0.0002	L 0.0002	L 0.0005	NA	NA	L 0.005	0.0002	NA	L 0.0005	NA	NA	NA
Mercury	L 0.0001	0.0003	0.07	L 0.001	L 0.0001	0.05	L 0.0001	L 0.0001	0.07	L 0.0001	L 0.001	L 0.02
Arsenic	L 0.0002	0.0023	L 0.0005	NA	NA	0.0008	0.0009	0.0150	0.0006	NA	NA	NA
Nickel	L 0.002	0.002	0.009	L 0.0001	0.004	NA	0.001	0.002	0.012	0.010	0.009	NA
Aluminum	0.03	0.02	0.23	0.21	0.260	0.30	0.07	0.135	NA	NA	NA	NA
Cobalt	L 0.002	L 0.001	L 0.002	L 0.001	L 0.001	L 0.002	NA	NA	NA	0.004	0.005	L 0.002
Boron	0.41	NA	0.45	0.22	NA	0.24	NA	NA	0.19	NA	NA	NA
Titanium	L 0.05	NA	NA	L 0.01	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	L 0.001	NA	NA	L 0.001	NA	NA	NA	NA
	Feb/78			Apr/78			Jun/78			Jul/78		

Continued...

Table 25. Continued.

PARAMETERS	00AT07DA0070 POPLAR CREEK - 11 MILES NORTH OF FORT MCMURRAY VIA HWY 63 - AOSERP			00AT07CE2191 CHRISTINA RIVER - ABOVE CONFLUENCE WITH CLEARWATER RIVER			00AT07DA0098 ELLS RIVER NEAR THE MOUTH NO.1 AOSERP			01AT07CE0011 GREGOIRE LAKE AT WIER - AOSERP		
	Chemex Lab	Pollution Control Lab	Inland Waters Lab	Chemex Lab	Pollution Control Lab	Inland Waters Lab	Chemex Lab	Pollution Control Lab	Inland Waters Lab	Chemex Lab	Pollution Control Lab	Inland Waters Lab
Calcium	24.2	25.0		30.0		31.5	25.0	0.37	23.8	19.0	18.0	
Magnesium	8.90	8.0		9.8		9.1	7.50	9.0	6.8	6.0	6.0	
Sodium	33.0	30		40.0		42.0	6.50	8.0	7.8	2.7	6.0	
Potassium	1.40	1.2		0.90		1.1	0.70	1.0	1.0	0.80	0.9	
Chloride	18.30	19.0		55.50		42.5	1.40	2.0	1.2	1.20	2.0	
Sulphate	15.6	14.0		13.0		210	13.8	13.0	14.0	5.8	9.0	
Total Alkalinity	123.4	131.0		132.6		107.0	83.2	79.0	67.0	64.6	67.0	
PH	7.90	8.0		7.85		7.7	7.30	8.0	7.4	7.5	7.4	
Carbonate	0.0	0.0		0.0		0.0	0.0	0.0	0.0	0.0	0.0	
Bicarbonate	150.5	160		162.0		130.4	101.5	97.0	81.7	NA	82.0	
Total Hardness	97.0	96.0		115.5		116.1	93.5	92.0	20.4	NA	71	
Fluoride	0.05	0.12		0.10		NA	L 0.05	0.13	0.09	L 0.05	0.12	
Silica	5.80	5.5		7.50		5.9	3.00	3.3	3.2	L 0.02	L 0.5	
Conductance	371.0	330.0		400.0		553.0	180.0	193.0	204.0	168.0	146.0	
Threshold Odor Number	2	1		2		NA	2	NA	NA	2	1	
Color	NA	NA		60		80	30	97.0	40.0	20	97	
Tannin & Lignin	2.3	NA		0.9		NA	0.7	0.6	NA	0.4	0.5	
Total Filtble. Res.	244.0	NA		264.0		NA	118.0	200.0	NA	110	NA	
Total Filtble. Res. Fixed	165.0	NA		188.0		NA	81.0	NA	NA	81	NA	
Total Non-Filtble. Res.	8.0	NA		128.0		105.0	16.4	NA	3.0	1.2	1.0	
Total Non-Filtble. Res. Fixed	3.6	NA		105.0		NA	9.2	NA	NA	L 0.4	NA	
Turbidity	7.5	2		61.0		37.0	5.0	4.0	NA	2.3	2.0	
