# GEOCHEMICAL ASSESSMENT OF SUBAQUEOUS TAILINGS DISPOSAL IN BUTTLE LAKE, BRITISH COLUMBIA

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## MEND REPORTS TO DATE:

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| 1.17.1c | Hydrogeochemical Investigation of Reactive Tailings at the Waite Amulet Tailings Site, Noranda, Quebec, Phase 3 - 1987 Program, Volume I - Report, May 1988. |
| | Hydrogeochemical Investigation of Reactive Tailings at the Waite Amulet Tailings Site, Noranda, Quebec, Phase 3 - 1987 Program, Volume II - Appendices, March 1988. |
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| 1.21.1a | Critical Review of the Reactive Acid Tailings Assessment Program (RATAP.BMT2), April 1990. |
| 1.21.1b | Workshop on Modelling of Reactive Tailings sponsored by the MEND Prediction Committee, Final Report, August 1990. |
| 2.11.1a | Subaqueous Disposal of Reactive Mine Wastes: An overview, June 1989. |
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| | A Preliminary Assessment of Subaqueous Tailings Disposal in Anderson Lake, Manitoba, March 1990. |
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| 5.5.1 | Reactive Acid Tailings Sulphide Stabilization (RATS) Research Plan, July 1988. |

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# Geochemical Assessment of Subaqueous Tailings Disposal in Buttle Lake, British Columbia

## A British Columbia Acid Mine Drainage Task Force Project in Contribution to MEND (Mine Environment Neutral Drainage)

**Prepared for and Funded by:**

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Frontispiece: Photograph of core BUT 2 collected from the south basin of Buttle Lake using from the south basin of Buttle Lake using the light weight gravity corer described by Pedersen et al (1985). Note the undisturbed interface, clear supernatant water, and natural sediments (brown) overlying grayish tailings.

# EXECUTIVE SUMMARY

Limited evidence suggests that the chemical reactivity of tailings is in fact inhibited by storage underwater, and that such storage may be a preferred long–term disposal option. To assess the long–term environmental feasibility of subaqueous disposal of mine tailings, this report examines the waters and sediments of the south basin of Buttle Lake, British Columbia (the site of an inactive submerged tailing deposit). The Cu, Zn and Pb–rich mine tailings were deposited in the lake via a submerged outfall from 1966 to 1984. The tailings are presently areally widespread across the basin and are being covered by a thin veneer of natural sediments. This report presents a detailed study of the distributions of metals in both the solid phases and interstitial waters of the sediments, and in the overlying surface waters.

High resolution profiles of dissolved Zn, Cu, Pb, Cd, Fe and Mn distributions in interstitial waters are presented for four cores collected from the south basin of Buttle Lake in the autumn of 1989. Three of the cores penetrated through the tailings layer into natural (pre–mine) sediments; the fourth, collected near the former tailings discharge point, consisted entirely of relatively coarse–grained pyrite–rich tailings. The dissolved metal distributions are interpreted in concert with mineralogic data and high resolution measurements of major and minor element distributions, including C, N and S, in the associated solid phases.

Water quality sampling was also carried out at the four coring stations. The sampling included physical profiling and discrete water sampling at three depths (surface, mid and bottom) for general parameters and metals analyses. Present water quality sampling and review of past data indicate considerably decreased metal concentrations since metal loadings from Myra Creek were reduced by the implementation of a collection and treatment system in 1983. However, metal concentrations of zinc, copper and cadmium, while decreased, occasionally exceeded provincial objectives proposed for the lake, particularly at depth. Metal concentrations vary seasonally and the highest levels are found during the winter months; concentrations are also higher at depth but apparently not as a result of metal releases from the sediment.

At all coring sites, a 1–2 cm thick veneer of natural, organic–rich sediments has accumulated on top of the tailings. The distribution of dissolved and solid–phase Fe and Mn indicates that the sediments are anoxic at all sites within a few cm of the sediment–water interface.

Fe and Mn oxides are enriched in the surface sediments at all locations, but these distributions are not in steady–state equilibrium with the respective pore water profiles. However, both elements are currently being progressively enriched in surface sediments by the diagenetic recycling of Fe and Mn in the upper few cm in all cores.

Dissolved Zn, Cu, Cd and Pb concentrations in pore waters from the former tailings–discharge area are very low in the upper two decimetres. The tailings at this location accumulated very rapidly, and the pore water results and benthic influx calculations indicate that there is currently no flux of Zn, Cu, Cd or Pb to the overlying water column at this site. In pore waters from the other locations, all of which are characterized by a layer of tailings up to three decimetres thick sitting atop methane–bearing anoxic natural sediments, dissolved Cu, Pb and Cd occur in relatively low concentration in the upper few centimetres. Zn concentrations in the pore waters at shallow depths are slightly higher than in bottom water of the lake at all three sites, suggesting that there is an upward flux of the metal to the overlying water. However,

the precipitation of Fe oxyhydroxides in the upper 30 to 50 mm at these locations appears to reduce the efflux of dissolved metals. Dissolved Zn, Cu, Pb and Cd are enriched together in specific, thin subsurface zones in all cores, indicating limited zones of release at depth. Such zones correlate with the presence of high dissolved organic carbon contents.

Benthic flux calculations indicate that effluxes of Zn, Cu, Cd and Pb from the sediments are very low, and are comparable in magnitude to fluxes associated with natural geochemical processes in lake and coastal marine sediments. A conservative (worst case) estimation suggests that less than 0.2 parts per trillion of Zn are being added to south basin deep water as a result of chemical reactivity of the metal–rich deposits on the lake floor. This amount is negligible, and it is reasonable to conclude that the submerged tailings are having no impact on Buttle Lake water quality at the present time. As burial by natural sediments continues, this conclusion will be reinforced.

# SOMMAIRE

Selon certaines données limitées, la réactivité chimique des résidus serait en fait inhibée lorsque ces résidus sont stockés sous l'eau; de plus, ce mode de stockage pourrait constituer une méthode préférée pour l'élimination à long terme. En vue d'évaluer la rentabilité environnementale à long terme de l'élimination subaquatique des résidus miniers, on examine, dans le présent rapport, les eaux et les sédiments du bassin sud du lac Buttle, en Colombie-Britannique (où se trouve un dépôt inactif de résidus submergés). Des résidus riches en Cu, en Zn et en Pb ont été déposés dans le lac à partir d'un point de rejet submergé, entre 1966 et 1984. Actuellement, un plaquage de sédiments naturels se dépose sur ces résidus qui sont répartis sur une grande surface dans le bassin. Dans ce rapport, on présente une étude détaillée de la distribution des métaux dans la phase solide et dans les eaux interstitielles des sédiments, ainsi que dans l'eau qui les recouvre.

Nous présentons des profils très précis de la distribution du Zn, du Cu, du Pb, du Cd, du Fe et du Mn dans les eaux interstitielles de quatre carottes prélevées dans le bassin sud du lac Buttle, à l'automne 1989. Dans le cas de trois carottes, la carotteuse avait traversé la couche de résidus et avait pénétré dans les sédiments naturels (déposés avant le début de l'exploitation minière); toute la quatrième carotte, prélevée à proximité de l'ancien point de rejet, était constituée de résidus relativement grossiers riches en pyrite. La distribution des métaux dissous est interprétée en tenant compte des données minéralogiques et des mesures très précises de la distribution des éléments principaux et secondaires, dont le C, le N et le S, dans les phases solides associées.

Nous avons également déterminé la qualité de l'eau aux quatre points de carottage. Ces mesures comprenaient, entre autres, la détermination de profils physiques et le prélèvement d'échantillons d'eau à trois profondeurs (à la surface, mi-chemin entre la surface et le fond, et au fond), en vue de déterminer les caractéristiques générales et de doser les métaux. Les résultats de ces échantillonnages et l'examen de données antérieures révèlent que la concentration des métaux a diminué considérablement depuis que les apports en espèces métalliques par le ruisseau Myra ont été réduits après la mise en place, en 1983, d'un système de récupération et de traitement. Toutefois, les concentrations de zinc, de cuivre et de cadmium, bien que réduites, dépassaient à l'occasion les objectifs provinciaux proposés pour le lac, particulièrement en profondeur. Les concentrations de métaux variaient avec les saisons, et les valeurs étaient maximales au cours des mois d'hiver; les concentrations étaient aussi plus élevées en profondeur, mais non en raison, semble-t-il, du dégagement d'espèces métalliques contenues dans les sédiments.

À tous les points de carottage, une couche de sédiments naturels riches en matière organique, de 1–2 cm d'épaisseur, s'était accumulée sur la surface des résidus. La distribution du Fe et du Mn dans la phase dissoute et dans la phase solide indique que les sédiments sont anoxiques à tous les points de carottage, à quelques centimètres de l'interface sédiments/eau.

À tous les points, les sédiments superficiels sont enrichis en Fe et en Mn, mais ces distributions ne sont pas équilibre avec les profils d'eau interstitielle correspondants. Toutefois, les sédiments superficiels sont en train d'être enrichis progressivement en Fe et en Mn par le recyclage diagénétique de ces deux éléments dans les premiers centimètres de toutes les carottes.

La concentration de Zn, de Cu, de Cd et de Pb dans les eaux interstitielles de l'ancienne zone de rejet est très faible dans les deux premiers décimètres. Les résidus à cet endroit s'accumulaient très rapidement, et les résultats relatifs aux eaux interstitielles ainsi que les valeurs calculées de l'apport benthique indiquent que le déplacement de Zn, de Cu, de Cd ou de Pb vers la colonne d'eau est nul à cet endroit. Dans les eaux interstitielles des autres endroits, qui sont tous caractérisés par une couche de résidus atteignant parfois trois décimètres d'épaisseur et reposant sur des sédiments naturels anoxiques contenant du méthane, la concentration de Cu, de Pb et de Cd est relativement faible dans les premiers centimètres. Aux trois endroits, la concentration de Zn dans les eaux interstitielles à de faibles profondeurs est légèrement plus élevée que dans les eaux de fond, ce qui laisse supposer qu'il y a déplacement ascendant des métaux vers les couches d'eau plus près de la surface. Toutefois, la précipitation des oxyhydroxydes de Fe dans les premiers 30 – 50 mm à ces endroits semble diminuer l'apport d'espèces métalliques dissoutes. Dans toutes les carottes, de minces zones spécifiques situées sous la surface sont enrichies en Zn, en Cu, en Pb et en Cd dissous, ce qui indique que les zones de dégagement d'espèces métalliques en profondeur sont limitées. Ces zones correspondent à la présence de poches de concentrations élevées en carbone organique dissous.

Les calculs de l'apport benthique révèlent que les quantités de Zn, de Cu, de Cd et de Pb dégagées par les sédiments sont très faibles et sont comparables à celles associées aux processus géochimiques naturels dans les sédiments des lacs et des zones littorales. Selon une estimation prudente (pire cas), l'accroissement de la concentration de Zn dans les eaux profondes du bassin sud, provoqué par la réactivité chimique des dépôts riches en métaux sur le fond lacustre, serait inférieur à 0,2 partie par trillion. Ce chiffre est négligeable, et il est raisonnable de conclure que les résidus submergés n'ont actuellement aucun effet sur la qualité de l'eau du lac Buttle. La précipitation de sédiments naturels sur ces résidus au fil des ans viendra renforcer cette conclusion.

# ACKNOWLEDGEMENTS

A number of people have made substantive contributions to this project. Clem Pelletier of Rescan Environmental Services Ltd. (Rescan) provided overall project coordination and senior review of the report. Dr. Tom Pedersen of the University of British Columbia (UBC) was responsible for detailed sediment work including sampling, analysis and reporting of this work. Bill Duncan (Rescan) was responsible for water quality sampling, data compilation and reporting of this work.

Rescan personnel involved in various aspects of the project, included Paul Davidson who assisted with water quality sampling, Monica Macierwicz who meticulously entered and validated the water quality and climate data into the database, and Janice Kukurudz who patiently wordprocessed this document. Review and editorial comments were provided by Gary Birch and David Flather. Water quality analyses were performed by Analytical Services Laboratory Ltd.

UBC personnel included Jay McNee and Patrick O'Hara who were instrumental in helping collect quality cores, and both carefully assisted with extraction and filtration of the interstitial water samples in the laboratory at the Westmin minesite. Bert Mueller performed the dissolved metals analyses with great care in the laboratory at UBC, and Maureen Soon, Shirley French, and Mark Noyon provided assistance and analytical expertise in making XRF, carbon, nitrogen, and sulphur measurements, also at UBC. Lowell Wade expeditiously provided X-ray diffraction data.

At Westmin Resources Ltd., we thank Rudy van Dyk (Environmental Engineer) and Joe Isaac (Chief Chemist) for making laboratory space available to us at the minesite, the use of their sampling boat for water quality sampling, access to their library, and for their hospitality. At B.C. Ministry of Environment, we thank Lloyd Erickson (Waste Management Branch) quickly provided up-to-date water quality data, reports and SEAM data for Buttle Lake and Malcolm Clark (Environmental Protection Unit) for loaning personal copies of various reports.

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# 1 - Introduction

# 1.0 INTRODUCTION

Disposal of sulphide-bearing mine tailings to marine and lacustrine waters has been practiced for millennia, often without consideration of the potential long-term reactivity of such metal-rich phases. Limited evidence is now available which suggests that chemical reactivity of submerged tailings is in fact inhibited by storage underwater, as summarized in the recent report to the Acid Mine Drainage Task Force (Rescan, 1989). However, very few assessments have been carried out in which the post-depositional (diagenetic) chemical character and behaviour of inactive submerged tailings deposits have been studied in detail. Extant information describes the chemical behaviour of tailings on the sea floor or lake bottoms during periods of active deposition (e.g. Pedersen, 1983a, 1984, 1985, and Pedersen and Losher, 1988); no detailed descriptions of the longer-term reactivity of inactive or abandoned submerged deposits have been published.

This rather sparse database constrains environmental impact planning and limits both regulatory and disposal options. Thus, there is a well-defined need for quality information on the long-term diagenetic reactivity of submerged mine wastes, both in marine and lacustrine waters. In this report, we present the results of the first detailed study of the distributions of metals in both the solid phases and interstitial waters of the abandoned tailings deposit in Buttle Lake, British Columbia, which is now being covered by a veneer of natural sediments.

## 1.1 Background to Study

In 1966, Westmin Resources commenced operation of a Zn-Cu-Pb-Au massive sulphide mine in Strathcona Park, Vancouver Island, B.C. The mine is located adjacent to Myra Creek and 6 km west of the south basin of Buttle Lake (Figure 1-1). The south basin is about 7 km long, and reaches a maximum depth of 87 m, roughly 4 km north of the former tailings discharge point (Figure 1-1). Some 5.5 x $10^6$ tons of tailings were discharged to this basin via a submerged outfall between 1966 and July, 1984, when the disposal strategy switched to tailing ponds on land. A relatively shallow sill about 5 km north of the outfall effectively confined physical dispersion to the south basin.

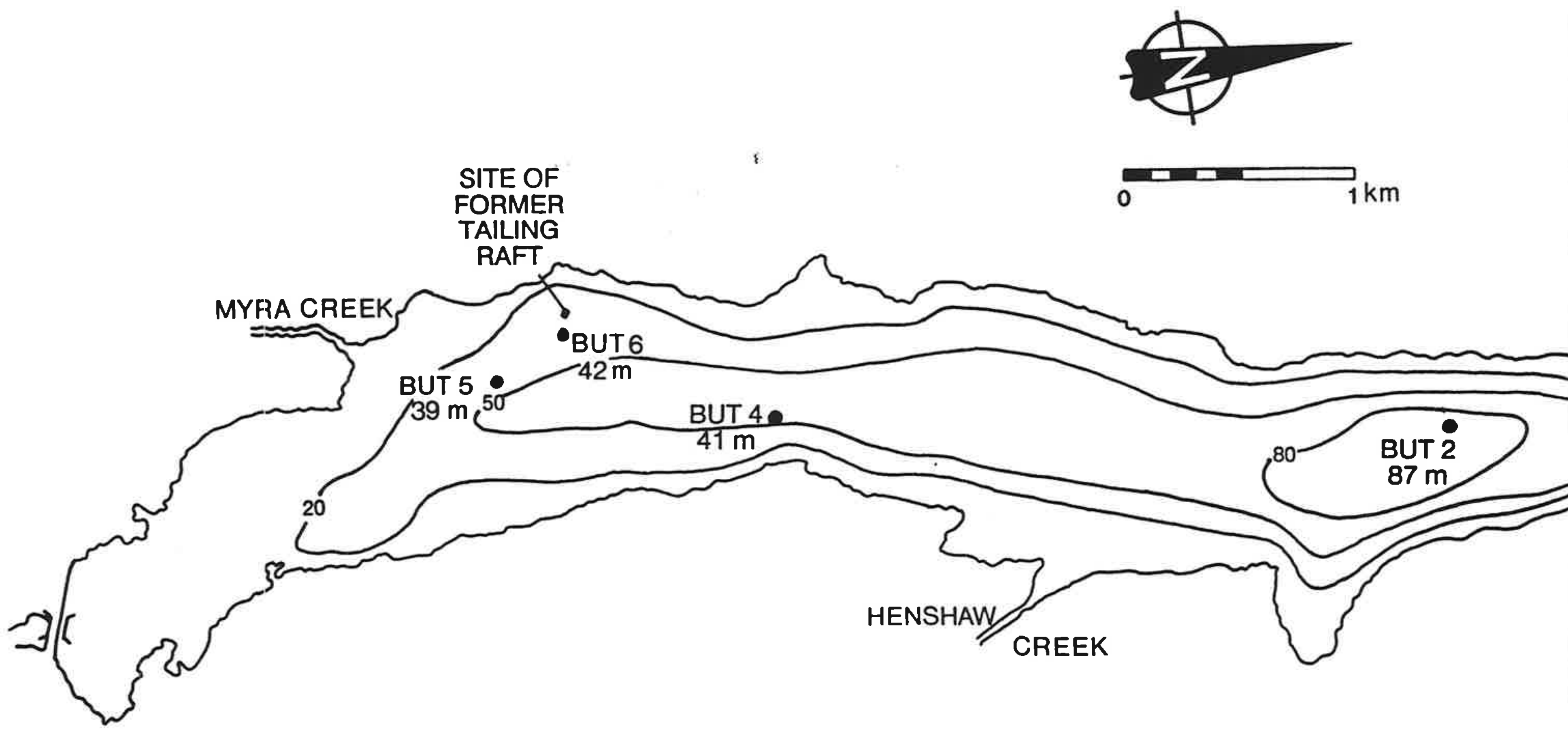


Figure 1-1 Core locations, south basin of Buttle Lake, Autumn, 1989. Isobaths (in metres) from Bohn (1982).

Westmin's current and past operations in the Myra Creek valley (summarized by Rescan, 1989) include the H-W, Lynx, Myra and Price mines from which Cu, Pb, Zn, Au, Ag, and Cd have been recovered. Open pit and underground mining of the Lynx deposit began in 1966 with a mill capacity of 750 tpd. Mill capacity has been increased several times; current output is about 4400 tpd. The mill process uses conventional crushing and grinding followed by differential flotation to produce separate copper, lead and zinc concentrates.

After concentrator startup in late 1966, tailings were discharged to a small nearby pond. Direct discharge to the lake commenced shortly thereafter. The sand-sized material from the tailings underflow was removed by cycloning and used as backfill in the underground mine, while the cyclone slime overflow was conducted from the minesite down a pipeline through seven drop boxes to a raft about 100 m offshore. The tails were discharged below the thermocline via a submerged outfall. Flocculants were used to assist settling of the solids.

The tailings were originally derived from the zinc circuit after milling of the high grade Cu-Pb-Zn ore and consisted of sand-sized and silt-sized silicate gangue minerals and residual copper, iron, lead and zinc sulphides. Base metal concentrations in the tailings solids ranged widely but averaged 7000, 1300 and 900 mg/kg for Zn, Cu and Pb, respectively. Lime (CaO) was the only reagent used in significant quantity; approximately 1.0 kg per tonne of ore was added to the tailings to raise the pH in the milling circuits and to enhance coagulation in the thickening tanks (Eccles, 1977). During the initial six years of operation, with ore from the Lynx Mine, dissolution of heavy metals in the milling circuit was minimal due to the high pH and extremely low solubility of metal sulphides. In June of 1970, the mill began limited production of lead ore (galena) and in early 1973 this was increased when high-lead ore came on-line. Because production of a copper concentrate with a low lead content was required, cyanide was used in the continuous copper-lead separation circuit. This resulted in substantially increased levels of cyanide and dissolved Cu in the effluent (at high pH, Cu complexes with $CN^-$). Consequently Westmin introduced alkaline chlorination to destroy residual cyanide and to precipitate dissolved Cu in the tailings. Metal concentrations in the effluent stream fell substantially after this introduction (see Table 5-8 in Rescan, 1989).

Dissolved zinc, copper, lead and cadmium concentrations in Buttle Lake water began to increase shortly after the mine commenced operation and peaked in 1981, reaching levels in south basin surface waters as high as 5.7 $\mu$mol $L^{-1}$ (370 $\mu$g $L^{-1}$) Zn, 0.6 $\mu$mol $L^{-1}$ (40 $\mu$g $L^{-1}$) Cu, 0.12 $\mu$mol $L^{-1}$ (25 $\mu$g $L^{-1}$) Pb, and 32 $\mu$mol $L^{-1}$ (3.6 $\mu$g $L^{-1}$) Cd (Deniseger et al., 1988). The high metal loadings were derived from acid mine drainage which percolated from a waste rock area into Myra Creek and thence to the lake. A report prepared for the mine in 1982 (Pedersen, 1982) and published a year later (Pedersen, 1983a) indicated that the tailings on the lake floor were not releasing dissolved metals into the overlying water column during the period when the lake water was badly contaminated. In 1983, a surface and groundwater collection and treatment system was installed to capture the bulk of the acid drainage. Metal levels subsequently declined significantly, although they have not yet reached historical background levels (L. Erickson, Waste Management Branch, Nanaimo, B.C., pers. comm.). Deniseger et al. (1988) note for example that Zn concentrations at depth frequently exceed the objective of 0.8 $\mu$mol $L^{-1}$ (50 $\mu$g $L^{-1}$). The high levels are attributed to continuing addition to the lake of metal-rich water derived from the mine site and delivered via Myra Creek. The most recent data (L. Ericksen, pers. comm.) show that for the last seven months of 1989 at the deepest station sampled (60 m depth off Henshaw Creek, Figure 1-1), the concentration of Zn ranged from 0.6 to 0.9 $\mu$mol $L^{-1}$ (40-60 $\mu$g $g^{-1}$), Cu from 0.02 to 0.08 $\mu$mol $L^{-1}$ (1-5 $\mu$g $g^{-1}$), and Pb from 0.005 to 0.01 $\mu$mol $L^{-1}$ (<1-2 $\mu$g $g^{-1}$); Cd concentrations were always <4 nmol $L^{-1}$ (<0.5 $\mu$g $g^{-1}$).

A second potential metal source remains the tailings. Pedersen (1982) suggested that oxidative diagenesis of the tailings might be expected to occur for a period immediately after the cessation of discharge, prior to the deposits being covered with a veneer of organic-rich natural sediments. Such a stratum would eventually be expected to foster anoxia at some (presumably shallow) depth, thus inhibiting potential further release of metals. Pedersen (1983b) used measured $^{210}$Pb and Mn distributions in a suite of cores collected from the south basin in July 1983 to estimate that 7 to 15 years would elapse before the tailings were covered by a layer of natural sediments thick enough to prevent oxidation. This estimate was reevaluated in this report.

# 2 - Study Area and Methods

# 2.0 STUDY AREA AND METHODS

## 2.1 Study Area

Buttle Lake is a large (35 km long x 1 km wide x 45 m deep) water body which occupies a U-shaped valley in an area of high relief on central Vancouver Island (Figure 1-1). Like many lakes on Vancouver Island, Buttle Lake is oligotrophic; nutrient levels are relatively low (Deniseger et al., 1988). The lake drains northeastward into Georgia Strait via Campbell lakes and the Campbell River, a major spawning watercourse for salmon.

## 2.2 Sampling Stations

Four primary sampling stations (BUT 2, 4, 5 and 6) were located throughout the south basin of Buttle Lake (Figure 1-1), but were concentrated near the site of former tailings discharge point. Water quality sampling, CTD profiling and lake sediment coring for pore water and solids analyses were conducted at each sampling station.

## 2.3 Study Methods

### 2.3.1 Water Quality, Hydrology and Climate Data Assimilations

Buttle Lake and Myra Creek have been extensively studied and numerous reports have been found in the literature and libraries of Westmin Resources Ltd., B.C. Research Ltd. and B.C. Ministry of Environment, Waste Management Branch, Nanaimo, B.C. The Waste Management Branch (WMB) has sampled numerous water quality sites in the Buttle-Campbell-John Hart Lake system. Monitoring first began in 1966, with regular monthly monitoring beginning in 1980, subsequently reduced to bimonthly monitoring in 1988. Due to the large size of the data set, only selected sites and only a limited parameter set were included in the dBASE computer storage and retrieval system. The two sites included are WMB stations 0130082 (Buttle Lake off Henshaw Creek) and 0130080 (Buttle Lake at Gold River Bridge). The parameter set included pH, temperature, specific conductivity, dissolved oxygen, extinction depth, total metals (Ca, Cd, Cu, Fe, Mg, Mn, Pb and Zn) and dissolved metals (Cd, Cu, Fe, Mn, Pb and Zn).

Available hydrological data from reports produced for Westmin Resources Ltd. have been obtained and supplemented by data available from B.C. Hydro. Climatological data were obtained from Westmin Resources Ltd. for the Myra Creek Station and from Environment Canada, Atmospheric Environment Services and entered into a dBASE file. Data included monthly precipitation and temperature values.

### 2.3.2 Water Quality

Lake water samples were collected at the four primary stations (Figure 1-1) using a Teflon-lined 5 L Go-Flow water sampler. Samples were taken at three depths where possible (0.5 m below the surface, mid-depth and at the bottom). The 1 L polyethylene sample bottles and caps were rinsed with sample water prior to filling. Bottles were carefully filled to the top using a Teflon tube attached to the water sampler to minimize air contact. No preservatives were added to the 1 L bottles which were maintained at 4°C during shipping and handling. The 250 ml acid-washed polyethylene bottles were filled in the same manner, field filtered and 2 ml nitric acid added for dissolved metal analysis.

Water samples were analyzed by Analytical Services Laboratories Ltd. (ASL) of Vancouver, B.C. Samples were analyzed for physical parameters including pH, specific conductivity, turbidity (NTU), total dissolved solids and total suspended solids (volatile and fixed), as well as anions and nutrients including alkalinity, sulphate, chloride, reactive silica, total phosphorus, nitrate/nitrite, ammonia, total dissolved nitrogen and total organic carbon using standard methods (APHA, 1985).

Dissolved metals were analyzed by various atomic absorption and emission spectroscopy methods as follows:

- Inductively coupled argon plasma (ICP) emission spectroscopy for higher concentration elements
- Graphite furnace atomic absorption spectroscopy for low concentration element
- Hydride generation atomic absorption spectroscopy for arsenic
- Cold vapour atomic absorption spectroscopy for mercury

In addition to water quality sampling, measurements were also made in the water column at the four stations where coring for pore water chemistry was performed. An Applied Microsystems CTD 12 profiler was used to measure conductivity, temperature, dissolved oxygen, pH, depth and transmissibility. The CTD 12 profiler was calibrated then lowered at each of the four stations at a speed of 0.5 - 1 m $s^{-1}$. The instrument sampling interval was programmed to read every 10 cm through the water column. Data were stored in the instrument and was downloaded at the surface to a microcomputer.

### 2.3.3 Core Collection and Processing

Four cores were collected from the south basin of Buttle Lake during the period of September 29 - October 1, 1989 using the lightweight gravity corer described by Pedersen et al. (1985), and either hydraulic or gas-powered winches mounted on an aluminum workboat. The corer uses an open catcher-free cleaned butyrate barrel, and is designed to minimize disturbance of the sediment-water interface during core collection. A very slow entry speed (about 10 cm $s^{-1}$) was used at all sites. An excellent interface (Frontispiece) was recovered at two of the four sites (BUT 2 and 4; Figure 1-1), where the corer penetrated through tailings into the underlying (pre-mine) natural sediments. Slight doming of the upper cm was observed at BUT 5; an estimated 5 mm of flocculent material was lost from the edges of the core at this location. The relatively coarse tailings at BUT 6 were essentially cohesionless and repeatedly washed out of the core barrel during several coring attempts. Hence, at this site alone, a soft plastic sphincter-type core catcher was fashioned on the spot and taped to the base of the open barrel. This permitted recovery of Core BUT 6, but at the cost of minor disturbance of the core top. As the data will attest, such disturbance had no significant effect on the quality of the analytical results obtained from this site. Cores were sealed with a full column of supernatant water immediately after removal from the corer, logged, and transported hand-held back to the mine site to minimize disturbance. Detailed core logs are listed in Appendix A.

Interstitial water samples were extracted from the cores in an environmental chemistry laboratory at the mine. To avoid oxidation artifacts during sampling (e.g. Bray et al., 1973), each core was extruded directly into a nitrogen-filled glove bag by gradually jacking up an o-ring sealed piston inside the barrel. The supernatant water on the top of the core was carefully removed by siphoning prior to extrusion, with the exception of the lower 10 cm of water which was removed with a syringe once the core was secured in the nitrogen atmosphere. A sample of this core-top water was collected for each core and was subsequently analyzed as "supernatant" water. In each case, processing commenced within two hours of collection of the core. Samples were sequentially sliced from the core, placed into 250 ml $N_2$-filled centrifuge bottles, sealed, removed from the glove bag, and centrifuged for 20 minutes at approximately 1200 RFC (Relative Centrifugal Force). The bottles were then placed in another $N_2$-filled glove bag, the supernatant water in each was decanted into a polypropylene syringe barrel, and the water was expressed through Nuclepore™ 0.45 $\mu$m polycarbonate membrane filters into 30 ml sample bottles. Five to 20 ml were typically recovered, the smallest volumes corresponding to the thin sample intervals used near the top of each core. Ultrapure Seastar™ concentrated $HNO_3$ was added immediately to the samples in proportion to their volume to bring the pH to 2. All plasticware and filters were rigorously acid-washed in a Class 100 laminar flow bench as follows. Virgin plasticware (except pipette tips) was:

1. wiped outside and rinsed inside with reagent grade chloroform to remove grease and soluble organic residues;
2. soaked at least 1 day in hot (40°C) 20% reagent-grade $HNO_3$;
3. rinsed twice with DDW (distilled, deionized water);
4. soaked at least 1 day in 0.1% Seastar ultrapure $HNO_3$;
5. rinsed once in DDW;
6. soaked at least 1 day in 0.1% Seastar $HNO_3$;
7. rinsed once in DDW; and
8. dried covered in a drying oven.

In order to obtain high resolution profiles to define diagenetic reactivity in the upper few centimeters of the sediments, 5 mm sample intervals were used in cores BUT 2, 4 and 6 for the top two cm, one cm increments were used for the next several cm, and 2 cm-thick slices were selected at intervals below the upper decimetre. One cm thick increments were selected for the upper portion of the core BUT 5 because the top was downbowed slightly during the coring and it was felt that 5 mm-thick samples would not yield enough water for subsequent analysis. Approximately 16 samples were collected from each core.

All samples were returned to UBC for analysis. The sediment samples were frozen and freeze-dried. An aliquot of each was ground in a tungsten carbide disk mill prior to preparation for X-ray fluorescence, CNS, and mineralogical analysis (XRD). Detailed analytical methods and quality control procedures are described in Appendix B.

# 3 - Results

## 3.0 RESULTS

### 3.1 Water Quality

Water column profiles of temperature, conductivity and percent transmission at the four stations in the south basin of Buttle Lake indicated the same general pattern at each station (Figures 3-1, 3-2, 3-3 and 3-4). Conductivity was low and varied little with depth. Percent transmission, while generally greater than 80%, was slightly lower in the surface 10 m and decreased again within 0.5 m of the bottom at stations BUT 5 and BUT 6. Temperature profiles indicated surface warming was occurring with surface temperatures near 7.5 °C decreasing uniformly to less than 5.0 °C at 40 m depth and to a minimum of 4.2 °C at 85 m depth. A strong thermocline had not yet developed in the south basin in late April, 1990.

Results of water quality testing at the four stations indicated generally similar water quality at each of the stations and to some extent depths sampled (Appendix C). The lake is soft with a calculated hardness (Ca, Mg) ranging from approximately from 30 to 40 mg $L^{-1}$ as $CaCO_3$. Calcium and magnesium concentrations range from 11.4 to 14.5 mg $L^{-1}$ and 0.68 to 1.10 mg $L^{-1}$, respectively. The lake is nearly neutral in pH (approx. 7.1), with alkalinity of approximately 23 mg $L^{-1}$ as $CaCO_3$. Sulphate concentrations were low ranging from 8.7 to 16.7 mg $L^{-1}$ with the lowest concentrations found at the surface. Chloride concentrations were generally less than 0.5 mg $L^{-1}$.

Conductivity varied slightly from 70.5 to 95.6 $\mu$mhos $cm^{-1}$ and generally increased with depth at each site; dissolved solids showed a similar pattern ranging from 50 to 80 mg $L^{-1}$ . Suspended, fixed and volatile solids concentrations were low ($<5$ mg $L^{-1}$ ) as was turbidity (generally $<0.5$ NTU). Concentrations of nutrients were low and varied little between stations. Total phosphorus concentrations ranged from 0.001 to 0.004 mg $L^{-1}$, while nitrate-nitrite nitrogen concentrations ranged from 0.064 to 0.13 mg $L^{-1}$ with the lowest values found at the surface. Total organic carbon concentrations were low ranging from 0.80 to 1.05 mg $L^{-1}$ and reactive silicate ranged from 3.6 to 4.7 mg $L^{-1}$. Neither of these parameters showed any consistent variation with depth.

Dissolved metal concentrations of aluminum, arsenic, copper, manganese and zinc were consistently above detection limits. Most metal levels were highest near the bottom at

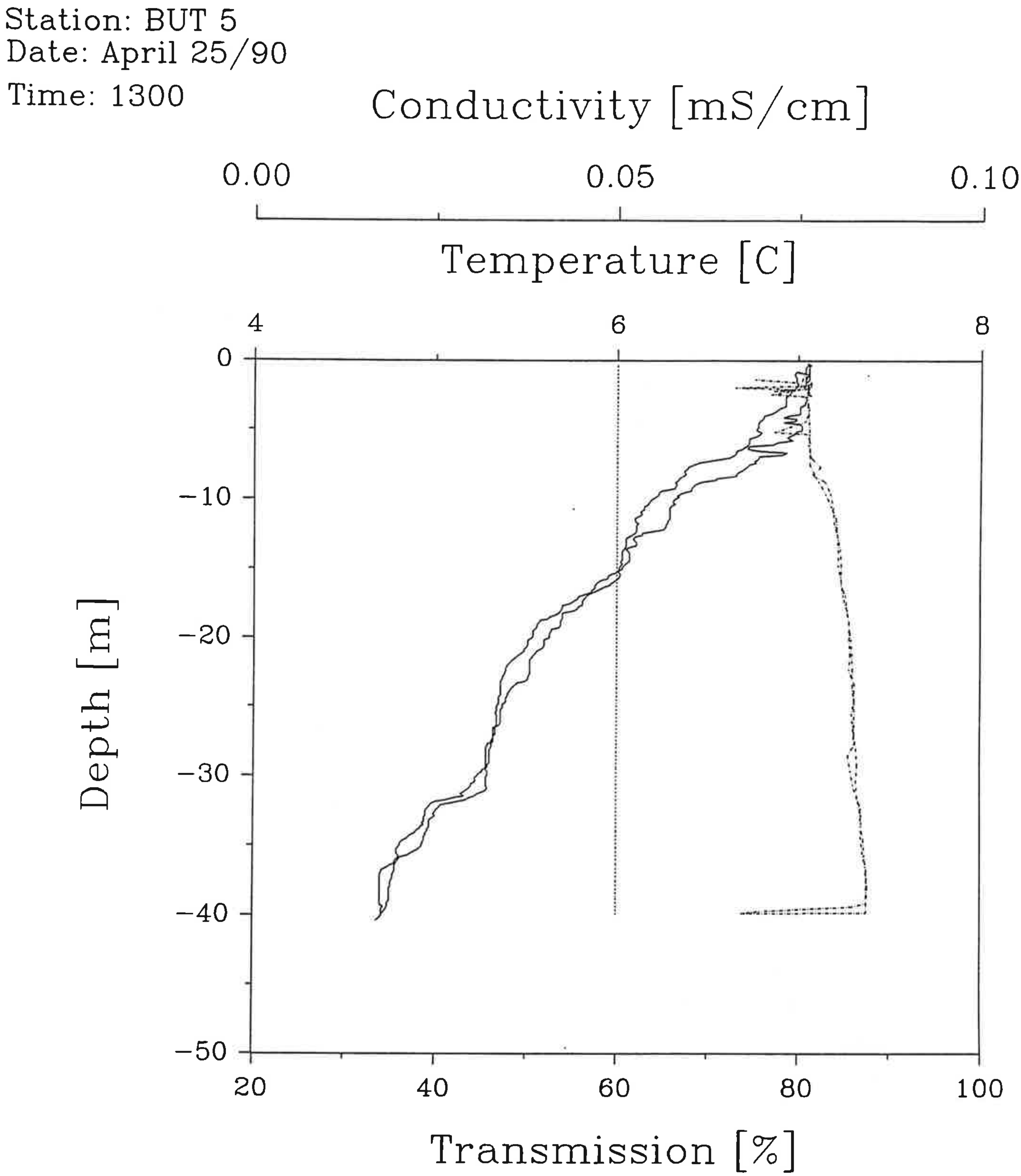


**Figure 3-1** Conductivity (---), temperature (——) and percent transmission (•-•-•) profiles for Station BUT 5.

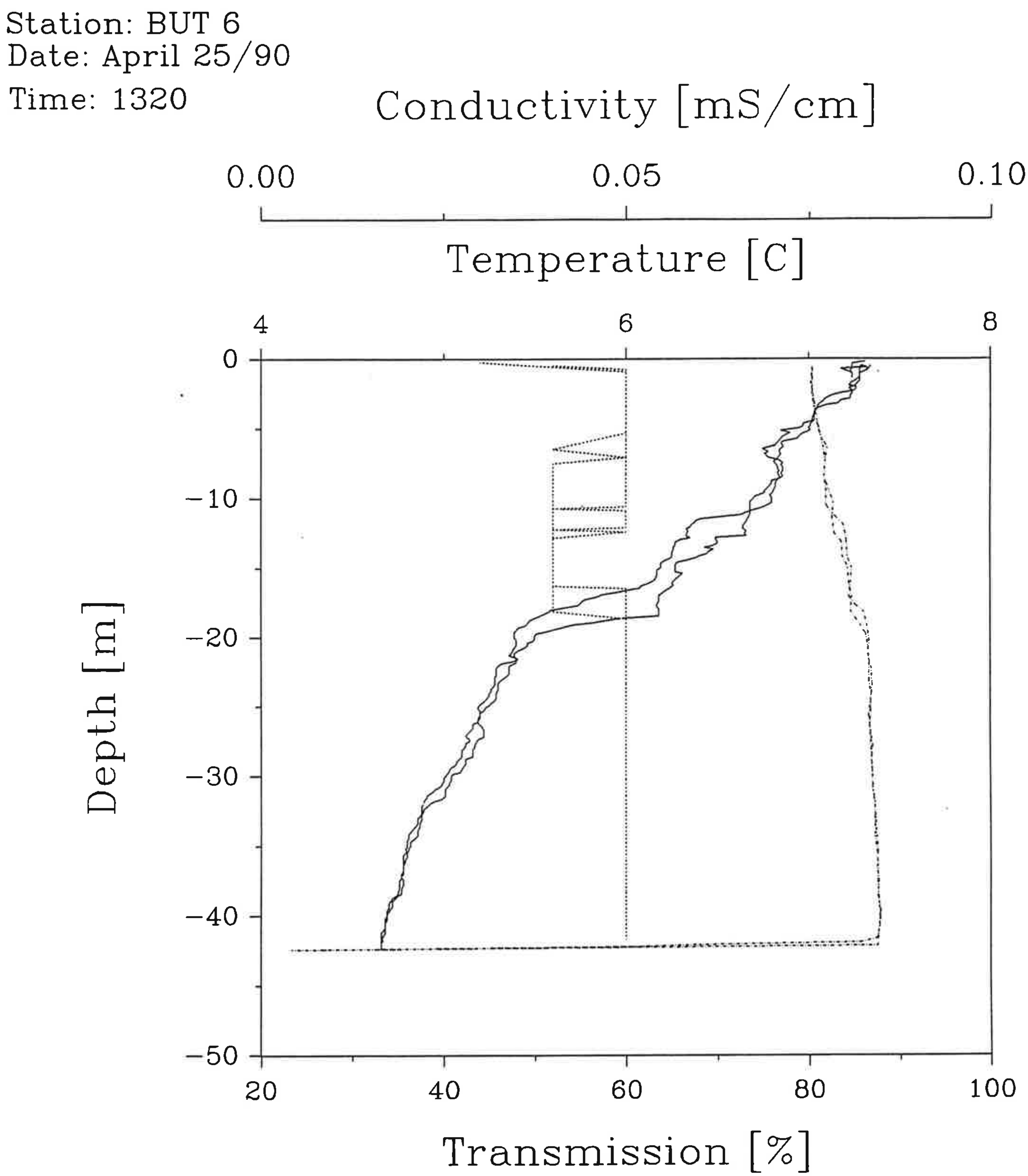


Figure 3-2 Conductivity (---), temperature (——) and percent transmission (•-•-•) profiles for Station BUT 6.

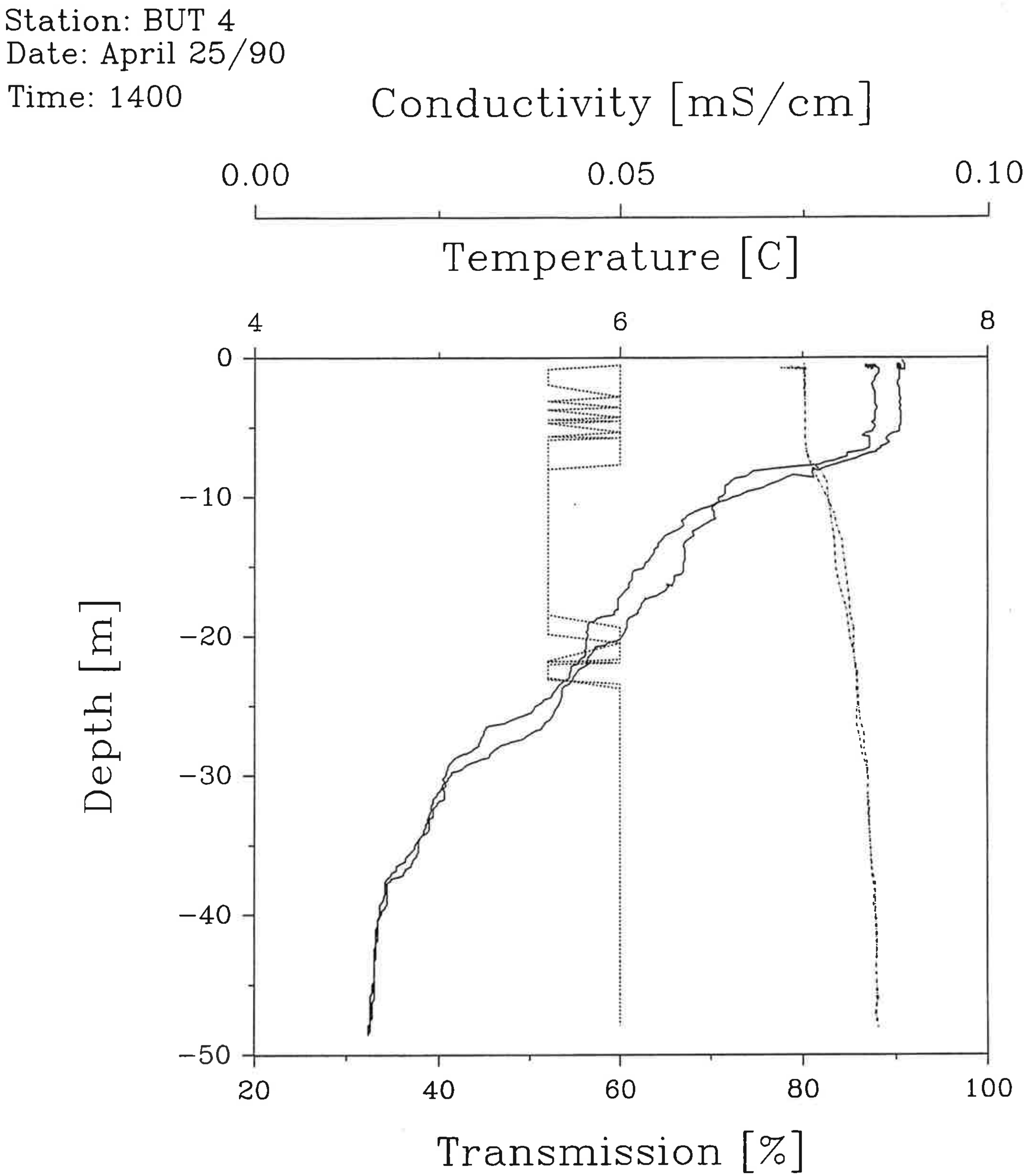


Figure 3-3 Conductivity (---), temperature (——) and percent transmission (•----•) profiles for Station BUT 4.

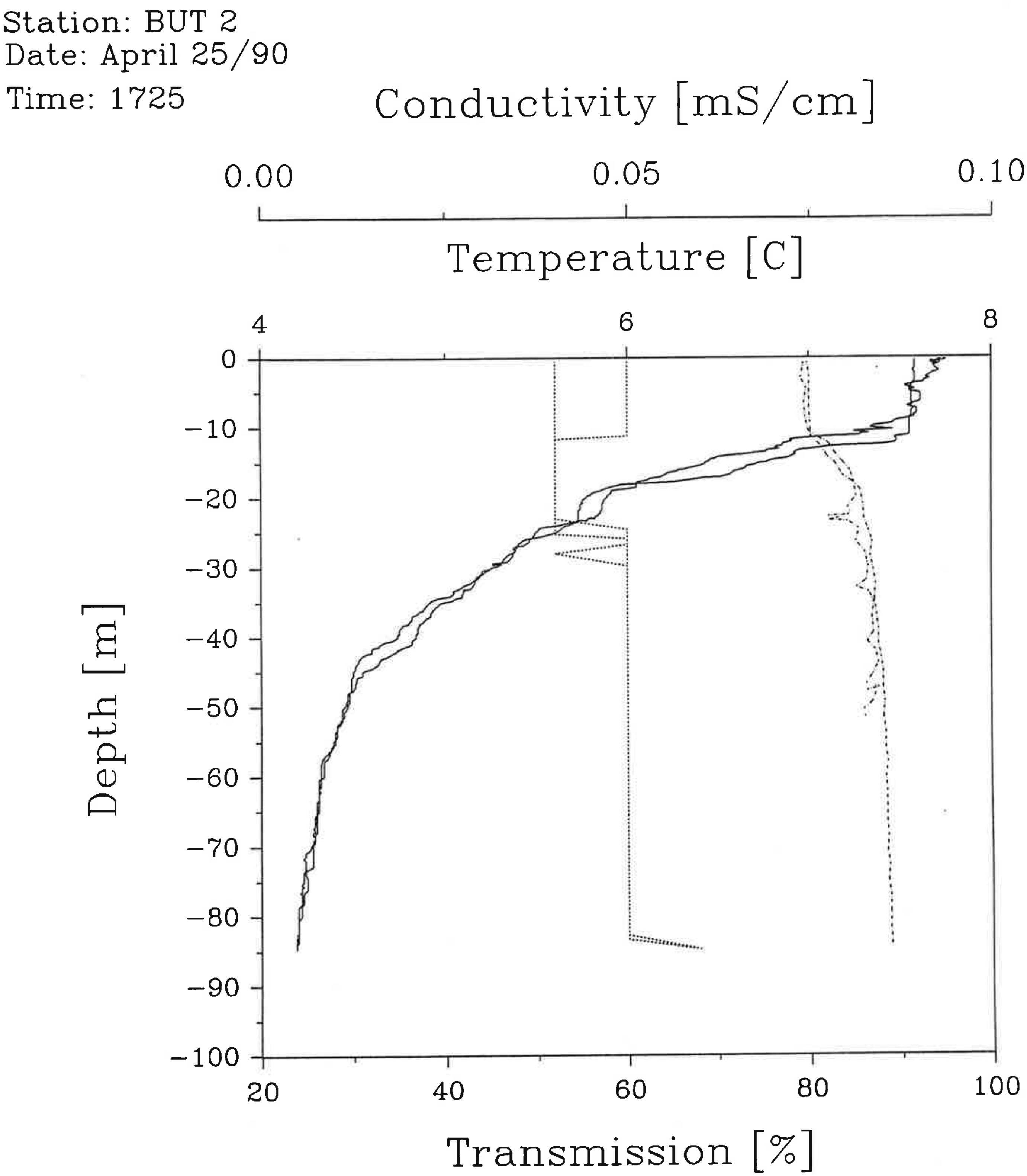


Figure 3-4 Conductivity (---), temperature (——) and percent transmission (•····) profiles for Station BUT 2.

the deepest station in the lake (BUT 2). Aluminum concentrations ranged from 0.22 to 0.40 mg $L^{-1}$ with the highest concentration found at station BUT 2 near the bottom. Arsenic concentrations ranged from <0.0001 to 0.0005 mg $L^{-1}$ with the highest concentrations being found at the surface and stations closest to Myra Creek. Copper concentrations ranged from <0.001 to 0.005 mg $L^{-1}$ with the highest concentration found at station BUT 2 near the bottom. Cadmium was not detected in surface waters but was detected as concentrations of up to 0.0004 mg $L^{-1}$ at depth at all stations except station BUT 4. Iron, mercury and nickel were consistently below detection limits at all sites and depths. Lead was detected (0.002 mg $L^{-1}$) only at station BUT 2 near the bottom. Manganese concentrations ranged from <0.005 to 0.014 mg $L^{-1}$ with the highest concentrations found with increasing depth. Zinc concentrations ranged from 0.22 to 0.052 mg $L^{-1}$ with lowest and highest values found at station BUT 2 at the surface and bottom depths, respectively. Surface concentrations of zinc ranged from 0.022 to 0.033 mg $L^{-1}$, while bottom concentrations ranged from 0.035 to 0.052 mg $L^{-1}$.