Surfactants	0.22	0.22		0.22		NA	0.12	0.15	NA	0.15	0.13	
Humic Acids	NA	NA		L 1.0		NA	L 1.0	NA	1.0	L 1.0	NA	
Fulvic Acid	NA	NA		17.0		NA	6	NA	13.0	4.0	NA	
Total Organic Carbon	27.0	40.0		26.5		17.0	16.0	17.0	13.0	17.0	15.0	
Total Inorganic Carbon	24.5	29.0		29.0		10.0	16.0	26.0	15.0	15.0	19.0	
Total Diss. Organic Carbon	25.5	NA		20.5		17.0	14.5	43.0	14.0	17.0	NA	
Nitrate Nitrogen	NA	NA		NA		NA	NA	NA	NA	0.013	0.002	
Nitrite Nitrogen	NA	0.016		NA		NA	NA	0.002	NA	0.003	NA	
Nitrate & Nitrite Nitrogen	0.040	0.062		0.140		0.13	0.061	0.065	0.08	0.016	0.014	
Ammonia Nitrogen	NA	L 0.05		0.100		0.003	0.004	L 0.05	L 0.1	0.044	0.67	
Total Kjeldahl Nitrogen	0.48	2.04		1.30		1.4	0.64	0.98	1.4	0.76	1.35	
Phenol	L 0.001	0.005		0.001		0.03	L 0.001	0.004	0.003	L 0.001	0.022	
Oil & Grease	1.0	2.6		0.9		105.0	L 0.1	0.2	L 1.0	0.5	0.3	
Sulphide	L 0.01	NA		NA		NA	L 0.01	1.00	NA	L 0.01	L 0.02	
Total Phosphorus	0.33	L 0.05		0.170		0.16	0.031	0.07	0.018	0.019	NA	
Ortho Phosphorus	0.011	0.016		0.064		0.029	0.008	0.013	0.010	0.004	L 0.002	
Cyanide	0.007	0.022		NA		NA	NA	NA	NA	0.002	L 0.002	
Chlorophyll "A"	NA	NA		NA		NA	NA	NA	NA	L 0.001	NA	
Chemical Oxygen Demand	60.0	73.0		55		NA	28	36.0	NA	27	42.0	
Cadmium	L 0.001	L 0.001		NA		NA	NA	L 0.001	NA	L 0.001	L 0.001	
Hexavalent Chromium	0.005	NA		0.006		NA	0.004	0.013	NA	0.005	NA	
Copper	L 0.001	L 0.001		0.002		0.003	L 0.001	0.002	0.002	L 0.001	0.003	
Iron	0.750	0.50		2.20		1.98	0.450	8.0	0.62	0.100	0.15	
Lead	0.007	L 0.003		L 0.002		L 0.004	L 0.002	L 0.003	L 0.004	L 0.002	0.004	
Manganese	0.074	0.080		0.079		0.11	0.012	0.013	0.017	0.052	NA	
Silver	L 0.001	L 0.001		L 0.001		L 0.004	NA	NA	NA	NA	NA	
Zinc	0.002	0.006		0.009		0.017	0.013	0.004	0.002	0.004	0.015	
Vanadium	L 0.001	L 0.002		L 0.001		L 0.001	L 0.001	L 0.002	L 0.001	L 0.001	L 0.002	
Selenium	L 0.0002	L 0.0002		L 0.2		0.0005	L 0.0002	L 0.00002	L 0.0005	0.0001	NA	
Mercury	0.0002	0.001		L 0.1		0.03	L 0.0001	L 0.0001	0.05	L 0.0001	L 0.001	
Arsenic	0.0009	0.0007		0.0015		L 0.0005	L 0.0002	0.0005	L 0.0005	L 0.0014	NA	
Nickel	0.003	L 0.001		L 0.001		0.002	0.001	0.005	0.004	L 0.001	0.003	
Aluminum	NA	NA		0.32		0.30	0.14	L 0.020	0.12	L 0.01	0.030	
Cobalt	L 0.001	L 0.001		NA		NA	NA	L 0.001	NA	L 0.001	L 0.001	
Boron	NA	NA		0.16		0.15	NA	NA	NA	NA	NA	
Titanium	NA	NA		NA		NA	NA	NA	NA	NA	NA	
Beryllium	NA	NA		NA		NA	NA	L 0.001	NA	NA	NA	
	Sept/78			Nov/78			Dec/78			Jan/79		

Continued...