Historical water quality data obtained from the B.C. Ministry of Environment, Waste Management Branch were extracted from the SEAM database for two sites (Sites 0130080 and 0130082) and are presented in Appendix C. Summary climate data for the Myra Creek weather station including total monthly precipitation (rain and snow) and monthly mean maximum and minimum temperatures are also presented in Appendix C for the years 1968 to 1989.

## 3.2 Solid-phase Chemistry and Mineralogy of Cores

The concentrations of major (Fe, Ti, Ca, K, Si, Al, Mg, P and Na) and minor elements (Zn, Pb, Cu, Ni, Co, Mn, Ba, Cr, V, Sr and Rb) were determined by X-ray fluorescence spectrometry as described in Appendix B. Results are listed in Appendix D. The concentrations of total carbon, nitrogen and sulphur were determined using elemental analysis as described in Appendix B; results are tabulated in Appendix E. Mineralogy was determined in a smaller number of samples by X-ray diffractometry, as outlined in Appendix B; results are tabulated in Appendix F. Of the four cores, BUT 2, 4 and 5 consist of three strata, with each layer well-defined by a number of the measured elemental distributions. The thin topmost layer in each of these three cores (described in the core logs as natural sediments) is in fact a mixture of tailings and natural sediments, as can be readily seen in the diminished but significant concentrations of Zn, Cu, Pb, Ba and S in the upper few cm (Figures 3-5, 3-6, 3-7 and Appendices D and E).

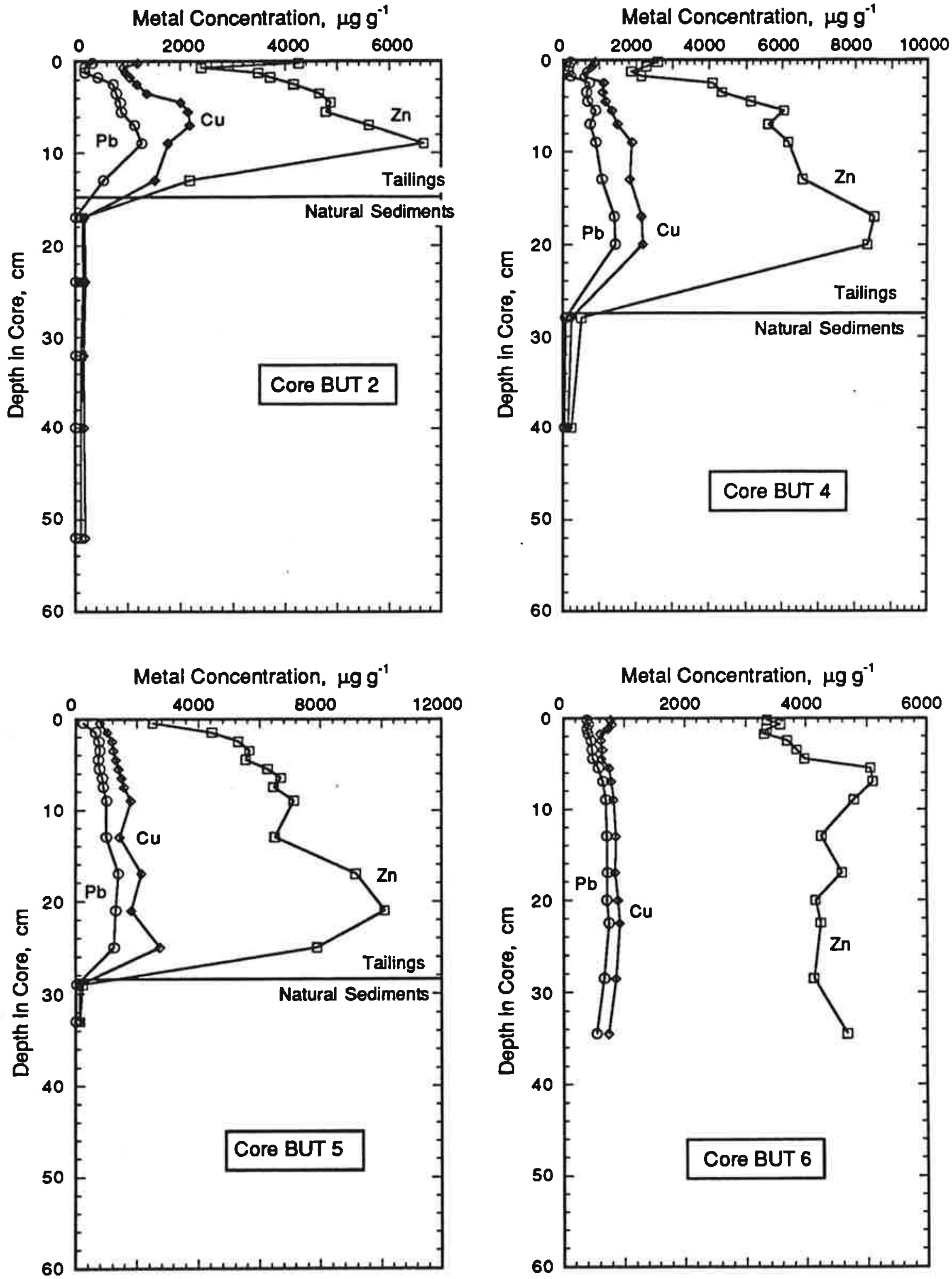


Figure 3-5 Sedimentary Pb, Zn and Cu concentration profiles in cores from the south basin of Buttle Lake. Note the variable scales on the abscissae.

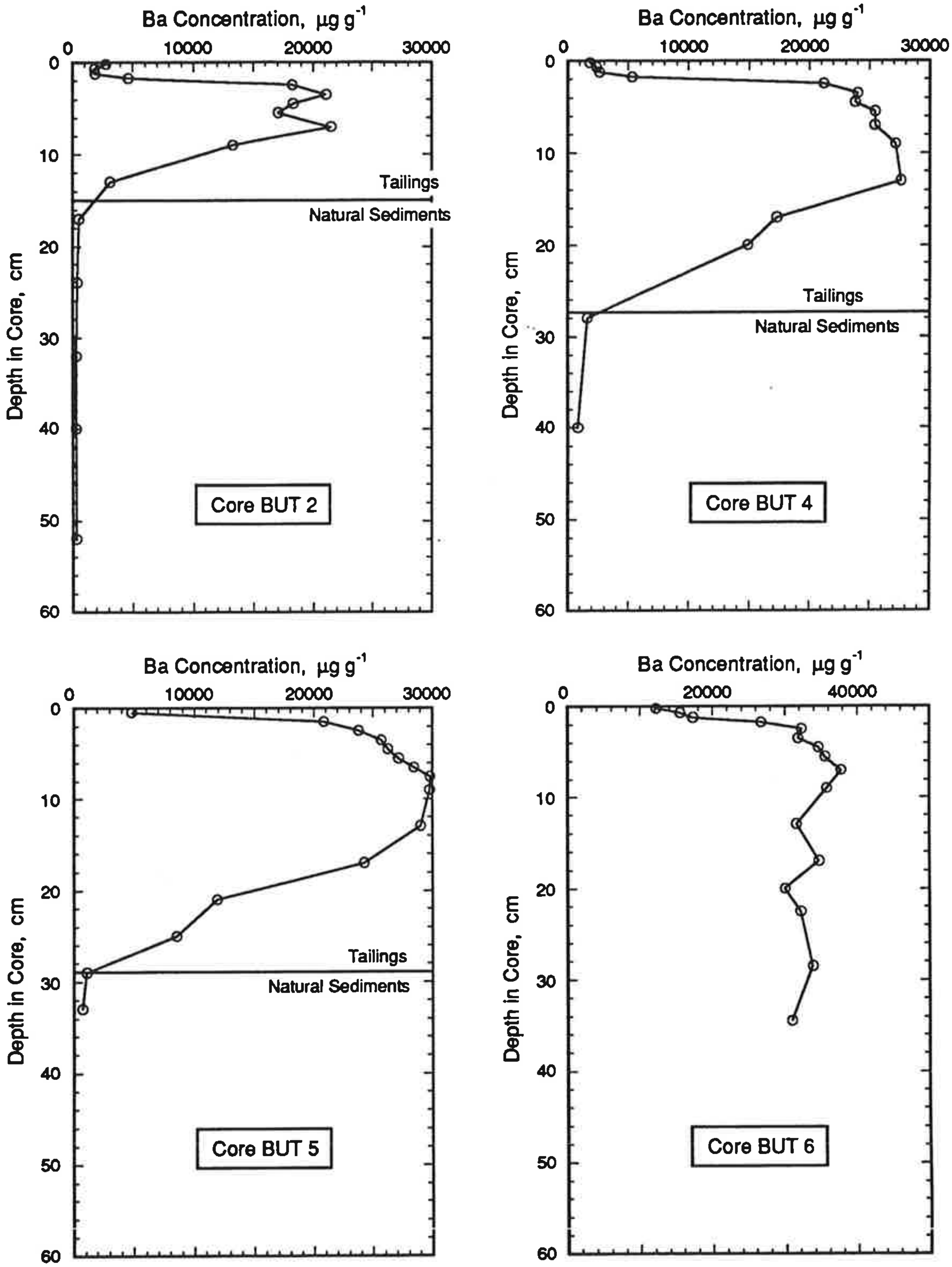


Figure 3-6 Sedimentary Ba concentration profiles in cores from the south basin of Buttle Lake. Note the variable scales on the abscissae.

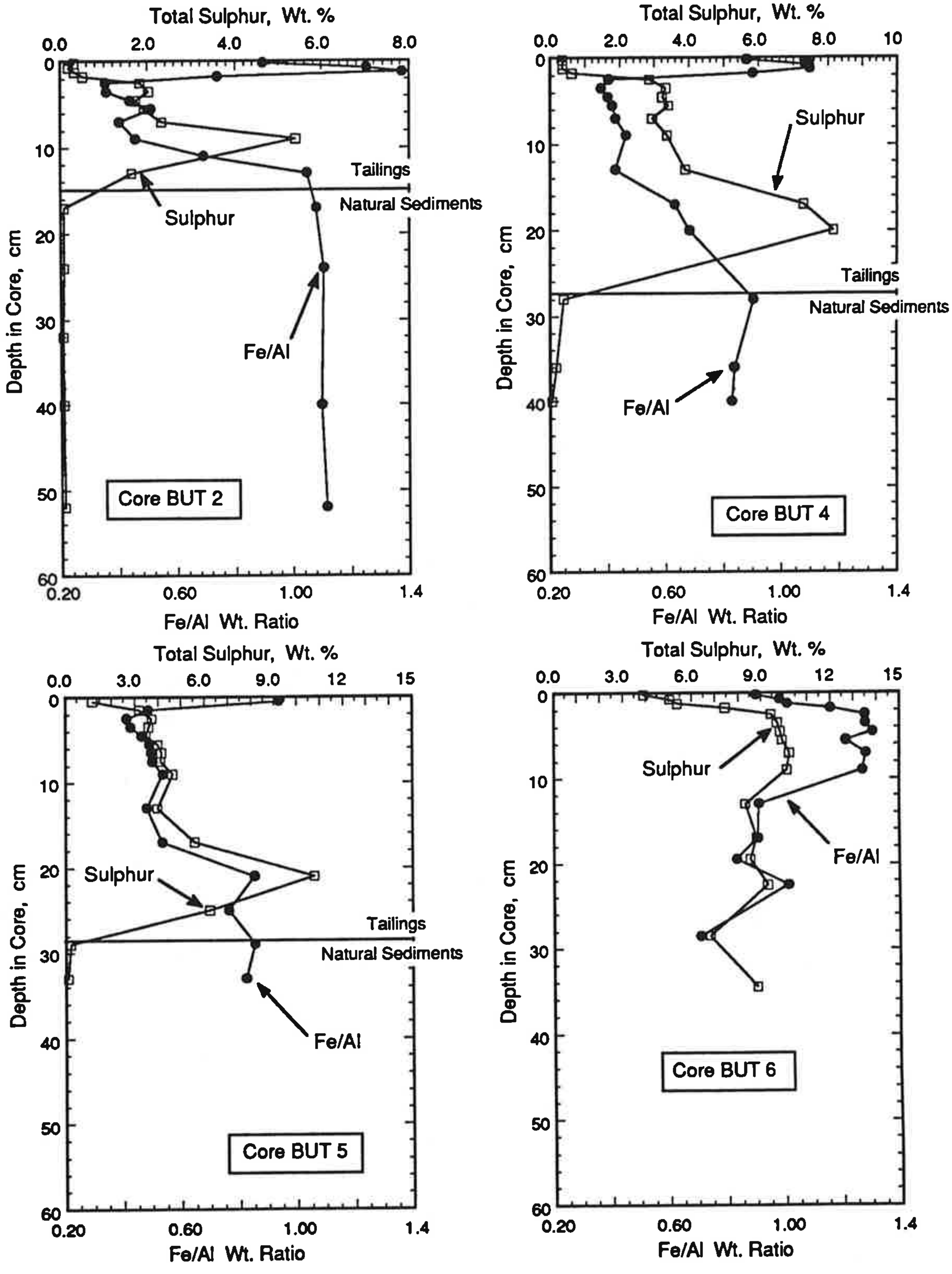


Figure 3-7 Sedimentary S concentration and Fe/Al wt. ratio profiles in cores from the south basin of Buttle Lake. Note the variable scales on the abscissae.

Zinc concentrations, for example, exceed 2000 $\mu g\ g^{-1}$ in the upper 10 mm of cores BUT 4 and 5 and 4000 $\mu g\ g^{-1}$ in the upper 5 mm of core BUT 2. Below the surface horizon in BUT 2, 4 and 5, the sediment composition is dominated by a tailings layer, again as shown by the Zn, Cu and Pb profiles (Figure 3-5). The thickness of this stratum increases with proximity to the former discharge point (~15 cm at BUT 2, ~25 cm at BUT 4, and ~28 cm at BUT 5). Note that in each case, variations in the heavy metal contents are stratigraphically consistent. The highest Zn concentrations, for example, occur toward the base of the tailings layer at the three sites. Natural, essentially tailings-free sediments underlie the tails layer in BUT 2, 4 and 5; Zn, Pb and Cu contents in the lower decimetre of these cores are at typical background levels (Figure 3-5 and Appendix D). Visual observations (Appendix A) and the distributions of heavy metals and sulphur (Figures 3-5, 3-6 and 3-7) indicate that core BUT 6 consists exclusively of tailings, with the exception of the upper 2 cm, which include an admixture of natural sediments. The best evidence for the latter observation is provided by the organic carbon and nitrogen profiles; both elements are strongly enriched in the uppermost 2 cm, and greatly depleted in the tailings (Figure 3-8 and Appendix E). The carbon and nitrogen distributions also clearly define the tri-layer stratigraphy which characterizes the other three cores. The C/N ratio profiles for the four cores are presented in Figure 3-9. High measured barium concentrations indicate that the tailings contain substantial concentrations of a barium mineral, presumably barite. Barite was not detected by x-ray diffractometry, however. Of the other trace elements measured, Co, Ni, Mn and Cr are depleted in the tailings relative to their typical concentrations in natural sediments, and Zr, Rb and Sr are relatively enriched. The distributions of the latter trio reflect mineralogical contrasts between the tailings and natural sediments in the basin.

Major element distributions demonstrate clearly that the tailings are composed of different aluminosilicate minerals than the natural fluvial detritus deposited in the basin. Low Na/Al and Si/Al ratios (Figure 3-10) and high K/Al ratios in the tailings (Figure 3-11) are particularly distinct when compared to the natural sediments in the lowermost strata of cores BUT 2, 4 and 5. X-ray diffractograms indicate that quartz and chlorite are common in both tailings and natural sediments (Appendix F) while plagioclase feldspar is much less common in the former. Muscovite and pyrite are particularly abundant in the tailings; the latter was not detectable in the natural sediments. These differences in mineralogy explain the contrasts seen in the elemental ratios profiled in Figures 3-10 and 3-11. The high K/Al and low Si/Al and Mg/Al ratios characteristic of

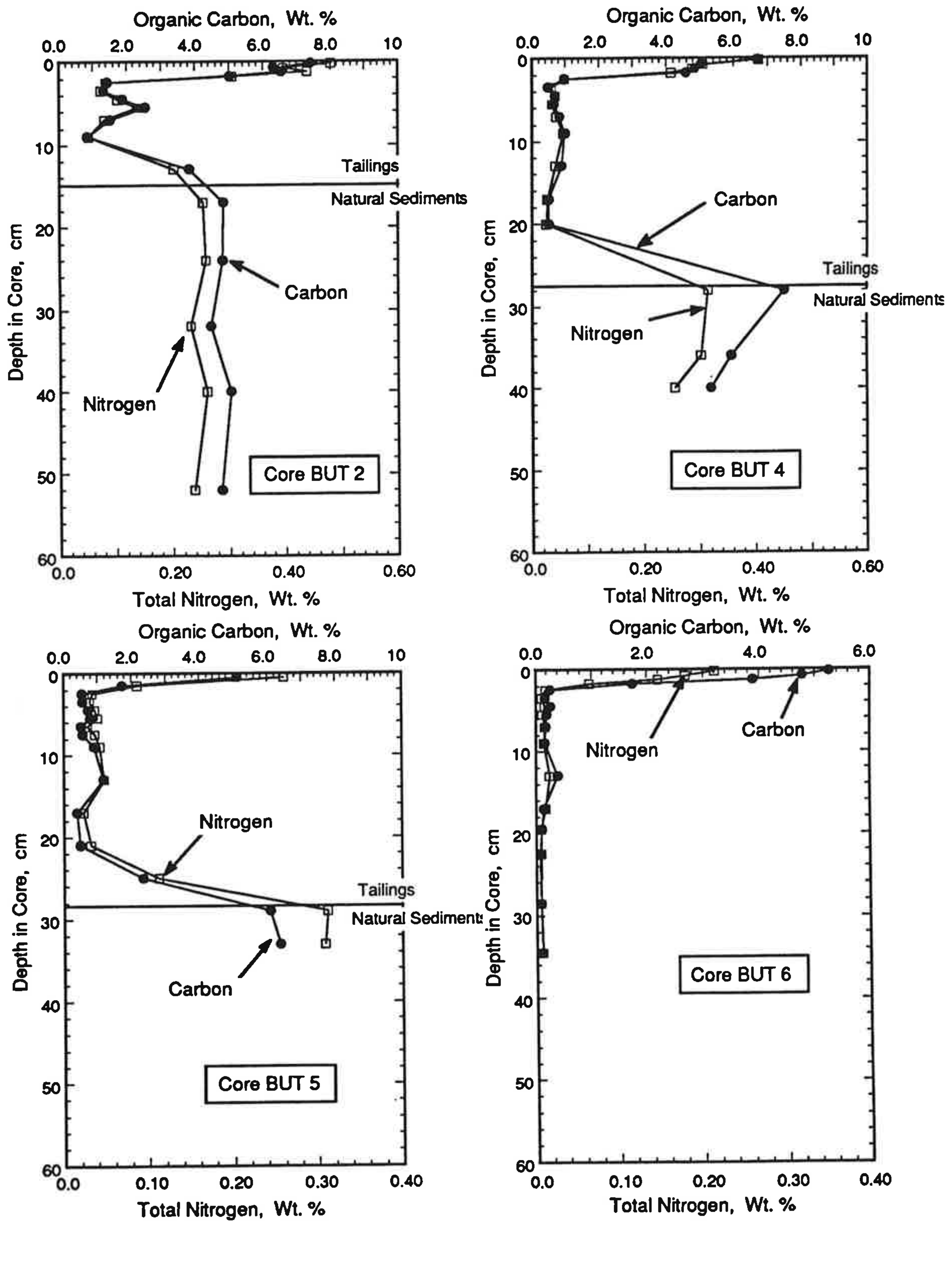


Figure 3-8 Sedimentary organic carbon and nitrogen profiles in cores from the south basin of Buttle Lake. Note the variable scales on the abscissae.

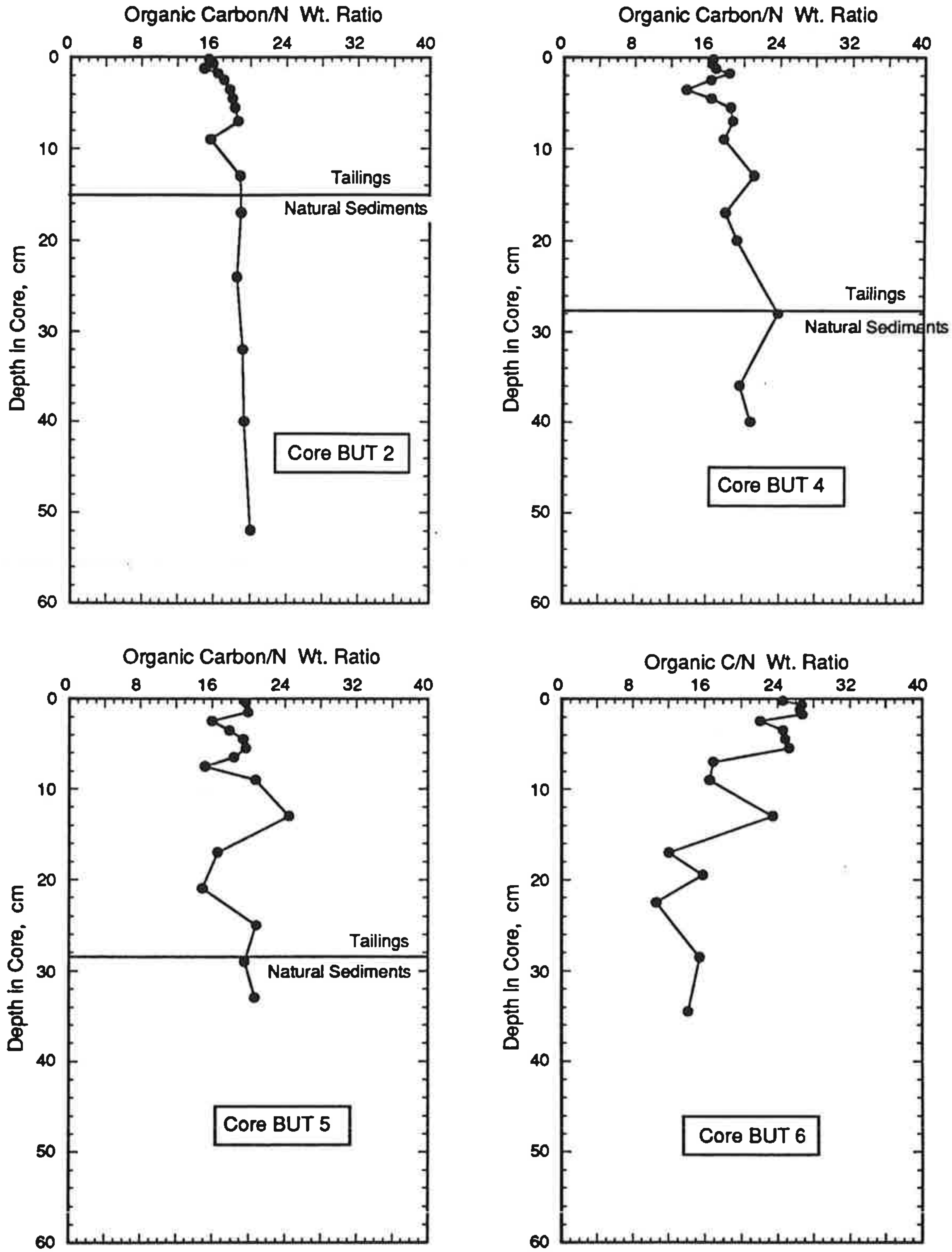


Figure 3-9 Organic carbon/nitrogen wt. ratio profiles in cores from the south basin of Buttle Lake.

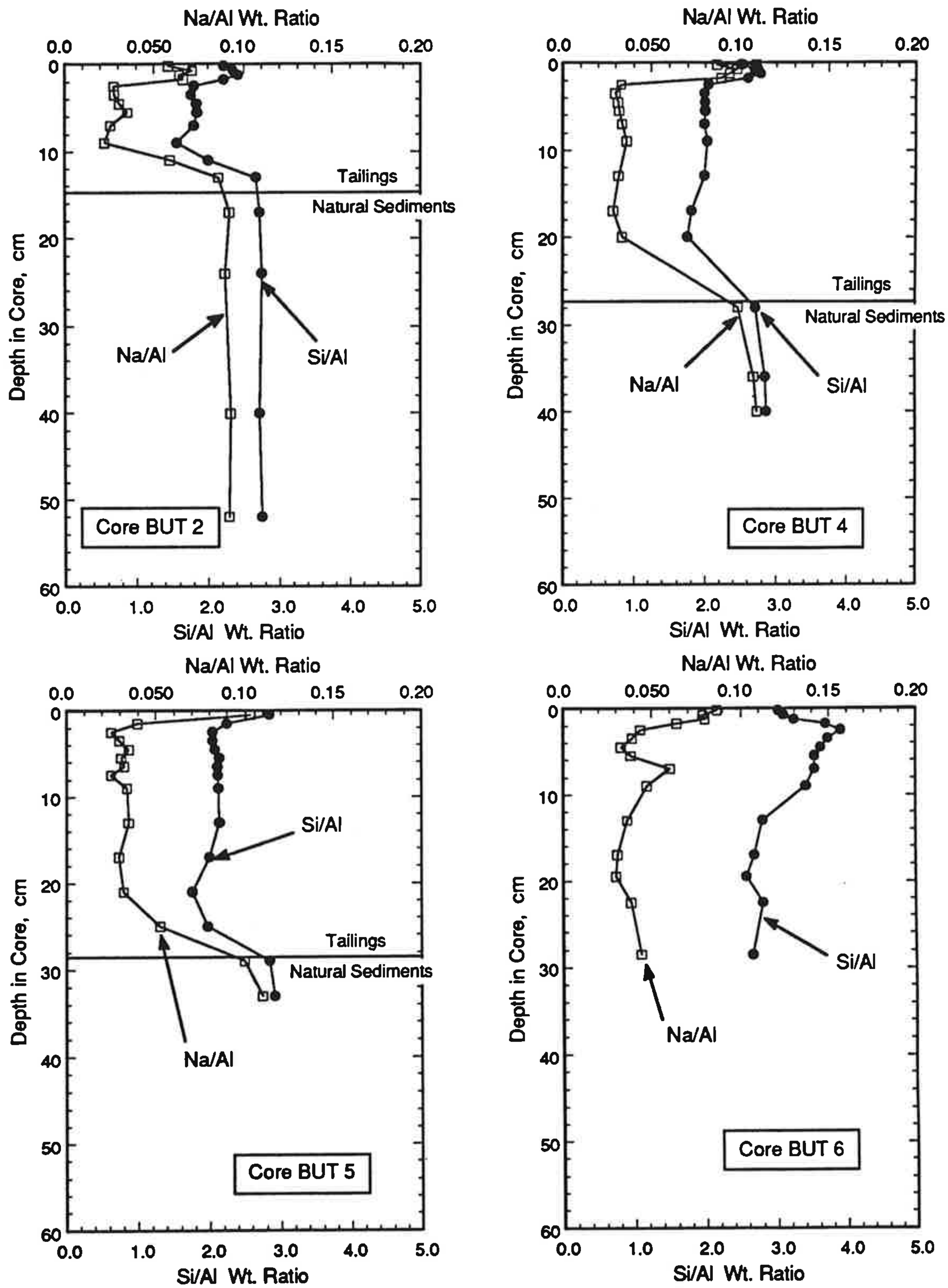


Figure 3-10 Sedimentary Si/Al and Na/Al wt. ratio profiles in cores from the south basin of Buttle Lake.

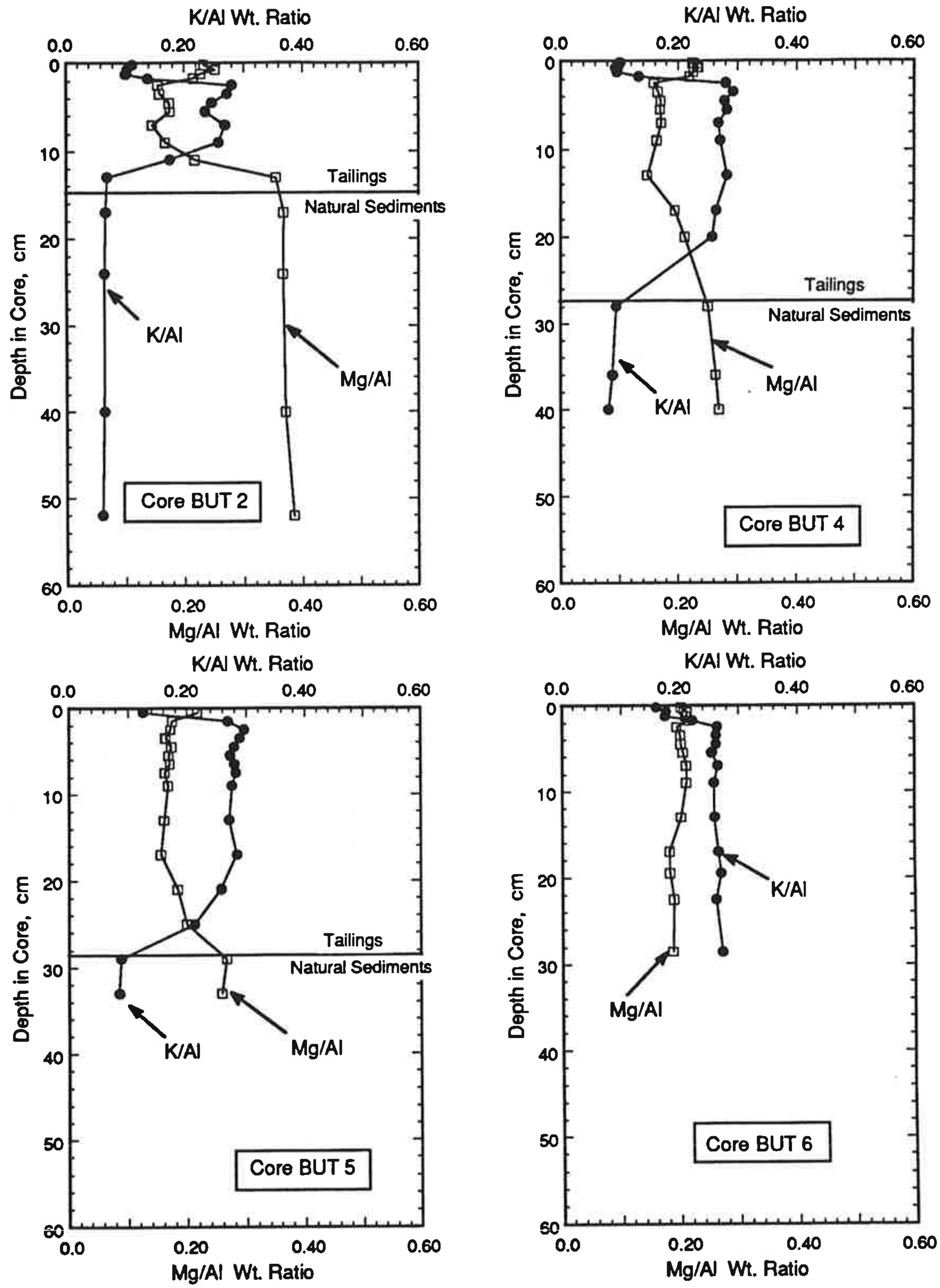


Figure 3-11 Sedimentary K/Al and Mg/Al wt. ratio profiles in cores from the south basin of Buttle Lake.

the tailings reflect the abundance of K- and Al-rich muscovite in these deposits. Similarly, the low Na/Al ratio in the tails is consistent with the lower plagioclase content indicated by the XRD results. The high S concentration in the tailings (Figure 3-7), noted above, reflects the presence of abundant pyrite gangue in the ore.

Manganese is markedly enriched in the surface sediments at all four core locations (Figure 3-12). Concentrations reach a maximum of nearly 3 wt. % (30,000 $\mu g\ g^{-1}$) in the upper 5 mm of BUT 2. Iron concentrations, plotted as Fe/Al to emphasize mineralogic contrasts, are similarly high in the upper 2 cm at sites BUT 2, 4 and 5, but no enrichment is seen at the top of core BUT 6 (Figure 3-12). As will be discussed further (see Section 4.3), the Mn and Fe distributions are influenced by diagenetic recycling as well as the recent accumulation of Fe- and Mn-rich fluvial detritus. High Fe/Al ratios in core BUT 6 (Figure 3-12) correlate well with the sulphur distribution (Figure 3-7) reflecting the high pyrite content in the tailings at this site.

## 3.3 Interstitial Water

Filtered pore waters were analyzed for dissolved Zn, Cu, Pb, Cd, Fe and Mn as described in Appendix B. All concentration data are listed in Appendix G. Analytical detection limits for all metals (Appendix B) are significantly lower in this study than in Pedersen (1983a), reflecting improvements in instrumentation. In addition, much higher resolution sampling of the cores for pore waters was used in this work compared to the low-resolution approach employed in 1983. As a result, dissolved metal distributions are reported with much greater detail in this study. One other major contrast exists between the current and the previous work; the south basin waters in the early 1980's contained very high dissolved metal concentrations, while as noted earlier, present levels have decreased significantly. Because of these differences, caution must be applied in drawing direct comparisons between the 1983 results and those presented here.

Dissolved Cu concentrations in all four 1989 cores are similar to the levels reported previously by Pedersen (1983a). Cu contents in supernatant (core-top) waters (Appendix G) are typically 0.04 ± 0.01 mmol $L^{-1}$ (about 3 $\mu g\ L^{-1}$), close to the Environment Canada water quality guideline of 2 $\mu g\ L^{-1}$, and similar to measurements made in bottom waters reported by Deniseger et al. (1988) and more recently, by the Waste Management Branch (L. Erickson, pers. comm.). In general, concentrations are low in the cores with the exception of a limited number of discrete horizons at depth

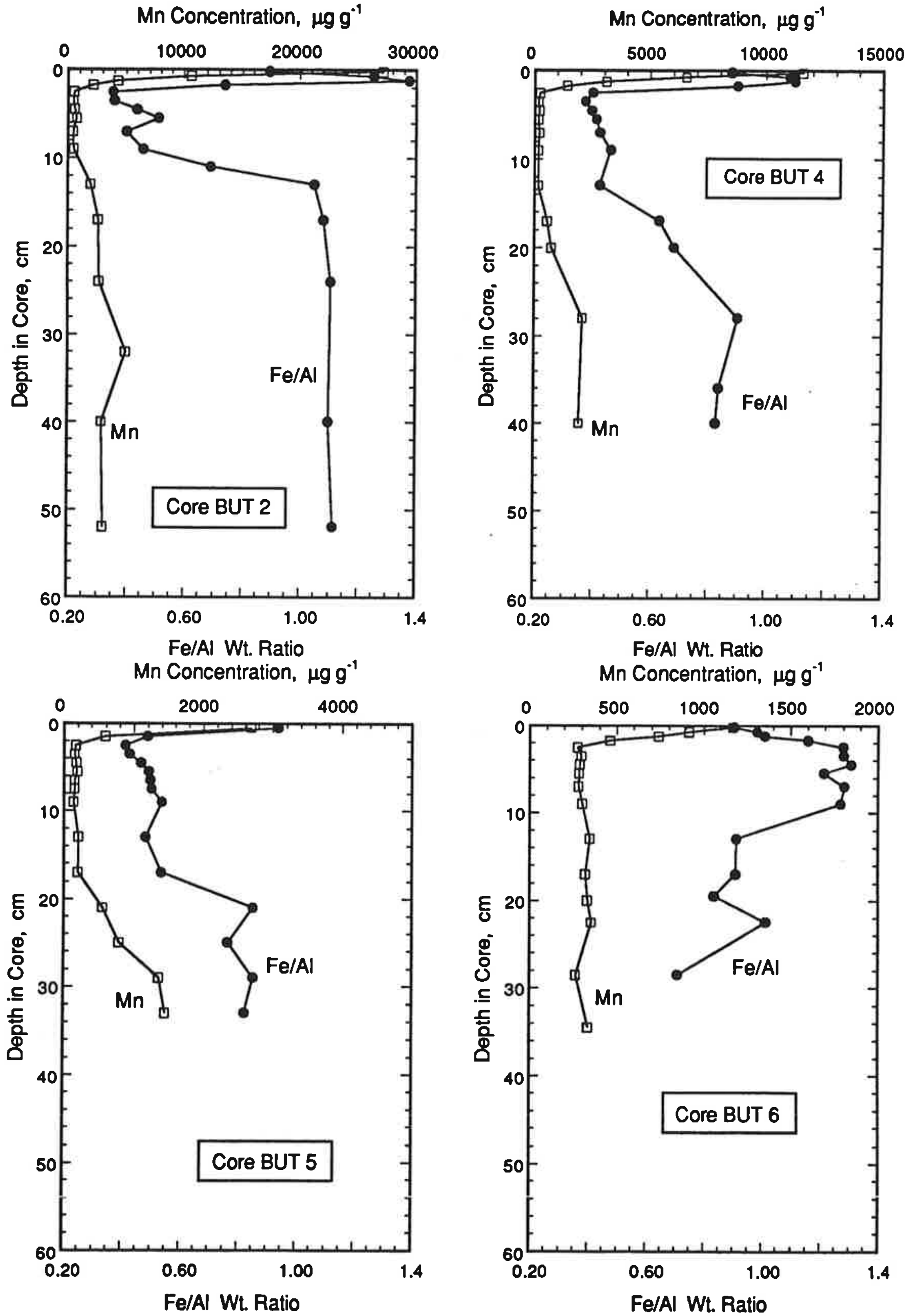


Figure 3-12 Sedimentary Mn concentration and Fe/Al wt. ratio profiles in cores from the south basin of Buttle Lake. Note the variable scales on the abscissae for Mn.

where levels are considerably enriched, reaching as much as 5 $\mu$mol $L^{-1}$ (Figure 3-13). Dissolved Zn values in the supernatant waters at stations BUT 2, 5 and 6 are all about 1 $\mu$mol $L^{-1}$ (65 $\mu$g $L^{-1}$), again similar to levels measured recently in bottom water (Deniseger et al., 1988; L. Erickson, pers. comm.) and about double the federal water quality criteria of 30 $\mu$g $L^{-1}$ (CCREM, 1987). Supernatant water in core BUT 4 contained twice as much dissolved Zn (~2 $\mu$mol $L^{-1}$) as was measured at the other three sites. Concentrations at depth are higher than observed in similar sediments in 1983, with the exception of core BUT 6 (the "pure tailings" core) in which levels are significantly less than in the overlying bottom water, at least in the upper two decimetres (Figure 3-13). It is notable that Zn is enriched in the same discrete horizons as Cu (and Pb and Cd) in all four cores (Figure 3-13). Zn concentrations in these layers reach values as high as 24 $\mu$mol $L^{-1}$ (core BUT 4, 7 cm depth).

Pb concentrations in supernatant waters are relatively low, reaching a maximum of 0.013 $\mu$mol $L^{-1}$ (<3 $\mu$g $L^{-1}$) in core BUT 6. This level is less than the Environment Canada criteria (5 $\mu$g $L^{-1}$) by about a factor of two. Concentrations in the upper two cm at all four sites are similarly low (Figure 3-13; Appendix G). However, as observed for the other heavy metals, Pb is enriched in discrete zones at depth at all four sites (Figure 3-13).

Cd levels are very low (<0.5 $\mu$g $L^{-1}$ or 5 nmol $L^{-1}$) in the supernatant waters at all locations (Appendix G). These measurements are entirely consistent with the values reported by Deniseger et al. (1988) and measured recently by the Waste Management Branch (L. Erickson, pers. comm.). Cd concentrations are extremely low (typically <0.2 nmol $L^{-1}$) in core BUT 6 ("pure tailings"). At depth at the other sites, concentrations are also notably low, with two exceptions: first, Cd is enriched in the same discrete zones as the Zn, Cu and Pb (compare Figure 3-14 with Figure 3-13), although the maximum concentrations reached do not exceed 10 nmol $L^{-1}$ (about 1 $\mu$g $L^{-1}$); second, in two of the four cores (BUT 2 and 4), the Cd level in the upper 5 mm is higher by a factor of about two than in the overlying supernatant or the immediately underlying pore water (Figure 3-14).

Dissolved Mn and Fe levels in pore waters are enriched relative to supernatant water within millimetres of the sediment-water interface at each station (Appendix G). Concentrations in the tri-layer cores reach extremely high levels at greater depths,exceeding 1 mmol $L^{-1}$ Fe (>75,000 $\mu$g $L^{-1}$) in BUT 4 and 5 (Figure 3-15) and 250

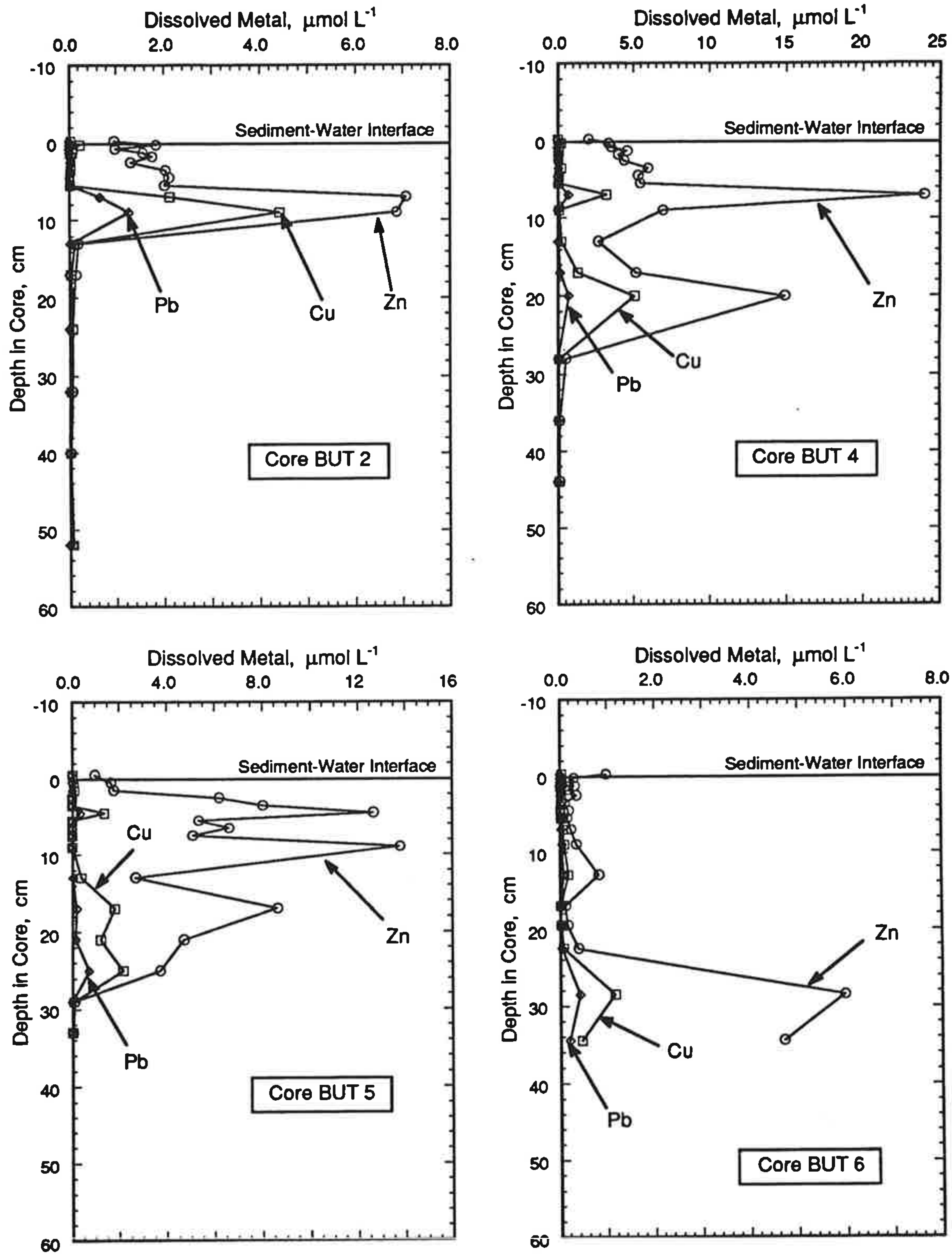


Figure 3-13 Dissolved Zn, Cu and Pb profiles in pore waters extracted from cores collected in the south basin of Buttle Lake. Note the variable scales on the abscissae.

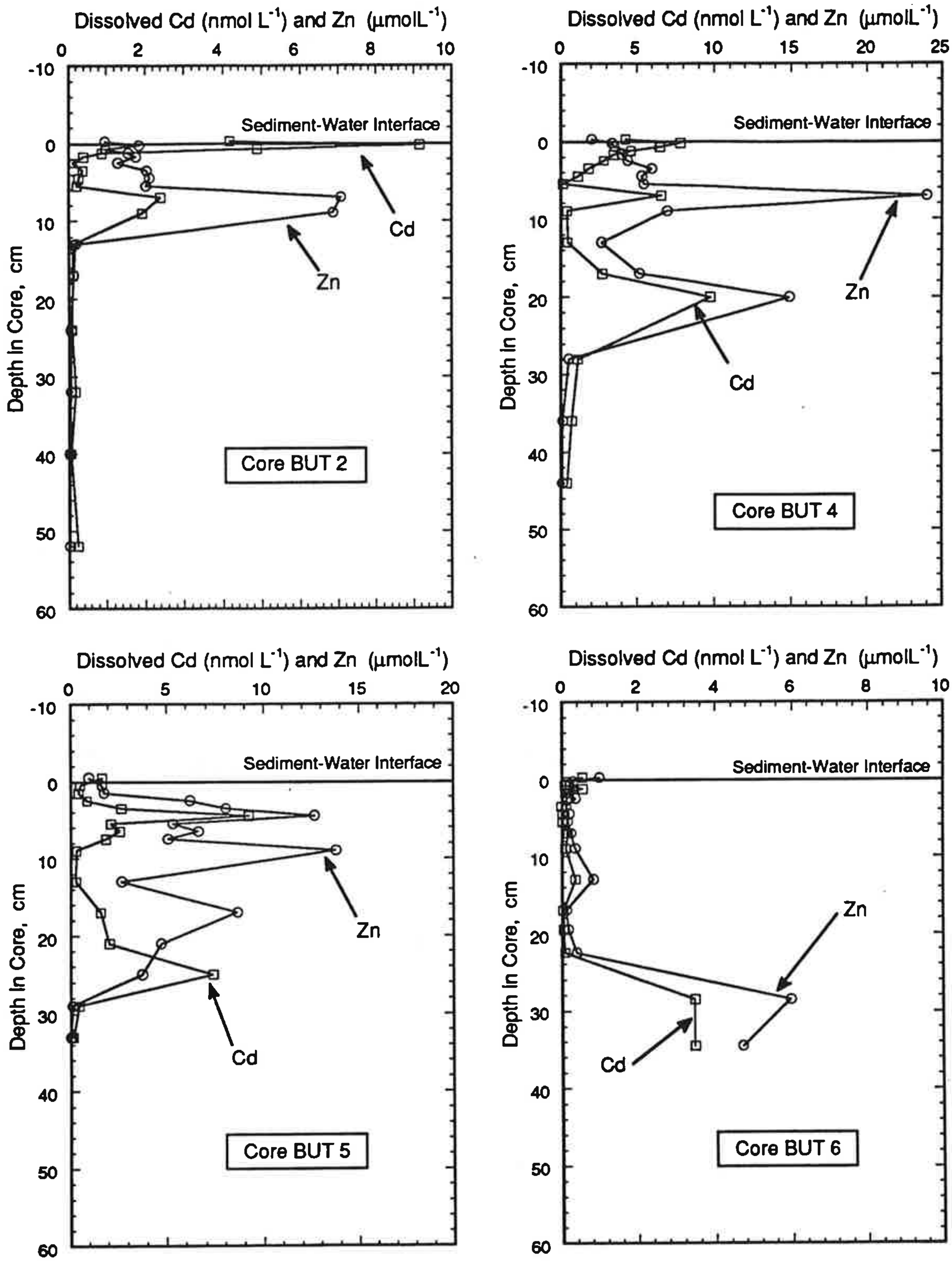


Figure 3-14 Dissolved Zn and Cd profiles in pore waters extracted from cores collected in the south basin of Buttle Lake. Note the variable scales on the abscissae.

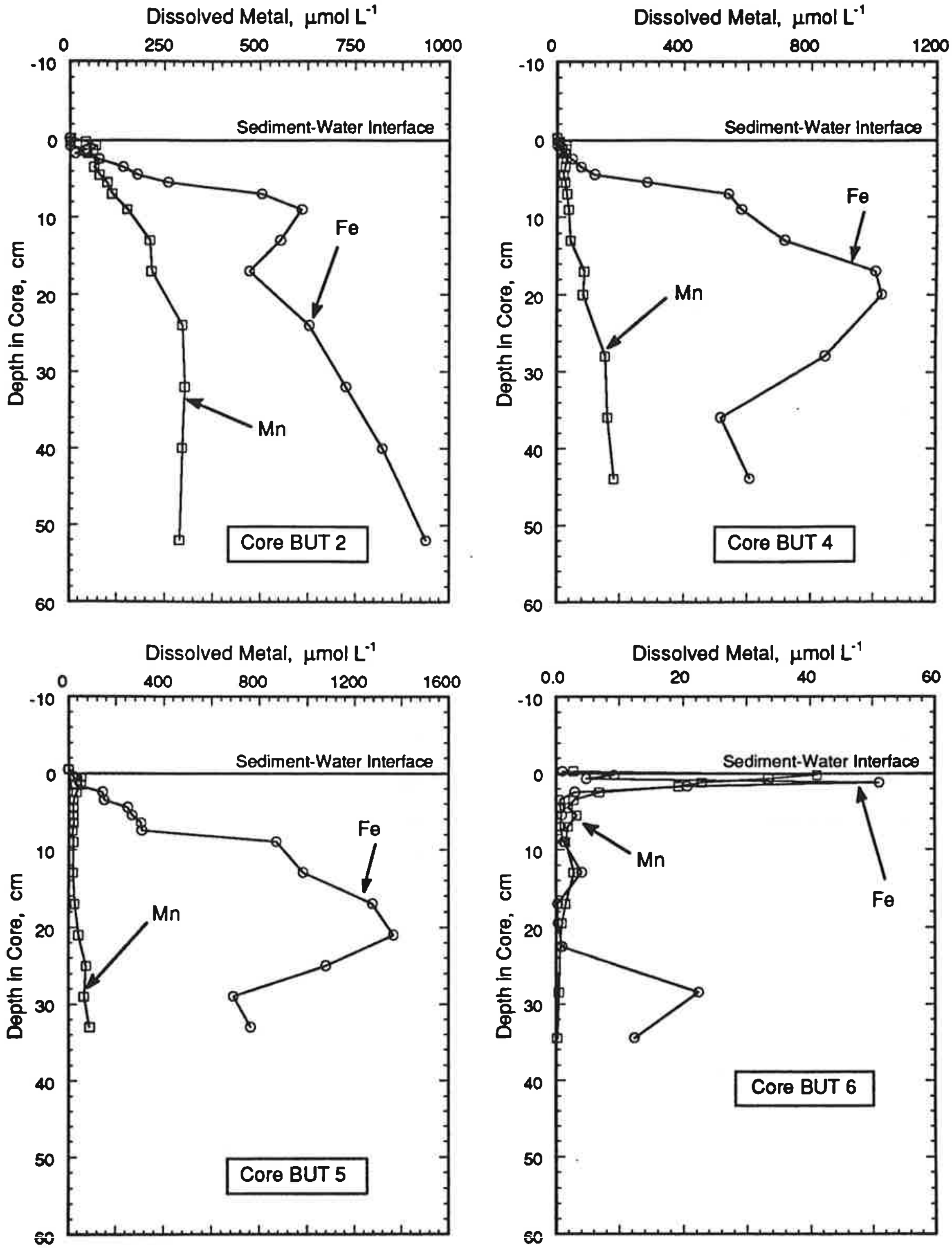


Figure 3-15 Dissolved Mn and Fe profiles in pore waters extracted from cores collected in the south basin of Buttle Lake. Note the variable scales on the abscissae.

$\mu$mol $L^{-1}$ Mn (>15,000 $\mu$g $L^{-1}$) in BUT 2. Pedersen (1983a) reported concentrations of equivalent order at depth in natural sediments at similar sites in the south basin. In the "pure tailings" core (BUT 6), concentrations at depth of both metals are relatively low (Figure 3-15).

# 4 - Discussion

Rescan

# 4.0 DISCUSSION

## 4.1 Water Quality

Buttle Lake is characterized as a soft-water, oligotrophic lake (Nordin et al., 1985). Sampling of the south basin in April 1990 indicated a hardness of 30 - 40 mg $L^{-1}$ $CaCO_3$ and low nutrient concentrations of up to 0.004, 0.13 and 4.7 mg $L^{-1}$ for total phosphorus, nitrate plus nitrite and reactive silicate, respectively. The nutrient concentrations are likely close to the maximum spring overturn concentrations. The lake is well oxygenated, as is typical of oligotrophic lakes, with dissolved oxygen concentrations above 5.0 mg $L^{-1}$ (generally >10 mg $L^{-1}$) both seasonally and throughout the water column (WMB - SEAM data in Appendix C; Nordin et al., 1985).

Temperature profiles collected in April 1990 indicated surface warming had started. The south basin shows a typical coastal lake stratification pattern. The water column is isothermal from January through March; warming begins in April and produces maximum summer stratification in August, while cooling occurs during September through December (WMB - SEAM data in Appendix C; Nordin et al., 1985). The stratification pattern affects the vertical pattern of inflows into a lake. During the winter, Myra Creek inflows on or near the surface but during the summer it enters as interflow at a depth of 10 - 30 m (WMB - SEAM data Appendix C; Nordin et al., 1985). This is important to note as Myra Creek is an anthropogenic source of metals loading to Buttle lake. High metal loadings have also been occasionally observed in Thelwood Creek with dissolved zinc concentrations as high as 3.24 mg $L^{-1}$ recorded (B.C. Research, 1980). The metals likely originate from deposits of minerals in lenses and in glacial deposits in the drainage basin. Disturbance of these deposits and exposure to air by slides, erosion, etc. could cause high metal loadings in Thelwood Creek.

During sampling in April 1990 the south basin of Buttle Lake was characterized by high transmissibility, low turbidity and low suspended solids at all depths. The slightly lower transmissibility in the top 20 m is likely the result of phytoplankton production in this zone. Turbidity data collected in April and May of 1981 indicated very high turbidity in the lower portions (>20 m depth; zero light transmission below 40 m) of this basin during the period of tailings deposition in the lake (Gillie, 1982). The surface waters displayed low turbidity values. The turbidity plume extended past the Narrows at depths of 25 - 50 m for more than 3 km down the lake.

The lake is characterized by low dissolved solids and consequently low conductivity with values being slightly lower at the surface. Conductivity values since 1981 to present have generally ranged between 60 and 95 $\mu$mhos $cm^{-1}$ with minimum and maximum values of 39 and 144 $\mu$mhos $cm^{-1}$, respectively, occurring in early 1982 (WMB - SEAM data in Appendix C). Measured anion concentrations are low (e.g., <0.5 mg $L^{-1}$ chloride and 8 to 17 $L^{-1}$ sulphate).

The pH of the south basin has generally ranged from 6.5 to 7.5 but extreme values of <3.0 and >12.0 were found in 1981 and 1982 (WMB - SEAM data in Appendix C). The low alkalinity of the lake (<24.0 mg $L^{-1}$ as $CaCO_3$) indicates a low buffering capacity and susceptibility to alterations in pH.

The low hardness of the lake is significant in that it affects the form and toxicity of numerous heavy metals (CCREM, 1987). Metals generally become more toxic in soft water. The metals that have been of primary concern in Buttle Lake are zinc, copper, cadmium and lead. The concentrations of these metals entering the lake via Myra Creek decreased after the installation of the surface and groundwater collection and treatment system at the Westmin mine site in 1983 (Deniseger et al., 1988). Metals levels in Buttle Lake itself have been decreasing since 1980, but surface metal concentrations have yet to reach background concentrations in the south basin (Table 4-1). Fluctuations in maximum zinc concentration from 1985 to 1989 seem to indicate the lake has not reached equilibrium concentrations (Table 4-1). Variations in annual hydrographs for Thelwood and Myra creeks, fluctuating lake levels and the timing of sampling can greatly influence the metal concentrations observed in the south basin. Therefore, it will be difficult to determine when equilibrium is reached, particularly if loading rates are also varying in the inflow waters.

The surface water samples collected during this study were within objectives suggested by Nordin et al. (1985) and the federal guidelines (CCREM, 1987) for zinc, copper, cadmium and lead. However, at depth zinc (0.052 mg $L^{-1}$) and copper (0.005 mg $L^{-1}$) exceeded both the lake-specific objectives and federal guidelines at some sites while cadmium (0.0003 mg $L^{-1}$) and lead (0.002 mg $L^{-1}$) exceeded only the guidelines at some

## Table 4-1

**Summarized Concentrations of Heavy Metals in Surface Waters of the South Basin of Buttle Lake (Station 0130082). Range of Values Throughout Year with Upper Values Generally Found During Winter Months. Adapted from Deniseger et al. (1988).**

| Year | Range | Total No. of Samples |
|---|---|---|
| **Total Cadmium** | | |
| 1980 | <0.5-13 | 6 |
| 1981 | 0.6 | 1 |
| 1982 | <0.5-0.6 | 2 |
| 1983 | <0.5 | 5 |
| 1984 | <0.5-0.5 | 7 |
| 1985 | <0.5 | 8 |
| 1986 | <0.5 | 9 |
| 1987 | <0.5 | 5 |
| 1988 | <0.5 | 5 |
| 1989 | <0.5 | 2 |
| 1990[1] | <0.2 | 1 |
| Objective[2] | 1.3 | |
| Guideline[3] | 0.2 | |
| **Total Copper** | | |
| 1980 | 5-30 | 6 |
| 1981 | 4-30 | 5 |
| 1982 | 4-15 | 5 |
| 1983 | 3-9 | 5 |
| 1984 | 2-20 | 8 |
| 1985 | <1-7 | 8 |
| 1986 | 1-<10 | 9 |
| 1987 | 2-10 | 5 |
| 1988 | <1-5 | 5 |
| 1989 | <1-9 | 6 |
| 1990[1] | 2 | 1 |
| Objective[2] | 2.5 | |
| Guideline[3] | 2 | |

**All values in micrograms $L^{-1}$**
**< Denotes below detection limits**
**1 Present study**
**2 Nordin et al. (1985)**
**3 CCREM (1987)**

## Table 4-1 (Cont'd)

| | Year | Range | Total No. of Samples |
|---|---|---|---|
| **Total Zinc** | | | |
| | 1980 | 110-370 | 6 |
| | 1981 | 100-280 | 5 |
| | 1982 | 30-170 | 3 |
| | 1983 | 18-120 | 5 |
| | 1984 | 10-140 | 8 |
| | 1985 | 30-70 | 8 |
| | 1986 | 20-50 | 9 |
| | 1987 | 20-80 | 5 |
| | 1988 | 11-60 | 5 |
| | 1989 | 12-40 | 6 |
| | 1990[1] | 22 | 1 |
| | Objective[2] | 50 | |
| | Guideline[3] | 30 | |
| **Total Lead** | | | |
| | 1980 | <1-4 | 6 |
| | 1981 | <1-4 | 1 |
| | 1982 | <1-4 | 2 |
| | 1983 | <1-3 | 6 |
| | 1984 | <1-2 | 6 |
| | 1985 | <1-1 | 5 |
| | 1986 | <1-4 | 9 |
| | 1987 | <1-9 | 5 |
| | 1988 | <1-2 | 4 |
| | 1989 | <1-1 | 6 |
| | 1990[1] | <1 | 1 |
| | Objective[2] | 5 | |
| | Guideline[3] | 1 | |

**All values in micrograms $L^{-1}$**
**< Denotes below detection limits**
**1 Present study**
**2 Nordin et al. (1985)**
**3 CCREM (1987)**

sites (Appendix C). This is a large improvement over historical metal levels and has been followed by a marked recovery of the biota in the lake (Deniseger et al., 1988).

## 4.2 Sedimentation Rate in the South Basin

The solid-phase chemical compositions described in Section 3.2 clearly indicate that tailings are widespread in the south basin of Buttle Lake, but that at all locations sampled, the deposits are being gradually covered with natural sediments. At every site at which coring was attempted, it appeared that natural sediments were present at the sediment-water interface. This was true even at those locations near the former discharge raft where the tails repeatedly washed out of the core barrel. Given that tailings deposition ceased in July of 1984, the rate of sedimentation of natural deposits can be estimated from the thickness of the organic-carbon-rich layer at each location (Figure 3-8 and Appendix E). In each case the natural sediment veneer is close to 2 cm thick. This layer still contains significant concentrations of tailings (Figure 3-5), which implies that the sediments are being bioturbated to some extent. Indeed, string-like faecal casts were observed on the surface of core BUT 2 suggesting the presence of an active infauna but bioturbation was clearly not intensive. However, with the laminated character of the upper few centimetres at stations BUT 2, 4, and 5 (Frontispiece) any bioturbation will smear the organic carbon profile and mix tailings upward into the surface sediments. Thus, the sedimentation rate in the south basin is at most 4 mm $yr^{-1}$, and is likely less. This estimate agrees well with the range calculated by Pedersen (1983b) using $^{210}Pb$ profiles.

## 4.3 Manganese and Iron Diagenesis

Bacterial oxidation of reactive organic matter in lacustrine sediments proceeds via a series of overlapping electron-transfer reactions. As degradation proceeds, thermodynamically-unstable reduced carbon compounds serve as electron donors and various oxidants act as terminal electron acceptors (see review in Chapter 3 of Rescan, 1989). During oxidation, organic matter will donate electrons to orbitals of lowest available energy level as this produces the greatest free energy gain per unit of organic material oxidized. The reaction sequence proceeds in an order mandated by the net free energy yield, with aerobic oxidation (the highest-yield reaction) preceding (in thermodynamic order) denitrification, manganese and iron oxyhydroxide reduction, sulphate reduction, and methanogenesis (Froelich et al., 1979).

In sediments in mesotrophic or eutrophic lakes, the organic carbon content is usually sufficient to establish anoxic conditions at depths ranging from a few millimetres to one decimetre. The resulting chemical zonation is therefore characterized by a decreasing redox potential with depth and the release to interstitial solution of a number of reaction products. Two such products are dissolved manganese and iron. Because Fe oxyhydroxide reduction commences almost as soon as $O_2$ has been depleted, the depth at which $Fe^{2+}$ first appears in pore water is a reasonably precise indicator of the sub-bottom oxic-anoxic boundary (Rescan, 1989). $MnO_2$ reduction and associated addition of $Mn^{2+}$ to pore water occurs at slightly shallower depths, and thus at a slightly higher oxidizing potential. The presence of Fe and Mn oxide phases in near-surface sediments has important implications for the diagenetic behaviour of heavy metals, given that both oxyhydroxides are effective at scavenging metals from solution (Kadko et al., 1987).

Joint comparison of the dissolved and solid-phase Mn distributions (Figure 4-1) indicates that Mn oxides are dissolving within millimetres of the sediment-water interface at all four sites. This is particularly obvious in cores BUT 5 and 6. The dissolved manganese concentration in the upper 5 mm at station BUT 2 is actually higher than in the equivalent sample interval at BUT 6 because of the different scales on the abscissae, but the profile is dominated by the much higher concentrations at depth in the former core. Clearly, there is an additional source of dissolved Mn in the natural sediments penetrated at stations BUT 2, 4 and 5 which is supporting upward diffusion of Mn toward the surface. Presumably, the source is the Mn oxyhydroxides which were buried by the tailings in the past and are still dissolving. Indeed, solid-phase Mn concentrations are high in the natural sediments underlying the tailings (Figure 4-1), although the Mn-rich zone at depth in each case is thicker than would be expected if the sediment-pore water system had been in steady-state diagenetic equilibrium prior to the commencement of tailings discharge. Why this should be the case is not known.

The pore water Mn profiles clearly are not in steady-state equilibrium with the solid phase distributions of the element. This is most obvious in core BUT 5 where Mn is diffusing upward from near the base of the core, as well as upward and downward from the maximum concentration in the top centimetre (Figure 4-1). Given a bulk diffusion coefficient (corrected for porosity and tortuosity) for $Mn^{2+}$ at 6°C of ~3.5 x $10^{-6}$ $cm^{2-1}$ (calculated from the data in Li and Gregory, 1974), it would take about 2 years for $Mn^{2+}$ to diffuse downward 10 cm (from the near-surface maximum to about the mid-depth minimum in BUT 5). This is of the same order as the length of time since the

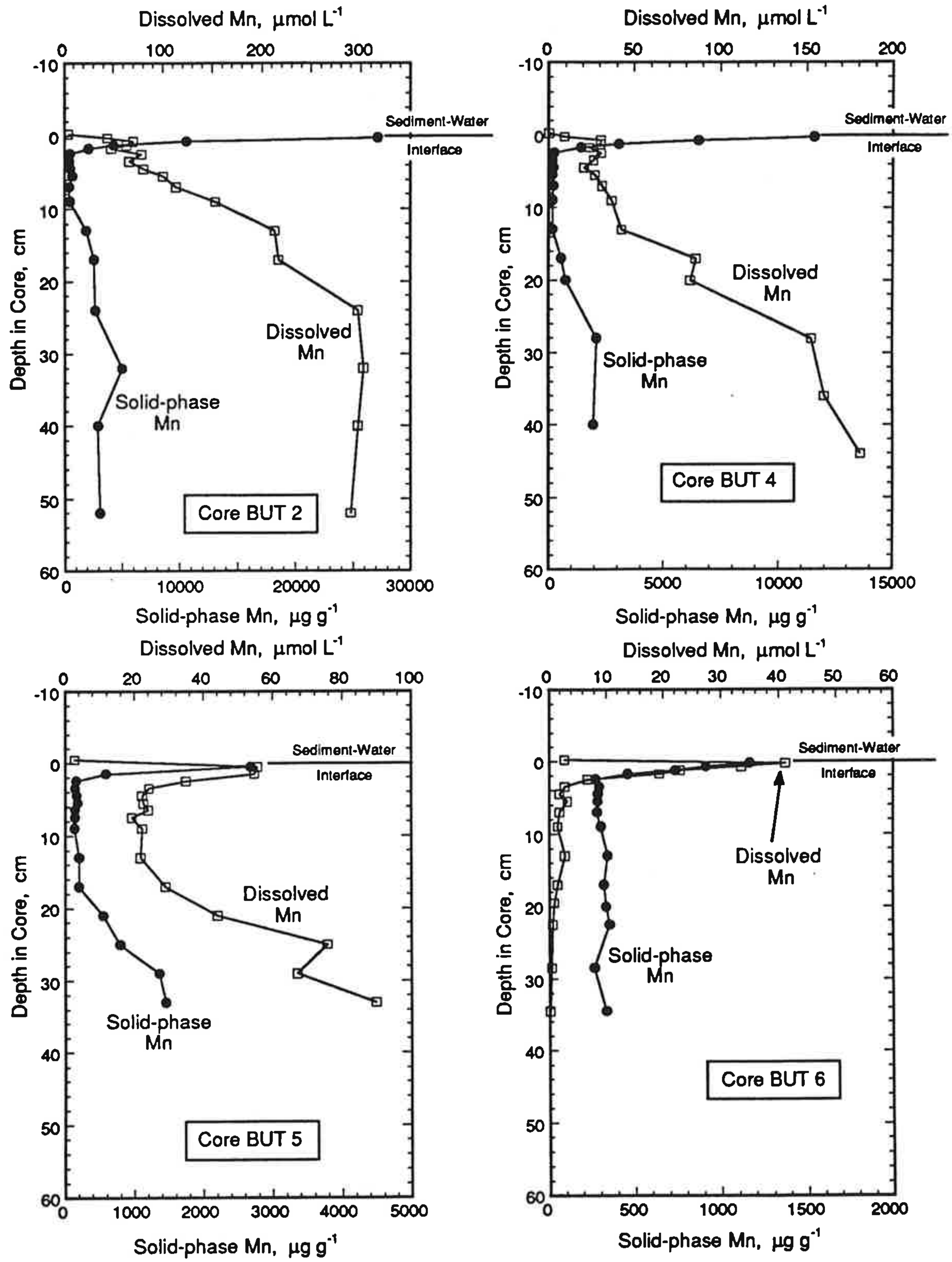


Figure 4-1 Dissolved and solid-phase Mn concentration profiles in cores from the south basin of Buttle Lake. Note the variable scales on the abscissae.

depositional regime markedly and suddenly changed in the south basin (i.e. when the tailings discharge ceased in 1984). Thus, it is not surprising that diffusion has not yet smoothed the pore water profiles. There has been insufficient time since the tailings deposition ceased for a new diagenetic equilibrium to become established. This observation applies to all four cores, and the same reasoning applies to the heavy metal distributions as discussed below.

The near-surface solid-phase and dissolved Mn distributions indicate that Mn oxyhydroxides must be precipitating at or very near the sediment-water interface at all sites. Thus, at least part of the solid-phase Mn maximum at the surface in each core can be attributed to diagenetic ingrowth as Mn oxides are buried just below the interface where they dissolve and support an upward diffusive flux of dissolved Mn. This, in turn, fosters the diagenetic accumulation of the element at the sediment surface.

In addition, detrital Mn and Fe oxyhydroxides must also be contributing significantly to the surface enrichments of these elements seen at the coring sites. Both phases are ubiquitous components of fluvial detritus typically occurring as coatings on particles (see Chapter 3 in Rescan, 1989, for a review).

As is the case for manganese, dissolved iron is added to pore water at shallow depths at all sites. At station BUT 6, for example, reductive dissolution of Fe oxyhydroxides must be occurring within 15 mm of the sediment-water interface (Figure 4-2); in BUT 2, 4 and 5, the dissolved Fe distributions indicate significant addition of $Fe^{2+}$ to pore water at about 20 mm depth. Above this horizon, upward concavity in the dissolved Fe profiles indicates consumption from solution reflecting oxidation and precipitation of upward-diffusing $Fe^{2+}$. This is presumably where the metal first encounters $O_2$ diffusing downward from the overlying lake water. Because Fe oxyhydroxides dissolve at a lower redox potential than Mn oxides, and because $Fe^{2+}$ oxidizes much more rapidly than $Mn^{2+}$ at ambient pH, the dissolved Mn and Fe distributions show a slight spatial separation at all sampling locations. $Mn^{2+}$ appears at high concentrations in the four cores some 5 to 10 mm above the depths where the dissolved Fe content jumps suddenly upward (Figure 3-15 and Appendix G). This difference may be responsible for the occurrence of the solid-phase Fe peak at 1.5 cm depth in cores BUT 2 and 4, just below its counterpart for Mn (compare Figures 4-1 and 4-2). The peak is interpreted to represent ingrowth of authigenically precipitated FeOOH, as a result of upward diffusion of $Fe^{2+}$ and precipitation near the surface.

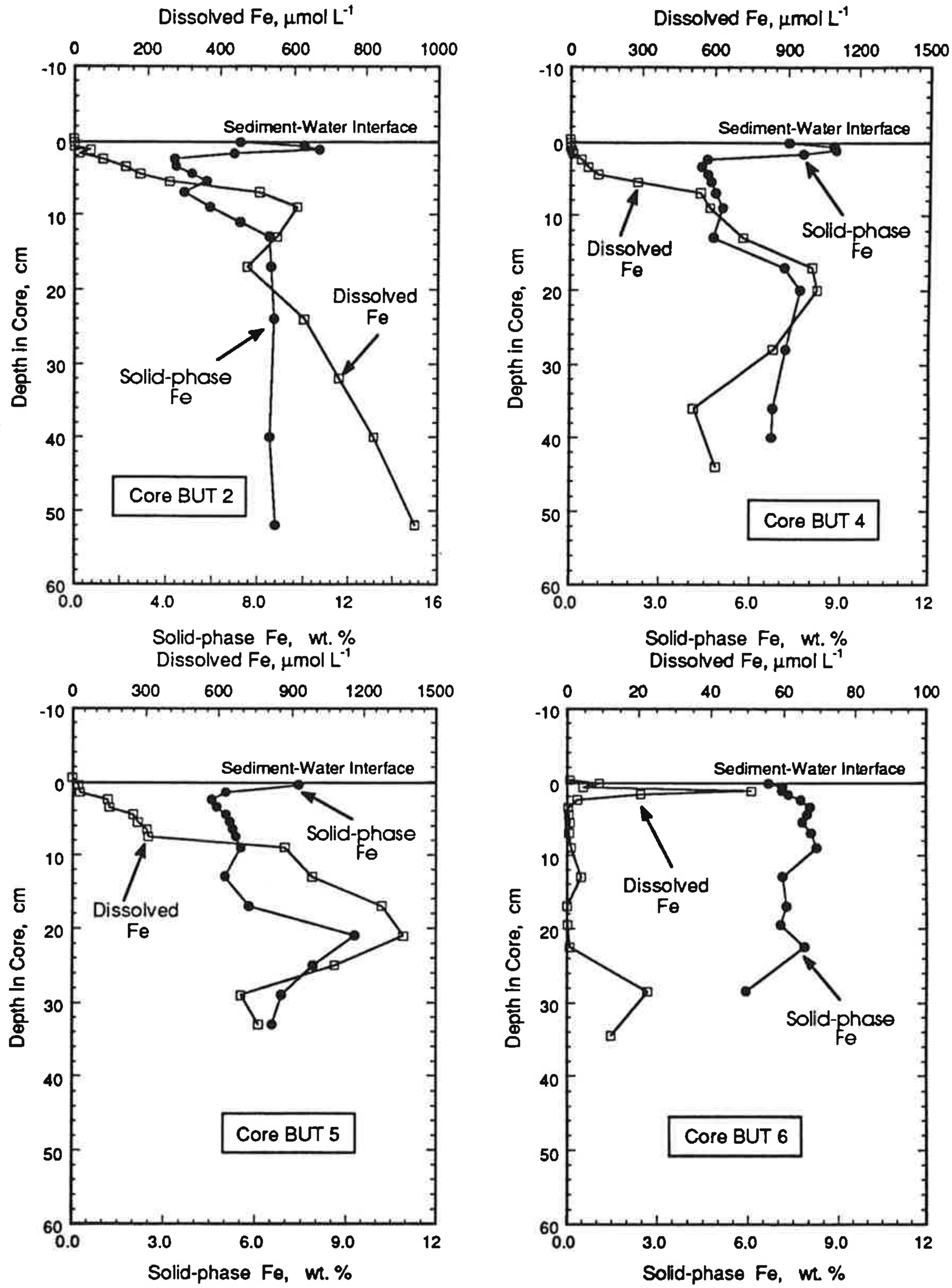


Figure 4-2 Dissolved and solid-phase Fe concentration profiles in cores from the south basin of Buttle Lake. Note the variable scales on the abscissae.

## 4.4 Zn, Cu, Pb and Cd Diagenesis

In the upper two decimetres of the "rapidly-accumulating pure tailings" facies represented by core BUT 6, dissolved Zn, Cu, Pb and Cd concentrations are extremely low (Figures 3-13 and 3-14, and Appendix G). Zn and Cd levels are lower than in the overlying lake water, while Pb and Cu values are of the same order as concentrations in south basin deep water. These distributions indicate that there can be no efflux of dissolved metals from the submerged tailings to the overlying water at this site.

Relatively high concentrations of Zn, Cu, Pb, Cd and Fe do occur in pore waters in the lower decimetre of core BUT 6, suggesting that release from solid phases is occurring at depth at this location. Why this should be the case is not clear. Certainly, there are no obvious changes in the elemental or mineralogic composition of the tailings in the lower half of this core, other than a marked depletion of the organic carbon content in the lowermost 20 cm (Appendix E), which could indicate an overall solid-phase compositional control on the pore water distributions.

At the other three sampling locations, where the tailings accumulated relatively slowly, several factors appear to control the dissolved heavy metals distributions. Each will be discussed in turn. First, sulphate reduction should be occurring at relatively shallow depths, considering that dissolution of Mn and Fe oxides occurs near the sediment-water interface. Methane is also abundant in the natural sediments below the tailings layers, indicating strongly reducing conditions at depth in the cores. The concomitant production of $H_2S$, as sulphate is reduced, should foster the precipitation of sulphide minerals, particularly FeS and/or $FeS_2$; where $H_2S$ is present (in solution largely as $HS^-$), the trace heavy metals should also precipitate, either as discrete phases (CuS, ZnS, CdS and PbS) or in solid solution with the authigenic iron sulphides. Such precipitation has been shown to occur naturally within the top 20 mm of the sediments in some lakes in eastern Canada (Carignan and Tessier, 1985; Carignan and Nriagu, 1985). Thus, the low concentrations of dissolved heavy metals in the natural sediment layers in the three cores are attributed to precipitation of authigenic sulphide minerals. Mn is unlikely to precipitate as a sulphide phase because MnS is relatively soluble (Jacobs and Emerson, 1982). Indeed, unlike the other metals, there is no indication of removal of dissolved Mn from solution at depth in the cores. In contrast to MnS, FeS is highly insoluble; the persistently-high dissolved iron concentrations at depth are thus attributed to a lack of dissolved sulphide, which reflects the low concentration of $SO_4^{2-}$ ion available for bacterially-mediated reduction in most lake waters.

Second, in all three cores there are discrete zones of metal release which are defined by the distributions of all four heavy metals, as discussed in Section 3.3. Sampling artifacts and/or contamination can be ruled out as a source of these irregularities in the profiles, given the consistent distributions of the four metals, the consistently extremely low concentrations in pore waters extracted from the natural sediments underlying the tailings, and the smoothness of the iron and manganese profiles. The one exception may be the high Zn concentration at 9 cm depth in BUT 5, which is not matched by commensurate increases in dissolved Cu, Pb and Cd. Non-steady-state depositional effects in south basin sediments are expected to be reflected by discontinuities in the pore water profiles, particularly relative to the distribution of diagenetically recycled phases (e.g. Mn and Fe oxides) as discussed in Section 4.3. The thin dissolved-metal-rich horizons seen in cores BUT 2, 4, and 5 therefore may have been influenced by non-steady-state effects. For example, the cessation of tailings discharge would have increased the exposure time of tailings at the sediment surface to bottom water oxygen for some period until an anoxic veneer of natural sediments had accumulated. During this period (from July 1984 to some later date) oxidation of the tailings could have occurred, with concomitant release of trace heavy metals from the more soluble oxidized alteration products. It is possible that the high concentrations of Zn, Cu, Pb and Cd seen between 4 and 10 cm depth in BUT 2, 4 and 5 are a waning reflection of this transition period, although there are no visual signs of oxidation of the tailings in this zone. In any event, past oxidation cannot be the sole explanation for the distributions.

The fact that the dissolved metal-rich zones are so thin implies that they are being dynamically maintained by zones of production and consumption. Otherwise, diffusion operating over time-scales of a few years would have at least partly smoothed the discontinuities seen in the present data. The precipitation (and sedimentation) of Fe and Mn oxyhydroxides in the near-surface sediments in the south basin can be expected to provide an adsorbent veil for upwardly diffusing trace metals because both oxide phases have a high scavenging capacity for a range of metallic cations and anions (see Chapter 3 in Rescan, 1989). Indeed, adsorption of Zn from pore water onto FeOOH in the upper 40 to 60 mm at sites BUT 2 and 4 (and less obviously in BUT 5) is implied by the spatial correlation between the dissolved Fe and Zn profiles near the sediment-water interface (Figure 4-3). Negative curvature (i.e. upward concavity) can be seen in

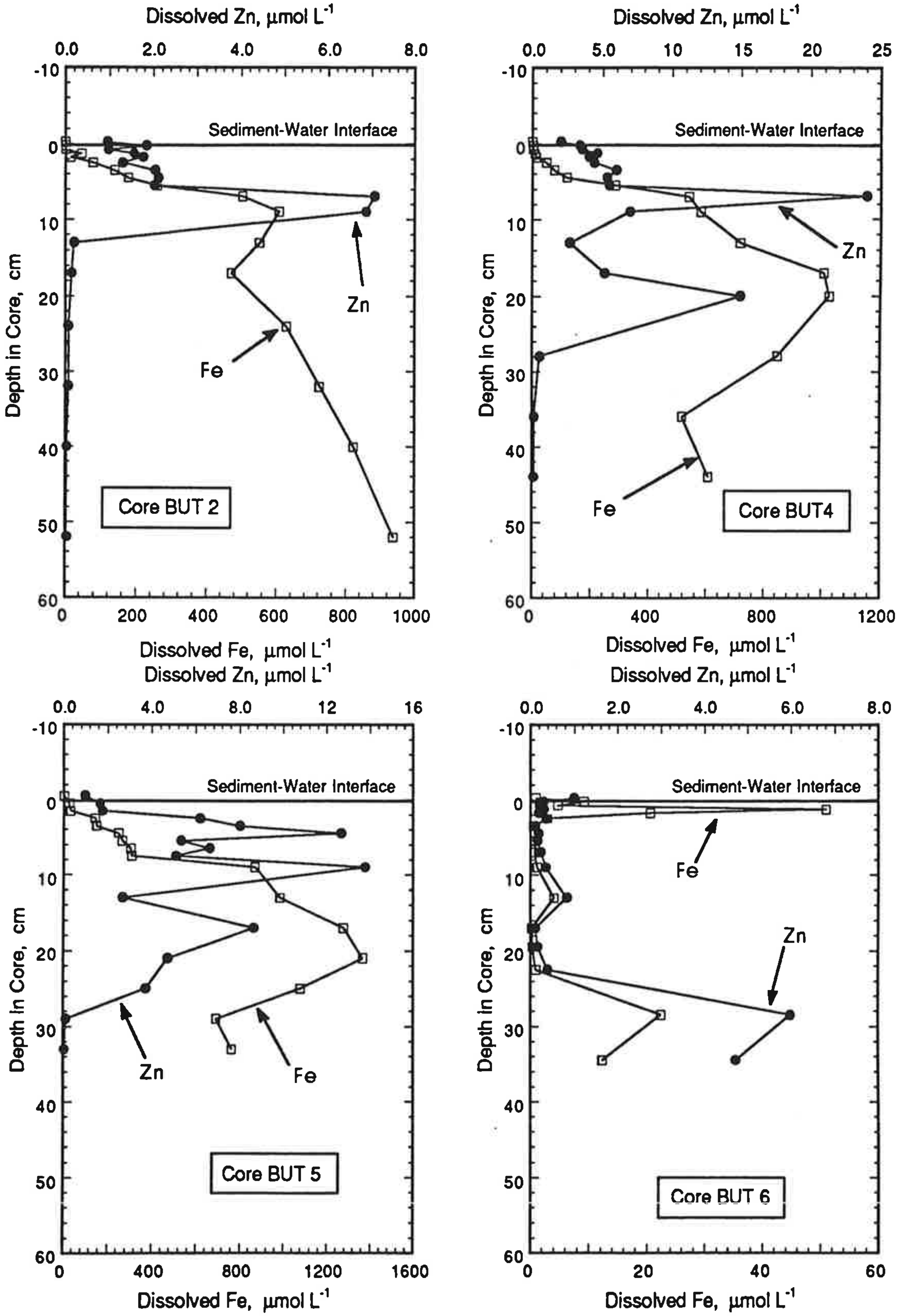


Figure 4-3 Dissolved Zn and Fe profiles in pore waters extracted from cores collected in the south basin of Buttle Lake. Note the variable scales on the abscissae.

the profiles of both elements in the top 6 cm at all three sites, indicating removal from solution. Presumably, Fe is being freshly precipitated as an oxyhydroxide phase and Zn is being scavenged by this authigenic product. The congruent Cu, Pb and Cd distributions imply that these metals are being similarly scavenged. The corollary of this model is that as FeOOH is subsequently buried and reduced, the trace metals will be recycled to interstitial solution and will diffuse upward to be rescavenged, or downward to be fixed in (presumably) sulphide phases in the underlying sulphate reduction zone. However, this simple model cannot explain why double maxima are seen in the trace metal profiles in BUT 4 and 5 (Figure 3-14).

It is well known that dissolved humic acids precipitate at low pH (e.g. Sholkovitz, 1976). Such precipitates were noted in several of the acidified pore water samples during analysis for dissolved metals (see Appendix G). Dissolved humic acids have a high complexing capacity for trace metals (see Rescan, 1989, p. 3-20), and where such compounds are abundant in solution, they can promote high concentrations of dissolved metals because they have a higher affinity for metallic cations than many inorganic solid-phase ligands (Stumm and Morgan, 1981). It is thus noteworthy that the highest dissolved heavy metal contents occur in the same samples as the humic acid precipitates (Appendix G). Why the DOC (dissolved organic carbon) content should be high in these samples is not clear - the sedimentary organic C and total N profiles (Figure 3-8) show no relationship with the occurrence of the organic precipitates, and there is similarly no correlation with variations in the composition of the organic material as indicated by the C/N ratio profiles (Figure 3-9). Nevertheless, it appears that the discrete zones where the dissolved metal concentrations are high are at least partly related to the occurrence of high DOC levels in the same horizons. An important implication of this association is that diffusion coefficients of metal-organic complexes are significantly smaller than for uncomplexed ions; thus the presence of dissolved humic compounds in sediments will act to lessen diffusive fluxes of metals.

Finally, the dissolved Cd concentration is higher in the uppermost 5 mm at stations BUT 2 and 4 than in the supernatant water or pore water in the immediately underlying sediments (Figure 3-14). We suggest that such distributions reflect the delivery of Cd to the sediment surface by settling organic matter of planktonic origin, and its subsequent release to solution as the organic material is metabolized. Support for this cycle is offered by the observation that some metals, such as Cu, are extracted by algae from the epilimnion of British lakes and carried to the sediment-water interface where they are released back into the hypolimnion (Hamilton-Taylor et al., 1984). Similarly, Gobeil et al. (1987) reported that Cd is released to solution at the interface in shallow marine sediments in the Laurentian Trough, presumably as a result of degradation of recently-settled organic material. The metal diffuses both upward and downward from the surface maximum, consumption at depth being due either to adsorption onto freshly-precipitated Mn oxides or precipitation of CdS. Such considerations apply equally to the sediments in BUT 2 and 4.

### 4.5 Benthic Fluxes

The concentrations of metals measured in the supernatant waters at each of the four core sites are very close to the values measured by Waste Management Branch personnel during the last seven months of 1989 (L. Erickson, pers. comm.). This comparison suggests that the measured dissolved metals concentrations in the core top water reasonably represent the metal levels in bottom water in the south basin. In order to produce reasonable estimates of benthic influxes or effluxes of metals to or from the sediments, we have chosen to use the mean of the concentrations of each metal measured in the four supernatant water samples (the slightly high Zn value in the supernatant for BUT 4 was omitted from the calculation of the mean for Zn). These average values are taken as being representative of the metal levels in the bottom water of the south basin.

Diffusive fluxes across the sediment-water interface are calculated from Fick's first law:

$$J = - \phi(K_c/F)(\partial C/\partial x)$$

where $\phi$ is the porosity (assumed here to be 1, since the water content in the organic-rich natural sediments was very high; the flux will be only slightly overestimated by the adoption of 100% porosity). $K_c$ is the diffusion coefficient for each metal (from Li and Gregory, 1974) corrected for estimated *in situ* temperature (6°C); the metals are presumed to occur largely as divalent ions - no allowance is made for complexation in the calculations. The coefficients are thus $4 \times 10^{-6}$ $cm^2$ $s^{-1}$ for Zn, Cu and Cd, and $5.5 \times 10^{-6}$ $cm^2$ $s^{-1}$ for Pb. $\partial C/\partial x$ is the concentration gradient calculated as the concentration difference between the bottom water (2.5 mm above the interface) and the mean dissolved metal concentration in the top cm of the sediments (taken to be at a depth of 5 mm; thus $\partial x$ is 0.75 cm). F is the formation factor (Manheim, 1970) which takes into account the tortuous diffusion path of an ion in wet sediments. Given the high water content of the uppermost sediments at each core site, we estimate the formation factor to be only slightly greater than unity; thus F is taken to be 1.1. No corrections are applied here for the possible electrical coupling of the divalent metal ions to the fluxes of major ions (see Lasaga, 1979), since the latter are unknown. In eastern Canadian lakes, Carignan and Tessier (1985) found that correcting for the coupling effect required a relatively small adjustment in the calculated flux for $Zn^{2+}$ (about +10% in one lake, and -7% in another). Since we have no major ion data, we have chosen to ignore this small potential effect on our calculated fluxes.

The flux calculations are listed in Table 4-2. Several points are noteworthy. First, Zn and Cd are diffusing from the overlying lake water into the tailings at site BUT 6. This is a reflection of the extremely low pore water metal concentrations in this facies and is similar to the result reported by Pedersen (1983a) for the rapidly accumulating tailings.

Second, Cd fluxes in general are very low; those out of the sediments are very similar to fluxes measured directly by Westerlund et al. (1986) in unpolluted Swedish coastal marine sediments (about 0.4 nmol $cm^{-2}$ $yr^{-1}$) and effluxes from unpolluted sediments in the Laurentian Trough (0.1 to 0.3 nmol $cm^{-2}$ $yr^{-1}$) estimated by Gobeil et al. (1987).

Third, Pb is diffusing out of the sediments at stations BUT 4, 5, and 6 but at an extremely low rate, on the same order as Cd. As far as we know, these are the first reported Pb fluxes from lake sediments, so we are unable to compare these results with data from other studies; however measurements of Pb in pore water made by Westerlund et al. (1986) in coastal marine sediments imply fluxes somewhat lower in magnitude than the low levels reported here. Pb appears to be diffusing from the lake water into the deposits at station BUT 2.

Fourth, the indicated benthic efflux of Cu at each location is also very low and is of the same order as effluxes measured by Westerlund et al. (1986) in Swedish shallow marine sediments, Pedersen (1985) in Holberg Inlet on Vancouver Island (0.4 nmol $cm^{-2}$ $yr^{-1}$) and by Heggie (1983) in unpolluted sediments in Resurrection Bay, Alaska (3 nmol $cm^{-2}$ $yr^{-1}$). Finally, Zn effluxes at stations BUT 2, 4 and 5 range from 7 to 38 nmol $cm^{-2}$ $yr^{-1}$, higher than those for the other metals. These levels are comparable to the natural flux emanating from unpolluted Swedish coastal sediments measured directly by Westerlund et al. (1986). To put the potential impact of this flux in context, we have integrated the maximum flux (38 nmol $cm^{-2}$ $yr^{-1}$) over the area of the bottom of the south basin

**Table 4-2**

**Calculated benthic fluxes of selected metals from sediments in the south basin of Buttle Lake. Concentration gradients ($\partial C/\partial x$) are all in units of $10^{-3}$ $\mu$mol $cm^{-4}$ of selected metals from sediments in the south basin of Buttle Lake. Fluxes (J) are all in units of nmol $cm^{-1}$ $yr^{-1}$.**

| Metal | | Station BUT 2 | BUT 4 | BUT 5 | BUT 6 |
|---|---|---|---|---|---|
| Zn | $\partial C/\partial x$ | 0.6 | 3.3 | 1.0 | -1.0 |
| | J | -7 | -38 | -11 | **+11** |
| Cu | $\partial C/\partial x$ | 0.17 | 0.21 | 0.08 | 0.002 |
| | J | -1.8 | -2.5 | -0.9 | -0.3 |
| Pb | $\partial C/\partial x$ | -0.001 | 0.009 | 0.023 | -3.0 |
| | -J | **+0.2** | -2 | -0.4 | -0.8 |
| Cd | $\partial C/\partial x$ | 0.006 | 0.006 | -0.003 | -0.0035 |
| | J | -0.7 | -0.7 | **+0.4** | **+0.4** |

**A negative sign indicates that the metal concentration in pore water is less than in the overlying lake water.**
**A negative sign indicates a flux out of the sediments.**
**Fluxes into the sediments are highlighted.**

assumed to be covered by deposits chemically similar to those cored at stations BUT 2, 4 and 5. Such deposits are roughly estimated to cover 2 $km^2$ (4 km by 0.5 km) of the floor of the south basin. In one year (approximately the residence time for water in the south basin), the total release of Zn to bottom water would be about 760 mol, or about 50 kg. This would be buffered to some extent by the uptake of Zn by deposits similar to those at BUT 6. Fifty kg of Zn added to the lower 50 m of south basin water (a volume of about 0.3 x $10^{12}$ L) would increase the concentration by only 0.003 nmol $L^{-1}$ (about 0.2 parts per trillion). This number is, of course, poorly constrained given the crude assumptions used in the calculations, but it is probably of the right order. Clearly, the benthic efflux of Zn implied by the pore water profiles at stations BUT 2, 4 and 5 is so small as to have an immeasurable impact on water quality.

# 5 - Conclusions

# 5.0 CONCLUSIONS

1. Zn-, Cu- and Pb-rich tailings are widely distributed across the south basin of Buttle Lake, and are now being covered with a veneer of organic-rich sediments at a rate on the order of 4 mm $yr^{-1}$ at all sites. High solid-phase metal concentrations are still observed in the upper 5 mm at all four core locations, which presumably reflects upward mixing of tailings by burrowing infauna.

2. Profiles of dissolved and solid-phase Mn and Fe indicate that at all locations, the deposits are anoxic below depths of about two or three cm.

3. Dissolved metals levels in pore waters in methane-bearing natural sediments underlying the tailings are extremely low, probably due to precipitation of authigenic sulphide minerals. High-resolution profiles in the upper two decimetres indicate that dissolved Zn, Pb, Cu and Cd concentrations are very low in tailings near the site of the former discharge point. In distal deposits, where the tailings accumulated more slowly and have formed a layer one to two decimetres thick, one or two thin and discrete zones of relatively high dissolved metals levels are observed. The control on these distributions is not clear, but the high metal values are associated with high dissolved organic carbon contents in the same horizons, suggesting that complexation by organic ligands may be important in keeping metals in solution.