Table 25. Concluded.

PARAMETERS	00AT07CD2300 [illegible] Feb/79 Chemex Lab	Pollution Control Lab	Inland Waters Lab	00AT07DA0090 [illegible] Mar/79 Chemex Lab	Pollution Control Lab	Inland Waters Lab	00AT07CE2000 [illegible] Apr/79 Chemex Lab	Pollution Control Lab	Inland Waters Lab	00AT07DA0090 [illegible] Jul/79 Chemex Lab	Pollution Control Lab	Inland Waters La
Calcium	20.0	18.0	19.6	85.0	1.16	85.5	21.5	20.0	22.7	24.2	25.0	25.4
Magnesium	6.50	6.0	6.5	21.7	23.0	21.7	5.40	5.0	5.8	0.20	L 1.0	L 0.1
Sodium	32.0	33.0		29.0	27.0	29.0	3.00	2.0	2.8	75.0	75.0	4.0
Potassium	1.10	0.9		1.50	1.5	1.7	1.60	1.4	1.7	11.80	11.7	0.9
Chloride	46.0	46.0		15.50	15.0	15.0	1.00	3.0	0.7	50.00	50.0	49.0
Sulphate	11.3	L 5.0		14.0	0.29	4.0	14.0	8.0	11.0	110.0	112.0	180.0
Total Alkalinity	72.1	68.0	65.0	296.3	334.0	336.0	63.0	66.0	63.0	1.6	12	NA
PH	7.9	7.2	7.5	8.10	7.8	7.5	7.70	7.5	7.5	6.15	6.3	6.2
Carbonate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NA	NA	0.0
Bicarbonate	88.0	83.0		NA	407.0	NA	77.0	80.0	NA	NA	15.0	NA
Total Hardness	77.0	71.0		NA	296.0	NA	76.0	73.0	NA	NA	NA	NA
Fluoride	0.08	0.10	0.09	0.23	0.29	0.20	0.08	0.14	0.10	1.07	1.0	L 0.05
Silica	13.20	12.2		15.70	15.5	15.0	7.70	7.5	7.7	0.15	L 0.5	4.9
Conductance	300.0	300.0		550.0	649.0	634.0	145.0	151.0	156.0	576.0	576.0	120.0
Threshold Odor Number	2	1		2	NA	NA	2	1.0	NA	NA	NA	NA
Color	15	98	30	30	98.0	40	13	95.0	120.0	NA	NA	NA
Tannin & Lignin	0.4	0.4		0.5	0.4	NA	2.6	1.4	NA	NA	NA	NA
Total Filtble. Res.	198	176.0		330.0	NA	411.0	95.0	230.0	140.0	NA	NA	NA
Total Filtble. Res. Fixed	129	170.0		207.0	NA	NA	68.0	NA	NA	NA	NA	NA
Total Non-Filtble. Res.	4.8	L 10.0		2.8	6.0	5.3	22.4	14.0	26.0	NA	NA	NA
Total Non-Filtble. Res. Fixed	0.4	NA		L 0.4	NA	NA	15.6	NA	NA	NA	NA	NA
Turbidity	5.4	3	1.5	13.0	12.0	4.0	10.0	0	6.0	NA	NA	NA
Surfactants	0.07	0.28		0.25	0.21	NA	0.21	0.19	NA	NA	NA	NA
Humic Acids	L 1.0	NA		L 1.0	NA	3.0	3.0	NA	1.0	NA	NA	NA
Fulvic Acid	L 1.0	NA		11.0	NA	14.0	29.0	NA	14.0	NA	NA	NA
Total Organic Carbon	6.5	6.0	6.0	14.5	56.0	15.0	16.5	15.0	14.0	NA	NA	NA
Total Inorganic Carbon	17.0	23.0	16.0	71.0	100.0	82.0	15.0	23.0	16.0	NA	NA	NA
Total Diss. Organic Carbon	6.0	NA	5.0	13.5	NA	14	15.5	NA	13.0	NA	NA	NA
Nitrate Nitrogen	0.190	0.10		0.406	NA	NA	0.221	NA	NA	NA	1.00	NA
Nitrite Nitrogen	0.010	0.06		0.014	NA	NA	0.009	0.007	NA	NA	NA	NA
Nitrate & Nitrite Nitrogen	0.200	0.16	0.17	0.420	0.248	0.19	0.230	0.210	0.19	NA	NA	NA
Ammonia Nitrogen	0.060	0.11	0.13	0.020	0.07	0.1	0.027	L 0.05	L 0.01	NA	NA	NA