4. A spatial correlation between increases in dissolved Fe in the upper several cm of the cores and increases of Zn, Cu, Pb and Cd in pore waters at approximately the same depths implies that dissolution of Fe oxyhydroxides may be releasing heavy metals to interstitial waters at shallow depths. The corollary of such an association is that freshly-precipitated FeOOH, which forms in the upper portion of the sediment column where upward-diffusing dissolved Fe reacts with downward-diffusing $O_2$, may be scavenging heavy metals from solution. Upward concavity seen in the uppermost several cm of the pore water metal profiles supports this suggestion. This implies that the Fe and Mn oxide-rich veneer at the core top is providing an absorbent veil which reduces upward diffusion of dissolved heavy metals from enriched zones below.

5. Comparison of the pore water metals profiles with the concentration of dissolved metals in south basin deep water indicates the metals must be diffusing into the tailings at the site near the former discharge raft. At the other locations there are very small effluxes of metals in most cases. Benthic flux calculations indicate that the amounts of Cu, Cd and Pb which can be diffusing out of the bottom are on the same order as is typically observed in unpolluted natural sediments. The largest efflux is of Zn; simple calculations indicate that if integrated over the appropriate area of the floor of the south basin, the Zn flux could increase the steady-state Zn content in deep water by less than 0.2 ng $L^{-1}$ (<0.2 parts per trillion).

6. Based on the high-resolution interstitial water data presented in this report, it is clear that the now-buried tailings in the south basin of Buttle Lake are having a negligible impact on water quality in this basin.

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## Appendix A

# Detailed Core Descriptions

# APPENDIX A: DETAILED CORE DESCRIPTIONS

## CORE BUT 2: North end of South Basin

87 m water depth, 61.5 total length; excellent, undisturbed interface; entry speed <0.2 m $sec^{-1}$; clear supernatant; capped and hand-held back to minesite.

**Log Description:**

0-3 mm: Medium brown fluff layer, undisturbed, some organic fragments visible on surface, along with thin string-like faecal casts. Very fine-grained, uncompacted, non-cohesive.

3-4 mm: pale brown; otherwise similar.

4-9 mm: chocolate brown; otherwise similar.

9-16 mm: pale brown; same material but slightly more compact.

16-18 mm: rusty-brown; similar to 9-16 mm interval.

18-21 mm: fluffy layer, poorly compacted, olive grey colour.

21-26 mm: very pale brown, similar to 9-16 mm interval.

26-29 mm: pale greyish brown.

29-70 mm: very fine-grained tailings evident, laminated on a variable 1-3 mm interval. 1 mm thick rusty layers at 40 mm and 50 mm. Occasional brown specks (organic matter?) disseminated throughout.

70-140 mm: more massive tailings; silty-gray, non-laminated.

140-615 mm (end): natural silt, pale olive gray-green. Organic fragments throughout. Lower 400 mm of core show signs of $CH_4$ degassing (bubbles formed *in situ*).

## CORE BUT 4: Eastern edge of axial trough, central South Basin

41 m water depth; 49 cm total length; pristine interface.

**Log Description:**

0-5 mm: fluffy, floc-like surface layer - medium dark brown.

5-15 mm: paler, slightly orange brown, uncompacted, very fine-grained.

15-20 mm: transitional to gray, unoxidized very fine-grained tailings.

20-280 mm: tailings, upper 150 mm of which are laminated on 1-2 mm scale. Occasional dark specks, presumably organic matter.

250-280 mm: more massive, dark steely-gray unlaminated tailings.

280-490 mm: natural sediments, dark olive-green silts, abundant organic fragments, evidence of $CH_4$ degassing.

## CORE BUT 5: South end of axial trough, north of mouth of Myra Creek

39 m water depth; 46 cm total length; slightly disturbed interface (domed top); probably about 5 mm lost around edges (corer entered slightly too quickly). Little resuspension evident; supernatant generally clear - some resuspended floc/fluff.

**Log Description:**

0-5 mm: domed, medium chocolate brown, uncompacted, fine-grained, organic fragments evident.

5-20 mm: orange-brown, same material.

20-300 mm: tailings, laminated throughout (particularly to 150 mm) on a 1-5 mm scale; occasional brownish layers ($<1$ mm thick) within tailings.

300-460 mm: natural sediments; homogeneous medium olive-green silt; organic fragments throughout; $CH_4$ bubbles formed before processing.

Overall: very similar to BUT 4. About 5 cm lost from bottom of core when inserting extrusion piston prior to processing.

## CORE BUT 6: Southwest end of axial trough, near site of former tailings discharge raft

42 m water depth; 45.5 cm total length. Plastic core catcher used which disturbed the interface (~top 1 cm).

**Log Description:**

0-12 mm: mixture of silty (to fine sand?) tailings and natural sediments, overlain by ~3 cm of gray water with suspended extremely fine tailings particles (essentially not settling). This layer was undoubtedly disturbed.

12-450 mm: essentially featureless, homogeneous gray silt-to-fine-sand-sized tailings. Fresh pyrite clearly visible. Note: tailings throughout the core looked very fresh - no signs of oxidation,

Appendix B

# Analytical Methods and Quality Control Data

Rescan

# APPENDIX B: ANALYTICAL METHODS AND QUALITY CONTROL DATA

## Graphite Furnace Atomic Absorption Analysis

Dissolved metal concentrations in pore waters were determined by direct-injection graphite-furnace atomic absorption spectrophotometry using a Varian SpectrAA 300 spectrophotometer with Zeeman background correction and a PSD 96 autosampler. All determinations were conducted using pyrolitic L'Vov platforms using peak area measurements and operating conditions adapted from those recommended by the manufacturer.

Standards were prepared by diluting 1000 ppm standard solutions with 1% twice-quartz-distilled $HNO_3$ in distilled deionized water. Where pore water metal concentrations were outside the linear calibration range, samples were diluted with the same 1% $HNO_3$.

To check the accuracy of the analyses, two pore water samples with very different metal levels were reanalyzed on different days using both the standard calibration curves method and standard additions. The results are presented in Table B-1. The concentrations determined by both methods are in good agreement. Also shown in the table are analytical precision estimates and the detection limit for each metal, defined in this study as six times the standard deviation of the blank.

## X-Ray Fluorescence Analysis

Following freeze-drying and grinding of the sediment samples to fine powders in a tungsten carbide disc mill, major and minor element concentrations were respectively measured on cast glass and pressed powder discs, using an automated Philips PW 1400 X-ray fluorescence spectrometer equipped with a Rh target anode. Glass discs were prepared using a slight modification of the method of Norrish and Hutton (1970), which eliminates the need to apply specific corrections for matrix absorption effects. For minor elements, a method similar to that described by Harvey and Atkin (1982) was used. The samples were prepared by forming a mixture of 4 g sample and 0.5 g finely-divided wax (Hoechst Wax C) into 32-mm diameter discs in a hydraulic press. Calibration for both sets of measurements was provided by a wide range of international

## Table B-1

### Quality Control Data for GFAAS Measurement of Dissolved Metal Concentrations in Buttle Lake Pore Waters

| Sample (Method) | Mn | Fe | Cu | Zn | Cd | Pb |
|---|---|---|---|---|---|---|
| M1 (normal), Day 1 | 246 | 8.8 | 2.6 | 62.6 | 0.47 | 0.32 |
| M1 (normal), Day 2 | 253 | 9.8 | 2.3 | 57.2 | 0.43 | 0.31 |
| %R.S.D. | 2.0 | 7.6 | 8.7 | 6.4 | 6.6 | 2.2 |
| M1 (std. additions) | 250 | 10.4 | 2.1 | 66.8 | 0.51 | 0.35 |
| M11 (normal), Day 1 | 8400 | 34000 | 281 | 480 | 0.22 | 262 |
| M11 (normal), Day 2 | 8940 | 31700 | 281 | 485 | 0.26 | 262 |
| %R.S.D. | 4.4 | 5.0 | 0 | 0.7 | 6.6 | 0 |
| M11 (std. additions) | 9260 | 28850 | 261 | 570 | 0.24 | 267 |
| Detection limit | 0.25 | 2.7 | 0.53 | 0.077 | 0.035 | 0.3 |

**All measurements are reported in mg $L^{-1}$**
**Normal = measurement by comparison to the linear calibration curve**
**R.S.D. = relative standard deviation**

geochemical reference standards, with discs prepared in the appropriate way, and using the element concentrations recommended by Abbey (1983). Analytical precision can be estimated for major elements by comparing the duplicate discs made for the top two samples from core BUT 4 (Table A). Accuracy was assessed by randomly including several geochemical reference samples as unknowns in the analytical run. The results of these measurements are listed in Table B-2. As can be seen the accuracy of the major element measurements is excellent.

For the minor elements, precision varies depending on the concentrations of the elements, and becomes poor as the detection limit is approached. Detection limits for the elements measured are on the order of 10 mg $g^{-1}$; measured concentrations near this level are precise only to within 50% relative standard deviation. For the concentrations typically encountered in tailings-free sediments, precision is typically better than + 5% ($1\sigma$, r.s.d.). In this study, only the Co and Ni contents approach the XRF detection limit;

## Table B-2

### XRF Major Element Quality Control Data, Comparing Concentrations Determined for Geochemical Reference Standards in this Study (m), with Concentrations Recommended (r) by Abbey (1983)

| Standard | | Fe | Ti | Ca | K | Si | Al | Mg | P | Na |
|---|---|---|---|---|---|---|---|---|---|---|
| NIMG | (m) | 1.38 | 0.06 | 0.56 | 3.12 | 35.37 | 6.51 | 0.01 | 0.00 | 1.25 |
| | (r) | 1.41 | 0.05 | 0.56 | 3.19 | 35.35 | 6.39 | 0.04 | 0.01 | 1.25 |
| AGV1 | (m) | 4.78 | 0.63 | 3.53 | 1.83 | 27.94 | 8.74 | 0.92 | 0.22 | 1.59 |
| | (r) | 4.76 | 0.64 | 3.53 | 1.87 | 27.83 | 9.09 | 0.92 | 0.22 | 1.60 |
| W2 | (m) | 7.52 | 0.64 | 7.71 | 0.42 | 24.15 | 7.70 | 3.80 | 0.06 | 0.83 |
| | (r) | 7.60 | 0.64 | 7.79 | 0.40 | 24.66 | 8.19 | 3.85 | 0.06 | 0.82 |
| NIMS | (m) | 1.04 | 0.01 | 0.49 | 10.01 | 31.82 | 9.56 | 0.26 | 0.06 | 0.14 |
| | (r) | 0.98 | 0.02 | 0.49 | 9.81 | 29.71 | 9.17 | 0.28 | 0.05 | 0.16 |
| G2 | (m) | 1.83 | 0.31 | 1.37 | 2.77 | 32.16 | 8.22 | 0.55 | 0.06 | 1.65 |
| G2 (Repeat) | (m) | 1.83 | 0.30 | 1.37 | 2.79 | 32.32 | 8.09 | 0.49 | 0.06 | 1.51 |
| | (r) | 1.88 | 0.29 | 1.40 | 2.85 | 32.32 | 8.15 | 0.45 | 0.06 | 1.51 |
| BEN | (m) | 8.89 | 1.52 | 9.97 | 0.91 | 17.87 | 5.04 | 7.78 | 0.46 | 1.12 |
| | (r) | 9.03 | 1.57 | 9.97 | 0.90 | 17.93 | 5.35 | 7.97 | 0.46 | 1.19 |
| BHVO1 | (m) | 8.73 | 1.62 | 8.31 | 0.35 | 23.67 | 7.24 | 4.34 | 0.12 | 0.85 |
| | (r) | 8.56 | 1.61 | 8.10 | 0.35 | 23.30 | 7.33 | 4.41 | 0.12 | 0.85 |
| MRG1 | (m) | 12.38 | 2.18 | 10.57 | 0.13 | 18.37 | 4.44 | 7.94 | 0.03 | 0.27 |
| | (r) | 12.48 | 2.21 | 10.56 | 0.12 | 18.36 | 4.50 | 8.13 | 0.02 | 0.26 |

**Results expressed as weigh percent (Wt.%)**

all other elements are well above the limit of detection. Accuracy of the measurements was assessed as for major elements. The results are listed in Table B-3 and are acceptable, given that the accuracy of the recommended reference standard values is often not that well constrained.

It should be noted that the extremely high Zn, Cu, Pb and Ba concentrations in the tailings lie outside the concentration range of the available reference standards used to calibrate the XRF. Extrapolation of the calibration curve to the range of the concentrations of these elements measured in the tailings probably introduced some inaccuracy; therefore the levels of these metals in the tailings samples reported in Appendix D should be considered to be good estimates, but not accurate in an absolute sense. This poses no difficulty given that the solid-phase minor element measurements have been used in this study only to assess the relative lateral and vertical distributions of the tailings.

**CNS and $CaCO_3$ Analysis**

Total carbon, nitrogen and sulphur were determined using elemental analysis. Total C and N were measured using a Carlo-Erba 1106 Elemental Analyzer which combusts the sample in a stream of $O_2$, separates the combustion gases ($CO_2$ and $N_2$ reduced from $NO_x$) chromatographically, and measures the gas concentrations (thus C and N contents) by thermal conductivity. Sulphur was determined using a Carlo-Erba NA-1500 CNS Analyzer, which employs the same methodology. The use of the two different instruments was required because the high sulphur content of the tailings swamped the C and N channels on the CNS Analyzer with $SO_2$. The analyzers are calibrated using acetanilide and the NRC marine sediment standards MESS-1 and BCSS-1. Accuracy is excellent; agreement with the recommended values for total C and N is always within analytical precision. The precision of the measurements ($1\sigma$, R.S.D.) was about 1.5%, 3% and 3% for C, N and S respectively.

Carbonate carbon was determined on all samples by coulometry using a Coulometrics Analyzer, which electrochemically measures the $CO_2$ evolved following addition of HCl to a sample. Concentrations were very low in the natural sediments (typically $<0.1$ wt. %), but ranged up to 0.8 wt.% in the tailings. Precision of the measurements ($1\ \sigma$, R.S.D.) was better than 3% for the higher carbonate carbon concentrations.

Organic carbon was determined by subtracting carbonate carbon from the total C measurements. Precision of the resulting organic C value was about $\pm$ 5 % ($1\ \sigma$, R.S.D.).

**X-ray Diffraction Analysis**

Samples were ground in a tungsten carbide disc mill to pass 200 mesh, and pressed in random orientation into a rigid disc held in an aluminum planchet. The samples were

## Table B-3

### XRF Minor Element Quality Control Data, Comparing Concentrations Determined for Geochemical Reference Standards in this Study (m), with Concentrations Recommended (r) by Abbey (1983)

| | | Zr | Sr | Rb | Pb | Zn | Cu | Ni | Co | Mn | V | Cr | Ba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGV1 | (m) | 231 | 610 | 64 | 32 | 72 | 68 | 4 | 17 | 778 | 88 | 29 | 1123 |
| | (r) | 230 | 660 | 67 | 33 | 86 | 59 | 15 | 16 | 728 | 125 | 10 | 1200 |
| BHVO1 | (m) | 171 | 369 | 14 | 3 | 88 | 142 | 97 | 40 | 1224 | 190 | 279 | 104 |
| | (r) | 180 | 420 | 10 | n.a. | 105 | 140 | 120 | 45 | 1316 | 300 | 320 | 135 |
| W2 | (m) | 92 | 180 | 21 | 9 | 63 | 91 | 44 | 38 | 1218 | 202 | 93 | 162 |
| | (r) | 100 | 190 | 21 | n.a. | 80 | 105 | 70 | 43 | 1300 | 260 | 92 | 175 |
| NIMS | (m) | 35 | 60 | 483 | 3 | 12 | 16 | 25 | 4 | 69 | 23 | 12 | 2269 |
| | (r) | 33 | 62 | 530 | 5 | 10 | 19 | 7 | 4 | 80 | 10 | 12 | 2400 |
| MRG1 | (m) | 105 | 254 | 9 | 6 | 164 | 133 | 154 | 86 | 1128 | 360 | 522 | 10 |
| MRG1(r) | (m) | 92 | 178 | 17 | n.a. | 139 | 140 | 120 | 69 | 1031 | 326 | 408 | 10 |
| | (r) | 105 | 260 | 8 | 10 | 190 | 135 | 195 | 86 | 1320 | 520 | 50 | 50 |
| G2 | (m) | 291 | 437 | 152 | 29 | 76 | 11 | n.d. | 5 | 260 | 32 | 16 | 1863 |
| | (r) | 300 | 480 | 170 | 30 | 84 | 10 | 3 | 5 | 265 | 36 | 8 | 1900 |
| GSP1 | (m) | 459 | 220 | 231 | 53 | 94 | 35 | 12 | 7 | 300 | 38 | 20 | 1234 |
| | (r) | 500 | 240 | 250 | 54 | 105 | 33 | 9 | 7 | 326 | 54 | 12 | 1300 |
| SY2 | (m) | 260 | 237 | 171 | 72 | 225 | 6 | 48 | 12 | 2406 | 35 | 11 | 462 |
| | (r) | 280 | 275 | 220 | 80 | 250 | 5 | 10 | 11 | 2480 | 52 | 12 | 460 |

**Results expressed as $\mu g\ g^{-1}$ (ppm).**

scanned using a Philips PW 1775 X-ray diffractometer powered by a Philips PW 1729 constant potential generator and equipped with a Philips PW 1050/70 vertical goniometer. A curved graphite crystal monochromator, an automated divergence slit , a 1° scatter slit, a gas proportional counter and CuK$\alpha$ radiation were used in the analysis. The diffractometer was controlled by a Philips PW 1710/00 microprocessor unit, and the data were reduced using a Zenith Z-150 PC. Analytical conditions employed included scanning from 4° to 60° 2$\theta$ in 0.03° 2$\theta$ increments, using a counting time of 3 seconds per increment. Diffractograms were recorded using a rate full scale of 500 counts per second, a time constant of 2 sec. and a chart speed of 10 mm/°2$\theta$.

Appendix C

# Water Quality and Climate Data

# Present Water Quality of Buttle Lake

## Table C-1

## Buttle Lake Water Quality-Station BUT 2

| Site Number | BUT 2-A | BUT 2-B | BUT 2-C |
|---|---|---|---|
| Date Sampled | Apr 25/90 | Apr 25/90 | Apr 25/90 |
| Time | 17:15 | 17:00 | 16:45 |
| Depth (m) | 1 | 44 | 88 |
| **Physical Tests** | | | |
| pH (lab) | 7.35 | 7.14 | 7.08 |
| Conductivity | 70.5 | 88.6 | 91.5 |
| Turbidity | 0.5 | 0.2 | 2.1 |
| Hardness (calc) | 31.8 | 38.7 | 39.6 |
| Suspended Solids | 2.0 | 2.7 | 4.0 |
| Fixed Solids | 2.0 | <1.0 | 3.3 |
| Volatile Solids | <1.0 | 2.7 | <1.0 |
| Dissolved Solids | 50.0 | 70.0 | 70.0 |
| **Anions & Nutrients** | | | |
| Alkalinity | 23.9 | 24.4 | 24.0 |
| Sulphate | 8.7 | 15.7 | 16.7 |
| Chloride | <0.5 | <0.5 | <0.5 |
| Silicate | 3.9 | 3.9 | 4.7 |
| T-Phosphorus | 0.002 | 0.002 | 0.003 |
| $NO_3/NO_2$ | 0.064 | 0.11 | 0.13 |
| TOC | 0.83 | 0.82 | 0.80 |
| **Dissolved Metals** | | | |
| Aluminium | 0.025 | 0.027 | 0.040 |
| Arsenic | 0.0003 | 0.0001 | <0.0001 |
| Cadmium | <0.0002 | 0.0002 | 0.0003 |
| Copper | 0.002 | 0.003 | 0.005 |
| Iron | <0.03 | <0.03 | <0.03 |
| Lead | <0.001 | <0.001 | 0.002 |
| Manganese | <0.005 | 0.011 | 0.014 |
| Mercury | <0.00005 | <0.00005 | <0.00005 |
| Nickel | <0.001 | <0.001 | <0.001 |
| Zinc | 0.022 | 0.049 | 0.052 |
| Calcium | 11.5 | 14.2 | 14.5 |
| Magnesium | 0.74 | 0.78 | 0.82 |

**Results expressed as milligrams per litre except for pH, Conductivity (µmhos/cm) and Turbidity (NTU)**
**< = Less than**
**$NO_3/NO_2$ = Nitrate/Nitrite nitrogen**
**TOC = Total Organic Carbon**

## Table C-2

## Buttle Lake Water Quality-Station BUT 4

| Site Number | BUT 4-A | BUT 4-B | BUT 4-C |
|---|---|---|---|
| Date Sampled | Apr 25/90 | Apr 25/90 | Apr 25/90 |
| Time | 16:35 | 16:25 | 16:10 |
| Depth (m) | 1 | 18 | 38 |
| **Physical Tests** | | | |
| pH (lab) | 7.12 | 7.07 | 7.08 |
| Conductivity | 71.1 | 73.9 | 76.1 |
| Turbidity | 0.4 | 0.4 | 0.4 |
| Hardness (calc) | 31.7 | 32.3 | 33.3 |
| Suspended Solids | <1.0 | 4.0 | 4.0 |
| Fixed Solids | <1.0 | <1.0 | <1.0 |
| Volatile Solids | <1.0 | 4.0 | 4.0 |
| Dissolved Solids | 50.0 | 60. | 60. |
| **Anions & Nutrients** | | | |
| Alkalinity | 22.8 | 21.9 | 21.6 |
| Sulphate | 9.2 | 11.5 | 11.7 |
| Chloride | <0.5 | <0.5 | <0.5 |
| Silicate | 4.0 | 3.9 | 3.7 |
| T-Phosphorus | 0.002 | 0.002 | 0.001 |
| $NO_3/NO_2$ | 0.064 | 0.087 | 0.088 |
| TOC | 0.83 | 0.95 | 1.05 |
| **Dissolved Metals** | | | |
| Aluminium | 0.024 | 0.032 | 0.027 |
| Arsenic | 0.0004 | 0.0003 | 0.0003 |
| Cadmium | <0.0002 | <0.0002 | <0.0002 |
| Copper | <0.001 | 0.002 | 0.002 |
| Iron | <0.03 | <0.03 | <0.03 |
| Lead | <0.001 | <0.001 | <0.001 |
| Manganese | <0.005 | 0.007 | 0.009 |
| Mercury | <0.00005 | <0.00005 | <0.00005 |
| Nickel | <0.001 | <0.001 | <0.001 |
| Zinc | 0.026 | 0.031 | 0.036 |
| Calcium | 11.4 | 11.8 | 12.2 |
| Magnesium | 0.70 | 0.68 | 0.69 |

**Results expressed as milligrams per litre except for pH, Conductivity (μmhos/cm) and Turbidity (NTU)**
**< = Less than**
**$NO_3/NO_2$ = Nitrate/Nitrite nitrogen**
**TOC = Total Organic Carbon**

## Table C-3

## Buttle Lake Water Quality-Station BUT 5

| Site Number | BUT 5-A | BUT 5-B | BUT 5-C |
|---|---|---|---|
| Date Sampled | Apr 25/90 | Apr 25/90 | Apr 25/90 |
| Time | 15:08 | 14:55 | 14:40 |
| Depth (m) | 1 | 20 | 40 |
| **Physical Tests** | | | |
| pH (lab) | 7.12 | 7.02 | 7.08 |
| Conductivity | 72.6 | 78.6 | 95.6 |
| Turbidity | 0.5 | 0.4 | 0.9 |
| Hardness (calc) | 32.4 | 34.8 | 35.7 |
| Suspended Solids | 2.7 | 2.0 | 5.3 |
| Fixed Solids | 2.6 | <1.0 | 2.0 |
| Volatile Solids | <1.0 | 2.0 | 3.3 |
| Dissolved Solids | 50. | 60. | 80. |
| **Anions & Nutrients** | | | |
| Alkalinity | 22.3 | 22.5 | 21.9 |
| Sulphate | 10.0 | 12.4 | 12.5 |
| Chloride | <0.5 | <0.5 | 2.7 |
| Silicate | 4.1 | 4.2 | 4.0 |
| T-Phosphorus | 0.002 | 0.003 | 0.002 |
| $NO_3/NO_2$ | 0.072 | 0.093 | 0.083 |
| TOC | 0.95 | 0.94 | 0.93 |
| **Dissolved Metals** | | | |
| Aluminium | 0.024 | 0.029 | 0.026 |
| Arsenic | 0.0005 | 0.0004 | 0.0004 |
| Cadmium | <0.0002 | 0.0004 | <0.0002 |
| Copper | 0.002 | 0.004 | 0.001 |
| Iron | <0.03 | <0.03 | <0.03 |
| Lead | <0.001 | <0.001 | <0.001 |
| Manganese | <0.005 | 0.008 | 0.009 |
| Mercury | <0.00005 | <0.00005 | <0.00005 |
| Nickel | <0.001 | <0.001 | <0.001 |
| Zinc | 0.025 | 0.040 | 0.035 |
| Calcium | 11.8 | 12.7 | 12.5 |
| Magnesium | 0.72 | 0.74 | 1.10 |

**Results expressed as milligrams per litre except for pH, Conductivity ($\mu$mhos/cm) and Turbidity (NTU)**
**< = Less than**
**$NO_3/NO_2$ = Nitrate/Nitrite nitrogen**
**TOC = Total Organic Carbon**

## Table C-4

## Buttle Lake Water Quality-Station BUT 6

| Site Number | BUT 6-A | BUT 6-B | BUT 6-C |
|---|---|---|---|
| Date Sampled | Apr 25/90 | Apr 25/90 | Apr 25/90 |
| Time | 15:25 | 15:35 | 15:50 |
| Depth (m) | 1 | 22 | 44 |
| **Physical Tests** | | | |
| pH (lab) | 7.11 | 7.14 | 7.09 |
| Conductivity | 74.2 | 76.5 | 88.0 |
| Turbidity | 0.4 | 0.3 | 0.3 |
| Hardness (calc) | 32.5 | 33.0 | 34.6 |
| Suspended Solids | 2.7 | <1.0 | <1.0 |
| Fixed Solids | <1.0 | <1.0 | <1.0 |
| Volatile Solids | 2.7 | <1.0 | <1.0 |
| Dissolved Solids | 60. | 60. | 70. |
| **Anions & Nutrients** | | | |
| Alkalinity | 22.0 | 23.8 | 23.5 |
| Sulphate | 11.6 | 11.0 | 15.2 |
| Chloride | <0.5 | <0.5 | <0.5 |
| Silicate | 4.0 | 4.0 | 3.6 |
| T-Phosphorus | 0.004 | 0.002 | 0.004 |
| $NO_3/NO_2$ | 0.072 | 0.089 | 0.11 |
| TOC | 0.97 | 0.95 | 0.94 |
| **Dissolved Metals** | | | |
| Aluminium | 0.026 | 0.022 | 0.027 |
| Arsenic | 0.0004 | 0.0002 | 0.0002 |
| Cadmium | <0.0002 | <0.0002 | 0.0003 |
| Copper | 0.002 | <0.001 | 0.003 |
| Iron | <0.03 | <0.03 | <0.03 |
| Lead | <0.001 | <0.001 | <0.001 |
| Manganese | 0.008 | <0.005 | 0.009 |
| Mercury | <0.00005 | <0.00005 | <0.00005 |
| Nickel | <0.001 | <0.001 | 0.001 |
| Zinc | 0.033 | 0.029 | 0.044 |
| Calcium | 11.9 | 12.0 | 13.6 |
| Magnesium | 0.70 | 0.74 | 0.77 |

**Results expressed as milligrams per litre except for pH, Conductivity (µmhos/cm) and Turbidity (NTU)**
**< = Less than**
**$NO_3/NO_2$ = Nitrate/Nitrite nitrogen**
**TOC = Total Organic Carbon**

# Historical Water Quality of Buttle Lake

# WMB - SEAM DATA

(Negative 9(s) values indicate missing data; other negative values indicate less than detection limits)

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| ** 0130080 | | | | | | | | |
| * 810217 | | | | | | | | |
| 0130080 | 810217 | 1005 | 0.00 | 7.50 | 59 | -9.99 | -0.0005 | -0.0005 |
| 0130080 | 810217 | 1010 | 5.00 | 7.50 | 59 | -9.99 | -0.0005 | -0.0005 |
| * 810312 | | | | | | | | |
| 0130080 | 810312 | 1500 | 0.00 | 7.50 | 59 | -9.99 | -9.9999 | -0.0005 |
| * 810414 | | | | | | | | |
| 0130080 | 810414 | 1105 | 0.00 | 7.60 | 60 | -9.99 | -9.9999 | -0.0005 |
| * 810624 | | | | | | | | |
| 0130080 | 810624 | 1350 | 0.00 | 7.40 | 60 | -9.99 | -0.0005 | -0.0005 |
| * 810819 | | | | | | | | |
| 0130080 | 810819 | 1200 | 0.00 | 7.80 | 53 | -9.99 | -0.0005 | -0.0005 |
| * 811117 | | | | | | | | |
| 0130080 | 811117 | 1445 | 0.00 | 7.50 | 56 | -9.99 | -0.0005 | -0.0005 |
| * 820223 | | | | | | | | |
| 0130080 | 820223 | 1315 | 0.00 | 7.30 | 59 | -9.99 | -0.0005 | 0.0005 |
| * 820615 | | | | | | | | |
| 0130080 | 820615 | 1500 | 0.00 | 7.60 | 61 | -9.99 | -0.0005 | -0.0005 |
| * 820818 | | | | | | | | |
| 0130080 | 820818 | 1450 | 0.00 | 7.40 | 51 | 8.13 | -0.0005 | -0.0005 |
| * 821208 | | | | | | | | |
| 0130080 | 821208 | 1600 | 0.00 | 7.90 | 56 | 9.08 | -0.0005 | -0.0005 |
| * 830324 | | | | | | | | |
| 0130080 | 830324 | 1245 | 0.00 | -9.99 | 58 | -9.99 | -9.9999 | -9.9999 |
| * 830426 | | | | | | | | |
| 0130080 | 830426 | 1530 | 0.00 | -9.99 | 60 | 9.43 | -0.0005 | 0.0007 |
| * 830517 | | | | | | | | |
| 0130080 | 830517 | 1000 | 0.00 | 7.50 | 60 | 9.47 | -0.0005 | -0.0005 |
| * 830616 | | | | | | | | |
| 0130080 | 830616 | 1200 | 0.00 | 5.50 | 59 | 6.61 | 0.0007 | 0.0007 |

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| * 830629 | | | | | | | | |
| 0130080 | 830629 | 1420 | 0.00 | 7.40 | 56 | 8.08 | -0.0005 | -0.0005 |
| 0130080 | 830629 | 1430 | 1.00 | 7.40 | 56 | 8.58 | -0.0005 | 0.0000 |
| * 830719 | | | | | | | | |
| 0130080 | 830719 | 1400 | 0.00 | 7.40 | 54 | 8.45 | -0.0005 | -0.0005 |
| * 830811 | | | | | | | | |
| 0130080 | 830811 | 1600 | 0.00 | -9.99 | 55 | 8.10 | -0.0005 | -0.0005 |
| * 830826 | | | | | | | | |
| 0130080 | 830826 | 1400 | 0.00 | -9.99 | 55 | 7.45 | -0.0005 | -0.0005 |
| * 831027 | | | | | | | | |
| 0130080 | 831027 | 1200 | 0.00 | 6.90 | 53 | 7.71 | -0.0005 | -0.0005 |
| * 831116 | | | | | | | | |
| 0130080 | 831116 | 1330 | 0.00 | 6.80 | 55 | 8.63 | -0.0005 | -0.0005 |
| * 831215 | | | | | | | | |
| 0130080 | 831215 | 1400 | 0.50 | 6.80 | 68 | 8.91 | -0.0005 | -0.0005 |
| * 840104 | | | | | | | | |
| 0130080 | 840104 | 1500 | 0.50 | 7.10 | 58 | 8.23 | -0.0005 | -0.0005 |
| * 840119 | | | | | | | | |
| 0130080 | 840119 | 1600 | 0.50 | 6.90 | 59 | 9.35 | -0.0005 | -0.0005 |
| * 840229 | | | | | | | | |
| 0130080 | 840229 | 1600 | 0.50 | 6.80 | 60 | 8.91 | -0.0005 | -0.0005 |
| * 840327 | | | | | | | | |
| 0130080 | 840327 | 1400 | 0.00 | 6.70 | 59 | 9.27 | -0.0005 | -0.0005 |
| * 840524 | | | | | | | | |
| 0130080 | 840524 | 1500 | 0.00 | 7.40 | 61 | 10.10 | -0.0005 | -0.0005 |
| * 840619 | | | | | | | | |
| 0130080 | 840619 | 1345 | 0.00 | 7.10 | 55 | 8.80 | -0.0005 | -0.0005 |
| * 840711 | | | | | | | | |
| 0130080 | 840711 | 1500 | 0.00 | 7.40 | 57 | 9.05 | -0.0005 | -0.0005 |
| * 840725 | | | | | | | | |
| 0130080 | 840725 | 1400 | 0.00 | 7.30 | 56 | 8.71 | -0.0005 | -0.0005 |

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| * 841002 | | | | | | | | |
| 0130080 | 841002 | 1330 | 0.00 | 7.60 | 55 | 8.75 | -0.0005 | -0.0005 |
| * 841010 | | | | | | | | |
| 0130080 | 841010 | 1600 | 0.00 | 7.30 | 54 | 7.69 | -0.0005 | -0.0005 |
| * 841211 | | | | | | | | |
| 0130080 | 841211 | 1430 | 0.00 | 7.00 | 56 | 8.81 | -0.0005 | -0.0005 |
| * 850128 | | | | | | | | |
| 0130080 | 850128 | 1600 | 0.00 | 7.50 | 59 | 9.38 | -0.0005 | -0.0005 |
| * 850410 | | | | | | | | |
| 0130080 | 850410 | 1400 | 0.00 | 8.00 | 61 | 9.73 | -0.0005 | -0.0005 |
| * 850709 | | | | | | | | |
| 0130080 | 850709 | 1700 | 0.00 | 7.70 | 59 | 8.37 | -0.0005 | -0.0005 |
| * 850725 | | | | | | | | |
| 0130080 | 850725 | 1530 | 0.00 | 7.80 | 55 | 7.78 | -0.0005 | -0.0005 |
| * 850909 | | | | | | | | |
| 0130080 | 850909 | 1500 | 0.00 | 7.50 | 60 | 9.17 | -0.0005 | -0.0005 |
| * 851024 | | | | | | | | |
| 0130080 | 851024 | 1500 | 0.00 | 7.60 | 61 | 9.98 | 0.0006 | 0.0006 |
| * 851204 | | | | | | | | |
| 0130080 | 851204 | 1500 | 0.00 | 7.30 | 63 | 10.40 | -9.9999 | -0.0005 |
| * 860206 | | | | | | | | |
| 0130080 | 860206 | 1330 | 0.00 | 7.20 | 62 | 8.60 | -0.0005 | -0.0005 |
| * 860225 | | | | | | | | |
| 0130080 | 860225 | 1300 | 0.00 | 7.40 | 62 | 8.76 | -9.9999 | -0.0005 |
| * 860319 | | | | | | | | |
| 0130080 | 860319 | 1600 | 0.00 | 7.10 | 63 | 9.72 | -0.0005 | -0.0005 |
| * 860430 | | | | | | | | |
| 0130080 | 860430 | 1500 | 0.00 | 7.10 | 63 | 9.64 | -0.0005 | -0.0005 |
| * 860603 | | | | | | | | |
| 0130080 | 860603 | 1400 | 0.00 | 7.40 | 62 | 10.30 | -0.0005 | -0.0005 |

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| * 870127 | | | | | | | | |
| 0130080 | 870127 | 1530 | 0.00 | 7.00 | 61 | 9.13 | -9.9999 | -0.0005 |
| * 870218 | | | | | | | | |
| 0130080 | 870218 | 1430 | 0.00 | 7.30 | 63 | 9.78 | -0.0005 | -0.0005 |
| * 870408 | | | | | | | | |
| 0130080 | 870408 | 1000 | 0.00 | -9.99 | -99 | 10.90 | -9.9999 | -0.0005 |
| * 870505 | | | | | | | | |
| 0130080 | 870505 | 1500 | 0.00 | -9.99 | -99 | 10.10 | -9.9999 | -0.0100 |
| * 870603 | | | | | | | | |
| 0130080 | 870603 | 1100 | 0.00 | -9.99 | -99 | 11.00 | -9.9999 | -0.0005 |
| * 870727 | | | | | | | | |
| 0130080 | 870727 | 1200 | 0.00 | -9.99 | -99 | 9.78 | -9.9999 | -0.0005 |
| * 871015 | | | | | | | | |
| 0130080 | 871015 | 1530 | 0.00 | 6.90 | 60 | 9.50 | -0.0005 | -0.0005 |
| * 871118 | | | | | | | | |
| 0130080 | 871118 | 1100 | 0.00 | -9.99 | -99 | 9.39 | -9.9999 | -0.0005 |
| * 871208 | | | | | | | | |
| 0130080 | 871208 | 1500 | 0.00 | 7.00 | 62 | 10.00 | -0.0005 | -0.0005 |
| * 880118 | | | | | | | | |
| 0130080 | 880118 | 1400 | 0.00 | 7.40 | 63 | 10.10 | -9.9999 | -0.0005 |
| * 880119 | | | | | | | | |
| 0130080 | 880119 | 0000 | 0.00 | 7.40 | 63 | 10.10 | -9.9999 | -0.0005 |
| * 880208 | | | | | | | | |
| 0130080 | 880208 | 1130 | 0.00 | 7.30 | 64 | 9.60 | -9.9999 | -0.0005 |
| * 880303 | | | | | | | | |
| 0130080 | 880303 | 1415 | 0.00 | -9.99 | -99 | 9.28 | -9.9999 | -0.0005 |
| * 880413 | | | | | | | | |
| 0130080 | 880413 | 0000 | 0.00 | 7.10 | 65 | 9.88 | -0.0100 | -0.0100 |
| * 880420 | | | | | | | | |
| 0130080 | 880420 | 1400 | 0.00 | 7.30 | 69 | 10.10 | -9.9999 | -0.0005 |

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| * 880518 | | | | | | | | |
| 0130080 | 880518 | 1300 | 0.00 | 7.60 | 66 | 10.10 | -9.9999 | -0.0005 |
| * 880615 | | | | | | | | |
| 0130080 | 880615 | 1230 | 0.00 | 7.60 | 60 | 9.90 | -9.9999 | 0.0006 |
| * 880719 | | | | | | | | |
| 0130080 | 880719 | 1530 | 0.00 | 7.60 | 59 | 9.12 | -9.9999 | -0.0005 |
| * 881103 | | | | | | | | |
| 0130080 | 881103 | 1200 | 0.00 | 7.30 | 60 | 9.40 | -9.9999 | -0.0005 |
| * 881221 | | | | | | | | |
| 0130080 | 881221 | 1500 | 0.00 | 7.20 | 62 | 9.50 | -9.9999 | -0.0005 |
| * 890112 | | | | | | | | |
| 0130080 | 890112 | 1000 | 0.00 | 7.06 | 60 | -9.99 | -9.9999 | -0.0005 |
| * 890206 | | | | | | | | |
| 0130080 | 890206 | 1400 | 0.00 | 7.20 | 60 | 9.39 | -9.9999 | -0.0005 |
| * 890307 | | | | | | | | |
| 0130080 | 890307 | 0000 | 0.00 | 7.40 | 62 | 9.94 | -9.9999 | -9.9999 |
| * 890511 | | | | | | | | |
| 0130080 | 890511 | 1200 | 0.50 | -9.99 | -99 | 10.30 | -9.9999 | -9.9999 |
| * 890614 | | | | | | | | |
| 0130080 | 890614 | 1100 | 0.00 | 7.40 | -99 | 10.20 | -9.9999 | -9.9999 |
| * 890710 | | | | | | | | |
| 0130080 | 890710 | 1300 | 0.00 | 7.20 | 57 | 8.66 | -9.9999 | -0.0005 |
| * 890814 | | | | | | | | |
| 0130080 | 890814 | 1500 | 0.00 | 7.30 | 54 | 9.44 | -9.9999 | 0.0020 |
| * 890907 | | | | | | | | |
| 0130080 | 890907 | 1430 | 0.00 | 7.70 | 55 | 8.74 | -9.9999 | 0.0015 |
| * 891024 | | | | | | | | |
| 0130080 | 891024 | 1340 | 0.00 | 7.60 | -99 | 9.39 | -9.9999 | -9.9999 |
| * 891207 | | | | | | | | |
| 0130080 | 891207 | 1530 | 0.00 | 7.70 | 60 | -9.99 | -9.9999 | -0.0005 |

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| * 891212 | | | | | | | | |
| 0130080 | 891212 | 1220 | 0.00 | 7.50 | -99 | 10.20 | -0.0005 | -0.0005 |
| * 900227 | | | | | | | | |
| 0130080 | 900227 | 1220 | 0.00 | 7.60 | -99 | -9.99 | -9.9999 | -9.9999 |
| ** 0130082 | | | | | | | | |
| * 810416 | | | | | | | | |
| 0130082 | 810416 | 0000 | 3.00 | -9.99 | 64 | -9.99 | 0.0080 | -9.9999 |
| 0130082 | 810416 | 0000 | 15.00 | -9.99 | -99 | -9.99 | 0.0025 | -9.9999 |
| 0130082 | 810416 | 0000 | 30.00 | -9.99 | -99 | -9.99 | 0.0010 | -9.9999 |
| 0130082 | 810416 | 0000 | 45.00 | -9.99 | 75 | -9.99 | 0.0023 | -9.9999 |
| * 810513 | | | | | | | | |
| 0130082 | 810513 | 0900 | 3.00 | 7.30 | 60 | -9.99 | 0.0007 | -9.9999 |
| 0130082 | 810513 | 0000 | 15.00 | -9.99 | -99 | -9.99 | 0.0007 | -9.9999 |
| 0130082 | 810513 | 0000 | 30.00 | -9.99 | -99 | -9.99 | 0.0010 | -9.9999 |
| 0130082 | 810513 | 0900 | 50.00 | 7.00 | 63 | -9.99 | 0.0008 | -9.9999 |
| * 810608 | | | | | | | | |
| 0130082 | 810608 | 0000 | 3.00 | -9.99 | -99 | -9.99 | 0.0012 | -9.9999 |
| 0130082 | 810608 | 0000 | 15.00 | -9.99 | -99 | -9.99 | 0.0020 | -9.9999 |
| 0130082 | 810608 | 0000 | 30.00 | -9.99 | -99 | -9.99 | 0.0014 | -9.9999 |
| 0130082 | 810608 | 0000 | 50.00 | -9.99 | -99 | -9.99 | 0.0015 | -9.9999 |
| * 810714 | | | | | | | | |
| 0130082 | 810714 | 0000 | 3.00 | -9.99 | 58 | -9.99 | 0.0011 | -9.9999 |
| 0130082 | 810714 | 0000 | 3.10 | -9.99 | -99 | -9.99 | -0.0005 | -9.9999 |
| 0130082 | 810714 | 0000 | 15.00 | -9.99 | -99 | -9.99 | -0.0005 | -9.9999 |
| 0130082 | 810714 | 0000 | 30.00 | -9.99 | -99 | -9.99 | 0.0016 | -9.9999 |
| 0130082 | 810714 | 0000 | 50.00 | -9.99 | 79 | -9.99 | 0.0012 | -9.9999 |
| * 810812 | | | | | | | | |
| 0130082 | 810812 | 0000 | 3.00 | 7.70 | 59 | -9.99 | -0.0005 | -9.9999 |
| 0130082 | 810812 | 0000 | 3.10 | -9.99 | -99 | -9.99 | -0.0005 | -9.9999 |
| 0130082 | 810812 | 0000 | 15.00 | -9.99 | -99 | -9.99 | -0.0005 | -9.9999 |
| 0130082 | 810812 | 0000 | 30.00 | -9.99 | -99 | -9.99 | 0.0007 | -9.9999 |
| 0130082 | 810812 | 0000 | 50.00 | 7.60 | 79 | -9.99 | 0.0010 | -9.9999 |
| * 810908 | | | | | | | | |
| 0130082 | 810908 | 0000 | 3.00 | 7.60 | 60 | 9.30 | -0.0005 | -9.9999 |
| 0130082 | 810908 | 0000 | 3.10 | -9.99 | -99 | -9.99 | -0.0005 | -9.9999 |
| 0130082 | 810908 | 0000 | 15.00 | -9.99 | -99 | -9.99 | -0.0005 | -9.9999 |

# BUTTLE LAKE WATER QUALITY DATA
# FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| 0130082 | 810908 | 0000 | 30.00 | -9.99 | -99 | -9.99 | 0.0005 | -9.9999 |
| 0130082 | 810908 | 0000 | 50.00 | 7.70 | 78 | 12.10 | 0.0008 | -9.9999 |
| * 811020 | | | | | | | | |
| 0130082 | 811020 | 0000 | 3.00 | 7.40 | 59 | -9.99 | -0.0005 | 0.0006 |
| 0130082 | 811020 | 0000 | 15.00 | -9.99 | -99 | -9.99 | -0.0005 | -0.0005 |
| 0130082 | 811020 | 0000 | 30.00 | -9.99 | -99 | -9.99 | 0.0006 | 0.0007 |
| 0130082 | 811020 | 0000 | 50.00 | 7.40 | 80 | -9.99 | 0.0009 | 0.0011 |
| * 811118 | | | | | | | | |
| 0130082 | 811118 | 0000 | 3.00 | 7.40 | 55 | -9.99 | 0.0005 | -9.9999 |
| 0130082 | 811118 | 0000 | 3.10 | -9.99 | -99 | -9.99 | 0.0005 | -9.9999 |
| 0130082 | 811118 | 0000 | 15.00 | -9.99 | -99 | -9.99 | 0.0007 | -9.9999 |
| 0130082 | 811118 | 0000 | 30.00 | -9.99 | -99 | -9.99 | 0.0007 | -9.9999 |
| 0130082 | 811118 | 0000 | 50.00 | 7.60 | 73 | -9.99 | 0.0008 | -9.9999 |
| * 820119 | | | | | | | | |
| 0130082 | 820119 | 1200 | 20.00 | -9.99 | 68 | -9.99 | 0.0007 | 0.0008 |
| * 820215 | | | | | | | | |
| 0130082 | 820215 | 0000 | 3.00 | 7.30 | 66 | -9.99 | 0.0006 | 0.0006 |
| 0130082 | 820215 | 0000 | 3.10 | -9.99 | -99 | -9.99 | 0.0008 | -9.9999 |
| 0130082 | 820215 | 0000 | 15.00 | -9.99 | -99 | -9.99 | -9.9999 | 0.0007 |
| 0130082 | 820215 | 0000 | 30.00 | -9.99 | -99 | -9.99 | 0.0010 | 0.0010 |
| 0130082 | 820215 | 0000 | 50.00 | 7.60 | 87 | -9.99 | 0.0010 | 0.0017 |
| * 820614 | | | | | | | | |
| 0130082 | 820614 | 0000 | 0.50 | 7.00 | 62 | -9.99 | -9.9999 | -0.0005 |
| * 830324 | | | | | | | | |
| 0130082 | 830324 | 1120 | 0.00 | -9.99 | 59 | -9.99 | -9.9999 | -9.9999 |
| * 830426 | | | | | | | | |
| 0130082 | 830426 | 0910 | 0.00 | -9.99 | -99 | 9.91 | -9.9999 | -0.0005 |
| * 830601 | | | | | | | | |
| 0130082 | 830601 | 0000 | 0.00 | 7.70 | 54 | 7.77 | -9.9999 | -0.0005 |
| * 830720 | | | | | | | | |
| 0130082 | 830720 | 0000 | 0.00 | 7.70 | 52 | 7.34 | -9.9999 | -0.0005 |
| * 830822 | | | | | | | | |
| 0130082 | 830822 | 0000 | 0.00 | 7.70 | 53 | 8.10 | -9.9999 | -0.0050 |
| 0130082 | 830822 | 0000 | 20.00 | -9.99 | -99 | 8.87 | -9.9999 | -0.0005 |
| 0130082 | 830822 | 0000 | 40.00 | -9.99 | -99 | 12.20 | -9.9999 | 0.0009 |