Total Kjeldahl Nitrogen	0.44	2.06		0.50	1.09	0.1	1.14	1.50	0.7	NA	NA	NA
Phenol	L 0.001	0.004		NA	NA	NA	L 0.001	0.010	NA	NA	NA	NA
Oil & Grease	1.3	0.4	L 1.0	NA	NA	NA	2.3	3.1	L 1.0	NA	NA	NA
Sulphide	L 0.01	L 0.02		NA	NA	4.0	L 0.01	L 0.02	NA	NA	NA	NA
Total Phosphorus	NA	0.07	0.034	0.035	0.05	0.019	0.115	0.13	0.057	NA	NA	NA
Ortho Phosphorus	NA	0.012		0.012	0.02	L 0.003	0.090	0.069	0.049	NA	NA	NA
Cyanide	NA	NA		NA	NA	NA	0.003	L 0.002	NA	NA	NA	NA
Chlorophyll "A"	NA	NA		NA	NA	NA	L 0.001	NA	NA	NA	NA	NA
Chemical Oxygen Demand	9	25.0		34.0	65.0	NA	61.0	38.0	NA	NA	NA	NA
Cadmium	NA	NA		NA	NA	L 0.001	NA	NA	NA	NA	NA	NA
Hexavalent Chromium	L 0.003	L 0.002		L 0.003	NA	NA	L 0.003	L 0.002	NA	NA	NA	NA
Copper	0.002	NA	0.001	0.004	L 0.001	0.002	L 0.001	0.003	0.001	0.053	0.049	0.05
Iron	0.750	0.67	0.69	1.220	7.8	1.26	2.000	1.73	2.4	0.140	NA	0.12
Lead	L 0.002	L 0.003	L 0.004	L 0.002	L 0.003	L 0.004	L 0.002	L 0.003	L 0.004	0.050	0.056	0.02
Manganese	0.020	0.025	0.031	0.046	0.066	0.064	L 0.120	0.120	0.13	0.340	0.396	0.03
Silver	NA	L 0.001		NA	NA	NA	L 0.001	NA	NA	NA	NA	NA
Zinc	0.002	0.010	0.003	0.044	0.036	0.008	0.003	0.018	0.021	0.051	0.053	0.04
Vanadium	L 0.001	L 0.002		L 0.001	L 0.002	L 0.002	L 0.001	L 0.002	0.002	0.063	0.046	NA
Selenium	L 0.0002	L 0.002		L 0.0002	NA	L 0.0005	L 0.0002	L 0.0002	NA	L 0.0002	NA	L 0.00
Mercury	L 0.0001	0.002	0.10	L 0.0001	L 0.0001	L 0.02	L 0.0001	L 0.0001	0.32	NA	NA	NA
Arsenic	L 0.0004	L 0.0002		0.0003	0.0003	L 0.0002	0.0009	0.0010	NA	0.0012	NA	L 0.001
Nickel	L 0.001	0.001	0.002	L 0.001	0.003	0.005	L 0.001	0.004	0.006	0.097	0.096	0.09
Aluminum	0.05	0.060	0.031	0.03	0.065	0.022	0.11	NA	0.13	0.22	NA	0.26
Cobalt	NA	L 0.001		NA	NA	NA	L 0.001	L 0.001	NA	NA	NA	NA
Boron	NA	NA		0.13	NA	NA	0.09	NA	0.10	0.09	NA	0.61
Titanium	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA		NA	NA	NA	L 0.001	NA	NA	NA	NA	NA

6. LIST OF AOSERP RESEARCH REPORTS

1.		AOSERP First Annual Report, 1975
2.	AF 4.1.1	Walleye and Goldeye Fisheries Investigations in the Peace-Athabasca Delta--1975
3.	HE 1.1.1	Structure of a Traditional Baseline Data System
4.	VE 2.2	A Preliminary Vegetation Survey of the Alberta Oil Sands Environmental Research Program Study Area
5.	HY 3.1	The Evaluation of Wastewaters from an Oil Sand Extraction Plant
6.		Housing for the North--The Stackwall System
7.	AF 3.1.1	A Synopsis of the Physical and Biological Limnology and Fisheries Programs within the Alberta Oil Sands Area
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