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE | TIME | DEPTH | PH | SPF COND | CA T | CD D | CD T |
|---|---|---|---|---|---|---|---|---|
| | y m d | h m | m | | uS/cm | mg/l | mg/l | mg/l |
| 0130082 | 830822 | 0000 | 100.0 | -9.99 | -99 | 12.20 | -9.9999 | 0.0027 |
| * 831025 | | | | | | | | |
| 0130082 | 831025 | 1130 | 0.00 | 7.50 | 60 | 8.20 | -9.9999 | -0.0005 |
| * 831214 | | | | | | | | |
| 0130082 | 831214 | 1500 | 0.00 | 7.30 | 66 | 9.89 | -9.9999 | -0.0005 |
| 0130082 | 831214 | 1500 | 20.00 | -9.99 | -99 | 9.59 | -9.9999 | -0.0100 |
| 0130082 | 831214 | 1500 | 40.00 | -9.99 | -99 | 9.84 | -9.9999 | -0.0100 |
| 0130082 | 831214 | 1500 | 132.0 | -9.99 | -99 | 9.79 | -9.9999 | -0.0100 |
| * 840214 | | | | | | | | |
| 0130082 | 840214 | 0930 | 0.00 | 7.40 | 67 | 8.84 | -9.9999 | -0.0100 |
| 0130082 | 840214 | 1330 | 20.00 | -9.99 | -99 | 8.12 | -9.9999 | -0.0100 |
| * 840327 | | | | | | | | |
| 0130082 | 840327 | 1200 | 0.00 | 7.20 | 63 | 8.93 | -9.9999 | -0.0005 |
| 0130082 | 840327 | 1204 | 20.00 | -9.99 | -99 | 9.45 | -9.9999 | 0.0007 |
| 0130082 | 840327 | 1208 | 40.00 | -9.99 | -99 | 11.60 | -9.9999 | 0.0022 |
| * 840501 | | | | | | | | |
| 0130082 | 840501 | 1300 | 0.00 | 7.50 | 69 | 9.81 | -9.9999 | 0.0005 |
| 0130082 | 840501 | 1300 | 20.00 | 7.50 | 71 | 10.00 | -9.9999 | 0.0005 |
| 0130082 | 840501 | 1300 | 40.00 | -9.99 | -99 | 10.60 | -9.9999 | 0.0006 |
| 0130082 | 840501 | 1305 | 65.00 | -9.99 | -99 | 11.10 | -9.9999 | 0.0007 |
| * 840619 | | | | | | | | |
| 0130082 | 840619 | 1250 | 0.00 | 7.30 | 60 | 8.64 | -9.9999 | -0.0005 |
| 0130082 | 840619 | 1245 | 20.00 | -9.99 | -99 | 8.19 | -9.9999 | -0.0005 |
| 0130082 | 840619 | 1240 | 40.00 | -9.99 | -99 | 11.30 | -9.9999 | 0.0007 |
| 0130082 | 840619 | 1230 | 69.00 | -9.99 | -99 | 12.30 | -9.9999 | 0.0024 |
| * 840725 | | | | | | | | |
| 0130082 | 840725 | 1440 | 0.00 | 7.70 | 56 | 8.31 | -9.9999 | -0.0005 |
| 0130082 | 840725 | 1430 | 20.00 | -9.99 | -99 | 8.74 | -9.9999 | -0.0005 |
| * 840822 | | | | | | | | |
| 0130082 | 840822 | 1440 | 0.00 | 7.10 | 54 | 8.77 | -9.9999 | -0.0005 |
| ~~0130082~~ | ~~840822~~ | ~~1405~~ | ~~20.00~~ | ~~-9.99~~ | ~~-99~~ | ~~9.44~~ | ~~-9.9999~~ | ~~-0.0005~~ |
| 0130082 | 840822 | 1410 | 40.00 | -9.99 | -99 | 10.80 | -9.9999 | -0.0005 |
| 0130082 | 840822 | 1415 | 65.00 | -9.99 | -99 | 12.40 | -9.9999 | 0.0007 |
| * 841002 | | | | | | | | |
| 0130082 | 841002 | 1340 | 0.00 | 7.50 | 55 | 8.70 | -9.9999 | -0.0005 |
| 0130082 | 841002 | 1335 | 20.00 | -9.99 | -99 | 9.88 | -9.9999 | -0.0005 |

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| 0130082 | 841002 | 1330 | 40.00 | -9.99 | -99 | 11.50 | -9.9999 | 0.0005 |
| 0130082 | 841002 | 1325 | 60.00 | -9.99 | -99 | 12.50 | -9.9999 | -0.0005 |
| * 841211 | | | | | | | | |
| 0130082 | 841211 | 1410 | 0.00 | 7.30 | 62 | 8.66 | -9.9999 | -0.0005 |
| 0130082 | 841211 | 1400 | 20.00 | -9.99 | -99 | 9.43 | -9.9999 | -0.0005 |
| 0130082 | 841211 | 1340 | 40.00 | -9.99 | -99 | 9.35 | -9.9999 | -0.0005 |
| 0130082 | 841211 | 1330 | 60.00 | -9.99 | -99 | 9.77 | -9.9999 | -0.0005 |
| * 850219 | | | | | | | | |
| 0130082 | 850219 | 1250 | 0.00 | 7.30 | 67 | 7.75 | -9.9999 | -0.0005 |
| 0130082 | 850219 | 1245 | 20.00 | 7.30 | 69 | 7.71 | -9.9999 | -0.0005 |
| 0130082 | 850219 | 1240 | 40.00 | -9.99 | -99 | 10.40 | -9.9999 | -0.0005 |
| 0130082 | 850219 | 1235 | 65.00 | -9.99 | -99 | 11.10 | -9.9999 | -0.0005 |
| * 850430 | | | | | | | | |
| 0130082 | 850430 | 1415 | 0.00 | 7.30 | 69 | 11.60 | -9.9999 | -0.0005 |
| 0130082 | 850430 | 1420 | 20.00 | -9.99 | -99 | 12.20 | -9.9999 | -0.0005 |
| 0130082 | 850430 | 1425 | 40.00 | -9.99 | -99 | 11.90 | -9.9999 | -0.0005 |
| 0130082 | 850430 | 1430 | 60.00 | -9.99 | -99 | 12.10 | -9.9999 | -0.0005 |
| * 850604 | | | | | | | | |
| 0130082 | 850604 | 1415 | 0.00 | 7.20 | 57 | 5.85 | -9.9999 | -0.0005 |
| 0130082 | 850604 | 1410 | 20.00 | -9.99 | -99 | 5.51 | -9.9999 | -0.0005 |
| 0130082 | 850604 | 1405 | 40.00 | -9.99 | -99 | 7.15 | -9.9999 | -0.0005 |
| 0130082 | 850604 | 1402 | 60.00 | -9.99 | -99 | 7.49 | -9.9999 | -0.0005 |
| * 850709 | | | | | | | | |
| 0130082 | 850709 | 1400 | 0.00 | 7.80 | 60 | 8.63 | -9.9999 | -0.0005 |
| 0130082 | 850709 | 1405 | 20.00 | -9.99 | -99 | 9.08 | -9.9999 | -0.0005 |
| 0130082 | 850709 | 1410 | 40.00 | -9.99 | -99 | 11.30 | -9.9999 | 0.0007 |
| 0130082 | 850709 | 1415 | 60.00 | -9.99 | -99 | 10.40 | -9.9999 | -0.0005 |
| 0130082 | 850709 | 1420 | 100.0 | -9.99 | -99 | 10.80 | -9.9999 | -0.0005 |
| * 850813 | | | | | | | | |
| 0130082 | 850813 | 1130 | 0.00 | 7.30 | 60 | 9.91 | -9.9999 | -0.0005 |
| 0130082 | 850813 | 1105 | 20.00 | -9.99 | -99 | 10.30 | -9.9999 | -0.0005 |
| 0130082 | 850813 | 1110 | 40.00 | -9.99 | -99 | 11.40 | -9.9999 | -0.0005 |
| 0130082 | 850813 | 1115 | 60.00 | -9.99 | -99 | 11.90 | -9.9999 | -0.0005 |
| * 850917 | | | | | | | | |
| 0130082 | 850917 | 1400 | 0.00 | 7.60 | -99 | 10.40 | -9.9999 | -0.0005 |
| 0130082 | 850917 | 1400 | 20.00 | 7.12 | -99 | 10.20 | -9.9999 | -0.0005 |
| 0130082 | 850917 | 1405 | 40.00 | -9.99 | -99 | 11.20 | -9.9999 | -0.0005 |
| 0130082 | 850917 | 1410 | 60.00 | -9.99 | -99 | 11.70 | -9.9999 | -0.0005 |

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| * 851022 | | | | | | | | |
| 0130082 | 851022 | 1240 | 0.00 | 7.10 | 63 | 10.30 | -9.9999 | -0.0005 |
| 0130082 | 851022 | 1242 | 20.00 | -9.99 | -99 | 9.17 | -9.9999 | 0.0006 |
| 0130082 | 851022 | 1245 | 40.00 | -9.99 | -99 | 10.80 | -9.9999 | -0.0005 |
| 0130082 | 851022 | 1248 | 60.00 | -9.99 | -99 | 11.40 | -9.9999 | -0.0005 |
| * 851212 | | | | | | | | |
| 0130082 | 851212 | 1300 | 0.00 | -9.99 | 68 | 11.80 | -9.9999 | -0.0005 |
| 0130082 | 851212 | 1255 | 20.00 | -9.99 | -99 | 11.20 | -9.9999 | -0.0005 |
| 0130082 | 851212 | 1252 | 40.00 | -9.99 | -99 | 11.30 | -9.9999 | -0.0005 |
| 0130082 | 851212 | 1250 | 60.00 | -9.99 | -99 | 12.50 | -9.9999 | -0.0005 |
| * 860211 | | | | | | | | |
| 0130082 | 860211 | 1044 | 0.00 | 6.90 | 61 | 9.59 | -0.0005 | -0.0005 |
| 0130082 | 860211 | 1055 | 10.00 | 6.80 | 61 | 9.31 | -0.0005 | -0.0005 |
| 0130082 | 860211 | 1045 | 20.00 | 6.90 | 77 | 11.40 | -0.0005 | -0.0005 |
| 0130082 | 860211 | 1050 | 30.00 | 6.90 | 78 | 11.70 | -0.0005 | 0.0006 |
| 0130082 | 860211 | 1035 | 40.00 | 6.90 | 80 | 12.30 | -0.0005 | 0.0006 |
| 0130082 | 860211 | 1040 | 60.00 | 6.80 | 83 | 14.10 | -0.0005 | -0.0005 |
| * 860311 | | | | | | | | |
| 0130082 | 860311 | 1100 | 0.00 | 7.10 | 66 | 11.00 | -0.0005 | -0.0005 |
| 0130082 | 860311 | 1115 | 10.00 | 7.10 | 66 | 10.80 | -0.0005 | -0.0005 |
| 0130082 | 860311 | 1110 | 20.00 | 7.10 | 68 | 11.50 | -0.0005 | -0.0005 |
| 0130082 | 860311 | 1107 | 30.00 | 7.10 | 73 | 12.20 | -0.0005 | -0.0005 |
| 0130082 | 860311 | 1105 | 40.00 | 7.20 | 76 | 13.10 | -0.0005 | -0.0005 |
| 0130082 | 860311 | 1102 | 60.00 | 7.10 | 80 | 13.40 | -0.0005 | -0.0005 |
| * 860415 | | | | | | | | |
| 0130082 | 860415 | 1145 | 0.00 | 7.20 | 68 | 10.60 | -0.0005 | -0.0005 |
| 0130082 | 860415 | 1140 | 10.00 | 7.20 | 71 | 10.60 | -0.0005 | -0.0005 |
| 0130082 | 860415 | 1135 | 20.00 | 7.20 | 73 | 11.30 | -0.0005 | -0.0005 |
| 0130082 | 860415 | 1130 | 30.00 | 7.10 | 77 | 11.60 | -0.0005 | -0.0005 |
| 0130082 | 860415 | 1125 | 40.00 | 7.20 | 79 | 11.90 | -0.0005 | -0.0005 |
| 0130082 | 860415 | 1120 | 60.00 | -9.99 | -99 | 12.10 | -0.0005 | -0.0005 |
| * 860512 | | | | | | | | |
| 0130082 | 860512 | 1400 | 0.00 | -9.99 | 69 | 11.70 | -0.0005 | -0.0005 |
| 0130082 | 860512 | 1400 | 10.00 | 7.10 | -99 | 12.70 | -0.0005 | -0.0005 |
| 0130082 | 860512 | 1400 | 20.00 | 7.10 | -99 | 11.80 | -0.0005 | -0.0005 |
| 0130082 | 860512 | 1400 | 30.00 | 7.00 | -99 | 11.90 | -0.0005 | -0.0005 |
| 0130082 | 860512 | 1400 | 40.00 | 6.90 | -99 | 11.80 | -0.0005 | -0.0005 |
| 0130082 | 860512 | 1400 | 60.00 | 7.00 | 71 | 11.50 | -0.0005 | -0.0005 |

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| * 860610 | | | | | | | | |
| 0130082 | 860610 | 1200 | 0.00 | 7.20 | 60 | 9.57 | -0.0005 | -0.0005 |
| 0130082 | 860610 | 1200 | 10.00 | 7.10 | 59 | 9.38 | -0.0005 | -0.0005 |
| 0130082 | 860610 | 1200 | 20.00 | 7.10 | 60 | 9.21 | -0.0005 | -0.0005 |
| 0130082 | 860610 | 1200 | 30.00 | 7.10 | 62 | 9.94 | -0.0005 | -0.0005 |
| 0130082 | 860610 | 1200 | 40.00 | 7.10 | 70 | 11.00 | -0.0005 | -0.0005 |
| 0130082 | 860610 | 1200 | 60.00 | 7.10 | 74 | 11.60 | -0.0005 | -0.0005 |
| * 860708 | | | | | | | | |
| 0130082 | 860708 | 1415 | 0.00 | 7.30 | 56 | 8.95 | -0.0005 | -0.0005 |
| 0130082 | 860708 | 1418 | 10.00 | 7.20 | 56 | 9.22 | -0.0005 | -0.0005 |
| 0130082 | 860708 | 1413 | 20.00 | 7.20 | 57 | 9.39 | -0.0005 | -0.0005 |
| 0130082 | 860708 | 1410 | 30.00 | 7.10 | 62 | 10.40 | -0.0005 | -0.0005 |
| 0130082 | 860708 | 1408 | 40.00 | 7.10 | 64 | 11.00 | -0.0005 | -0.0005 |
| 0130082 | 860708 | 1406 | 60.00 | 7.20 | 70 | 12.40 | -0.0005 | -0.0005 |
| * 860812 | | | | | | | | |
| 0130082 | 860812 | 1128 | 0.00 | 7.60 | 57 | 9.32 | -0.0005 | -0.0005 |
| 0130082 | 860812 | 1130 | 10.00 | 7.50 | 65 | 10.60 | -0.0005 | -0.0005 |
| 0130082 | 860812 | 1135 | 20.00 | 7.40 | 61 | 9.66 | -0.0005 | -0.0005 |
| 0130082 | 860812 | 1115 | 30.00 | 7.60 | 63 | 10.00 | -0.0005 | -0.0005 |
| 0130082 | 860812 | 1120 | 40.00 | 7.50 | 68 | 11.00 | -0.0005 | -0.0005 |
| 0130082 | 860812 | 1125 | 60.00 | 7.40 | 71 | 11.70 | -0.0005 | -0.0005 |
| * 870204 | | | | | | | | |
| 0130082 | 870204 | 1230 | 0.00 | 7.10 | 65 | 9.29 | -0.0005 | -0.0005 |
| 0130082 | 870204 | 1230 | 10.00 | 7.10 | 65 | 9.52 | -0.0005 | -0.0005 |
| 0130082 | 870204 | 1230 | 20.00 | 7.20 | 69 | 10.00 | -0.0005 | -0.0005 |
| 0130082 | 870204 | 1230 | 30.00 | 7.20 | 73 | 11.10 | -0.0005 | -0.0005 |
| 0130082 | 870204 | 1230 | 40.00 | 7.20 | 74 | 10.70 | -0.0005 | -0.0005 |
| 0130082 | 870204 | 1230 | 60.00 | 7.20 | 77 | 10.80 | -0.0005 | -0.0005 |
| * 870414 | | | | | | | | |
| 0130082 | 870414 | 1115 | 0.00 | 7.40 | 70 | 11.80 | -0.0005 | -0.0005 |
| 0130082 | 870414 | 1115 | 10.00 | 7.40 | 71 | 11.70 | -0.0005 | -0.0005 |
| 0130082 | 870414 | 1115 | 20.00 | 7.40 | 70 | 11.80 | -0.0005 | -0.0005 |
| 0130082 | 870414 | 1115 | 30.00 | 7.30 | 72 | 11.90 | -0.0005 | -0.0005 |
| 0130082 | 870414 | 1115 | 40.00 | 7.30 | 79 | 13.20 | -0.0005 | 0.0006 |
| 0130082 | 870414 | 1115 | 60.00 | 7.30 | 78 | 12.90 | -0.0005 | -0.0005 |
| * 870708 | | | | | | | | |
| 0130082 | 870708 | 1115 | 0.00 | 7.10 | 56 | 8.26 | -9.9999 | -0.0005 |
| 0130082 | 870708 | 1115 | 10.00 | 7.20 | 55 | 8.10 | -9.9999 | -0.0005 |
| 0130082 | 870708 | 1115 | 20.00 | 7.20 | 58 | 8.45 | -9.9999 | -0.0005 |
| 0130082 | 870708 | 1115 | 30.00 | 7.20 | 62 | 9.13 | -9.9999 | -0.0005 |

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| 0130082 | 870708 | 1115 | 40.00 | 7.10 | 71 | 10.20 | -9.9999 | -0.0005 |
| 0130082 | 870708 | 1115 | 60.00 | 7.10 | 77 | 11.20 | -9.9999 | -0.0005 |
| * 870909 | | | | | | | | |
| 0130082 | 870909 | 1430 | 0.00 | 7.60 | 60 | 9.80 | -0.0005 | -0.0005 |
| 0130082 | 870909 | 1430 | 10.00 | 7.50 | 61 | 10.10 | -0.0005 | -0.0005 |
| 0130082 | 870909 | 1430 | 20.00 | 7.20 | 62 | 10.00 | -0.0005 | -0.0005 |
| 0130082 | 870909 | 1430 | 30.00 | 7.40 | 60 | 9.95 | -0.0005 | -0.0005 |
| 0130082 | 870909 | 1430 | 40.00 | 7.10 | 71 | 11.50 | -0.0005 | -0.0005 |
| 0130082 | 870909 | 1430 | 60.00 | 7.00 | 75 | 11.80 | -0.0005 | -0.0005 |
| * 871109 | | | | | | | | |
| 0130082 | 871109 | 1300 | 0.00 | 7.20 | 67 | 10.40 | -0.0005 | -0.0005 |
| * 880119 | | | | | | | | |
| 0130082 | 880119 | 1300 | 0.00 | 7.40 | 72 | 11.20 | -0.0005 | -0.0005 |
| * 880308 | | | | | | | | |
| 0130082 | 880308 | 1000 | 0.00 | 7.30 | 80 | 12.30 | -0.0005 | -0.0005 |
| * 880510 | | | | | | | | |
| 0130082 | 880510 | 1200 | 0.00 | 7.70 | 67 | 10.70 | -0.0005 | -0.0005 |
| 0130082 | 880510 | 1205 | 10.00 | 7.50 | 63 | 10.80 | -0.0005 | -0.0005 |
| 0130082 | 880510 | 1210 | 20.00 | 7.50 | 67 | 11.10 | -0.0005 | -0.0005 |
| 0130082 | 880510 | 1215 | 30.00 | 7.40 | 82 | 14.20 | -0.0005 | -0.0005 |
| 0130082 | 880510 | 1220 | 40.00 | 7.60 | 72 | 12.80 | -0.0005 | -0.0005 |
| 0130082 | 880510 | 1225 | 60.00 | 7.40 | 91 | 15.00 | -0.0005 | -0.0005 |
| * 880706 | | | | | | | | |
| 0130082 | 880706 | 1100 | 0.00 | 7.60 | 62 | 9.80 | -0.0005 | -0.0005 |
| 0130082 | 880706 | 1102 | 10.00 | 7.60 | 61 | 9.71 | -0.0005 | -0.0005 |
| 0130082 | 880706 | 1104 | 20.00 | 7.50 | 63 | 9.97 | -0.0005 | 0.0005 |
| 0130082 | 880706 | 1106 | 30.00 | 7.40 | 74 | 12.10 | -0.0005 | -0.0005 |
| 0130082 | 880706 | 1108 | 40.00 | 7.40 | 80 | 13.10 | -0.0005 | -0.0005 |
| 0130082 | 880706 | 1110 | 60.00 | 7.10 | 87 | 14.10 | -0.0005 | -0.0005 |
| * 880913 | | | | | | | | |
| 0130082 | 880913 | 1245 | 0.00 | 7.20 | 61 | 10.10 | -0.0005 | -0.0005 |
| 0130082 | 880913 | 1245 | 10.00 | 7.40 | 63 | 10.50 | -0.0005 | -0.0005 |
| 0130082 | 880913 | 1245 | 20.00 | 7.40 | 66 | 10.90 | -0.0005 | -0.0005 |
| 0130082 | 880913 | 1245 | 30.00 | 7.40 | 70 | 11.20 | -0.0005 | -0.0005 |
| 0130082 | 880913 | 1245 | 40.00 | 7.30 | 77 | 12.20 | -0.0005 | -0.0005 |
| 0130082 | 880913 | 1245 | 60.00 | 7.20 | 83 | 13.70 | -0.0005 | -0.0005 |

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| * 881108 | | | | | | | | |
| 0130082 | 881108 | 1115 | 0.00 | 7.70 | 62 | 10.10 | -9.9999 | -9.9999 |
| 0130082 | 881108 | 1117 | 10.00 | 7.60 | 61 | 10.20 | -9.9999 | -9.9999 |
| 0130082 | 881108 | 1118 | 20.00 | 7.40 | 57 | 9.20 | -9.9999 | -9.9999 |
| 0130082 | 881108 | 1120 | 30.00 | 7.40 | 64 | 10.50 | -9.9999 | -9.9999 |
| 0130082 | 881108 | 1122 | 40.00 | 7.30 | 74 | 12.20 | -9.9999 | -9.9999 |
| 0130082 | 881108 | 1125 | 60.00 | 7.30 | 80 | 13.10 | -9.9999 | -9.9999 |
| * 890118 | | | | | | | | |
| 0130082 | 890118 | 1130 | 0.00 | 7.40 | 81 | 12.00 | -0.0005 | -0.0005 |
| 0130082 | 890118 | 1131 | 10.00 | 7.30 | 81 | 11.60 | -0.0005 | -0.0005 |
| 0130082 | 890118 | 1132 | 20.00 | 7.30 | 81 | 11.20 | -0.0005 | -0.0005 |
| 0130082 | 890118 | 1133 | 30.00 | 7.40 | 81 | 11.20 | -0.0005 | -0.0005 |
| 0130082 | 890118 | 1134 | 40.00 | 7.40 | 81 | 11.60 | -0.0005 | -0.0005 |
| 0130082 | 890118 | 1135 | 50.00 | 7.30 | 83 | 11.70 | -0.0005 | -0.0005 |
| * 890307 | | | | | | | | |
| 0130082 | 890307 | 1100 | 0.00 | 7.40 | 75 | 12.40 | -9.9999 | -9.9999 |
| * 890613 | | | | | | | | |
| 0130082 | 890613 | 1300 | 0.00 | 7.70 | 57 | 9.16 | -9.9999 | -9.9999 |
| 0130082 | 890613 | 1205 | 10.00 | 7.70 | 54 | 8.90 | -9.9999 | -9.9999 |
| 0130082 | 890613 | 1210 | 20.00 | -9.99 | -99 | 10.70 | -9.9999 | -9.9999 |
| 0130082 | 890613 | 1211 | 30.00 | 7.70 | 70 | 12.10 | -9.9999 | -9.9999 |
| 0130082 | 890613 | 1215 | 40.00 | 7.70 | 78 | 13.10 | -9.9999 | -9.9999 |
| 0130082 | 890613 | 1218 | 60.00 | 7.60 | 82 | 13.80 | -9.9999 | -9.9999 |
| * 890822 | | | | | | | | |
| 0130082 | 890822 | 1000 | 0.00 | 7.80 | 60 | 9.78 | -9.9999 | -9.9999 |
| 0130082 | 890822 | 1002 | 10.00 | 7.60 | 72 | 11.70 | -9.9999 | -9.9999 |
| 0130082 | 890822 | 1004 | 20.00 | 7.50 | 64 | 10.50 | -9.9999 | -9.9999 |
| 0130082 | 890822 | 1006 | 30.00 | 7.50 | 68 | 11.20 | -9.9999 | -9.9999 |
| 0130082 | 890822 | 1008 | 40.00 | 7.40 | 74 | 12.20 | -9.9999 | -9.9999 |
| 0130082 | 890822 | 1010 | 60.00 | 7.40 | 80 | 13.10 | -9.9999 | -9.9999 |
| * 891024 | | | | | | | | |
| 0130082 | 891024 | 1050 | 0.00 | 7.40 | 64 | 10.10 | -9.9999 | -9.9999 |
| 0130082 | 891024 | 1052 | 10.00 | 7.50 | 61 | 9.58 | -9.9999 | -9.9999 |
| 0130082 | 891024 | 1054 | 20.00 | 7.40 | 55 | 8.64 | -9.9999 | -9.9999 |
| 0130082 | 891024 | 1056 | 30.00 | 7.40 | 67 | 10.60 | -9.9999 | -9.9999 |
| 0130082 | 891024 | 1058 | 40.00 | 7.30 | 72 | 11.50 | -9.9999 | -9.9999 |
| 0130082 | 891024 | 1100 | 60.00 | 7.30 | 77 | 12.30 | -9.9999 | -9.9999 |
| * 891212 | | | | | | | | |
| 0130082 | 891212 | 1000 | 0.00 | 7.70 | 62 | 10.50 | -0.0005 | -0.0005 |

BUTTLE LAKE WATER QUALITY DATA
FOR SITES 0130080 AND 0130082

| SITE | DATE y m d | TIME h m | DEPTH m | PH | SPF COND uS/cm | CA T mg/l | CD D mg/l | CD T mg/l |
|---|---|---|---|---|---|---|---|---|
| 0130082 | 891212 | 1002 | 10.00 | 7.50 | 62 | 10.40 | -0.0005 | -0.0005 |
| 0130082 | 891212 | 1004 | 20.00 | 7.40 | 60 | 9.79 | -0.0005 | -0.0005 |
| 0130082 | 891212 | 1006 | 30.00 | 7.50 | 63 | 10.90 | -0.0005 | -0.0005 |
| 0130082 | 891212 | 1008 | 40.00 | 7.40 | 68 | 11.40 | -0.0005 | -0.0005 |
| 0130082 | 891212 | 1010 | 60.00 | 7.30 | 78 | 13.60 | -0.0005 | -0.0005 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| ** 0130080 | | | | | | | | | |
| * 810217 | | | | | | | | | |
| 0130080 | 810217 | 0.00 | 0.004 | 0.005 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130080 | 810217 | 5.00 | 0.003 | 0.006 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 810312 | | | | | | | | | |
| 0130080 | 810312 | 0.00 | -9.999 | 0.010 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 810414 | | | | | | | | | |
| 0130080 | 810414 | 0.00 | -9.999 | 0.007 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 810624 | | | | | | | | | |
| 0130080 | 810624 | 0.00 | 0.003 | 0.007 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 810819 | | | | | | | | | |
| 0130080 | 810819 | 0.00 | 0.001 | 0.002 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 811117 | | | | | | | | | |
| 0130080 | 811117 | 0.00 | 0.003 | 0.005 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 820223 | | | | | | | | | |
| 0130080 | 820223 | 0.00 | 0.003 | 0.006 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 820615 | | | | | | | | | |
| 0130080 | 820615 | 0.00 | 0.004 | 0.004 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 820818 | | | | | | | | | |
| 0130080 | 820818 | 0.00 | 0.002 | 0.003 | -0.01 | 0.03 | 0.75 | -0.01 | 0.01 |
| * 821208 | | | | | | | | | |
| 0130080 | 821208 | 0.00 | 0.002 | 0.004 | 0.03 | 0.05 | 0.72 | -0.01 | 0.01 |
| * 830324 | | | | | | | | | |
| 0130080 | 830324 | 0.00 | -9.999 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 830426 | | | | | | | | | |
| 0130080 | 830426 | 0.00 | 0.003 | 0.004 | 0.02 | 0.03 | 0.80 | 0.01 | 0.02 |
| * 830517 | | | | | | | | | |
| 0130080 | 830517 | 0.00 | 0.004 | 0.002 | 0.02 | 0.02 | 0.96 | 0.01 | 0.01 |
| * 830616 | | | | | | | | | |
| 0130080 | 830616 | 0.00 | 0.020 | 0.020 | 0.04 | 0.11 | 0.60 | -0.01 | -0.01 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| * 830629 | | | | | | | | | |
| 0130080 | 830629 | 0.00 | 0.001 | 0.003 | 0.02 | 0.04 | 0.74 | -0.01 | -0.01 |
| 0130080 | 830629 | 1.00 | 0.001 | 0.003 | 0.03 | 0.03 | 0.55 | -0.01 | -0.01 |
| * 830719 | | | | | | | | | |
| 0130080 | 830719 | 0.00 | 0.002 | 0.002 | 0.03 | 0.23 | 0.70 | -0.01 | -0.01 |
| * 830811 | | | | | | | | | |
| 0130080 | 830811 | 0.00 | 0.002 | 0.002 | -0.01 | -0.01 | 0.88 | -0.01 | -0.01 |
| * 830826 | | | | | | | | | |
| 0130080 | 830826 | 0.00 | 0.002 | 0.004 | 0.02 | 0.04 | 0.73 | -0.01 | -0.01 |
| * 831027 | | | | | | | | | |
| 0130080 | 831027 | 0.00 | -0.001 | 0.004 | -0.01 | 0.07 | 0.74 | -0.01 | -0.01 |
| * 831116 | | | | | | | | | |
| 0130080 | 831116 | 0.00 | -0.001 | 0.003 | 0.02 | 0.03 | 0.64 | -0.01 | -0.01 |
| * 831215 | | | | | | | | | |
| 0130080 | 831215 | 0.50 | -0.001 | 0.003 | 0.01 | 0.06 | 0.80 | -0.01 | 0.01 |
| * 840104 | | | | | | | | | |
| 0130080 | 840104 | 0.50 | 0.003 | 0.004 | 0.02 | 0.13 | 0.87 | -0.01 | 0.02 |
| * 840119 | | | | | | | | | |
| 0130080 | 840119 | 0.50 | 0.002 | 0.003 | -0.01 | -0.01 | 0.76 | -0.01 | -0.01 |
| * 840229 | | | | | | | | | |
| 0130080 | 840229 | 0.50 | 0.001 | 0.003 | -0.01 | 0.02 | 0.76 | -0.01 | -0.01 |
| * 840327 | | | | | | | | | |
| 0130080 | 840327 | 0.00 | 0.001 | 0.003 | -0.01 | -0.01 | 0.81 | -0.01 | -0.01 |
| * 840524 | | | | | | | | | |
| 0130080 | 840524 | 0.00 | 0.002 | 0.002 | 0.02 | 0.04 | 0.98 | -0.01 | 0.01 |
| * 840619 | | | | | | | | | |
| 0130080 | 840619 | 0.00 | 0.001 | 0.002 | -0.01 | 0.11 | 0.98 | -0.01 | 0.01 |
| * 840711 | | | | | | | | | |
| 0130080 | 840711 | 0.00 | 0.003 | 0.004 | 0.02 | 0.25 | 0.86 | -0.01 | -0.01 |
| * 840725 | | | | | | | | | |
| 0130080 | 840725 | 0.00 | -0.001 | 0.003 | 0.02 | 0.13 | 0.85 | -0.01 | 0.01 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| * 841002 | | | | | | | | | |
| 0130080 | 841002 | 0.00 | -0.001 | 0.002 | -0.01 | 0.04 | 0.71 | -0.01 | -0.01 |
| * 841010 | | | | | | | | | |
| 0130080 | 841010 | 0.00 | 0.001 | 0.003 | -0.01 | 0.11 | 0.70 | -0.01 | -0.01 |
| * 841211 | | | | | | | | | |
| 0130080 | 841211 | 0.00 | 0.002 | 0.002 | 0.03 | 0.07 | 0.93 | -0.01 | -0.01 |
| * 850128 | | | | | | | | | |
| 0130080 | 850128 | 0.00 | 0.002 | 0.003 | -0.01 | 0.15 | 0.95 | -0.01 | -0.01 |
| * 850410 | | | | | | | | | |
| 0130080 | 850410 | 0.00 | 0.002 | 0.003 | 0.02 | 0.09 | 0.90 | -0.01 | -0.01 |
| * 850709 | | | | | | | | | |
| 0130080 | 850709 | 0.00 | 0.003 | 0.003 | -0.01 | 0.04 | 0.74 | -0.01 | -0.01 |
| * 850725 | | | | | | | | | |
| 0130080 | 850725 | 0.00 | -0.001 | 0.002 | -0.01 | 0.09 | 0.84 | -0.01 | -0.01 |
| * 850909 | | | | | | | | | |
| 0130080 | 850909 | 0.00 | -0.001 | -0.001 | -0.01 | -0.01 | 0.80 | -0.01 | -0.01 |
| * 851024 | | | | | | | | | |
| 0130080 | 851024 | 0.00 | 0.001 | 0.002 | 0.01 | 0.05 | 0.89 | -0.01 | -0.01 |
| * 851204 | | | | | | | | | |
| 0130080 | 851204 | 0.00 | -9.999 | 0.001 | -9.99 | -0.01 | -9.99 | -9.99 | -0.01 |
| * 860206 | | | | | | | | | |
| 0130080 | 860206 | 0.00 | 0.001 | 0.002 | 0.02 | 0.02 | 0.83 | -0.01 | -0.01 |
| * 860225 | | | | | | | | | |
| 0130080 | 860225 | 0.00 | -9.999 | 0.003 | -9.99 | -0.01 | -9.99 | -9.99 | -0.01 |
| * 860319 | | | | | | | | | |
| 0130080 | 860319 | 0.00 | 0.002 | 0.003 | -0.01 | 0.02 | 0.93 | -0.01 | -0.01 |
| * 860430 | | | | | | | | | |
| 0130080 | 860430 | 0.00 | 0.002 | 0.003 | -0.01 | 0.01 | 0.89 | -0.01 | -0.01 |
| * 860603 | | | | | | | | | |
| 0130080 | 860603 | 0.00 | 0.002 | 0.003 | 0.02 | 0.02 | 0.84 | -0.01 | -0.01 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| * 870127 | | | | | | | | | |
| 0130080 | 870127 | 0.00 | -9.999 | 0.003 | -9.99 | 0.05 | 0.77 | -9.99 | -0.01 |
| * 870218 | | | | | | | | | |
| 0130080 | 870218 | 0.00 | 0.001 | 0.002 | 0.02 | 0.03 | 0.90 | -0.01 | -0.01 |
| * 870408 | | | | | | | | | |
| 0130080 | 870408 | 0.00 | -9.999 | 0.004 | -9.99 | -0.10 | 0.89 | -9.99 | -0.01 |
| * 870505 | | | | | | | | | |
| 0130080 | 870505 | 0.00 | -9.999 | 0.003 | -9.99 | 0.03 | 0.78 | -9.99 | -0.01 |
| * 870603 | | | | | | | | | |
| 0130080 | 870603 | 0.00 | -9.999 | 0.002 | -9.99 | 0.04 | 0.88 | -9.99 | -0.01 |
| * 870727 | | | | | | | | | |
| 0130080 | 870727 | 0.00 | -9.999 | 0.002 | -9.99 | 0.07 | 0.83 | -9.99 | -0.01 |
| * 871015 | | | | | | | | | |
| 0130080 | 871015 | 0.00 | 0.004 | 0.004 | 0.01 | 0.03 | 0.80 | -0.01 | -0.01 |
| * 871118 | | | | | | | | | |
| 0130080 | 871118 | 0.00 | -9.999 | 0.005 | -9.99 | 0.08 | 0.80 | -9.99 | -0.01 |
| * 871208 | | | | | | | | | |
| 0130080 | 871208 | 0.00 | -0.001 | 0.002 | -0.01 | 0.06 | 0.82 | -0.01 | -0.01 |
| * 880118 | | | | | | | | | |
| 0130080 | 880118 | 0.00 | -9.999 | 0.002 | -9.99 | 0.08 | 0.86 | -9.99 | -0.01 |
| * 880119 | | | | | | | | | |
| 0130080 | 880119 | 0.00 | -9.999 | 0.003 | -9.99 | 0.07 | 0.88 | -9.99 | -0.01 |
| * 880208 | | | | | | | | | |
| 0130080 | 880208 | 0.00 | -9.999 | 0.002 | -9.99 | 0.05 | 0.86 | -9.99 | -0.01 |
| * 880303 | | | | | | | | | |
| 0130080 | 880303 | 0.00 | -9.999 | 0.003 | -9.99 | 0.04 | 0.85 | -9.99 | -0.01 |
| * 880413 | | | | | | | | | |
| 0130080 | 880413 | 0.00 | 0.002 | 0.003 | -0.01 | 0.05 | 0.87 | -0.01 | -0.01 |
| * 880420 | | | | | | | | | |
| 0130080 | 880420 | 0.00 | -9.999 | 0.002 | -9.99 | 0.06 | 0.89 | -9.99 | -0.01 |

# BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| * | 880518 | | | | | | | | |
| 0130080 | 880518 | 0.00 | -9.999 | 0.002 | -9.99 | 0.07 | 0.88 | -9.99 | -0.01 |
| * | 880615 | | | | | | | | |
| 0130080 | 880615 | 0.00 | -9.999 | 0.003 | -9.99 | 0.03 | 0.87 | -9.99 | -0.01 |
| * | 880719 | | | | | | | | |
| 0130080 | 880719 | 0.00 | -9.999 | -0.001 | -9.99 | 0.09 | 0.85 | -9.99 | -0.01 |
| * | 881103 | | | | | | | | |
| 0130080 | 881103 | 0.00 | -9.999 | 0.002 | -9.99 | 0.04 | 0.73 | -9.99 | -0.01 |
| * | 881221 | | | | | | | | |
| 0130080 | 881221 | 0.00 | -9.999 | 0.001 | -9.99 | 0.03 | 0.79 | -9.99 | -0.01 |
| * | 890112 | | | | | | | | |
| 0130080 | 890112 | 0.00 | -9.999 | 0.004 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * | 890206 | | | | | | | | |
| 0130080 | 890206 | 0.00 | -9.999 | 0.002 | -9.99 | 0.02 | 0.80 | -9.99 | -0.01 |
| * | 890307 | | | | | | | | |
| 0130080 | 890307 | 0.00 | -0.001 | 0.003 | -0.01 | 0.04 | 0.85 | -0.01 | -0.01 |
| * | 890511 | | | | | | | | |
| 0130080 | 890511 | 0.50 | 0.001 | 0.005 | -0.01 | 0.02 | 0.87 | -0.01 | -0.01 |
| * | 890614 | | | | | | | | |
| 0130080 | 890614 | 0.00 | 0.002 | 0.002 | -0.01 | 0.01 | 0.80 | -0.01 | -0.01 |
| * | 890710 | | | | | | | | |
| 0130080 | 890710 | 0.00 | 0.001 | 0.001 | -9.99 | -0.01 | 0.73 | -9.99 | -0.01 |
| * | 890814 | | | | | | | | |
| 0130080 | 890814 | 0.00 | -9.999 | 0.001 | -9.99 | 0.04 | 0.80 | -9.99 | -0.01 |
| * | 890907 | | | | | | | | |
| 0130080 | 890907 | 0.00 | -9.999 | 0.001 | -9.99 | 0.08 | 0.78 | -9.99 | -0.01 |
| * | 891024 | | | | | | | | |
| 0130080 | 891024 | 0.00 | -0.001 | -0.001 | -0.01 | -0.01 | 0.72 | -0.01 | -0.01 |
| * | 891207 | | | | | | | | |
| 0130080 | 891207 | 0.00 | -9.999 | 0.002 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| * 891212 | | | | | | | | | |
| 0130080 | 891212 | 0.00 | 0.002 | 0.002 | -0.01 | 0.03 | 0.77 | -0.01 | -0.01 |
| * 900227 | | | | | | | | | |
| 0130080 | 900227 | 0.00 | -9.999 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| ** 0130082 | | | | | | | | | |
| * 810416 | | | | | | | | | |
| 0130082 | 810416 | 3.00 | 0.020 | -9.999 | -9.99 | -9.99 | 0.98 | -9.99 | -9.99 |
| 0130082 | 810416 | 15.00 | 0.020 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810416 | 30.00 | 0.030 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810416 | 45.00 | 0.040 | -9.999 | -9.99 | -9.99 | 1.10 | -9.99 | -9.99 |
| * 810513 | | | | | | | | | |
| 0130082 | 810513 | 3.00 | 0.009 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810513 | 15.00 | 0.013 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810513 | 30.00 | 0.016 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810513 | 50.00 | 0.015 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 810608 | | | | | | | | | |
| 0130082 | 810608 | 3.00 | 0.012 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810608 | 15.00 | 0.020 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810608 | 30.00 | 0.030 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810608 | 50.00 | 0.020 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 810714 | | | | | | | | | |
| 0130082 | 810714 | 3.00 | 0.005 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810714 | 3.10 | 0.005 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810714 | 15.00 | 0.005 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810714 | 30.00 | 0.010 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810714 | 50.00 | 0.010 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 810812 | | | | | | | | | |
| 0130082 | 810812 | 3.00 | 0.002 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810812 | 3.10 | 0.002 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810812 | 15.00 | 0.005 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810812 | 30.00 | 0.007 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810812 | 50.00 | 0.009 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 810908 | | | | | | | | | |
| 0130082 | 810908 | 3.00 | 0.001 | -9.999 | -9.99 | -9.99 | 0.86 | -9.99 | -9.99 |
| 0130082 | 810908 | 3.10 | 0.003 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810908 | 15.00 | 0.005 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810908 | 30.00 | 0.006 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 810908 | 50.00 | 0.007 | -9.999 | -9.99 | -9.99 | 0.98 | -9.99 | -9.99 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| * 811020 | | | | | | | | | |
| 0130082 | 811020 | 3.00 | 0.005 | 0.007 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 811020 | 15.00 | 0.010 | 0.016 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 811020 | 30.00 | 0.007 | 0.010 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 811020 | 50.00 | 0.008 | 0.010 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 811118 | | | | | | | | | |
| 0130082 | 811118 | 3.00 | 0.007 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 811118 | 3.10 | 0.007 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 811118 | 15.00 | 0.011 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 811118 | 30.00 | 0.012 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 811118 | 50.00 | 0.007 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 820119 | | | | | | | | | |
| 0130082 | 820119 | 20.00 | -9.999 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 820215 | | | | | | | | | |
| 0130082 | 820215 | 3.00 | 0.008 | 0.009 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 820215 | 3.10 | 0.007 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 820215 | 15.00 | -9.999 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 820215 | 30.00 | -9.999 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| 0130082 | 820215 | 50.00 | 0.009 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 820614 | | | | | | | | | |
| 0130082 | 820614 | 0.50 | -9.999 | 0.004 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 830324 | | | | | | | | | |
| 0130082 | 830324 | 0.00 | -9.999 | -9.999 | -9.99 | -9.99 | -9.99 | -9.99 | -9.99 |
| * 830426 | | | | | | | | | |
| 0130082 | 830426 | 0.00 | -9.999 | 0.005 | -9.99 | -0.10 | 0.77 | -9.99 | 0.02 |
| * 830601 | | | | | | | | | |
| 0130082 | 830601 | 0.00 | -9.999 | 0.003 | -9.99 | 0.05 | 0.65 | -9.99 | -0.01 |
| * 830720 | | | | | | | | | |
| 0130082 | 830720 | 0.00 | -9.999 | 0.005 | -9.99 | 0.03 | 0.69 | -9.99 | -0.01 |
| * 830822 | | | | | | | | | |
| 0130082 | 830822 | 0.00 | -9.999 | 0.004 | -9.99 | 0.03 | 0.67 | -9.99 | -0.01 |
| 0130082 | 830822 | 20.00 | -9.999 | 0.004 | -9.99 | 0.06 | 0.73 | -9.99 | 0.01 |
| 0130082 | 830822 | 40.00 | -9.999 | 0.100 | -9.99 | 0.92 | 1.12 | -9.99 | 0.06 |
| 0130082 | 830822 | 100.0 | -9.999 | 0.310 | -9.99 | 9.30 | 4.34 | -9.99 | 0.21 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| * 831025 | | | | | | | | | |
| 0130082 | 831025 | 0.00 | -9.999 | 0.003 | -9.99 | 0.07 | 0.71 | -9.99 | 0.01 |
| * 831214 | | | | | | | | | |
| 0130082 | 831214 | 0.00 | -9.999 | 0.009 | -9.99 | 0.11 | 0.77 | -9.99 | 0.03 |
| 0130082 | 831214 | 20.00 | -9.999 | 0.020 | -9.99 | 0.13 | 0.78 | -9.99 | 0.04 |
| 0130082 | 831214 | 40.00 | -9.999 | 0.010 | -9.99 | 0.12 | 0.81 | -9.99 | 0.04 |
| 0130082 | 831214 | 132.0 | -9.999 | 0.030 | -9.99 | 0.31 | 0.90 | -9.99 | 0.04 |
| * 840214 | | | | | | | | | |
| 0130082 | 840214 | 0.00 | -9.999 | 0.020 | -9.99 | 0.06 | 0.87 | -9.99 | 0.04 |
| 0130082 | 840214 | 20.00 | -9.999 | 0.020 | -9.99 | 0.11 | 0.77 | -9.99 | 0.04 |
| * 840327 | | | | | | | | | |
| 0130082 | 840327 | 0.00 | -9.999 | 0.009 | -9.99 | 0.03 | 0.68 | -9.99 | 0.03 |
| 0130082 | 840327 | 20.00 | -9.999 | 0.011 | -9.99 | 0.04 | 0.76 | -9.99 | 0.04 |
| 0130082 | 840327 | 40.00 | -9.999 | 0.140 | -9.99 | 7.20 | 2.91 | -9.99 | 0.33 |
| * 840501 | | | | | | | | | |
| 0130082 | 840501 | 0.00 | -9.999 | 0.007 | -9.99 | 0.10 | 0.81 | -9.99 | 0.03 |
| 0130082 | 840501 | 20.00 | -9.999 | 0.009 | -9.99 | 0.09 | 0.79 | -9.99 | 0.03 |
| 0130082 | 840501 | 40.00 | -9.999 | 0.010 | -9.99 | 0.18 | 0.93 | -9.99 | 0.04 |
| 0130082 | 840501 | 65.00 | -9.999 | 0.013 | -9.99 | 0.44 | 0.99 | -9.99 | 0.05 |
| * 840619 | | | | | | | | | |
| 0130082 | 840619 | 0.00 | -9.999 | 0.003 | -9.99 | 0.05 | 0.88 | -9.99 | 0.01 |
| 0130082 | 840619 | 20.00 | -9.999 | 0.005 | -9.99 | 0.07 | 0.72 | -9.99 | 0.01 |
| 0130082 | 840619 | 40.00 | -9.999 | 0.012 | -9.99 | 0.34 | 1.07 | -9.99 | 0.05 |
| 0130082 | 840619 | 69.00 | -9.999 | 0.290 | -9.99 | 10.50 | 4.37 | -9.99 | 0.26 |
| * 840725 | | | | | | | | | |
| 0130082 | 840725 | 0.00 | -9.999 | 0.002 | -9.99 | 0.03 | 0.76 | -9.99 | -0.01 |
| 0130082 | 840725 | 20.00 | -9.999 | 0.003 | -9.99 | 0.05 | 0.66 | -9.99 | -0.01 |
| * 840822 | | | | | | | | | |
| 0130082 | 840822 | 0.00 | -9.999 | 0.002 | -9.99 | 0.06 | 0.75 | -9.99 | -0.01 |
| 0130082 | 840822 | 20.00 | -9.999 | 0.003 | -9.99 | -0.01 | 0.73 | -9.99 | -0.01 |
| 0130082 | 840822 | 40.00 | -9.999 | 0.005 | -9.99 | 0.09 | 0.88 | -9.99 | 0.02 |
| 0130082 | 840822 | 65.00 | -9.999 | 0.012 | -9.99 | 0.07 | 0.97 | -9.99 | 0.05 |
| * 841002 | | | | | | | | | |
| 0130082 | 841002 | 0.00 | -9.999 | 0.002 | -9.99 | 0.06 | 0.65 | -9.99 | -0.01 |
| 0130082 | 841002 | 20.00 | -9.999 | 0.004 | -9.99 | 0.10 | 0.76 | -9.99 | -0.01 |
| 0130082 | 841002 | 40.00 | -9.999 | 0.007 | -9.99 | 0.08 | 0.80 | -9.99 | 0.04 |
| 0130082 | 841002 | 60.00 | -9.999 | 0.007 | -9.99 | 0.10 | 0.85 | -9.99 | 0.05 |

# BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| * 841211 | | | | | | | | | |
| 0130082 | 841211 | 0.00 | -9.999 | 0.005 | -9.99 | 0.09 | 0.83 | -9.99 | 0.01 |
| 0130082 | 841211 | 20.00 | -9.999 | 0.005 | -9.99 | 0.12 | 0.86 | -9.99 | 0.03 |
| 0130082 | 841211 | 40.00 | -9.999 | 0.005 | -9.99 | 0.11 | 0.87 | -9.99 | 0.03 |
| 0130082 | 841211 | 60.00 | -9.999 | 0.005 | -9.99 | 0.13 | 0.88 | -9.99 | 0.04 |
| * 850219 | | | | | | | | | |
| 0130082 | 850219 | 0.00 | -9.999 | 0.005 | -9.99 | 0.08 | 0.90 | -9.99 | 0.02 |
| 0130082 | 850219 | 20.00 | -9.999 | 0.010 | -9.99 | 0.06 | 1.00 | -9.99 | 0.02 |
| 0130082 | 850219 | 40.00 | -9.999 | 0.007 | -9.99 | 1.01 | -0.02 | -9.99 | 0.02 |
| 0130082 | 850219 | 65.00 | -9.999 | 0.008 | -9.99 | 0.04 | 1.04 | -9.99 | 0.03 |
| * 850430 | | | | | | | | | |
| 0130082 | 850430 | 0.00 | -9.999 | 0.007 | -9.99 | 0.07 | 0.92 | -9.99 | 0.02 |
| 0130082 | 850430 | 20.00 | -9.999 | 0.007 | -9.99 | 0.06 | 0.99 | -9.99 | 0.02 |
| 0130082 | 850430 | 40.00 | -9.999 | 0.008 | -9.99 | 0.09 | 0.92 | -9.99 | 0.03 |
| 0130082 | 850430 | 60.00 | -9.999 | 0.007 | -9.99 | 0.07 | 0.94 | -9.99 | 0.03 |
| * 850604 | | | | | | | | | |
| 0130082 | 850604 | 0.00 | -9.999 | 0.003 | -9.99 | 0.03 | 0.76 | -9.99 | 0.01 |
| 0130082 | 850604 | 20.00 | -9.999 | 0.006 | -9.99 | 0.04 | 0.68 | -9.99 | 0.01 |
| 0130082 | 850604 | 40.00 | -9.999 | 0.005 | -9.99 | 0.05 | 0.87 | -9.99 | 0.02 |
| 0130082 | 850604 | 60.00 | -9.999 | 0.007 | -9.99 | 0.05 | 0.86 | -9.99 | 0.02 |
| * 850709 | | | | | | | | | |
| 0130082 | 850709 | 0.00 | -9.999 | -0.001 | -9.99 | 0.03 | 0.77 | -9.99 | -0.01 |
| 0130082 | 850709 | 20.00 | -9.999 | 0.003 | -9.99 | 0.06 | 0.75 | -9.99 | -0.01 |
| 0130082 | 850709 | 40.00 | -9.999 | 0.020 | -9.99 | 0.07 | 0.92 | -9.99 | 0.01 |
| 0130082 | 850709 | 60.00 | -9.999 | 0.003 | -9.99 | 0.07 | 0.83 | -9.99 | 0.02 |
| 0130082 | 850709 | 100.0 | -9.999 | 0.002 | -9.99 | 0.06 | 0.87 | -9.99 | 0.02 |
| * 850813 | | | | | | | | | |
| 0130082 | 850813 | 0.00 | -9.999 | -0.001 | -9.99 | 0.07 | 0.73 | -9.99 | -0.01 |
| 0130082 | 850813 | 20.00 | -9.999 | 0.003 | -9.99 | -0.01 | 0.73 | -9.99 | -0.01 |
| 0130082 | 850813 | 40.00 | -9.999 | 0.004 | -9.99 | 0.16 | 0.80 | -9.99 | 0.01 |
| 0130082 | 850813 | 60.00 | -9.999 | 0.004 | -9.99 | -0.01 | 0.85 | -9.99 | 0.01 |
| * 850917 | | | | | | | | | |
| 0130082 | 850917 | 0.00 | -9.999 | -0.001 | -9.99 | 0.04 | 0.77 | -9.99 | -0.01 |
| 0130082 | 850917 | 20.00 | -9.999 | 0.002 | -9.99 | 0.03 | 0.77 | -9.99 | -0.01 |
| 0130082 | 850917 | 40.00 | -9.999 | 0.005 | -9.99 | 0.02 | 0.82 | -9.99 | 0.02 |
| 0130082 | 850917 | 60.00 | -9.999 | 0.004 | -9.99 | 0.04 | 0.86 | -9.99 | 0.03 |
| * 851022 | | | | | | | | | |
| 0130082 | 851022 | 0.00 | -9.999 | 0.002 | -9.99 | 0.02 | 0.79 | -9.99 | -0.01 |
| 0130082 | 851022 | 20.00 | -9.999 | 0.030 | -9.99 | 0.21 | 0.70 | -9.99 | 0.02 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| 0130082 | 851022 | 40.00 | -9.999 | 0.020 | -9.99 | 0.07 | 0.85 | -9.99 | 0.01 |
| 0130082 | 851022 | 60.00 | -9.999 | 0.020 | -9.99 | 0.07 | 0.87 | -9.99 | 0.03 |
| * | 851212 | | | | | | | | |
| 0130082 | 851212 | 0.00 | -9.999 | 0.004 | -9.99 | 0.07 | 0.82 | -9.99 | 0.01 |
| 0130082 | 851212 | 20.00 | -9.999 | 0.009 | -9.99 | 0.11 | 0.83 | -9.99 | 0.01 |
| 0130082 | 851212 | 40.00 | -9.999 | 0.009 | -9.99 | 0.11 | 0.81 | -9.99 | 0.02 |
| 0130082 | 851212 | 60.00 | -9.999 | 0.009 | -9.99 | 0.05 | 0.82 | -9.99 | 0.03 |
| * | 860211 | | | | | | | | |
| 0130082 | 860211 | 0.00 | -0.001 | 0.003 | 0.04 | 0.05 | 0.67 | 0.01 | 0.02 |
| 0130082 | 860211 | 10.00 | 0.004 | 0.005 | 0.03 | 0.06 | 0.65 | 0.01 | 0.02 |
| 0130082 | 860211 | 20.00 | 0.005 | 0.006 | 0.04 | 0.06 | 0.78 | 0.02 | 0.02 |
| 0130082 | 860211 | 30.00 | 0.007 | 0.009 | 0.05 | 0.09 | 0.76 | 0.03 | 0.03 |
| 0130082 | 860211 | 40.00 | 0.008 | 0.020 | 0.06 | 0.09 | 0.75 | 0.03 | 0.04 |
| 0130082 | 860211 | 60.00 | 0.007 | 0.020 | 0.05 | 0.09 | 0.80 | 0.04 | 0.05 |
| * | 860311 | | | | | | | | |
| 0130082 | 860311 | 0.00 | 0.004 | -0.010 | -0.01 | 0.08 | 0.65 | 0.01 | 0.04 |
| 0130082 | 860311 | 10.00 | 0.004 | -0.010 | 0.02 | 0.06 | 0.63 | 0.02 | 0.02 |
| 0130082 | 860311 | 20.00 | 0.007 | 0.010 | 0.02 | 0.06 | 0.75 | 0.02 | 0.02 |
| 0130082 | 860311 | 30.00 | 0.005 | -0.010 | 0.02 | 0.03 | 0.71 | 0.02 | 0.02 |
| 0130082 | 860311 | 40.00 | 0.006 | 0.020 | 0.02 | 0.05 | 0.73 | 0.02 | 0.02 |
| 0130082 | 860311 | 60.00 | 0.006 | 0.010 | 0.03 | 0.05 | 0.75 | 0.03 | 0.03 |
| * | 860415 | | | | | | | | |
| 0130082 | 860415 | 0.00 | 0.005 | -0.010 | 0.02 | 0.09 | 0.82 | 0.01 | 0.02 |
| 0130082 | 860415 | 10.00 | 0.005 | 0.010 | 0.02 | -0.01 | 0.80 | 0.02 | 0.02 |
| 0130082 | 860415 | 20.00 | 0.004 | 0.010 | 0.02 | 0.08 | 0.80 | 0.03 | 0.03 |
| 0130082 | 860415 | 30.00 | 0.005 | 0.010 | 0.18 | 0.03 | 0.74 | 0.03 | 0.04 |
| 0130082 | 860415 | 40.00 | 0.005 | 0.010 | 0.02 | 0.02 | 0.79 | 0.04 | 0.04 |
| 0130082 | 860415 | 60.00 | 0.005 | 0.010 | 0.02 | 0.02 | 0.80 | 0.04 | 0.04 |
| * | 860512 | | | | | | | | |
| 0130082 | 860512 | 0.00 | 0.004 | -0.010 | -0.01 | -0.01 | 0.82 | -0.01 | 0.02 |
| 0130082 | 860512 | 10.00 | 0.003 | -0.010 | 0.01 | -0.01 | 0.82 | -0.01 | 0.02 |
| 0130082 | 860512 | 20.00 | 0.004 | -0.010 | 0.06 | -0.01 | 0.89 | -0.01 | 0.02 |
| 0130082 | 860512 | 30.00 | 0.007 | -0.010 | 0.01 | -0.01 | 0.97 | 0.02 | 0.02 |
| 0130082 | 860512 | 40.00 | 0.006 | -0.010 | 0.03 | 0.03 | 0.81 | 0.02 | 0.03 |
| 0130082 | 860512 | 60.00 | 0.003 | -0.010 | -0.01 | 0.01 | 0.80 | -0.01 | 0.02 |
| * | 860610 | | | | | | | | |
| 0130082 | 860610 | 0.00 | 0.002 | -0.010 | -0.01 | -0.01 | 0.74 | -0.01 | -0.01 |
| 0130082 | 860610 | 10.00 | 0.002 | -0.010 | 0.02 | 0.02 | 0.67 | -0.01 | -0.01 |
| 0130082 | 860610 | 20.00 | 0.002 | -0.010 | 0.02 | 0.02 | 0.55 | -0.01 | -0.01 |
| 0130082 | 860610 | 30.00 | 0.003 | -0.010 | 0.02 | 0.03 | 0.59 | -0.01 | -0.01 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| 0130082 | 860610 | 40.00 | 0.004 | -0.010 | 0.02 | 0.04 | 0.73 | 0.01 | 0.02 |
| 0130082 | 860610 | 60.00 | 0.004 | -0.010 | 0.02 | 0.04 | 0.75 | 0.02 | 0.02 |
| * 860708 | | | | | | | | | |
| 0130082 | 860708 | 0.00 | 0.001 | -0.010 | 0.01 | 0.02 | 0.69 | -0.01 | -0.01 |
| 0130082 | 860708 | 10.00 | -0.001 | -0.010 | 0.02 | 0.02 | 0.61 | -0.01 | -0.01 |
| 0130082 | 860708 | 20.00 | -0.001 | -0.010 | 0.03 | 0.03 | 0.62 | -0.01 | -0.01 |
| 0130082 | 860708 | 30.00 | 0.004 | -0.010 | 0.03 | 0.03 | 0.75 | -0.01 | -0.01 |
| 0130082 | 860708 | 40.00 | 0.005 | -0.010 | -9.99 | 0.03 | 0.76 | -0.01 | 0.01 |
| 0130082 | 860708 | 60.00 | 0.003 | -0.010 | 0.03 | 0.04 | 0.75 | 0.02 | 0.02 |
| * 860812 | | | | | | | | | |
| 0130082 | 860812 | 0.00 | 0.001 | -0.010 | -0.01 | -0.01 | 0.75 | -0.01 | -0.01 |
| 0130082 | 860812 | 10.00 | 0.001 | -0.010 | 0.01 | -0.01 | 0.67 | -0.01 | -0.01 |
| 0130082 | 860812 | 20.00 | 0.002 | -0.010 | -0.01 | -0.01 | 0.70 | -0.01 | -0.01 |
| 0130082 | 860812 | 30.00 | 0.002 | -0.010 | 0.01 | -0.01 | 0.73 | -0.01 | -0.01 |
| 0130082 | 860812 | 40.00 | 0.002 | -0.010 | 0.08 | -0.01 | 0.71 | 0.01 | 0.01 |
| 0130082 | 860812 | 60.00 | 0.003 | -0.010 | 0.02 | -0.01 | 0.74 | 0.02 | 0.02 |
| * 870204 | | | | | | | | | |
| 0130082 | 870204 | 0.00 | 0.005 | -0.010 | 0.03 | 0.03 | 0.69 | 0.02 | 0.03 |
| 0130082 | 870204 | 10.00 | 0.005 | -0.010 | 0.03 | 0.03 | 0.69 | 0.02 | 0.03 |
| 0130082 | 870204 | 20.00 | 0.006 | -0.010 | 0.02 | 0.03 | 0.70 | 0.03 | 0.04 |
| 0130082 | 870204 | 30.00 | 0.006 | 0.010 | 0.02 | 0.05 | 0.76 | 0.04 | 0.04 |
| 0130082 | 870204 | 40.00 | 0.006 | 0.010 | 0.03 | 0.05 | 0.74 | 0.04 | 0.04 |
| 0130082 | 870204 | 60.00 | 0.007 | 0.010 | 0.04 | 0.06 | 0.72 | 0.04 | 0.05 |
| * 870414 | | | | | | | | | |
| 0130082 | 870414 | 0.00 | 0.003 | 0.006 | -0.01 | 0.10 | 0.81 | 0.02 | 0.03 |
| 0130082 | 870414 | 10.00 | 0.004 | 0.007 | -0.01 | 0.10 | 0.78 | 0.03 | 0.03 |
| 0130082 | 870414 | 20.00 | 0.003 | 0.007 | -0.01 | 0.11 | 0.79 | 0.02 | 0.03 |
| 0130082 | 870414 | 30.00 | 0.003 | 0.007 | -0.01 | 0.11 | 0.76 | 0.03 | 0.04 |
| 0130082 | 870414 | 40.00 | 0.005 | 0.011 | -0.01 | 0.09 | 0.85 | 0.05 | 0.06 |
| 0130082 | 870414 | 60.00 | 0.005 | 0.009 | -0.01 | 0.15 | 0.81 | 0.05 | 0.05 |
| * 870708 | | | | | | | | | |
| 0130082 | 870708 | 0.00 | -9.999 | 0.002 | -9.99 | 0.03 | 0.65 | -9.99 | -0.01 |
| 0130082 | 870708 | 10.00 | -9.999 | 0.003 | -9.99 | 0.03 | 0.61 | -9.99 | -0.01 |
| 0130082 | 870708 | 20.00 | -9.999 | 0.005 | -9.99 | 0.11 | 0.64 | -9.99 | -0.01 |
| 0130082 | 870708 | 30.00 | -9.999 | 0.005 | -9.99 | 0.05 | 0.69 | -9.99 | 0.01 |
| 0130082 | 870708 | 40.00 | -9.999 | 0.005 | -9.99 | 0.05 | 0.74 | -9.99 | 0.03 |
| 0130082 | 870708 | 60.00 | -9.999 | 0.006 | -9.99 | 0.07 | 0.80 | -9.99 | 0.04 |
| * 870909 | | | | | | | | | |
| 0130082 | 870909 | 0.00 | 0.001 | 0.003 | -0.01 | -0.01 | 0.88 | -0.01 | -0.01 |
| 0130082 | 870909 | 10.00 | 0.001 | 0.004 | -0.01 | 0.01 | 0.79 | -0.01 | -0.01 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| 0130082 | 870909 | 20.00 | 0.001 | 0.004 | -0.01 | 0.01 | 0.75 | -0.01 | -0.01 |
| 0130082 | 870909 | 30.00 | 0.001 | 0.004 | -0.01 | 0.01 | 0.92 | -0.01 | -0.01 |
| 0130082 | 870909 | 40.00 | 0.002 | 0.007 | 0.02 | 0.02 | 0.84 | 0.02 | 0.03 |
| 0130082 | 870909 | 60.00 | 0.003 | 0.007 | -0.01 | 0.03 | 0.80 | 0.02 | 0.03 |
| * 871109 | | | | | | | | | |
| 0130082 | 871109 | 0.00 | 0.002 | 0.005 | 0.02 | 0.07 | 0.75 | 0.02 | 0.02 |
| * 880119 | | | | | | | | | |
| 0130082 | 880119 | 0.00 | 0.002 | 0.005 | -0.01 | 0.08 | 0.71 | 0.02 | 0.03 |
| * 880308 | | | | | | | | | |
| 0130082 | 880308 | 0.00 | 0.005 | 0.006 | 0.03 | 0.12 | 0.76 | 0.02 | 0.03 |
| * 880510 | | | | | | | | | |
| 0130082 | 880510 | 0.00 | 0.002 | 0.002 | 0.01 | 0.23 | 0.74 | -0.01 | 0.01 |
| 0130082 | 880510 | 10.00 | 0.001 | 0.001 | -0.01 | 0.09 | 0.77 | -0.01 | -0.01 |
| 0130082 | 880510 | 20.00 | 0.002 | 0.002 | -0.01 | 0.09 | 0.73 | -0.01 | 0.02 |
| 0130082 | 880510 | 30.00 | 0.003 | 0.004 | 0.01 | 0.08 | 0.81 | 0.02 | 0.03 |
| 0130082 | 880510 | 40.00 | 0.002 | 0.002 | -0.01 | 0.08 | 0.78 | 0.01 | 0.02 |
| 0130082 | 880510 | 60.00 | 0.004 | 0.004 | 0.01 | 0.13 | 0.87 | 0.02 | 0.03 |
| * 880706 | | | | | | | | | |
| 0130082 | 880706 | 0.00 | 0.002 | 0.003 | -0.01 | 0.06 | 0.77 | -0.01 | -0.01 |
| 0130082 | 880706 | 10.00 | 0.001 | 0.003 | -0.01 | 0.04 | 0.68 | -0.01 | -0.01 |
| 0130082 | 880706 | 20.00 | 0.001 | 0.002 | -0.01 | 0.04 | 0.63 | -0.01 | -0.01 |
| 0130082 | 880706 | 30.00 | 0.002 | 0.003 | -0.01 | 0.09 | 0.75 | -0.01 | 0.01 |
| 0130082 | 880706 | 40.00 | 0.002 | 0.003 | 0.01 | 0.03 | 0.78 | -0.01 | 0.02 |
| 0130082 | 880706 | 60.00 | 0.002 | 0.004 | 0.01 | 0.07 | 0.83 | -0.01 | 0.02 |
| * 880913 | | | | | | | | | |
| 0130082 | 880913 | 0.00 | 0.003 | 0.003 | 0.01 | 0.04 | 0.89 | -0.01 | -0.01 |
| 0130082 | 880913 | 10.00 | -0.001 | 0.004 | 0.01 | 0.04 | 0.81 | -0.01 | -0.01 |
| 0130082 | 880913 | 20.00 | -0.001 | 0.003 | 0.01 | 0.03 | 0.81 | -0.01 | -0.01 |
| 0130082 | 880913 | 30.00 | 0.004 | 0.004 | 0.01 | 0.01 | 0.78 | -0.01 | -0.01 |
| 0130082 | 880913 | 40.00 | 0.002 | 0.003 | -0.01 | 0.03 | 0.75 | -0.01 | -0.01 |
| 0130082 | 880913 | 60.00 | 0.002 | 0.004 | -0.01 | -0.01 | 0.81 | -0.01 | 0.01 |
| * 881108 | | | | | | | | | |
| 0130082 | 881108 | 0.00 | -0.001 | 0.001 | 0.02 | 0.04 | 0.65 | -0.01 | -0.01 |
| 0130082 | 881108 | 10.00 | 0.002 | 0.002 | 0.02 | 0.07 | 0.62 | -0.01 | -0.01 |
| 0130082 | 881108 | 20.00 | 0.005 | 0.006 | 0.03 | 0.16 | 0.57 | 0.01 | 0.02 |
| 0130082 | 881108 | 30.00 | 0.003 | 0.006 | 0.02 | 0.15 | 0.70 | -0.01 | 0.01 |
| 0130082 | 881108 | 40.00 | 0.002 | 0.003 | 0.02 | 0.05 | 0.76 | -0.01 | -0.01 |
| 0130082 | 881108 | 60.00 | 0.002 | 0.003 | 0.02 | 0.05 | 0.78 | -0.01 | 0.01 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | CU D mg/l | CU T mg/l | FE D mg/l | FE T mg/l | MG T mg/l | MN D mg/l | MN T mg/l |
|---|---|---|---|---|---|---|---|---|---|
| * 890118 | | | | | | | | | |
| 0130082 | 890118 | 0.00 | -0.001 | -0.001 | -0.01 | 0.05 | 0.80 | -0.01 | 0.01 |
| 0130082 | 890118 | 10.00 | 0.002 | 0.002 | -0.01 | 0.06 | 0.77 | -0.01 | 0.01 |
| 0130082 | 890118 | 20.00 | 0.001 | 0.001 | 0.01 | 0.02 | 0.73 | -0.01 | 0.01 |
| 0130082 | 890118 | 30.00 | 0.002 | 0.003 | -0.01 | 0.02 | 0.73 | -0.01 | 0.01 |
| 0130082 | 890118 | 40.00 | 0.002 | 0.002 | -0.01 | 0.04 | 0.74 | -0.01 | 0.01 |
| 0130082 | 890118 | 50.00 | 0.001 | 0.002 | -0.01 | 0.05 | 0.74 | -0.01 | 0.01 |
| * 890307 | | | | | | | | | |
| 0130082 | 890307 | 0.00 | 0.001 | 0.004 | 0.04 | 0.11 | 0.78 | 0.04 | 0.04 |
| * 890613 | | | | | | | | | |
| 0130082 | 890613 | 0.00 | 0.002 | 0.002 | -0.01 | -0.01 | 0.65 | -0.01 | -0.01 |
| 0130082 | 890613 | 10.00 | 0.002 | 0.002 | -0.01 | 0.02 | 0.59 | -0.01 | -0.01 |
| 0130082 | 890613 | 20.00 | 0.002 | 0.002 | 0.01 | 0.02 | 0.72 | -0.01 | -0.01 |
| 0130082 | 890613 | 30.00 | 0.002 | 0.003 | 0.01 | 0.04 | 0.74 | -0.01 | -0.01 |
| 0130082 | 890613 | 40.00 | 0.001 | 0.013 | 0.02 | 0.04 | 0.75 | -0.01 | 0.01 |
| 0130082 | 890613 | 60.00 | 0.002 | 0.002 | 0.03 | 0.03 | 0.80 | 0.02 | 0.02 |
| * 890822 | | | | | | | | | |
| 0130082 | 890822 | 0.00 | 0.001 | 0.001 | -0.01 | 0.02 | 0.69 | -0.01 | 0.03 |
| 0130082 | 890822 | 10.00 | -0.001 | 0.001 | 0.01 | 0.02 | 0.67 | -0.01 | 0.03 |
| 0130082 | 890822 | 20.00 | -0.001 | -0.001 | 0.02 | 0.02 | 0.70 | -0.01 | -0.01 |
| 0130082 | 890822 | 30.00 | 0.001 | 0.001 | -0.01 | 0.02 | 0.78 | -0.01 | 0.01 |
| 0130082 | 890822 | 40.00 | 0.001 | 0.002 | -0.01 | 0.03 | 0.75 | -0.01 | 0.03 |
| 0130082 | 890822 | 60.00 | 0.001 | 0.001 | -0.01 | 0.03 | 0.77 | -0.01 | 0.02 |
| * 891024 | | | | | | | | | |
| 0130082 | 891024 | 0.00 | 0.002 | 0.002 | 0.02 | 0.03 | 0.71 | -0.01 | -0.01 |
| 0130082 | 891024 | 10.00 | 0.003 | 0.004 | 0.03 | 0.11 | 0.62 | -0.01 | 0.01 |
| 0130082 | 891024 | 20.00 | 0.002 | 0.002 | 0.08 | 0.11 | 0.57 | 0.01 | 0.01 |
| 0130082 | 891024 | 30.00 | 0.002 | 0.005 | 0.03 | 0.14 | 0.74 | -0.01 | -0.01 |
| 0130082 | 891024 | 40.00 | 0.004 | 0.005 | 0.03 | 0.05 | 0.74 | -0.01 | -0.01 |
| 0130082 | 891024 | 60.00 | -0.001 | 0.005 | 0.04 | 0.04 | 0.76 | -0.01 | -0.01 |
| * 891212 | | | | | | | | | |
| 0130082 | 891212 | 0.00 | 0.003 | 0.009 | 0.02 | 0.04 | 0.70 | -0.01 | -0.01 |
| 0130082 | 891212 | 10.00 | 0.002 | 0.002 | 0.02 | 0.04 | 0.70 | -0.01 | -0.01 |
| 0130082 | 891212 | 20.00 | 0.003 | 0.006 | 0.03 | 0.08 | 0.65 | -0.01 | 0.01 |
| 0130082 | 891212 | 30.00 | 0.002 | 0.003 | 0.02 | 0.05 | 0.70 | -0.01 | -0.01 |
| 0130082 | 891212 | 40.00 | 0.004 | 0.004 | 0.01 | 0.06 | 0.66 | 0.01 | 0.01 |
| 0130082 | 891212 | 60.00 | 0.002 | 0.004 | 0.01 | 0.03 | 0.81 | -0.01 | -0.01 |

# BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | PB D mg/l | PB T mg/l | ZN D mg/l | ZN T mg/l |
|---|---|---|---|---|---|---|
| ** 0130080 | | | | | | |
| * 810217 | | | | | | |
| 0130080 | 810217 | 0.00 | -0.001 | -0.001 | 0.100 | 0.100 |
| 0130080 | 810217 | 5.00 | -0.001 | -0.001 | 0.110 | 0.120 |
| * 810312 | | | | | | |
| 0130080 | 810312 | 0.00 | -9.999 | -0.001 | -9.999 | 0.130 |
| * 810414 | | | | | | |
| 0130080 | 810414 | 0.00 | -9.999 | -0.001 | -9.999 | 0.120 |
| * 810624 | | | | | | |
| 0130080 | 810624 | 0.00 | -0.001 | 0.005 | 0.100 | 0.100 |
| * 810819 | | | | | | |
| 0130080 | 810819 | 0.00 | -0.001 | -0.001 | 0.040 | 0.040 |
| * 811117 | | | | | | |
| 0130080 | 811117 | 0.00 | 0.001 | 0.001 | 0.070 | 0.080 |
| * 820223 | | | | | | |
| 0130080 | 820223 | 0.00 | -0.001 | 0.001 | -9.999 | -9.999 |
| * 820615 | | | | | | |
| 0130080 | 820615 | 0.00 | -0.001 | -0.001 | 0.030 | 0.030 |
| * 820818 | | | | | | |
| 0130080 | 820818 | 0.00 | -0.001 | -0.001 | 0.040 | 0.050 |
| * 821208 | | | | | | |
| 0130080 | 821208 | 0.00 | -0.001 | 0.001 | 0.070 | 0.080 |
| * 830324 | | | | | | |
| 0130080 | 830324 | 0.00 | -9.999 | -9.999 | -9.999 | -9.999 |
| * 830426 | | | | | | |
| 0130080 | 830426 | 0.00 | -0.001 | -0.001 | 0.080 | 0.090 |
| * 830517 | | | | | | |
| 0130080 | 830517 | 0.00 | -0.001 | -0.001 | 0.070 | 0.100 |
| * 830616 | | | | | | |
| 0130080 | 830616 | 0.00 | 0.011 | 0.014 | -0.010 | -0.010 |

# BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | PB D mg/l | PB T mg/l | ZN D mg/l | ZN T mg/l |
|---|---|---|---|---|---|---|
| * 830629 | | | | | | |
| 0130080 | 830629 | 0.00 | -0.001 | 0.002 | 0.040 | 0.050 |
| 0130080 | 830629 | 1.00 | 0.001 | 0.002 | 0.030 | 0.050 |
| * 830719 | | | | | | |
| 0130080 | 830719 | 0.00 | -0.001 | -0.001 | 0.040 | 0.040 |
| * 830811 | | | | | | |
| 0130080 | 830811 | 0.00 | -0.001 | 0.002 | 0.040 | 0.040 |
| * 830826 | | | | | | |
| 0130080 | 830826 | 0.00 | -0.001 | -0.001 | 0.020 | 0.030 |
| * 831027 | | | | | | |
| 0130080 | 831027 | 0.00 | 0.001 | 0.001 | 0.030 | 0.050 |
| * 831116 | | | | | | |
| 0130080 | 831116 | 0.00 | -0.001 | -0.001 | 0.030 | 0.040 |
| * 831215 | | | | | | |
| 0130080 | 831215 | 0.50 | -0.001 | 0.001 | 0.050 | 0.060 |
| * 840104 | | | | | | |
| 0130080 | 840104 | 0.50 | -0.001 | -0.001 | 0.060 | 0.070 |
| * 840119 | | | | | | |
| 0130080 | 840119 | 0.50 | -0.001 | -0.001 | 0.060 | 0.070 |
| * 840229 | | | | | | |
| 0130080 | 840229 | 0.50 | -0.001 | -0.001 | 0.050 | 0.050 |
| * 840327 | | | | | | |
| 0130080 | 840327 | 0.00 | -0.001 | 0.001 | 0.060 | 0.060 |
| * 840524 | | | | | | |
| 0130080 | 840524 | 0.00 | -0.100 | -0.100 | 0.050 | 0.070 |
| * 840619 | | | | | | |
| 0130080 | 840619 | 0.00 | -0.001 | 0.001 | 0.030 | 0.050 |
| * 840711 | | | | | | |
| 0130080 | 840711 | 0.00 | -0.001 | -0.001 | 0.030 | 0.060 |
| * 840725 | | | | | | |
| 0130080 | 840725 | 0.00 | -0.001 | -0.001 | 0.030 | 0.030 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | PB D mg/l | PB T mg/l | ZN D mg/l | ZN T mg/l |
|---|---|---|---|---|---|---|
| * 841002 | | | | | | |
| 0130080 | 841002 | 0.00 | -0.001 | 0.001 | 0.030 | 0.040 |
| * 841010 | | | | | | |
| 0130080 | 841010 | 0.00 | -0.001 | -0.001 | 0.010 | 0.020 |
| * 841211 | | | | | | |
| 0130080 | 841211 | 0.00 | -0.001 | -0.001 | 0.040 | 0.050 |
| * 850128 | | | | | | |
| 0130080 | 850128 | 0.00 | -0.100 | -0.100 | 0.050 | 0.050 |
| * 850410 | | | | | | |
| 0130080 | 850410 | 0.00 | -0.100 | -0.100 | 0.050 | 0.050 |
| * 850709 | | | | | | |
| 0130080 | 850709 | 0.00 | -0.001 | -0.001 | 0.030 | 0.030 |
| * 850725 | | | | | | |
| 0130080 | 850725 | 0.00 | -0.100 | -0.100 | 0.020 | 0.090 |
| * 850909 | | | | | | |
| 0130080 | 850909 | 0.00 | -0.001 | -0.001 | -0.030 | -0.030 |
| * 851024 | | | | | | |
| 0130080 | 851024 | 0.00 | -0.100 | 0.002 | 0.030 | 0.040 |
| * 851204 | | | | | | |
| 0130080 | 851204 | 0.00 | -9.999 | 0.002 | -9.999 | 0.040 |
| * 860206 | | | | | | |
| 0130080 | 860206 | 0.00 | -0.001 | 0.002 | 0.040 | 0.040 |
| * 860225 | | | | | | |
| 0130080 | 860225 | 0.00 | -9.999 | -0.001 | -9.999 | 0.020 |
| * 860319 | | | | | | |
| 0130080 | 860319 | 0.00 | 0.001 | 0.003 | 0.040 | 0.040 |
| * 860430 | | | | | | |
| 0130080 | 860430 | 0.00 | -0.001 | 0.001 | 0.030 | 0.030 |
| * 860603 | | | | | | |
| 0130080 | 860603 | 0.00 | 0.001 | 0.002 | 0.040 | 0.040 |

# BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | PB D mg/l | PB T mg/l | ZN D mg/l | ZN T mg/l |
|---|---|---|---|---|---|---|
| * 870127 | | | | | | |
| 0130080 | 870127 | 0.00 | -9.999 | 0.002 | -9.999 | 0.030 |
| * 870218 | | | | | | |
| 0130080 | 870218 | 0.00 | 0.001 | 0.005 | 0.030 | 0.030 |
| * 870408 | | | | | | |
| 0130080 | 870408 | 0.00 | -9.999 | 0.002 | -9.999 | 0.030 |
| * 870505 | | | | | | |
| 0130080 | 870505 | 0.00 | -9.999 | 0.003 | -9.999 | 0.030 |
| * 870603 | | | | | | |
| 0130080 | 870603 | 0.00 | -9.999 | 0.004 | -9.999 | 0.030 |
| * 870727 | | | | | | |
| 0130080 | 870727 | 0.00 | -9.999 | 0.001 | -9.999 | 0.020 |
| * 871015 | | | | | | |
| 0130080 | 871015 | 0.00 | -0.001 | -0.001 | 0.020 | 0.025 |
| * 871118 | | | | | | |
| 0130080 | 871118 | 0.00 | -9.999 | 0.003 | -9.999 | 0.017 |
| * 871208 | | | | | | |
| 0130080 | 871208 | 0.00 | -0.001 | 0.002 | 0.016 | 0.030 |
| * 880118 | | | | | | |
| 0130080 | 880118 | 0.00 | -9.999 | 0.002 | -9.999 | 0.050 |
| * 880119 | | | | | | |
| 0130080 | 880119 | 0.00 | -9.999 | 0.006 | -9.999 | 0.030 |
| * 880208 | | | | | | |
| 0130080 | 880208 | 0.00 | -9.999 | 0.002 | -9.999 | 0.030 |
| * 880303 | | | | | | |
| 0130080 | 880303 | 0.00 | -9.999 | 0.001 | -9.999 | 0.032 |
| * 880413 | | | | | | |
| 0130080 | 880413 | 0.00 | -0.001 | -0.001 | 0.030 | 0.030 |
| * 880420 | | | | | | |
| 0130080 | 880420 | 0.00 | -9.999 | -0.001 | -9.999 | 0.015 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | PB D mg/l | PB T mg/l | ZN D mg/l | ZN T mg/l |
|---|---|---|---|---|---|---|
| * 880518 | | | | | | |
| 0130080 | 880518 | 0.00 | -9.999 | -0.100 | -9.999 | 0.030 |
| * 880615 | | | | | | |
| 0130080 | 880615 | 0.00 | -9.999 | 0.002 | -9.999 | 0.050 |
| * 880719 | | | | | | |
| 0130080 | 880719 | 0.00 | -9.999 | -0.001 | -9.999 | 0.016 |
| * 881103 | | | | | | |
| 0130080 | 881103 | 0.00 | -9.999 | -0.001 | -9.999 | 0.010 |
| * 881221 | | | | | | |
| 0130080 | 881221 | 0.00 | -9.999 | -0.001 | -9.999 | 0.016 |
| * 890112 | | | | | | |
| 0130080 | 890112 | 0.00 | -9.999 | -9.999 | -9.999 | 0.055 |
| * 890206 | | | | | | |
| 0130080 | 890206 | 0.00 | -9.999 | 0.001 | -9.999 | 0.029 |
| * 890307 | | | | | | |
| 0130080 | 890307 | 0.00 | 0.001 | 0.001 | 0.020 | 0.023 |
| * 890511 | | | | | | |
| 0130080 | 890511 | 0.50 | 0.001 | 0.002 | 0.019 | 0.021 |
| * 890614 | | | | | | |
| 0130080 | 890614 | 0.00 | 0.001 | -0.001 | 0.013 | 0.018 |
| * 890710 | | | | | | |
| 0130080 | 890710 | 0.00 | -9.999 | -0.100 | -9.999 | 0.014 |
| * 890814 | | | | | | |
| 0130080 | 890814 | 0.00 | -9.999 | -0.100 | -9.999 | 0.020 |
| * 890907 | | | | | | |
| 0130080 | 890907 | 0.00 | -9.999 | 0.001 | -9.999 | 0.010 |
| * 891024 | | | | | | |
| 0130080 | 891024 | 0.00 | 0.001 | 0.003 | 0.009 | 0.013 |
| * 891207 | | | | | | |
| 0130080 | 891207 | 0.00 | -9.999 | -9.999 | -9.999 | 0.020 |

# BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | PB D mg/l | PB T mg/l | ZN D mg/l | ZN T mg/l |
|---|---|---|---|---|---|---|
| * 891212 | | | | | | |
| 0130080 | 891212 | 0.00 | 0.001 | 0.002 | 0.014 | 0.014 |
| * 900227 | | | | | | |
| 0130080 | 900227 | 0.00 | -9.999 | -9.999 | -9.999 | -9.999 |
| ** 0130082 | | | | | | |
| * 810416 | | | | | | |
| 0130082 | 810416 | 3.00 | 0.007 | -9.999 | 0.230 | -9.999 |
| 0130082 | 810416 | 15.00 | 0.006 | -9.999 | 0.170 | -9.999 |
| 0130082 | 810416 | 30.00 | 0.009 | -9.999 | 0.280 | -9.999 |
| 0130082 | 810416 | 45.00 | 0.022 | -9.999 | 0.370 | -9.999 |
| * 810513 | | | | | | |
| 0130082 | 810513 | 3.00 | 0.003 | -9.999 | 0.150 | -9.999 |
| 0130082 | 810513 | 15.00 | -0.001 | -9.999 | 0.210 | -9.999 |
| 0130082 | 810513 | 30.00 | 0.005 | -9.999 | 0.250 | -9.999 |
| 0130082 | 810513 | 50.00 | 0.003 | -9.999 | 0.210 | -9.999 |
| * 810608 | | | | | | |
| 0130082 | 810608 | 3.00 | 0.002 | -9.999 | 0.160 | -9.999 |
| 0130082 | 810608 | 15.00 | 0.009 | -9.999 | 0.180 | -9.999 |
| 0130082 | 810608 | 30.00 | 0.008 | -9.999 | 0.230 | -9.999 |
| 0130082 | 810608 | 50.00 | 0.007 | -9.999 | 0.250 | -9.999 |
| * 810714 | | | | | | |
| 0130082 | 810714 | 3.00 | -0.001 | -9.999 | 0.130 | -9.999 |
| 0130082 | 810714 | 3.10 | 0.010 | -9.999 | 0.120 | -9.999 |
| 0130082 | 810714 | 15.00 | -0.001 | -9.999 | 0.130 | -9.999 |
| 0130082 | 810714 | 30.00 | 0.014 | -9.999 | 0.200 | -9.999 |
| 0130082 | 810714 | 50.00 | 0.006 | -9.999 | 0.240 | -9.999 |
| * 810812 | | | | | | |
| 0130082 | 810812 | 3.00 | -0.001 | -9.999 | 0.080 | -9.999 |
| 0130082 | 810812 | 3.10 | -0.001 | -9.999 | 0.090 | -9.999 |
| 0130082 | 810812 | 15.00 | -0.001 | -9.999 | 0.130 | -9.999 |
| 0130082 | 810812 | 30.00 | 0.002 | -9.999 | 0.160 | -9.999 |
| 0130082 | 810812 | 50.00 | 0.011 | -9.999 | 0.230 | -9.999 |
| * 810908 | | | | | | |
| 0130082 | 810908 | 3.00 | -0.001 | -9.999 | 0.110 | -9.999 |
| 0130082 | 810908 | 3.10 | -0.001 | -9.999 | 0.100 | -9.999 |
| 0130082 | 810908 | 15.00 | -0.001 | -9.999 | 0.130 | -9.999 |
| 0130082 | 810908 | 30.00 | -0.001 | -9.999 | 0.160 | -9.999 |
| 0130082 | 810908 | 50.00 | 0.010 | -9.999 | 0.200 | -9.999 |

# BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | PB D mg/l | PB T mg/l | ZN D mg/l | ZN T mg/l |
|---|---|---|---|---|---|---|
| * 811020 | | | | | | |
| 0130082 | 811020 | 3.00 | -0.001 | 0.001 | 0.100 | 0.120 |
| 0130082 | 811020 | 15.00 | -0.001 | 0.001 | 0.180 | 0.210 |
| 0130082 | 811020 | 30.00 | 0.003 | 0.005 | 0.170 | 0.190 |
| 0130082 | 811020 | 50.00 | 0.008 | 0.025 | 0.210 | 0.290 |
| * 811118 | | | | | | |
| 0130082 | 811118 | 3.00 | -0.001 | -9.999 | 0.130 | -9.999 |
| 0130082 | 811118 | 3.10 | -0.001 | -9.999 | 0.130 | -9.999 |
| 0130082 | 811118 | 15.00 | -0.001 | -9.999 | 0.190 | -9.999 |
| 0130082 | 811118 | 30.00 | -0.001 | -9.999 | 0.190 | -9.999 |
| 0130082 | 811118 | 50.00 | 0.003 | -9.999 | 0.160 | -9.999 |
| * 820119 | | | | | | |
| 0130082 | 820119 | 20.00 | -9.999 | -9.999 | 0.230 | 0.230 |
| * 820215 | | | | | | |
| 0130082 | 820215 | 3.00 | -0.001 | 0.004 | -9.999 | -9.999 |
| 0130082 | 820215 | 3.10 | 0.001 | -9.999 | -9.999 | -9.999 |
| 0130082 | 820215 | 15.00 | 0.001 | 0.006 | -9.999 | -9.999 |
| 0130082 | 820215 | 30.00 | 0.001 | 0.006 | -9.999 | -9.999 |
| 0130082 | 820215 | 50.00 | 0.005 | 0.055 | -9.999 | -9.999 |
| * 820614 | | | | | | |
| 0130082 | 820614 | 0.50 | -9.999 | -0.001 | -9.999 | -9.999 |
| * 830324 | | | | | | |
| 0130082 | 830324 | 0.00 | -9.999 | -9.999 | -9.999 | -9.999 |
| * 830426 | | | | | | |
| 0130082 | 830426 | 0.00 | -9.999 | 0.001 | -9.999 | 0.080 |
| * 830601 | | | | | | |
| 0130082 | 830601 | 0.00 | -9.999 | -0.001 | -9.999 | 0.050 |
| * 830720 | | | | | | |
| 0130082 | 830720 | 0.00 | -9.999 | 0.003 | -9.999 | 0.040 |
| * 830822 | | | | | | |
| 0130082 | 830822 | 0.00 | -9.999 | 0.001 | -9.999 | 0.018 |
| 0130082 | 830822 | 20.00 | -9.999 | 0.001 | -9.999 | 0.070 |
| 0130082 | 830822 | 40.00 | -9.999 | 0.021 | -9.999 | 0.250 |
| 0130082 | 830822 | 100.0 | -9.999 | 0.260 | -9.999 | 1.450 |

# BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | PB D mg/l | PB T mg/l | ZN D mg/l | ZN T mg/l |
|---|---|---|---|---|---|---|
| * 831025 | | | | | | |
| 0130082 | 831025 | 0.00 | -9.999 | -0.001 | -9.999 | 0.040 |
| * 831214 | | | | | | |
| 0130082 | 831214 | 0.00 | -9.999 | 0.003 | -9.999 | 0.120 |
| 0130082 | 831214 | 20.00 | -9.999 | -0.100 | -9.999 | 0.130 |
| 0130082 | 831214 | 40.00 | -9.999 | -0.100 | -9.999 | 0.130 |
| 0130082 | 831214 | 132.0 | -9.999 | -0.100 | -9.999 | 0.180 |
| * 840214 | | | | | | |
| 0130082 | 840214 | 0.00 | -9.999 | -0.100 | -9.999 | 0.140 |
| 0130082 | 840214 | 20.00 | -9.999 | -0.100 | -9.999 | 0.150 |
| * 840327 | | | | | | |
| 0130082 | 840327 | 0.00 | -9.999 | -0.001 | -9.999 | 0.110 |
| 0130082 | 840327 | 20.00 | -9.999 | 0.001 | -9.999 | 0.150 |
| 0130082 | 840327 | 40.00 | -9.999 | 0.070 | -9.999 | 0.600 |
| * 840501 | | | | | | |
| 0130082 | 840501 | 0.00 | -9.999 | 0.002 | -9.999 | 0.120 |
| 0130082 | 840501 | 20.00 | -9.999 | 0.003 | -9.999 | 0.160 |
| 0130082 | 840501 | 40.00 | -9.999 | 0.006 | -9.999 | 0.180 |
| 0130082 | 840501 | 65.00 | -9.999 | 0.011 | -9.999 | 0.230 |
| * 840619 | | | | | | |
| 0130082 | 840619 | 0.00 | -9.999 | -0.001 | -9.999 | 0.050 |
| 0130082 | 840619 | 20.00 | -9.999 | -0.001 | -9.999 | 0.050 |
| 0130082 | 840619 | 40.00 | -9.999 | 0.011 | -9.999 | 0.210 |
| 0130082 | 840619 | 69.00 | -9.999 | 0.150 | -9.999 | 1.330 |
| * 840725 | | | | | | |
| 0130082 | 840725 | 0.00 | -9.999 | -0.001 | -9.999 | 0.030 |
| 0130082 | 840725 | 20.00 | -9.999 | -0.001 | -9.999 | 0.050 |
| * 840822 | | | | | | |
| 0130082 | 840822 | 0.00 | -9.999 | -0.001 | -9.999 | 0.010 |
| 0130082 | 840822 | 20.00 | -9.999 | -0.001 | -9.999 | 0.040 |
| 0130082 | 840822 | 40.00 | -9.990 | -0.001 | -9.999 | 0.070 |
| 0130082 | 840822 | 65.00 | -9.999 | -0.001 | -9.999 | 0.150 |
| * 841002 | | | | | | |
| 0130082 | 841002 | 0.00 | -9.999 | 0.001 | -9.999 | 0.030 |
| 0130082 | 841002 | 20.00 | -9.999 | 0.004 | -9.999 | 0.070 |
| 0130082 | 841002 | 40.00 | -9.999 | 0.002 | -9.999 | 0.130 |
| 0130082 | 841002 | 60.00 | -9.999 | 0.003 | -9.999 | 0.170 |

# BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | PB D mg/l | PB T mg/l | ZN D mg/l | ZN T mg/l |
|---|---|---|---|---|---|---|
| * 841211 | | | | | | |
| 0130082 | 841211 | 0.00 | -9.999 | -0.100 | -9.999 | 0.060 |
| 0130082 | 841211 | 20.00 | -9.999 | -0.100 | -9.999 | 0.090 |
| 0130082 | 841211 | 40.00 | -9.999 | -0.100 | -9.999 | 0.080 |
| 0130082 | 841211 | 60.00 | -9.999 | -0.100 | -9.999 | 0.110 |
| * 850219 | | | | | | |
| 0130082 | 850219 | 0.00 | -9.999 | -0.001 | -9.999 | 0.070 |
| 0130082 | 850219 | 20.00 | -9.999 | 0.002 | -9.999 | 0.090 |
| 0130082 | 850219 | 40.00 | -9.999 | -0.001 | -9.999 | 0.090 |
| 0130082 | 850219 | 65.00 | -9.999 | 0.002 | -9.999 | 0.110 |
| * 850430 | | | | | | |
| 0130082 | 850430 | 0.00 | -9.999 | -0.100 | -9.999 | 0.070 |
| 0130082 | 850430 | 20.00 | -9.999 | -0.100 | -9.999 | 0.090 |
| 0130082 | 850430 | 40.00 | -9.999 | -0.100 | -9.999 | 0.090 |
| 0130082 | 850430 | 60.00 | -9.999 | -0.100 | -9.999 | 0.110 |
| * 850604 | | | | | | |
| 0130082 | 850604 | 0.00 | -9.999 | -0.001 | -9.999 | 0.050 |
| 0130082 | 850604 | 20.00 | -9.999 | 0.004 | -9.999 | 0.060 |
| 0130082 | 850604 | 40.00 | -9.999 | -0.001 | -9.999 | 0.090 |
| 0130082 | 850604 | 60.00 | -9.999 | -0.001 | -9.999 | 0.110 |
| * 850709 | | | | | | |
| 0130082 | 850709 | 0.00 | -9.999 | -0.100 | -9.999 | 0.050 |
| 0130082 | 850709 | 20.00 | -9.999 | -0.100 | -9.999 | 0.070 |
| 0130082 | 850709 | 40.00 | -9.999 | -0.100 | -9.999 | 0.100 |
| 0130082 | 850709 | 60.00 | -9.999 | -0.100 | -9.999 | 0.090 |
| 0130082 | 850709 | 100.0 | -9.999 | -0.100 | -9.999 | 0.090 |
| * 850813 | | | | | | |
| 0130082 | 850813 | 0.00 | -9.999 | -0.001 | -9.999 | 0.040 |
| 0130082 | 850813 | 20.00 | -9.999 | -0.001 | -9.999 | 0.050 |
| 0130082 | 850813 | 40.00 | -9.999 | -0.001 | -9.999 | 0.070 |
| 0130082 | 850813 | 60.00 | -9.999 | -0.001 | -9.999 | 0.080 |
| * 850917 | | | | | | |
| 0130082 | 850917 | 0.00 | -9.999 | -0.001 | -9.999 | 0.030 |
| 0130082 | 850917 | 20.00 | -9.999 | -0.001 | -9.999 | 0.050 |
| 0130082 | 850917 | 40.00 | -9.999 | -0.001 | -9.999 | 0.070 |
| 0130082 | 850917 | 60.00 | -9.999 | -0.001 | -9.999 | 0.080 |
| * 851022 | | | | | | |
| 0130082 | 851022 | 0.00 | -9.999 | 0.001 | -9.999 | 0.030 |
| 0130082 | 851022 | 20.00 | -9.999 | 0.006 | -9.999 | 0.080 |

# BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | PB D mg/l | PB T mg/l | ZN D mg/l | ZN T mg/l |
|---|---|---|---|---|---|---|
| 0130082 | 851022 | 40.00 | -9.999 | 0.002 | -9.999 | 0.070 |
| 0130082 | 851022 | 60.00 | -9.999 | 0.002 | -9.999 | 0.090 |
| * 851212 | | | | | | |
| 0130082 | 851212 | 0.00 | -9.999 | 0.001 | -9.999 | 0.050 |
| 0130082 | 851212 | 20.00 | -9.999 | 0.002 | -9.999 | 0.060 |
| 0130082 | 851212 | 40.00 | -9.999 | -0.001 | -9.999 | 0.050 |
| 0130082 | 851212 | 60.00 | -9.999 | -0.001 | -9.999 | 0.070 |
| * 860211 | | | | | | |
| 0130082 | 860211 | 0.00 | -0.001 | 0.004 | 0.040 | 0.040 |
| 0130082 | 860211 | 10.00 | -0.001 | 0.014 | 0.040 | 0.040 |
| 0130082 | 860211 | 20.00 | -0.001 | 0.007 | 0.060 | 0.060 |
| 0130082 | 860211 | 30.00 | -0.001 | 0.002 | 0.070 | 0.070 |
| 0130082 | 860211 | 40.00 | -0.001 | 0.004 | 0.080 | 0.080 |
| 0130082 | 860211 | 60.00 | -0.001 | 0.009 | 0.090 | 0.090 |
| * 860311 | | | | | | |
| 0130082 | 860311 | 0.00 | -0.001 | -0.001 | 0.040 | 0.050 |
| 0130082 | 860311 | 10.00 | -0.001 | 0.003 | 0.050 | 0.050 |
| 0130082 | 860311 | 20.00 | -0.001 | -0.001 | 0.050 | 0.060 |
| 0130082 | 860311 | 30.00 | -0.001 | -0.001 | 0.060 | 0.060 |
| 0130082 | 860311 | 40.00 | -0.001 | -0.001 | 0.060 | 0.070 |
| 0130082 | 860311 | 60.00 | -0.001 | 0.002 | 0.080 | 0.080 |
| * 860415 | | | | | | |
| 0130082 | 860415 | 0.00 | -0.001 | 0.001 | 0.040 | 0.050 |
| 0130082 | 860415 | 10.00 | -0.001 | -0.001 | 0.050 | 0.050 |
| 0130082 | 860415 | 20.00 | -0.001 | 0.003 | 0.050 | 0.060 |
| 0130082 | 860415 | 30.00 | -0.001 | 0.002 | 0.060 | 0.070 |
| 0130082 | 860415 | 40.00 | -0.001 | 0.001 | 0.060 | 0.070 |
| 0130082 | 860415 | 60.00 | -0.001 | 0.003 | 0.070 | 0.080 |
| * 860512 | | | | | | |
| 0130082 | 860512 | 0.00 | -0.001 | -0.001 | 0.040 | 0.050 |
| 0130082 | 860512 | 10.00 | -0.001 | -0.001 | 0.040 | 0.050 |
| 0130082 | 860512 | 20.00 | -0.001 | -0.001 | 0.050 | 0.050 |
| 0130082 | 860512 | 30.00 | -0.001 | -0.001 | 0.050 | 0.060 |
| 0130082 | 860512 | 40.00 | -0.001 | 0.002 | 0.060 | 0.070 |
| 0130082 | 860512 | 60.00 | -0.001 | 0.001 | 0.040 | 0.050 |
| * 860610 | | | | | | |
| 0130082 | 860610 | 0.00 | -0.001 | 0.001 | 0.020 | 0.030 |
| 0130082 | 860610 | 10.00 | -0.001 | -0.001 | 0.020 | 0.020 |
| 0130082 | 860610 | 20.00 | -0.001 | 0.008 | 0.020 | 0.020 |
| 0130082 | 860610 | 30.00 | -0.001 | -0.001 | 0.040 | 0.040 |

BUTTLE LAKE WATER QUALITY DATA

| SITE | DATE y m d | DEPTH m | PB D mg/l | PB T mg/l | ZN D mg/l | ZN T mg/l |
|---|---|---|---|---|---|---|
| 0130082 | 860610 | 40.00 | -0.001 | -0.001 | 0.060 | 0.060 |
| 0130082 | 860610 | 60.00 | -0.001 | 0.001 | 0.060 | 0.060 |
| * 860708 | | | | | | |
| 0130082 | 860708 | 0.00 | -0.001 | 0.001 | 0.020 | 0.020 |
| 0130082 | 860708 | 10.00 | 0.001 | 0.002 | 0.020 | 0.030 |
| 0130082 | 860708 | 20.00 | -0.001 | 0.003 | 0.030 | 0.030 |
| 0130082 | 860708 | 30.00 | -0.001 | 0.003 | 0.050 | 0.050 |
| 0130082 | 860708 | 40.00 | -0.001 | 0.004 | 0.050 | 0.050 |
| 0130082 | 860708 | 60.00 | -0.001 | 0.003 | 0.060 | 0.070 |
| * 860812 | | | | | | |
| 0130082 | 860812 | 0.00 | -0.001 | -0.001 | 0.015 | 0.020 |
| 0130082 | 860812 | 10.00 | -0.001 | -0.001 | 0.021 | 0.030 |
| 0130082 | 860812 | 20.00 | -0.001 | -0.001 | 0.030 | 0.040 |
| 0130082 | 860812 | 30.00 | -0.001 | -0.001 | 0.030 | 0.040 |
| 0130082 | 860812 | 40.00 | -0.001 | 0.002 | 0.060 | 0.060 |
| 0130082 | 860812 | 60.00 | -0.001 | 0.002 | 0.060 | 0.070 |
| * 870204 | | | | | | |
| 0130082 | 870204 | 0.00 | -0.001 | -0.001 | 0.050 | 0.070 |
| 0130082 | 870204 | 10.00 | -0.001 | -0.001 | 0.060 | 0.070 |
| 0130082 | 870204 | 20.00 | -0.001 | 0.002 | 0.070 | 0.080 |
| 0130082 | 870204 | 30.00 | -0.001 | 0.001 | 0.090 | 0.110 |
| 0130082 | 870204 | 40.00 | 0.001 | 0.001 | 0.090 | 0.090 |
| 0130082 | 870204 | 60.00 | -0.001 | 0.001 | 0.080 | 0.090 |
| * 870414 | | | | | | |
| 0130082 | 870414 | 0.00 | 0.001 | 0.009 | 0.070 | 0.080 |
| 0130082 | 870414 | 10.00 | 0.001 | 0.007 | 0.080 | 0.080 |
| 0130082 | 870414 | 20.00 | 0.001 | 0.004 | 0.070 | 0.070 |
| 0130082 | 870414 | 30.00 | 0.001 | 0.005 | 0.080 | 0.080 |
| 0130082 | 870414 | 40.00 | 0.001 | 0.008 | 0.110 | 0.120 |
| 0130082 | 870414 | 60.00 | 0.001 | 0.004 | 0.120 | 0.120 |
| * 870708 | | | | | | |
| 0130082 | 870708 | 0.00 | -9.999 | 0.002 | -9.999 | 0.020 |
| 0130082 | 870708 | 10.00 | -9.999 | 0.002 | -9.999 | 0.030 |
| 0130082 | 870708 | 20.00 | -9.999 | 0.003 | -9.999 | 0.040 |
| 0130082 | 870708 | 30.00 | -9.999 | 0.008 | -9.999 | 0.060 |
| 0130082 | 870708 | 40.00 | -9.999 | 0.005 | -9.999 | 0.090 |
| 0130082 | 870708 | 60.00 | -9.999 | 0.003 | -9.999 | 0.100 |
| * 870909 | | | | | | |
| 0130082 | 870909 | 0.00 | 0.001 | 0.001 | 0.030 | 0.030 |
| 0130082 | 870909 | 10.00 | -0.001 | 0.001 | 0.030 | 0.030 |

# BUTTLE LAKE WATER QUALITY PROFILES
# FOR SITE 0130082

| SITE | DATE y m d | TIME | DEPTH m | PH | SPF COND uS/cm | TEMP H2O deg C | DISS O2 mg/l | EXTN DEPTH m |
|---|---|---|---|---|---|---|---|---|
| 0130082 | 820720 | 1450 | 65.00 | 7.26 | -99 | 4.90 | 9.44 | -9.9 |
| ** 820929 | | | | | | | | |
| 0130082 | 820929 | 1340 | 0.00 | -9.99 | -99 | 16.20 | 8.40 | 13.5 |
| 0130082 | 820929 | 1340 | 5.00 | -9.99 | -99 | 16.00 | 8.90 | -9.9 |
| 0130082 | 820929 | 1340 | 10.00 | -9.99 | -99 | 16.00 | 8.80 | -9.9 |
| 0130082 | 820929 | 1340 | 15.00 | -9.99 | -99 | 15.50 | 9.00 | -9.9 |
| 0130082 | 820929 | 1340 | 20.00 | -9.99 | -99 | 9.00 | 9.80 | -9.9 |
| 0130082 | 820929 | 1340 | 25.00 | -9.99 | -99 | 7.50 | 9.90 | -9.9 |
| 0130082 | 820929 | 1340 | 30.00 | -9.99 | -99 | 7.50 | 10.00 | -9.9 |
| ** 840214 | | | | | | | | |
| 0130082 | 840214 | 1200 | 0.00 | 6.80 | 80 | 3.70 | 13.10 | 6.0 |
| 0130082 | 840214 | 1200 | 5.00 | 6.91 | 79 | 3.60 | 12.87 | -9.9 |
| 0130082 | 840214 | 1200 | 10.00 | 6.90 | 79 | 3.60 | 12.69 | -9.9 |
| 0130082 | 840214 | 1200 | 15.00 | 6.94 | 80 | 3.60 | 12.63 | -9.9 |
| 0130082 | 840214 | 1200 | 20.00 | 6.93 | 80 | 3.70 | 12.75 | -9.9 |
| 0130082 | 840214 | 1200 | 25.00 | 6.94 | 81 | 3.70 | 12.35 | -9.9 |
| 0130082 | 840214 | 1200 | 30.00 | 6.94 | 82 | 3.70 | 12.22 | -9.9 |
| 0130082 | 840214 | 1200 | 35.00 | 6.94 | 82 | 3.70 | 12.17 | -9.9 |
| 0130082 | 840214 | 1200 | 40.00 | 6.96 | 82 | 3.70 | 12.12 | -9.9 |
| 0130082 | 840214 | 1200 | 45.00 | 6.96 | 82 | 3.70 | 12.05 | -9.9 |
| 0130082 | 840214 | 1200 | 50.00 | 6.95 | 83 | 3.70 | 12.02 | -9.9 |
| ** 840501 | | | | | | | | |
| 0130082 | 840501 | 1240 | 0.00 | -9.99 | -99 | -99.99 | -9.99 | 6.0 |
| ** 840619 | | | | | | | | |
| 0130082 | 840619 | 1230 | 0.00 | -9.99 | -99 | -99.99 | -9.99 | 5.0 |
| ** 840726 | | | | | | | | |
| 0130082 | 840726 | 1422 | 0.00 | -9.99 | -99 | -99.99 | -9.99 | 7.0 |
| ** 840822 | | | | | | | | |
| 0130082 | 840822 | 1330 | 0.00 | -9.99 | -99 | -99.99 | -9.99 | 6.5 |
| ** 841002 | | | | | | | | |
| 0130082 | 841002 | 1400 | 0.00 | -9.99 | -99 | -99.99 | -9.99 | 5.0 |
| ** 841211 | | | | | | | | |
| 0130082 | 841211 | 1525 | 0.00 | -9.99 | -99 | -99.99 | -9.99 | 5.0 |
| ** 850209 | | | | | | | | |
| 0130082 | 850209 | 1130 | 0.00 | -9999 | -99 | -99.99 | -9.99 | 6.0 |

# BUTTLE LAKE WATER QUALITY PROFILES
## FOR SITE 0130082

| SITE | DATE y m d | TIME | DEPTH m | PH | SPF COND uS/cm | TEMP H2O deg C | DISS O2 mg/l | EXTN DEPTH m |
|---|---|---|---|---|---|---|---|---|
| ** 850430 | | | | | | | | |
| 0130082 | 850430 | 1410 | 0.00 | -9.99 | -99 | -99.99 | -9.99 | 5.5 |
| ** 850604 | | | | | | | | |
| 0130082 | 850604 | 1430 | 0.00 | -9.99 | -99 | -99.99 | -9.99 | 4.0 |
| ** 850709 | | | | | | | | |
| 0130082 | 850709 | 1400 | 0.00 | -9.99 | -99 | -99.99 | -9.99 | 6.0 |
| ** 850813 | | | | | | | | |
| 0130082 | 850813 | 1030 | 0.00 | -9.99 | -99 | -99.99 | -9.99 | 7.5 |
| ** 850917 | | | | | | | | |
| 0130082 | 850917 | 1400 | 0.00 | -9.99 | -99 | 16.61 | 10.10 | 7.5 |
| 0130082 | 850917 | 1400 | 5.00 | 7.32 | -99 | 16.11 | 9.90 | -9.9 |
| 0130082 | 850917 | 1400 | 10.00 | 7.32 | -99 | 15.70 | 9.90 | -9.9 |
| 0130082 | 850917 | 1400 | 15.00 | 7.16 | -99 | 12.00 | 10.80 | -9.9 |
| 0130082 | 850917 | 1400 | 20.00 | 7.12 | -99 | 8.20 | 11.60 | -9.9 |
| 0130082 | 850917 | 1400 | 25.00 | 7.05 | -99 | 7.30 | 11.70 | -9.9 |
| 0130082 | 850917 | 1400 | 30.00 | 7.02 | -99 | 7.00 | 11.70 | -9.9 |
| 0130082 | 850917 | 1400 | 35.00 | 6.99 | -99 | 6.50 | 11.70 | -9.9 |
| 0130082 | 850917 | 1400 | 40.00 | 6.97 | -99 | 6.20 | 11.60 | -9.9 |
| 0130082 | 850917 | 1400 | 45.00 | 6.97 | -99 | 6.00 | 11.70 | -9.9 |
| 0130082 | 850917 | 1400 | 50.00 | 6.96 | -99 | 5.80 | 11.60 | -9.9 |
| 0130082 | 850917 | 1400 | 55.00 | 6.96 | -99 | 5.60 | 11.60 | -9.9 |
| ** 851022 | | | | | | | | |
| 0130082 | 851022 | 1240 | 0.00 | -9.99 | -99 | -99.99 | -9.99 | 8.0 |
| ** 851212 | | | | | | | | |
| 0130082 | 851212 | 1230 | 0.00 | 7.28 | 77 | 4.53 | 11.42 | 8.0 |
| 0130082 | 851212 | 1230 | 5.00 | 7.19 | 78 | 4.55 | 11.26 | -9.9 |
| 0130082 | 851212 | 1230 | 10.00 | 7.13 | 77 | 4.55 | 11.26 | -9.9 |
| 0130082 | 851212 | 1230 | 15.00 | 7.13 | 78 | 4.55 | 11.19 | -9.9 |
| 0130082 | 851212 | 1230 | 20.00 | 7.12 | 78 | 4.55 | 11.19 | -9.9 |
| 0130082 | 851212 | 1230 | 25.00 | 7.12 | 78 | 4.52 | 11.15 | -9.9 |
| 0130082 | 851212 | 1230 | 30.00 | 7.14 | 78 | 4.52 | 11.08 | -9.9 |
| 0130082 | 851212 | 1230 | 30.00 | 7.14 | 78 | 4.52 | 11.08 | -9.9 |
| 0130082 | 851212 | 1230 | 35.00 | 7.14 | 79 | 4.52 | 11.09 | -9.9 |
| 0130082 | 851212 | 1230 | 40.00 | 7.15 | 80 | 4.48 | 11.11 | -9.9 |
| 9130082 | 851212 | 1230 | 45.00 | 7.14 | 80 | 4.42 | 11.08 | -9.9 |
| 0130082 | 851212 | 1230 | 50.00 | 7.15 | 82 | 4.40 | 11.04 | -9.9 |
| ** 860211 | | | | | | | | |
| 0130082 | 860211 | 1010 | 0.00 | 7.52 | 69 | 3.13 | 9.38 | 5.0 |

BUTTLE LAKE WATER QUALITY PROFILES
FOR SITE 0130082

| SITE | DATE y m d | TIME | DEPTH m | PH | SPF COND uS/cm | TEMP H2O deg C | DISS O2 mg/l | EXTN DEPTH m |
|---|---|---|---|---|---|---|---|---|
| 0130082 | 860211 | 1010 | 5.00 | 7.41 | 68 | 3.36 | 9.51 | -9.9 |
| 0130082 | 860211 | 1010 | 10.00 | 7.37 | 68 | 3.43 | 8.94 | -9.9 |
| 0130082 | 860211 | 1010 | 15.00 | 7.31 | 77 | 3.56 | 8.71 | -9.9 |
| 0130082 | 860211 | 1010 | 20.00 | 7.28 | 86 | 3.72 | 8.31 | -9.9 |
| 0130082 | 860211 | 1010 | 25.00 | 7.27 | 87 | 3.51 | 8.36 | -9.9 |
| 0130082 | 860211 | 1010 | 30.00 | 7.26 | 88 | 3.51 | 8.42 | -9.9 |
| 0130082 | 860211 | 1010 | 35.00 | 7.26 | 89 | 3.49 | 8.45 | -9.9 |
| 0130082 | 860211 | 1010 | 40.00 | 7.25 | 90 | 3.49 | 8.43 | -9.9 |
| 0130082 | 860211 | 1010 | 45.00 | 7.26 | 91 | 3.34 | 8.57 | -9.9 |
| 0130082 | 860211 | 1010 | 50.00 | 7.25 | 93 | 3.33 | 8.63 | -9.9 |
| 0130082 | 860211 | 1010 | 55.00 | 7.24 | 93 | 3.32 | 8.63 | -9.9 |
| 0130082 | 860211 | 1010 | 60.00 | 7.24 | 95 | 3.32 | 8.63 | -9.9 |
| ** 860415 | | | | | | | | |
| 0130082 | 860415 | 1120 | 0.00 | 7.23 | 72 | 6.52 | 12.48 | 7.0 |
| 0130082 | 860415 | 1120 | 5.00 | 7.18 | 74 | 6.22 | 12.47 | -9.9 |
| 0130082 | 860415 | 1120 | 10.00 | 7.16 | 76 | 5.93 | 12.44 | -9.9 |
| 0130082 | 860415 | 1120 | 15.00 | 7.15 | 76 | 5.49 | 12.49 | -9.9 |
| 0130082 | 860415 | 1120 | 20.00 | 7.13 | 80 | 4.68 | 12.48 | -9.9 |
| 0130082 | 860415 | 1120 | 25.00 | 7.10 | 80 | 4.59 | 12.43 | -9.9 |
| 0130082 | 860415 | 1120 | 30.00 | 7.08 | 84 | 4.37 | 12.32 | -9.9 |
| 0130082 | 860415 | 1120 | 35.00 | 7.07 | 85 | 4.21 | 12.24 | -9.9 |
| 0130082 | 860415 | 1120 | 40.00 | 7.06 | 86 | 4.20 | 12.18 | -9.9 |
| 0130082 | 860415 | 1120 | 45.00 | 7.05 | 86 | 4.21 | 12.11 | -9.9 |
| 0130082 | 860415 | 1120 | 50.00 | 7.04 | 85 | 4.13 | 12.11 | -9.9 |
| 0130082 | 860415 | 1120 | 55.00 | 7.04 | 86 | 4.05 | 12.10 | -9.9 |
| 0130082 | 860415 | 1120 | 60.00 | 7.04 | 85 | 3.92 | 12.13 | -9.9 |
| 0130082 | 860415 | 1120 | 65.00 | 7.03 | 86 | 3.81 | 11.99 | -9.9 |
| 0130082 | 860415 | 1120 | 70.00 | 7.02 | 85 | 3.67 | 11.97 | -9.9 |
| ** 860512 | | | | | | | | |
| 0130082 | 860512 | 1400 | 0.00 | 7.28 | 76 | 7.86 | 12.09 | 6.0 |
| 0130082 | 860512 | 1400 | 5.00 | 7.27 | 76 | 7.85 | 12.09 | -9.9 |
| 0130082 | 860512 | 1400 | 10.00 | 7.25 | 76 | 7.57 | 12.11 | -9.9 |
| 0130082 | 860512 | 1400 | 15.00 | 7.25 | 75 | 6.43 | 12.17 | -9.9 |
| 0130082 | 860512 | 1400 | 20.00 | 7.21 | 74 | 5.97 | 12.18 | -9.9 |
| 0130082 | 860512 | 1400 | 25.00 | 7.19 | 74 | 5.07 | 12.14 | -9.9 |
| 0130082 | 860512 | 1400 | 30.00 | 7.14 | 79 | 4.89 | 12.12 | -9.9 |
| 0130082 | 860512 | 1400 | 35.00 | 7.11 | 81 | 4.76 | 12.09 | -9.9 |
| 0130082 | 860512 | 1400 | 40.00 | 7.08 | 81 | 4.67 | 12.03 | -9.9 |
| 0130082 | 860512 | 1400 | 45.00 | 7.07 | 83 | 4.61 | 12.00 | -9.9 |
| 0130082 | 860512 | 1400 | 50.00 | 7.05 | 83 | 4.55 | 11.97 | -9.9 |
| ** 860610 | | | | | | | | |
| 0130082 | 860610 | 1220 | 0.00 | 6.95 | 65 | 13.96 | 11.13 | 6.0 |

# BUTTLE LAKE WATER QUALITY PROFILES
## FOR SITE 0130082

| SITE | DATE y m d | TIME | DEPTH m | PH | SPF COND uS/cm | TEMP H2O deg C | DISS O2 mg/l | EXTN DEPTH m |
|---|---|---|---|---|---|---|---|---|
| 0130082 | 860610 | 1220 | 5.00 | 7.05 | 64 | 13.17 | 11.21 | -9.9 |
| 0130082 | 860610 | 1220 | 10.00 | 7.07 | 63 | 10.74 | 11.30 | -9.9 |
| 0130082 | 860610 | 1220 | 15.00 | 7.05 | 64 | 8.66 | 11.62 | -9.9 |
| 0130082 | 860610 | 1220 | 20.00 | 7.03 | 63 | 7.36 | 12.05 | -9.9 |
| 0130082 | 860610 | 1220 | 25.00 | 7.01 | 63 | 6.56 | 12.08 | -9.9 |
| 0130082 | 860610 | 1220 | 30.00 | 7.00 | 65 | 6.14 | 11.98 | -9.9 |
| 0130082 | 860610 | 1220 | 35.00 | 6.99 | 72 | 5.70 | 11.89 | -9.9 |
| 0130082 | 860610 | 1220 | 40.00 | 6.98 | 75 | 5.41 | 11.84 | -9.9 |
| 0130082 | 860610 | 1220 | 45.00 | 6.97 | 77 | 5.28 | 11.77 | -9.9 |
| 0130082 | 860610 | 1220 | 50.00 | 6.96 | 78 | 5.15 | 11.71 | -9.9 |
| 0130082 | 860610 | 1220 | 55.00 | 6.96 | 82 | 4.86 | 11.67 | -9.9 |
| 0130082 | 860610 | 1220 | 60.00 | 6.97 | 83 | 4.72 | 11.65 | -9.9 |
| ** 860708 | | | | | | | | |
| 0130082 | 860708 | 1400 | 0.00 | 7.30 | 62 | 16.02 | 10.21 | 8.0 |
| 0130082 | 860708 | 1400 | 5.00 | 7.31 | 62 | 14.65 | 10.09 | -9.9 |
| 0130082 | 860708 | 1400 | 10.00 | 7.28 | 62 | 12.70 | 10.54 | -9.9 |
| 0130082 | 860708 | 1400 | 15.00 | 7.28 | 61 | 10.77 | 10.36 | -9.9 |
| 0130082 | 860708 | 1400 | 20.00 | 7.14 | 65 | 7.75 | 11.49 | -9.9 |
| 0130082 | 860708 | 1400 | 25.00 | 7.11 | 69 | 6.65 | 11.60 | -9.9 |
| 0130082 | 860708 | 1400 | 30.00 | 7.09 | 69 | 6.40 | 11.65 | -9.9 |
| 0130082 | 860708 | 1400 | 35.00 | 7.06 | 70 | 6.10 | 11.64 | -9.9 |
| 0130082 | 860708 | 1400 | 40.00 | 7.03 | 75 | 5.69 | 11.58 | -9.9 |
| 0130082 | 860708 | 1400 | 45.00 | 7.01 | 75 | 5.40 | 11.46 | -9.9 |
| 0130082 | 860708 | 1400 | 50.00 | 7.01 | 79 | 5.18 | 11.56 | -9.9 |
| ** 860812 | | | | | | | | |
| 0130082 | 860812 | 1100 | 0.00 | 7.26 | 64 | 21.34 | 9.04 | 14.0 |
| 0130082 | 860812 | 1100 | 5.00 | 7.28 | 64 | 20.81 | 9.08 | -9.9 |
| 0130082 | 860812 | 1100 | 10.00 | 7.17 | 69 | 18.19 | 9.15 | -9.9 |
| 0130082 | 860812 | 1100 | 15.00 | 7.08 | 70 | 12.92 | 10.25 | -9.9 |
| 0130082 | 860812 | 1100 | 20.00 | 7.04 | 66 | 7.88 | 11.07 | -9.9 |
| 0130082 | 860812 | 1100 | 25.00 | 6.97 | 68 | 7.05 | 11.32 | -9.9 |
| 0130082 | 860812 | 1100 | 30.00 | 6.92 | 69 | 6.71 | 11.33 | -9.9 |
| 0130082 | 860812 | 1100 | 35.00 | 6.99 | 70 | 6.43 | 11.34 | -9.9 |
| 0130082 | 860812 | 1100 | 40.00 | 6.85 | 75 | 5.93 | 11.33 | -9.9 |
| 0130082 | 860812 | 1100 | 45.00 | 6.83 | 76 | 5.68 | 11.26 | -9.9 |
| 0130082 | 860812 | 1100 | 50.00 | 6.81 | 78 | 5.37 | 11.22 | -9.9 |
| ** 870204 | | | | | | | | |
| 0130082 | 870204 | 1230 | 0.00 | 7.19 | 70 | 3.69 | 14.20 | -9.9 |
| 0130082 | 870204 | 1230 | 5.00 | 7.14 | 70 | 3.66 | 13.60 | -9.9 |
| 0130082 | 870204 | 1230 | 10.00 | 7.12 | 70 | 3.64 | 13.54 | -9.9 |
| 0130082 | 870204 | 1230 | 15.00 | 7.10 | 70 | 3.62 | 13.46 | -9.9 |
| 0130082 | 870204 | 1230 | 20.00 | 7.09 | 71 | 3.64 | 13.45 | -9.9 |

# BUTTLE LAKE WATER QUALITY PROFILES
## FOR SITE 0130082

| SITE | DATE y m d | TIME | DEPTH m | PH | SPF COND uS/cm | TEMP H2O deg C | DISS O2 mg/l | EXTN DEPTH m |
|---|---|---|---|---|---|---|---|---|
| 0130082 | 870204 | 1230 | 25.00 | 7.05 | 75 | 3.78 | 13.40 | -9.9 |
| 0130082 | 870204 | 1230 | 30.00 | 7.02 | 76 | 3.80 | 13.30 | -9.9 |
| 0130082 | 870204 | 1230 | 35.00 | 7.01 | 80 | 3.76 | 13.33 | -9.9 |
| 0130082 | 870204 | 1230 | 40.00 | 7.01 | 81 | 3.69 | 13.34 | -9.9 |
| 0130082 | 870204 | 1230 | 45.00 | 7.00 | 81 | 3.70 | 13.32 | -9.9 |
| 0130082 | 870204 | 1230 | 50.00 | 6.99 | 82 | 3.67 | 13.26 | -9.9 |
| ** 870414 | | | | | | | | |
| 0130082 | 870414 | 1130 | 0.00 | 7.20 | 75 | 5.38 | 12.39 | 6.0 |
| 0130082 | 870414 | 1130 | 5.00 | 7.08 | 75 | 5.29 | 12.32 | -9.9 |
| 0130082 | 870414 | 1130 | 10.00 | 7.07 | 75 | 5.07 | 12.37 | -9.9 |
| 0130082 | 870414 | 1130 | 15.00 | 7.04 | 75 | 4.98 | 12.35 | -9.9 |
| 0130082 | 870414 | 1130 | 20.00 | 7.02 | 75 | 4.86 | 12.32 | -9.9 |
| 0130082 | 870414 | 1130 | 25.00 | 7.03 | 75 | 4.48 | 12.32 | -9.9 |
| 0130082 | 870414 | 1130 | 30.00 | 6.96 | 82 | 4.35 | 12.32 | -9.9 |
| 0130082 | 870414 | 1130 | 35.00 | 6.94 | 83 | 4.27 | 12.31 | -9.9 |
| 0130082 | 870414 | 1130 | 40.00 | 6.91 | 84 | 4.23 | 12.34 | -9.9 |
| 0130082 | 870414 | 1130 | 45.00 | 6.90 | 84 | 4.18 | 12.30 | -9.9 |
| 0130082 | 870414 | 1130 | 50.00 | 6.89 | 983 | 4.05 | 12.27 | -9.9 |
| ** 870909 | | | | | | | | |
| 0130082 | 870909 | 1355 | 0.00 | 7.38 | 64 | 20.67 | 9.61 | 13.5 |
| 0130082 | 870909 | 1355 | 5.00 | 7.42 | 63 | 19.34 | 9.85 | -9.9 |
| 0130082 | 870909 | 1355 | 10.00 | 7.30 | 70 | 18.22 | 10.01 | -9.9 |
| 0130082 | 870909 | 1355 | 15.00 | 7.11 | 64 | 11.61 | 11.24 | -9.9 |
| 0130082 | 870909 | 1355 | 20.00 | 6.98 | 65 | 8.49 | 11.92 | -9.9 |
| 0130082 | 870909 | 1355 | 25.00 | 6.93 | 66 | 7.48 | 12.04 | -9.9 |
| 0130082 | 870909 | 1355 | 30.00 | 6.89 | 69 | 7.03 | 12.11 | -9.9 |
| 0130082 | 870909 | 1355 | 35.00 | 6.81 | 75 | 6.26 | 11.99 | -9.9 |
| 0130082 | 870909 | 1355 | 40.00 | 6.76 | 76 | 5.88 | 11.99 | -9.9 |
| 0130082 | 870909 | 1355 | 45.00 | 6.72 | 76 | 5.68 | 12.07 | -9.9 |
| 0130082 | 870909 | 1355 | 50.00 | 6.69 | 78 | 5.53 | 12.05 | -9.9 |
| ** 880510 | | | | | | | | |
| 0130082 | 880510 | 1030 | 0.00 | 7.42 | 71 | 9.27 | 10.54 | -9.9 |
| 0130082 | 880510 | 1030 | 5.00 | 7.37 | 70 | 8.08 | 11.06 | -9.9 |
| 0130082 | 880510 | 1030 | 10.00 | 7.36 | 71 | 7.68 | 11.23 | -9.9 |
| 0130082 | 880510 | 1030 | 15.00 | 7.33 | 71 | 6.97 | 11.45 | -9.9 |
| 0130082 | 880510 | 1030 | 20.00 | 7.31 | 72 | 6.51 | 11.69 | -9.9 |
| 0130082 | 880510 | 1030 | 25.00 | 7.28 | 73 | 6.08 | 11.86 | -9.9 |
| 0130082 | 880510 | 1030 | 30.00 | 7.26 | 75 | 5.79 | 11.99 | -9.9 |
| 0130082 | 880510 | 1030 | 35.00 | 7.24 | 75 | 5.63 | 12.08 | -9.9 |
| 0130082 | 880510 | 1030 | 40.00 | 7.23 | 73 | 5.38 | 12.17 | -9.9 |
| 0130082 | 880510 | 1030 | 45.00 | -9.99 | -99 | 5.17 | -9.99 | -9.9 |

BUTTLE LAKE WATER QUALITY PROFILES
FOR SITE 0130082

| SITE | DATE y m d | TIME | DEPTH m | PH | SPF COND uS/cm | TEMP H2O deg C | DISS O2 mg/l | EXTN DEPTH m |
|---|---|---|---|---|---|---|---|---|
| ** 880614 | | | | | | | | |
| 0130082 | 880614 | 1000 | 0.00 | 7.30 | 66 | 13.63 | 8.60 | -9.9 |
| 0130082 | 880614 | 1000 | 5.00 | 7.31 | 68 | 11.75 | 9.43 | -9.9 |
| 0130082 | 880614 | 1000 | 7.50 | 7.28 | 67 | 10.70 | 9.80 | -9.9 |
| 0130082 | 880614 | 1000 | 10.00 | 7.25 | 67 | 10.40 | 9.92 | -9.9 |
| 0130082 | 880614 | 1000 | 15.00 | 7.20 | 65 | 9.02 | 10.37 | -9.9 |
| 0130082 | 880614 | 1000 | 20.00 | 7.13 | 68 | 7.47 | 10.92 | -9.9 |
| 0130082 | 880614 | 1000 | 25.00 | 7.06 | 71 | 6.61 | 11.25 | -9.9 |
| 0130082 | 880614 | 1000 | 30.00 | 7.02 | 74 | 6.16 | 11.39 | -9.9 |
| 0130082 | 880614 | 1000 | 35.00 | 6.97 | 80 | 5.61 | 11.67 | -9.9 |
| 0130082 | 880614 | 1000 | 40.00 | 6.92 | 85 | 5.22 | 11.77 | -9.9 |
| 0130082 | 880614 | 1000 | 45.00 | 6.91 | 87 | 5.15 | 11.86 | -9.9 |
| 0130082 | 880614 | 1000 | 50.00 | 6.89 | 90 | 4.99 | 12.00 | -9.9 |
| ** 880706 | | | | | | | | |
| 0130082 | 880706 | 1030 | 0.00 | 7.32 | 65 | 12.59 | 8.72 | -9.9 |
| 0130082 | 880706 | 1030 | 5.00 | 7.31 | 64 | 12.16 | 8.86 | -9.9 |
| 0130082 | 880706 | 1030 | 10.00 | 7.28 | 64 | 11.42 | 9.33 | -9.9 |
| 0130082 | 880706 | 1030 | 15.00 | 7.23 | 63 | 10.04 | 9.68 | -9.9 |
| 0130082 | 880706 | 1030 | 20.00 | 7.14 | 67 | 8.29 | 10.12 | -9.9 |
| 0130082 | 880706 | 1030 | 25.00 | 7.06 | 73 | 6.84 | 11.03 | -9.9 |
| 0130082 | 880706 | 1030 | 30.00 | 7.00 | 79 | 6.07 | 11.28 | -9.9 |
| 0130082 | 880706 | 1030 | 35.00 | 6.96 | 82 | 5.70 | 11.19 | -9.9 |
| 0130082 | 880706 | 1030 | 40.00 | 6.93 | 82 | 5.58 | 10.99 | -9.9 |
| ** 880913 | | | | | | | | |
| 0130082 | 880913 | 1255 | 0.00 | 7.52 | 64 | 17.73 | 9.98 | 18.5 |
| 0130082 | 880913 | 1255 | 5.00 | 7.49 | 65 | 17.25 | 10.77 | -9.9 |
| 0130082 | 880913 | 1255 | 10.00 | 7.46 | 65 | 17.02 | 11.05 | -9.9 |
| 0130082 | 880913 | 1255 | 15.00 | 7.34 | 67 | 11.99 | 12.77 | -9.9 |
| 0130082 | 880913 | 1255 | 20.00 | 7.28 | 69 | 8.79 | 13.51 | -9.9 |
| 0130082 | 880913 | 1255 | 25.00 | 7.14 | 71 | 7.59 | 13.40 | -9.9 |
| 0130082 | 880913 | 1255 | 30.00 | 7.09 | 74 | 7.18 | 13.82 | -9.9 |
| 0130082 | 880913 | 1255 | 35.00 | 7.04 | 79 | 6.50 | 14.14 | -9.9 |
| 0130082 | 880913 | 1255 | 40.00 | 7.00 | 81 | 6.11 | 13.57 | -9.9 |
| 0130082 | 880913 | 1255 | 45.00 | 6.96 | 82 | 5.95 | 13.98 | -9.9 |
| 0130082 | 880913 | 1255 | 50.00 | 6.93 | 85 | 5.72 | 13.96 | -9.9 |
| ** 881108 | | | | | | | | |
| 0130082 | 881108 | 1115 | 0.00 | 6.96 | 71 | 9.43 | 9.81 | 7.0 |
| 0130082 | 881108 | 1115 | 5.00 | 6.96 | 71 | 9.38 | 10.64 | -9.9 |
| 0130082 | 881108 | 1115 | 10.00 | 6.93 | 68 | 8.86 | 10.78 | -9.9 |
| 0130082 | 881108 | 1115 | 15.00 | 6.89 | 71 | 8.31 | 10.87 | -9.9 |
| 0130082 | 881108 | 1115 | 20.00 | 6.87 | 66 | 7.97 | 12.11 | -9.9 |
| 0130082 | 881108 | 1115 | 25.00 | 6.84 | 66 | 7.82 | 12.08 | -9.9 |

# BUTTLE LAKE WATER QUALITY PROFILES
## FOR SITE 0130082

| SITE | DATE y m d | TIME | DEPTH m | PH | SPF COND uS/cm | TEMP H2O deg C | DISS O2 mg/l | EXTN DEPTH m |
|---|---|---|---|---|---|---|---|---|
| 0130082 | 881108 | 1115 | 30.00 | 6.81 | 73 | 7.22 | 11.10 | -9.9 |
| 0130082 | 881108 | 1115 | 35.00 | 6.77 | 77 | 6.83 | 11.01 | -9.9 |
| 0130082 | 881108 | 1115 | 40.00 | 6.73 | 83 | 6.18 | 10.26 | -9.9 |
| 0130082 | 881108 | 1115 | 45.00 | 6.71 | 83 | 5.94 | 10.35 | -9.9 |
| 0130082 | 881108 | 1115 | 50.00 | 6.69 | 86 | 5.61 | 10.34 | -9.9 |
| 0130082 | 881108 | 1115 | 55.00 | 6.67 | 87 | 5.47 | 10.36 | -9.9 |
| ** 890118 | | | | | | | | |
| 0130082 | 890118 | 1154 | 0.00 | 7.20 | 85 | 4.59 | 11.62 | 11.0 |
| 0130082 | 890118 | 1154 | 5.00 | 7.13 | 84 | 4.59 | 11.57 | -9.9 |
| 0130082 | 890118 | 1154 | 10.00 | 7.08 | 84 | 4.57 | 11.51 | -9.9 |
| 0130082 | 890118 | 1154 | 15.00 | 7.06 | 84 | 4.57 | 11.51 | -9.9 |
| 0130082 | 890118 | 1154 | 20.00 | 7.03 | 84 | 4.57 | 11.51 | -9.9 |
| 0130082 | 890118 | 1154 | 25.00 | 7.02 | 82 | 4.57 | 11.73 | -9.9 |
| 0130082 | 890118 | 1154 | 30.00 | 7.01 | 83 | 4.55 | 12.98 | -9.9 |
| 0130082 | 890118 | 1154 | 35.00 | 6.99 | 82 | 4.55 | 12.22 | -9.9 |
| 0130082 | 890118 | 1154 | 40.00 | 6.98 | 82 | 4.51 | 11.84 | -9.9 |
| 0130082 | 890118 | 1154 | 45.00 | 6.97 | 83 | 4.49 | 11.71 | -9.9 |
| 0130082 | 890118 | 1154 | 50.00 | 6.97 | 83 | 4.49 | 11.64 | -9.9 |
| ** 890511 | | | | | | | | |
| 0130082 | 890511 | 0915 | 0.00 | 7.22 | 73 | 7.61 | 9.41 | 5.5 |
| 0130082 | 890511 | 0915 | 5.00 | 7.27 | 75 | 7.04 | 9.61 | -9.9 |
| 0130082 | 890511 | 0915 | 10.00 | 7.30 | 73 | 6.76 | 9.73 | -9.9 |
| 0130082 | 890511 | 0915 | 15.00 | 7.31 | 75 | 6.39 | 9.83 | -9.9 |
| 0130082 | 890511 | 0915 | 20.00 | 7.29 | 78 | 5.77 | 10.02 | -9.9 |
| 0130082 | 890511 | 0915 | 25.00 | 7.29 | 82 | 5.46 | 10.09 | -9.9 |
| 0130082 | 890511 | 0915 | 30.00 | 7.26 | 89 | 5.00 | 10.10 | -9.9 |
| 0130082 | 890511 | 0915 | 35.00 | 7.25 | 89 | 4.89 | 10.10 | -9.9 |
| 0130082 | 890511 | 0915 | 40.00 | 7.23 | 93 | 4.55 | 10.10 | -9.9 |
| 0130082 | 890511 | 0915 | 45.00 | 7.19 | 93 | 4.45 | 10.09 | -9.9 |
| 0130082 | 890511 | 0915 | 50.00 | 7.19 | 95 | 4.29 | 10.04 | -9.9 |
| ** 890613 | | | | | | | | |
| 0130082 | 890613 | 1150 | 0.00 | 7.51 | 71 | 15.53 | 10.04 | 7.0 |
| 0130082 | 890613 | 1150 | 5.00 | 7.48 | 67 | 14.82 | 10.38 | -9.9 |
| 0130082 | 890613 | 1150 | 10.00 | 7.53 | 63 | 12.13 | 11.19 | -9.9 |
| 0130082 | 890613 | 1150 | 15.00 | 7.52 | 71 | 9.50 | 11.59 | -9.9 |
| 0130082 | 890613 | 1150 | 20.00 | 7.47 | 75 | 7.34 | 12.25 | -9.9 |
| 0130082 | 890613 | 1150 | 25.00 | 7.42 | 79 | 6.55 | 12.50 | -9.9 |
| 0130082 | 890613 | 1150 | 30.00 | 7.36 | 85 | 5.77 | 12.01 | -9.9 |
| 0130082 | 890613 | 1150 | 35.00 | 7.33 | 89 | 5.36 | 12.14 | -9.9 |
| 0130082 | 890613 | 1150 | 40.00 | 7.30 | 88 | 5.21 | 12.17 | -9.9 |
| 0130082 | 890613 | 1150 | 45.00 | 7.26 | 91 | 4.97 | 11.97 | -9.9 |
| 0130082 | 890613 | 1150 | 50.00 | 7.23 | 92 | 4.87 | 11.98 | -9.9 |

# BUTTLE LAKE WATER QUALITY PROFILES
## FOR SITE 0130082

| SITE | DATE y m d | TIME | DEPTH m | PH | SPF COND uS/cm | TEMP H2O deg C | DISS O2 mg/l | EXTN DEPTH m |
|---|---|---|---|---|---|---|---|---|
| 0130082 | 890613 | 1150 | 55.00 | 7.21 | 93 | 4.72 | 11.88 | -9.9 |
| 0130082 | 890613 | 1150 | 60.00 | 7.19 | 94 | 4.65 | 11.86 | -9.9 |
| ** 890822 | | | | | | | | |
| 0130082 | 890822 | 1000 | 0.00 | 7.30 | 71 | 18.50 | 9.40 | 12.0 |
| 0130082 | 890822 | 1000 | 5.00 | 7.33 | 68 | 18.48 | 9.45 | -9.9 |
| 0130082 | 890822 | 1000 | 10.00 | 7.34 | 81 | 16.02 | 9.60 | -9.9 |
| 0130082 | 890822 | 1000 | 15.00 | 7.42 | 71 | 12.56 | 10.78 | -9.9 |
| 0130082 | 890822 | 1000 | 20.00 | 7.44 | 75 | 8.31 | 11.32 | -9.9 |
| 0130082 | 890822 | 1000 | 25.00 | 7.39 | 77 | 7.11 | 11.57 | -9.9 |
| 0130082 | 890822 | 1000 | 30.00 | 7.38 | 78 | 6.70 | 11.58 | -9.9 |
| 0130082 | 890822 | 1000 | 35.00 | 7.34 | 86 | 6.37 | 11.27 | -9.9 |
| 0130082 | 890822 | 1000 | 40.00 | 7.32 | 86 | 5.63 | 11.17 | -9.9 |
| 0130082 | 890822 | 1000 | 45.00 | 7.32 | 86 | 5.63 | 11.17 | -9.9 |
| 0130082 | 890822 | 1000 | 50.00 | 7.29 | 88 | 5.31 | 11.12 | -9.9 |
| ** 891024 | | | | | | | | |
| 0130082 | 891024 | 1000 | 0.00 | 7.57 | 75 | 12.30 | 10.47 | 11.0 |
| 0130082 | 891024 | 1000 | 5.00 | 7.57 | 75 | 12.30 | 10.78 | -9.9 |
| 0130082 | 891024 | 1000 | 10.00 | 7.59 | 73 | 11.17 | 10.55 | -9.9 |
| 0130082 | 891024 | 1000 | 15.00 | 7.57 | 69 | 10.31 | 10.80 | -9.9 |
| 0130082 | 891024 | 1000 | 20.00 | 7.50 | 71 | 9.56 | 10.88 | -9.9 |
| 0130082 | 891024 | 1000 | 25.00 | 7.47 | 79 | 7.14 | 10.99 | -9.9 |
| 0130082 | 891024 | 1000 | 30.00 | 7.43 | 80 | 6.56 | 10.99 | -9.9 |
| 0130082 | 891024 | 1000 | 35.00 | 7.39 | 85 | 6.08 | 10.80 | -9.9 |
| 0130082 | 891024 | 1000 | 40.00 | 7.39 | 87 | 5.83 | 10.69 | -9.9 |
| 0130082 | 891024 | 1000 | 45.00 | 7.31 | 89 | 5.58 | 10.58 | -9.9 |
| 0130082 | 891024 | 1000 | 50.00 | 7.30 | 89 | 5.39 | 10.51 | -9.9 |
| ** 891212 | | | | | | | | |
| 0130082 | 891212 | 1020 | 0.00 | -9.99 | -99 | 6.28 | 10.95 | -9.9 |
| 0130082 | 891212 | 1020 | 5.00 | -9.99 | -99 | 6.28 | 10.95 | -9.9 |
| 0130082 | 891212 | 1020 | 10.00 | -9.99 | -99 | 6.28 | 10.95 | -9.9 |
| 0130082 | 891212 | 1020 | 15.00 | -9.99 | -99 | 6.19 | 11.11 | -9.9 |
| 0130082 | 891212 | 1020 | 20.00 | -9.99 | -99 | 6.09 | 11.08 | -9.9 |
| 0130082 | 891212 | 1020 | 25.00 | -9.99 | -99 | 6.06 | 11.00 | -9.9 |
| 0130082 | 891212 | 1020 | 30.00 | -9.99 | -99 | 6.02 | 11.03 | -9.9 |
| 0130082 | 891212 | 1020 | 35.00 | -9.99 | -99 | 6.00 | 10.99 | -9.9 |
| 0130082 | 891212 | 1020 | 40.00 | -9.99 | -99 | 5.96 | 10.97 | -9.9 |
| 0130082 | 891212 | 1020 | 45.00 | -9.99 | -99 | 5.90 | 10.86 | -9.9 |
| 0130082 | 891212 | 1020 | 50.00 | -9.99 | -99 | 5.63 | 10.43 | -9.9 |
| 0130082 | 891212 | 1020 | 55.00 | -9.99 | -99 | 5.34 | 9.93 | -9.9 |
| 0130082 | 891212 | 1020 | 60.00 | -9.99 | -99 | 5.28 | 9.71 | -9.9 |

# Climate Data for Myra Creek Weather Station

(Negative 9 values indicate missing data)

WEATHER DATA
MYRA CREEK

| YEAR | MONTH | RAIN mm | SNOW cm | TOTAL PCPN mm | MAX T deg C | MIN T deg C |
|---|---|---|---|---|---|---|
| ** 1968 | | | | | | |
| 1968 | 1 | 587.0 | 189.0 | 776.0 | -99.9 | -99.9 |
| 1968 | 2 | 304.0 | 15.0 | 319.0 | -99.9 | -99.9 |
| 1968 | 3 | 364.0 | 0.0 | 364.0 | -99.9 | -99.9 |
| 1968 | 4 | 157.0 | 6.0 | 163.0 | -99.9 | -99.9 |
| 1968 | 5 | 64.0 | 0.0 | 64.0 | -99.9 | -99.9 |
| 1968 | 6 | 114.0 | 0.0 | 114.0 | -99.9 | -99.9 |
| 1968 | 7 | 46.0 | 0.0 | 46.0 | -99.9 | -99.9 |
| 1968 | 8 | 89.0 | 0.0 | 89.0 | -99.9 | -99.9 |
| 1968 | 9 | 154.0 | 0.0 | 154.0 | -99.9 | -99.9 |
| 1968 | 10 | 777.0 | 0.0 | 777.0 | -99.9 | -99.9 |
| 1968 | 11 | 557.0 | 5.0 | 562.0 | -99.9 | -99.9 |
| 1968 | 12 | 89.0 | 73.0 | 162.0 | -99.9 | -99.9 |
| ** 1969 | | | | | | |
| 1969 | 1 | 240.0 | 109.0 | 349.0 | -99.9 | -99.9 |
| 1969 | 2 | 257.0 | 59.0 | 316.0 | -99.9 | -99.9 |
| 1969 | 3 | 258.0 | 15.0 | 273.0 | -99.9 | -99.9 |
| 1969 | 4 | 389.0 | 15.0 | 404.0 | -99.9 | -99.9 |
| 1969 | 5 | 147.0 | 0.0 | 147.0 | -99.9 | -99.9 |
| 1969 | 6 | 23.0 | 0.0 | 23.0 | -99.9 | -99.9 |
| 1969 | 7 | 33.0 | 0.0 | 33.0 | -99.9 | -99.9 |
| 1969 | 8 | 97.0 | 0.0 | 97.0 | -99.9 | -99.9 |
| 1969 | 9 | 295.0 | 0.0 | 295.0 | -99.9 | -99.9 |
| 1969 | 10 | 202.0 | 0.0 | 202.0 | -99.9 | -99.9 |
| 1969 | 11 | 475.0 | 0.0 | 475.0 | -99.9 | -99.9 |
| 1969 | 12 | 374.0 | 225.0 | 599.0 | -99.9 | -99.9 |
| ** 1970 | | | | | | |
| 1970 | 1 | 242.0 | 58.0 | 300.0 | -99.9 | -99.9 |
| 1970 | 2 | 77.0 | 10.0 | 87.0 | -99.9 | -99.9 |
| 1970 | 3 | 215.0 | 60.0 | 275.0 | -99.9 | -99.9 |
| 1970 | 3 | 306.0 | 90.0 | 396.0 | -99.9 | -99.9 |
| 1970 | 4 | 310.0 | 26.0 | 336.0 | -99.9 | -99.9 |
| 1970 | 5 | 59.0 | 0.0 | 59.0 | -99.9 | -99.9 |
| 1970 | 6 | 37.0 | 0.0 | 37.0 | -99.9 | -99.9 |
| 1970 | 7 | 26.0 | 0.0 | 26.0 | -99.9 | -99.9 |
| 1970 | 8 | 39.0 | 0.0 | 39.0 | -99.9 | -99.9 |
| 1970 | 9 | 125.0 | 0.0 | 125.0 | -99.9 | -99.9 |
| 1970 | 10 | 263.0 | 0.0 | 263.0 | -99.9 | -99.9 |
| 1970 | 11 | 259.0 | 59.0 | 318.0 | -99.9 | -99.9 |
| 1970 | 12 | 96.0 | 237.0 | 333.0 | -99.9 | -99.9 |
| ** 1971 | | | | | | |
| 1971 | 1 | 278.0 | 59.0 | 337.0 | -99.9 | -99.9 |

WEATHER DATA
MYRA CREEK

| YEAR | MONTH | RAIN mm | SNOW cm | TOTAL PCPN mm | MAX T deg C | MIN T deg C |
|---|---|---|---|---|---|---|
| 1971 | 2 | 207.0 | 46.0 | 253.0 | -99.9 | -99.9 |
| 1971 | 3 | 283.0 | 176.0 | 459.0 | -99.9 | -99.9 |
| 1971 | 4 | 153.0 | 63.0 | 216.0 | -99.9 | -99.9 |
| 1971 | 5 | 77.0 | 0.0 | 77.0 | -99.9 | -99.9 |
| 1971 | 6 | 136.0 | 0.0 | 136.0 | -99.9 | -99.9 |
| 1971 | 7 | 14.0 | 0.0 | 14.0 | -99.9 | -99.9 |
| 1971 | 8 | 113.0 | 0.0 | 113.0 | -99.9 | -99.9 |
| 1971 | 9 | 188.0 | 0.0 | 188.0 | -99.9 | -99.9 |
| 1971 | 10 | 334.0 | 0.0 | 334.0 | -99.9 | -99.9 |
| 1971 | 11 | 576.0 | 7.0 | 583.0 | -99.9 | -99.9 |
| 1971 | 12 | 33.0 | 344.0 | 377.0 | -99.9 | -99.9 |
| ** 1972 | | | | | | |
| 1972 | 1 | 126.0 | 124.0 | 250.0 | -99.9 | -99.9 |
| 1972 | 2 | 261.0 | 140.0 | 401.0 | -99.9 | -99.9 |
| 1972 | 3 | 422.0 | 53.0 | 475.0 | -99.9 | -99.9 |
| 1972 | 4 | 282.0 | 122.0 | 404.0 | -99.9 | -99.9 |
| 1972 | 5 | 34.0 | 0.0 | 34.0 | -99.9 | -99.9 |
| 1972 | 6 | 75.0 | 0.0 | 75.0 | -99.9 | -99.9 |
| 1972 | 8 | 82.0 | 0.0 | 82.0 | -99.9 | -99.9 |
| 1972 | 8 | 50.0 | 0.0 | 50.0 | -99.9 | -99.9 |
| 1972 | 9 | 241.0 | 0.0 | 241.0 | -99.9 | -99.9 |
| 1972 | 10 | 23.0 | 0.0 | 23.0 | -99.9 | -99.9 |
| 1972 | 11 | 322.0 | 11.0 | 333.0 | -99.9 | -99.9 |
| 1972 | 12 | 387.0 | 67.0 | 454.0 | -99.9 | -99.9 |
| ** 1973 | | | | | | |
| 1973 | 1 | 478.0 | 153.0 | 631.0 | -99.9 | -99.9 |
| 1973 | 2 | 176.0 | 32.0 | 208.0 | -99.9 | -99.9 |
| 1973 | 3 | 118.0 | 51.0 | 169.0 | -99.9 | -99.9 |
| 1973 | 4 | 34.0 | 0.0 | 34.0 | -99.9 | -99.9 |
| 1973 | 5 | 207.0 | 0.0 | 207.0 | -99.9 | -99.9 |
| 1973 | 6 | 105.0 | 0.0 | 105.0 | -99.9 | -99.9 |
| 1973 | 7 | 24.0 | 0.0 | 24.0 | -99.9 | -99.9 |
| 1973 | 8 | 7.0 | 0.0 | 7.0 | -99.9 | -99.9 |
| 1973 | 9 | 43.0 | 0.0 | 43.0 | -99.9 | -99.9 |
| 1973 | 10 | 366.0 | 0.0 | 366.0 | -99.9 | -99.9 |
| 1973 | 11 | 196.0 | 243.0 | 439.0 | -99.9 | -99.9 |
| 1973 | 12 | 596.0 | 26.0 | 622.0 | -99.9 | -99.9 |
| ** 1974 | | | | | | |
| 1974 | 1 | 495.0 | 80.0 | 575.0 | -99.9 | -99.9 |
| 1974 | 2 | 359.0 | 10.0 | 369.0 | -99.9 | -99.9 |
| 1974 | 3 | 680.0 | 118.0 | 798.0 | -99.9 | -99.9 |
| 1974 | 4 | 206.0 | 0.0 | 206.0 | -99.9 | -99.9 |

WEATHER DATA
MYRA CREEK

| YEAR | MONTH | RAIN mm | SNOW cm | TOTAL PCPN mm | MAX T deg C | MIN T deg C |
|---|---|---|---|---|---|---|
| 1974 | 5 | 116.0 | 1.0 | 117.0 | -99.9 | -99.9 |
| 1974 | 6 | 52.0 | 0.0 | 52.0 | -99.9 | -99.9 |
| 1974 | 7 | 72.0 | 0.0 | 72.0 | -99.9 | -99.9 |
| 1974 | 8 | 4.0 | 0.0 | 4.0 | -99.9 | -99.9 |
| 1974 | 9 | 51.0 | 0.0 | 51.0 | -99.9 | -99.9 |
| 1974 | 10 | 162.0 | 0.0 | 162.0 | -99.9 | -99.9 |
| 1974 | 11 | 491.0 | 52.0 | 543.0 | -99.9 | -99.9 |
| 1974 | 12 | 520.0 | 17.0 | 537.0 | -99.9 | -99.9 |
| ** 1975 | | | | | | |
| 1975 | 1 | 131.0 | 157.0 | 288.0 | -99.9 | -99.9 |
| 1975 | 2 | 70.0 | 167.0 | 237.0 | -99.9 | -99.9 |
| 1975 | 3 | 102.0 | 93.0 | 195.0 | -99.9 | -99.9 |
| 1975 | 4 | 39.0 | 36.0 | 75.0 | -99.9 | -99.9 |
| 1975 | 5 | 61.0 | 0.0 | 61.0 | -99.9 | -99.9 |
| 1975 | 6 | 36.0 | 0.0 | 36.0 | -99.9 | -99.9 |
| 1975 | 7 | 1.0 | 0.0 | 1.0 | -99.9 | -99.9 |
| 1975 | 8 | 212.0 | 0.0 | 212.0 | -99.9 | -99.9 |
| 1975 | 9 | 6.0 | 0.0 | 6.0 | -99.9 | -99.9 |
| 1975 | 10 | 572.0 | 15.0 | 587.0 | -99.9 | -99.9 |
| 1975 | 11 | 1128.0 | 90.0 | 1218.0 | -99.9 | -99.9 |
| 1975 | 12 | 338.0 | 119.0 | 457.0 | -99.9 | -99.9 |
| ** 1976 | | | | | | |
| 1976 | 1 | 188.0 | 85.0 | 273.0 | -99.9 | -99.9 |
| 1976 | 2 | 215.0 | 139.0 | 354.0 | -99.9 | -99.9 |
| 1976 | 3 | 184.0 | 47.0 | 231.0 | -99.9 | -99.9 |
| 1976 | 4 | 81.0 | 0.0 | 81.0 | -99.9 | -99.9 |
| 1976 | 5 | 110.0 | 0.0 | 110.0 | -99.9 | -99.9 |
| 1976 | 6 | 187.0 | 0.0 | 187.0 | -99.9 | -99.9 |
| 1976 | 7 | 78.0 | 0.0 | 78.0 | -99.9 | -99.9 |
| 1976 | 8 | 74.0 | 0.0 | 74.0 | -99.9 | -99.9 |
| 1976 | 9 | 65.0 | 0.0 | 65.0 | -99.9 | -99.9 |
| 1976 | 10 | 236.0 | 0.0 | 236.0 | -99.9 | -99.9 |
| 1976 | 11 | 224.0 | 0.0 | 224.0 | -99.9 | -99.9 |
| 1976 | 12 | 304.0 | 1.0 | 305.0 | -99.9 | -99.9 |
| ** 1977 | | | | | | |
| 1977 | 1 | 92.0 | 64.0 | 156.0 | -99.9 | -99.9 |
| 1977 | 2 | 394.0 | 24.0 | 418.0 | -99.9 | -99.9 |
| 1977 | 4 | 135.0 | 7.0 | 142.0 | -99.9 | -99.9 |
| 1977 | 5 | 135.0 | 0.0 | 135.0 | -99.9 | -99.9 |
| 1977 | 6 | 68.0 | 0.0 | 68.0 | -99.9 | -99.9 |
| 1977 | 7 | 58.0 | 0.0 | 58.0 | -99.9 | -99.9 |
| 1977 | 8 | 42.0 | 0.0 | 42.0 | -99.9 | -99.9 |

06/05/90

# WEATHER DATA
## MYRA CREEK

| YEAR | MONTH | RAIN mm | SNOW cm | TOTAL PCPN mm | MAX T deg C | MIN T deg C |
|---|---|---|---|---|---|---|
| 1977 | 9 | 150.0 | 0.0 | 150.0 | -99.9 | -99.9 |
| 1977 | 10 | 535.0 | 0.0 | 535.0 | -99.9 | -99.9 |
| 1977 | 11 | 607.0 | 23.0 | 630.0 | -99.9 | -99.9 |
| 1977 | 12 | 282.0 | 76.0 | 358.0 | -99.9 | -99.9 |
| ** 1978 | | | | | | |
| 1978 | 1 | 82.0 | 195.0 | 277.0 | -99.9 | -99.9 |
| 1978 | 2 | 232.0 | 25.0 | 257.0 | -99.9 | -99.9 |
| 1978 | 3 | 340.0 | 0.0 | 340.0 | -99.9 | -99.9 |
| 1978 | 4 | 103.0 | 6.0 | 109.0 | -99.9 | -99.9 |
| 1978 | 5 | 122.0 | 0.0 | 122.0 | -99.9 | -99.9 |
| 1978 | 6 | 23.0 | 0.0 | 23.0 | -99.9 | -99.9 |
| 1978 | 7 | 21.0 | 0.0 | 21.0 | -99.9 | -99.9 |
| 1978 | 8 | 257.0 | 0.0 | 257.0 | -99.9 | -99.9 |
| 1978 | 9 | 283.0 | 0.0 | 283.0 | -99.9 | -99.9 |
| 1978 | 10 | 136.0 | 0.0 | 136.0 | -99.9 | -99.9 |
| 1978 | 11 | 264.0 | 12.0 | 276.0 | -99.9 | -99.9 |
| 1978 | 12 | 79.0 | 87.0 | 166.0 | -99.9 | -99.9 |
| ** 1979 | | | | | | |
| 1979 | 1 | 65.0 | 49.0 | 114.0 | -99.9 | -99.9 |
| 1979 | 2 | 314.0 | 153.0 | 467.0 | -99.9 | -99.9 |
| 1979 | 3 | 273.0 | 58.0 | 331.0 | -99.9 | -99.9 |
| 1979 | 4 | 82.0 | 0.0 | 82.0 | -99.9 | -99.9 |
| 1979 | 5 | 90.0 | 0.0 | 90.0 | -99.9 | -99.9 |
| 1979 | 6 | 42.0 | 0.0 | 42.0 | 20.3 | 7.6 |
| 1979 | 7 | 123.0 | 0.0 | 123.0 | 24.1 | 11.0 |
| 1979 | 8 | 48.0 | 0.0 | 480.0 | 24.6 | 11.9 |
| 1979 | 9 | 372.0 | 0.0 | 372.0 | 18.5 | 8.8 |
| 1979 | 10 | 329.0 | 0.0 | 329.0 | 13.6 | 5.1 |
| 1979 | 11 | 181.0 | 0.0 | 181.0 | 4.0 | 0.2 |
| 1979 | 12 | 579.0 | 60.0 | 639.0 | 3.4 | -0.3 |
| ** 1980 | | | | | | |
| 1980 | 1 | 82.0 | 166.0 | 248.0 | -1.1 | -5.5 |
| 1980 | 2 | 301.0 | 8.0 | 309.0 | 3.4 | -2.0 |
| 1980 | 3 | 93.0 | 54.0 | 147.0 | 6.8 | -1.1 |
| 1980 | 4 | 227.0 | 10.0 | 237.0 | 12.2 | 1.2 |
| 1980 | 5 | 42.0 | 0.0 | 42.0 | 17.8 | 5.5 |
| 1980 | 6 | 87.0 | 0.0 | 87.0 | 18.7 | 8.1 |
| 1980 | 7 | 68.0 | 0.0 | 68.0 | 23.1 | 10.7 |
| 1980 | 9 | 200.0 | 0.0 | 200.0 | 19.2 | 8.5 |
| 1980 | 10 | 180.0 | 0.0 | 180.0 | 13.3 | 5.1 |
| 1980 | 11 | 451.0 | 0.0 | 451.0 | 6.3 | 2.0 |
| 1980 | 12 | 659.9 | 53.0 | 712.0 | 4.2 | 0.0 |

# WEATHER DATA
## MYRA CREEK

| YEAR | MONTH | RAIN mm | SNOW cm | TOTAL PCPN mm | MAX T deg C | MIN T deg C |
|---|---|---|---|---|---|---|
| ** 1981 | | | | | | |
| 1981 | 1 | 344.0 | 3.0 | 347.0 | 5.0 | 1.0 |
| 1981 | 2 | 426.0 | 0.0 | 426.0 | 4.5 | -0.3 |
| 1981 | 3 | 189.0 | 1.0 | 190.0 | 10.0 | 0.7 |
| 1981 | 4 | 240.0 | 28.0 | 268.0 | 11.2 | 1.4 |
| 1981 | 5 | 104.0 | 0.0 | 104.0 | 15.3 | 5.2 |
| 1981 | 6 | 112.0 | 0.0 | 112.0 | 16.7 | 7.5 |
| 1981 | 7 | 84.0 | 0.0 | 84.0 | 23.8 | 11.3 |
| 1981 | 8 | 37.0 | 0.0 | 37.0 | 26.5 | 12.2 |
| 1981 | 9 | 298.0 | 0.0 | 298.0 | 18.7 | 8.3 |
| 1981 | 10 | 450.0 | 0.0 | 450.0 | 12.0 | 3.2 |
| 1981 | 11 | 465.0 | 0.0 | 465.0 | 6.6 | 2.3 |
| 1981 | 12 | 309.0 | 103.0 | 412.0 | 1.6 | -2.2 |
| ** 1982 | | | | | | |
| 1982 | 1 | 163.1 | 135.4 | 298.5 | 0.1 | -4.0 |
| 1982 | 2 | 371.0 | 134.4 | 505.4 | 3.0 | -1.6 |
| 1982 | 3 | 67.4 | 42.5 | 109.9 | 7.9 | -2.2 |
| 1982 | 4 | 129.2 | 64.0 | 193.2 | 9.7 | -0.5 |
| 1982 | 5 | 22.4 | 0.0 | 22.4 | 16.4 | 3.3 |
| 1982 | 6 | 27.1 | 0.0 | 27.1 | 24.3 | 7.9 |
| 1982 | 7 | 52.0 | 0.0 | 52.0 | 22.9 | 10.9 |
| 1982 | 8 | 37.0 | 0.0 | 37.0 | 23.4 | 10.3 |
| 1982 | 8 | 34.5 | 0.0 | 34.5 | 22.6 | 10.5 |
| 1982 | 9 | 89.4 | 0.0 | 89.4 | 20.9 | 9.3 |
| 1982 | 10 | 778.9 | 0.0 | 778.9 | 11.8 | 4.6 |
| 1982 | 11 | 197.2 | 15.5 | 212.7 | 2.1 | -1.6 |
| 1982 | 12 | 461.7 | 31.0 | 492.7 | 1.5 | -1.8 |
| ** 1983 | | | | | | |
| 1983 | 1 | 511.0 | 18.5 | 529.5 | 3.3 | -0.1 |
| 1983 | 2 | 609.3 | 15.1 | 624.4 | 4.4 | 0.2 |
| 1983 | 3 | 371.3 | 4.0 | 375.3 | 9.2 | 0.7 |
| 1983 | 4 | 83.5 | 0.0 | 83.5 | 14.4 | 1.8 |
| 1983 | 5 | 41.5 | 0.0 | 41.5 | 20.4 | 5.7 |
| 1983 | 6 | 130.0 | 0.0 | 130.0 | 18.2 | 8.6 |
| 1983 | 7 | 94.7 | 0.0 | 94.7 | 21.0 | 9.4 |
| 1983 | 8 | 59.6 | 0.0 | 59.6 | 24.8 | 11.4 |
| 1983 | 9 | 59.7 | 0.0 | 59.7 | 18.8 | 7.5 |
| 1983 | 10 | 217.8 | 0.0 | 217.8 | 12.1 | 3.7 |
| 1983 | 11 | 617.3 | 2.0 | 619.3 | 6.2 | 1.6 |
| 1983 | 12 | 91.1 | 101.7 | 192.8 | -1.0 | -5.7 |

WEATHER DATA
MYRA CREEK

| YEAR | MONTH | RAIN mm | SNOW cm | TOTAL PCPN mm | MAX T deg C | MIN T deg C |
|---|---|---|---|---|---|---|
| ** 1984 | | | | | | |
| 1984 | 1 | 385.3 | 14.0 | 399.3 | 3.7 | -1.7 |
| 1984 | 2 | 492.0 | 27.5 | 519.5 | 5.3 | 0.1 |
| 1984 | 3 | 164.2 | 23.4 | 187.6 | 9.5 | 1.1 |
| 1984 | 4 | 261.7 | 1.2 | 262.9 | 10.7 | 1.6 |
| 1984 | 5 | 192.7 | 0.0 | 192.7 | 13.3 | 3.9 |
| 1984 | 6 | 31.5 | 0.0 | 31.5 | 19.0 | 8.2 |
| 1984 | 7 | 8.8 | 0.0 | 8.8 | 25.4 | 11.0 |
| 1984 | 8 | 46.3 | 0.0 | 46.3 | 22.1 | 11.7 |
| 1984 | 9 | 95.0 | 0.0 | 95.0 | 17.8 | 6.8 |
| 1984 | 10 | 559.8 | 16.3 | 576.1 | 10.6 | 2.8 |
| 1984 | 11 | 261.2 | 78.6 | 339.8 | 3.2 | -1.0 |
| 1984 | 12 | 159.2 | 60.9 | 220.1 | -0.4 | -4.5 |
| ** 1985 | | | | | | |
| 1985 | 1 | 60.0 | 4.0 | 64.0 | 1.7 | -2.7 |
| 1985 | 2 | 116.0 | 59.2 | 175.2 | 4.3 | -2.2 |
| 1985 | 3 | 101.1 | 46.4 | 147.5 | 7.3 | -1.9 |
| 1985 | 4 | 113.3 | 0.9 | 114.2 | 11.0 | 0.4 |
| 1985 | 5 | 90.3 | 1.9 | 92.2 | 17.3 | 4.1 |
| 1985 | 6 | 21.1 | 0.0 | 21.1 | 20.7 | 7.1 |
| 1985 | 7 | 32.3 | 0.0 | 32.3 | 28.6 | 11.4 |
| 1985 | 8 | 21.2 | 0.0 | 21.2 | 25.3 | 9.5 |
| 1985 | 9 | 76.9 | 0.0 | 76.9 | 19.5 | 6.2 |
| 1985 | 10 | 501.7 | 4.1 | 505.8 | 11.6 | 3.6 |
| 1985 | 11 | 385.2 | 24.3 | 409.5 | 4.5 | 0.3 |
| 1985 | 12 | 255.2 | 74.2 | 329.4 | 1.5 | -3.4 |
| ** 1986 | | | | | | |
| 1986 | 1 | 702.7 | 33.5 | 736.2 | 4.9 | -1.2 |
| 1986 | 2 | 260.6 | 51.5 | 312.1 | 3.5 | -3.8 |
| 1986 | 3 | 418.1 | 0.0 | 418.1 | 8.2 | 0.4 |
| 1986 | 4 | 85.0 | 3.2 | 88.2 | 10.9 | 1.9 |
| 1986 | 5 | 237.9 | 1.0 | 238.9 | 15.5 | 4.4 |
| 1986 | 6 | 89.2 | 0.0 | 89.2 | 20.5 | 9.0 |
| 1986 | 7 | 41.7 | 0.0 | 41.7 | 20.6 | 10.1 |
| 1986 | 8 | 4.0 | 0.0 | 4.0 | 29.7 | 13.2 |
| 1986 | 9 | 54.0 | 0.0 | 54.0 | 19.8 | 8.1 |
| 1986 | 10 | 176.0 | 0.0 | 176.0 | 16.4 | 4.5 |
| 1986 | 11 | 583.2 | 6.5 | 589.7 | 7.0 | 1.3 |
| 1986 | 12 | 355.1 | 34.9 | 390.0 | 2.6 | -0.9 |
| ** 1987 | | | | | | |
| 1987 | 1 | 509.0 | 24.4 | 533.4 | 3.3 | -0.5 |
| 1987 | 2 | 321.3 | 15.5 | 336.8 | 6.3 | 0.3 |

WEATHER DATA
MYRA CREEK

| YEAR | MONTH | RAIN mm | SNOW cm | TOTAL PCPN mm | MAX T deg C | MIN T deg C |
|---|---|---|---|---|---|---|
| 1987 | 3 | 418.8 | 6.5 | 425.3 | 9.1 | 1.0 |
| 1987 | 4 | 262.7 | 0.0 | 262.7 | 12.3 | 2.4 |
| 1987 | 5 | 234.6 | 0.0 | 234.6 | 17.3 | 5.2 |
| 1987 | 6 | 184.0 | 0.0 | 184.0 | 22.5 | 9.1 |
| 1987 | 7 | 59.4 | 0.0 | 59.4 | 23.1 | 9.6 |
| 1987 | 8 | 18.3 | 0.0 | 18.3 | 26.4 | 11.2 |
| 1987 | 9 | 98.4 | 0.0 | 98.4 | 23.0 | 9.3 |
| 1987 | 10 | 83.8 | 0.0 | 83.8 | 14.7 | 4.9 |
| 1987 | 11 | 591.8 | 0.0 | 591.8 | 7.4 | 3.7 |
| 1987 | 12 | 400.9 | 36.5 | 437.4 | 1.6 | -1.8 |
| ** 1988 | | | | | | |
| 1988 | 1 | 284.7 | 58.5 | 343.2 | 2.1 | -1.6 |
| 1988 | 2 | 255.6 | 7.2 | 262.8 | 5.6 | -0.6 |
| 1988 | 3 | 200.4 | 11.5 | 211.9 | 8.0 | 0.5 |
| 1988 | 4 | 197.7 | 17.7 | 215.4 | 13.4 | 2.4 |
| 1988 | 5 | 215.4 | 0.0 | 215.4 | 14.4 | 5.1 |
| 1988 | 6 | 80.0 | 0.0 | 80.0 | 18.5 | 7.1 |
| 1988 | 7 | 25.4 | 0.0 | 25.4 | 23.4 | 9.8 |
| 1988 | 8 | 29.1 | 0.0 | 29.1 | 24.7 | 11.4 |
| 1988 | 9 | 114.2 | 0.0 | 114.2 | 22.0 | 8.5 |
| 1988 | 10 | 246.4 | 0.0 | 246.4 | 14.0 | 6.1 |
| 1988 | 11 | 541.5 | 40.0 | 581.5 | 7.0 | 1.3 |
| 1988 | 12 | 144.2 | 57.0 | 201.2 | 4.7 | -1.1 |
| ** 1989 | | | | | | |
| 1989 | 1 | 279.0 | 56.3 | 335.3 | 3.8 | -4.1 |
| 1989 | 2 | 51.3 | 51.0 | 102.3 | 2.0 | -7.6 |
| 1989 | 3 | 184.4 | 39.6 | 224.0 | 6.6 | -1.9 |
| 1989 | 4 | 188.0 | 10.0 | 198.0 | 15.7 | 0.8 |
| 1989 | 5 | 62.5 | 0.0 | 62.5 | 18.1 | 4.3 |
| 1989 | 6 | 71.8 | 0.0 | 71.8 | 22.4 | 9.3 |
| 1989 | 7 | 41.7 | 0.0 | 41.7 | 22.2 | 11.0 |
| 1989 | 8 | 41.8 | 0.0 | 41.8 | 23.7 | 11.9 |
| 1989 | 9 | 17.6 | 0.0 | 17.6 | 23.4 | 8.8 |
| 1989 | 10 | 339.4 | 0.0 | 339.4 | 12.6 | 5.4 |
| 1989 | 11 | 236.5 | 13.3 | 249.8 | 6.5 | 1.8 |
| 1989 | 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

## Appendix D

# XRF Analyses of Cores

# APPENDIX D: XRF ANALYSES OF CORES

**Table D-1**

**Major Element Composition and Major Element Ratios in Buttle Lake Cores (Analysis by XRF)**

| Sample Interval | Depth (cm) | Fe Wt. % | Ti Wt. % | Ca Wt. % | K Wt. % | Si Wt. % | Al Wt. % | Mg Wt. % | P Wt. % | Na Wt. % |
|---|---|---|---|---|---|---|---|---|---|---|
| **CORE BUT 2** | | | | | | | | | | |
| 0-0.5 | 0.25 | 7.24 | 0.46 | 1.86 | 0.91 | 17.91 | 8.09 | 1.88 | 0.135 | 0.47 |
| 0.5-1 | 0.75 | 10.03 | 0.50 | 2.03 | 0.83 | 18.76 | 8.00 | 2.01 | 0.113 | 0.57 |
| 1-1.5 | 1.25 | 10.69 | 0.43 | 1.73 | 0.79 | 18.76 | 7.77 | 1.77 | 0.105 | 0.50 |
| 1.5-2 | 1.75 | 6.97 | 0.46 | 1.66 | 1.30 | 20.90 | 9.43 | 2.03 | 0.096 | 0.62 |
| 2-3 | 2.5 | 4.36 | 0.29 | 0.43 | 3.44 | 22.21 | 12.31 | 1.91 | 0.044 | 0.34 |
| 3-4 | 3.5 | 4.43 | 0.31 | 0.49 | 3.35 | 21.82 | 12.37 | 1.95 | 0.048 | 0.35 |
| 4-5 | 4.5 | 5.12 | 0.36 | 0.80 | 2.88 | 21.49 | 11.69 | 2.03 | 0.061 | 0.36 |
| 5-6 | 5.5 | 5.77 | 0.37 | 0.89 | 2.66 | 20.89 | 11.31 | 1.98 | 0.061 | 0.40 |
| 6-8 | 7 | 4.79 | 0.33 | 0.47 | 3.20 | 21.48 | 11.92 | 1.74 | 0.057 | 0.31 |
| 8-10 | 9 | 5.92 | 0.28 | 0.34 | 3.32 | 20.24 | 12.92 | 2.16 | 0.048 | 0.29 |
| 10-12 | 11 | 7.24 | 0.52 | 1.66 | 1.83 | 20.95 | 10.47 | 2.27 | 0.092 | 0.62 |
| 12-14 | 13 | 8.53 | 0.74 | 3.11 | 0.56 | 21.71 | 8.13 | 2.88 | 0.113 | 0.70 |
| 16-18 | 17 | 8.60 | 0.77 | 3.21 | 0.53 | 21.61 | 7.97 | 2.93 | 0.113 | 0.73 |
| 22-26 | 24 | 8.73 | 0.74 | 3.22 | 0.51 | 21.69 | 7.89 | 2.89 | 0.109 | 0.70 |
| 38-42 | 40 | 8.55 | 0.76 | 3.12 | 0.50 | 21.12 | 7.79 | 2.88 | 0.109 | 0.72 |
| 50-54 | 52 | 8.80 | 0.78 | 3.33 | 0.48 | 21.70 | 7.89 | 3.04 | 0.105 | 0.72 |
| **CORE BUT 4** | | | | | | | | | | |
| 0-0.5 | 0.25 | 7.25 | 0.49 | 1.87 | 0.82 | 20.60 | 8.27 | 1.86 | 0.126 | 0.90 |
| 0-0.5Rep | 0.25 | 7.22 | 0.48 | 1.88 | 0.83 | 20.67 | 8.20 | 1.83 | 0.122 | 0.71 |
| 0.5-1 | 0.75 | 8.72 | 0.49 | 1.99 | 0.75 | 21.71 | 8.08 | 1.87 | 0.105 | 0.79 |
| 0.5-1Rep | 0.75 | 8.71 | 0.48 | 2.00 | 0.77 | 21.75 | 7.95 | 1.86 | 0.096 | 0.78 |
| 1-1.5 | 1.25 | 8.79 | 0.48 | 1.96 | 0.77 | 22.20 | 8.01 | 1.80 | 0.096 | 0.75 |
| 1.5-2 | 1.75 | 7.71 | 0.47 | 1.77 | 1.13 | 22.25 | 8.57 | 1.87 | 0.087 | 0.76 |
| 2-3 | 2.5 | 4.53 | 0.34 | 0.46 | 3.16 | 23.07 | 11.28 | 1.78 | 0.048 | 0.37 |
| 3-4 | 3.5 | 4.35 | 0.32 | 0.34 | 3.39 | 22.98 | 11.58 | 1.91 | 0.044 | 0.34 |
| 4-5 | 4.5 | 4.55 | 0.34 | 0.49 | 3.18 | 22.80 | 11.45 | 1.94 | 0.044 | 0.36 |
| 5-6 | 5.5 | 4.67 | 0.32 | 0.44 | 3.19 | 22.58 | 11.30 | 1.91 | 0.048 | 0.36 |
| 6-8 | 7 | 4.82 | 0.34 | 0.51 | 3.03 | 22.52 | 11.33 | 1.93 | 0.048 | 0.38 |
| 8-10 | 9 | 5.05 | 0.32 | 0.41 | 2.96 | 22.18 | 10.95 | 1.78 | 0.048 | 0.39 |
| 12-14 | 13 | 4.75 | 0.35 | 0.46 | 3.16 | 22.22 | 11.20 | 1.64 | 0.052 | 0.35 |
| 16-18 | 17 | 7.11 | 0.34 | 0.49 | 2.96 | 20.33 | 11.26 | 2.18 | 0.052 | 0.32 |
| 18-22 | 20 | 7.63 | 0.34 | 0.50 | 2.88 | 19.53 | 11.19 | 2.36 | 0.052 | 0.37 |
| 26-30 | 28 | 7.17 | 0.51 | 1.96 | 0.75 | 21.48 | 7.94 | 1.98 | 0.105 | 0.78 |
| 34-38 | 36 | 6.75 | 0.53 | 2.25 | 0.72 | 22.89 | 8.06 | 2.12 | 0.100 | 0.86 |
| 38-42 | 40 | 6.71 | 0.57 | 2.37 | 0.66 | 23.14 | 8.09 | 2.18 | 0.100 | 0.88 |

**Rep = repeated analysis of the same glass disc**

# Table D-2

## Major Element Composition and Major Element Ratios in Buttle Lake Cores (Analysis by XRF)

| Sample Interval | Depth (cm) | Fe Wt. % | Ti Wt. % | Ca Wt. % | K Wt. % | Si Wt. % | Al Wt. % | Mg Wt. % | P Wt. % | Na Wt. % |
|---|---|---|---|---|---|---|---|---|---|---|
| **CORE BUT 5** | | | | | | | | | | |
| 0-1 | 0.5 | 7.41 | 0.45 | 1.76 | 0.99 | 22.40 | 7.90 | 1.71 | 0.087 | 0.81 |
| 1-2 | 1.5 | 5.01 | 0.35 | 0.66 | 2.77 | 23.06 | 10.30 | 1.80 | 0.057 | 0.41 |
| 2-3 | 2.5 | 4.56 | 0.32 | 0.36 | 3.28 | 22.62 | 11.09 | 1.91 | 0.039 | 0.28 |
| 3-4 | 3.5 | 4.73 | 0.32 | 0.43 | 3.21 | 22.68 | 11.13 | 1.82 | 0.044 | 0.33 |
| 4-5 | 4.5 | 5.02 | 0.33 | 0.50 | 3.02 | 22.46 | 10.84 | 1.88 | 0.052 | 0.38 |
| 5-6 | 5.5 | 5.15 | 0.34 | 0.59 | 2.86 | 22.44 | 10.52 | 1.77 | 0.052 | 0.32 |
| 6-7 | 6.5 | 5.24 | 0.32 | 0.59 | 2.95 | 22.28 | 10.57 | 1.80 | 0.052 | 0.34 |
| 7-8 | 7.5 | 5.34 | 0.31 | 0.55 | 3.02 | 22.61 | 10.69 | 1.73 | 0.052 | 0.27 |
| 8-10 | 9 | 5.51 | 0.31 | 0.49 | 2.84 | 21.83 | 10.30 | 1.72 | 0.057 | 0.35 |
| 12-14 | 13 | 4.99 | 0.34 | 0.64 | 2.82 | 22.19 | 10.41 | 1.67 | 0.052 | 0.36 |
| 16-18 | 17 | 5.78 | 0.35 | 0.42 | 3.07 | 21.62 | 10.85 | 1.68 | 0.048 | 0.32 |
| 20-22 | 21 | 9.29 | 0.35 | 0.50 | 2.80 | 19.13 | 10.91 | 2.00 | 0.057 | 0.35 |
| 24-26 | 25 | 7.90 | 0.43 | 0.99 | 2.20 | 20.36 | 10.35 | 2.06 | 0.074 | 0.54 |
| 28-30 | 29 | 6.86 | 0.55 | 2.21 | 0.71 | 22.83 | 8.05 | 2.14 | 0.100 | 0.80 |
| 32-34 | 33 | 6.54 | 0.55 | 2.34 | 0.68 | 23.14 | 7.96 | 2.05 | 0.100 | 0.87 |
| **CORE BUT 6** | | | | | | | | | | |
| 0-0.5 | 0.25 | 6.69 | 0.39 | 1.78 | 1.18 | 22.41 | 7.41 | 1.50 | 0.070 | 0.64 |
| 0.5-1 | 0.75 | 7.15 | 0.38 | 2.05 | 1.28 | 22.55 | 7.27 | 1.55 | 0.070 | 0.57 |
| 1-1.5 | 1.25 | 7.13 | 0.38 | 2.00 | 1.23 | 22.95 | 7.06 | 1.48 | 0.070 | 0.56 |
| 1.5-2 | 1.75 | 7.34 | 0.32 | 2.17 | 1.41 | 23.40 | 6.33 | 1.36 | 0.061 | 0.40 |
| 2-3 | 2.5 | 7.76 | 0.30 | 2.26 | 1.60 | 23.74 | 6.06 | 1.18 | 0.057 | 0.26 |
| 3-4 | 3.5 | 8.06 | 0.30 | 2.34 | 1.65 | 23.46 | 6.29 | 1.27 | 0.057 | 0.24 |
| 4-5 | 4.5 | 7.97 | 0.29 | 2.38 | 1.60 | 22.12 | 6.10 | 1.23 | 0.057 | 0.20 |
| 5-6 | 5.5 | 7.81 | 0.31 | 2.42 | 1.64 | 22.77 | 6.43 | 1.32 | 0.061 | 0.24 |
| 6-8 | 7 | 8.10 | 0.31 | 2.40 | 1.67 | 22.30 | 6.31 | 1.33 | 0.065 | 0.38 |
| 8-10 | 9 | 8.28 | 0.31 | 2.36 | 1.68 | 22.26 | 6.51 | 1.37 | 0.057 | 0.31 |
| 12-14 | 13 | 7.15 | 0.32 | 2.16 | 2.03 | 21.94 | 7.83 | 1.58 | 0.057 | 0.28 |
| 16-18 | 17 | 7.28 | 0.31 | 1.99 | 2.12 | 21.52 | 8.01 | 1.46 | 0.057 | 0.24 |
| 18-21 | 19.5 | 7.08 | 0.32 | 1.94 | 2.29 | 21.81 | 8.49 | 1.55 | 0.052 | 0.25 |
| 21-24 | 22.5 | 7.88 | 0.31 | 1.91 | 2.03 | 21.79 | 7.77 | 1.47 | 0.057 | 0.30 |
| 27-30 | 28.5 | 5.94 | 0.32 | 2.22 | 2.27 | 22.26 | 8.37 | 1.57 | 0.057 | 0.37 |

## Table D-3

## Major Element Composition and Major Element Ratios in Buttle Lake Cores (Analysis by XRF)

| Sample Interval | Depth (cm) | Fe/Al Wt. Ratio | Si/Al Wt. Ratio | Ti/Al Wt. Ratio | Ca/Al Wt. Ratio | K/Al Wt. Ratio | Mg/Al Wt. Ratio | Na/Al Wt. Ratio |
|---|---|---|---|---|---|---|---|---|
| **CORE BUT 2** | | | | | | | | |
| 0-0.5 | 0.25 | 0.89 | 2.21 | 0.056 | 0.230 | 0.112 | 0.233 | 0.058 |
| 0.5-1 | 0.75 | 1.25 | 2.34 | 0.063 | 0.254 | 0.104 | 0.252 | 0.071 |
| 1-1.5 | 1.25 | 1.38 | 2.41 | 0.055 | 0.223 | 0.101 | 0.227 | 0.064 |
| 1.5-2 | 1.75 | 0.74 | 2.22 | 0.049 | 0.176 | 0.138 | 0.215 | 0.066 |
| 2-3 | 2.5 | 0.35 | 1.80 | 0.024 | 0.035 | 0.279 | 0.155 | 0.027 |
| 3-4 | 3.5 | 0.36 | 1.76 | 0.025 | 0.039 | 0.271 | 0.157 | 0.028 |
| 4-5 | 4.5 | 0.44 | 1.84 | 0.031 | 0.068 | 0.246 | 0.174 | 0.031 |
| 5-6 | 5.5 | 0.51 | 1.85 | 0.033 | 0.079 | 0.235 | 0.175 | 0.035 |
| 6-8 | 7 | 0.40 | 1.80 | 0.028 | 0.040 | 0.268 | 0.146 | 0.026 |
| 8-10 | 9 | 0.46 | 1.57 | 0.021 | 0.026 | 0.257 | 0.168 | 0.022 |
| 10-12 | 11 | 0.69 | 2.00 | 0.050 | 0.158 | 0.174 | 0.217 | 0.059 |
| 12-14 | 13 | 1.05 | 2.67 | 0.091 | 0.383 | 0.069 | 0.354 | 0.086 |
| 16-18 | 17 | 1.08 | 2.71 | 0.096 | 0.403 | 0.067 | 0.368 | 0.092 |
| 22-26 | 24 | 1.11 | 2.75 | 0.094 | 0.409 | 0.065 | 0.367 | 0.089 |
| 38-42 | 40 | 1.10 | 2.71 | 0.098 | 0.401 | 0.064 | 0.370 | 0.092 |
| 50-54 | 52 | 1.11 | 2.75 | 0.099 | 0.422 | 0.061 | 0.385 | 0.092 |
| **CORE BUT 4** | | | | | | | | |
| 0-0.5 | 0.25 | 0.88 | 2.49 | 0.060 | 0.226 | 0.100 | 0.225 | 0.109 |
| 0-0.5Rep | 0.25 | 0.88 | 2.52 | 0.059 | 0.229 | 0.101 | 0.224 | 0.086 |
| 0.5-1 | 0.75 | 1.08 | 2.69 | 0.061 | 0.247 | 0.093 | 0.231 | 0.098 |
| 0.5-1Rep | 0.75 | 1.10 | 2.74 | 0.060 | 0.252 | 0.097 | 0.235 | 0.098 |
| 1-1.5 | 1.25 | 1.10 | 2.77 | 0.060 | 0.244 | 0.096 | 0.225 | 0.094 |
| 1.5-2 | 1.75 | 0.90 | 2.60 | 0.055 | 0.206 | 0.132 | 0.218 | 0.089 |
| 2-3 | 2.5 | 0.40 | 2.04 | 0.030 | 0.041 | 0.280 | 0.158 | 0.033 |
| 3-4 | 3.5 | 0.38 | 1.98 | 0.028 | 0.029 | 0.292 | 0.165 | 0.029 |
| 4-5 | 4.5 | 0.40 | 1.99 | 0.030 | 0.042 | 0.278 | 0.169 | 0.031 |
| 5-6 | 5.5 | 0.41 | 2.00 | 0.028 | 0.039 | 0.282 | 0.169 | 0.032 |
| 6-8 | 7 | 0.43 | 1.99 | 0.030 | 0.045 | 0.267 | 0.170 | 0.033 |
| 8-10 | 9 | 0.46 | 2.03 | 0.030 | 0.038 | 0.270 | 0.163 | 0.036 |
| 12-14 | 13 | 0.42 | 1.98 | 0.032 | 0.041 | 0.282 | 0.146 | 0.031 |
| 16-18 | 17 | 0.63 | 1.81 | 0.030 | 0.044 | 0.263 | 0.194 | 0.028 |
| 18-22 | 20 | 0.68 | 1.75 | 0.030 | 0.045 | 0.257 | 0.211 | 0.033 |
| 26-30 | 28 | 0.90 | 2.71 | 0.064 | 0.247 | 0.095 | 0.250 | 0.099 |
| 34-38 | 36 | 0.84 | 2.84 | 0.066 | 0.279 | 0.089 | 0.263 | 0.107 |
| 38-42 | 40 | 0.83 | 2.86 | 0.070 | 0.292 | 0.081 | 0.269 | 0.109 |

**Rep = repeated analysis of the same glass disc**

## Table D-4

### Major Element Composition and Major Element Ratios in Buttle Lake Cores (Analysis by XRF)

| Sample Interval | Depth (cm) | Fe/Al Wt. Ratio | Si/Al Wt. Ratio | Ti/Al Wt. Ratio | Ca/Al Wt. Ratio | K/Al Wt. Ratio | Mg/Al Wt. Ratio | Na/Al Wt. Ratio |
|---|---|---|---|---|---|---|---|---|
| **CORE BUT 5** | | | | | | | | |
| 0-1 | 0.5 | 0.94 | 2.84 | 0.057 | 0.223 | 0.125 | 0.217 | 0.103 |
| 1-2 | 1.5 | 0.49 | 2.24 | 0.034 | 0.064 | 0.268 | 0.174 | 0.040 |
| 2-3 | 2.5 | 0.41 | 2.04 | 0.029 | 0.032 | 0.296 | 0.172 | 0.025 |
| 3-4 | 3.5 | 0.42 | 2.04 | 0.029 | 0.039 | 0.288 | 0.164 | 0.030 |
| 4-5 | 4.5 | 0.46 | 2.07 | 0.030 | 0.046 | 0.279 | 0.173 | 0.035 |
| 5-6 | 5.5 | 0.49 | 2.13 | 0.032 | 0.056 | 0.272 | 0.168 | 0.031 |
| 6-7 | 6.5 | 0.50 | 2.11 | 0.031 | 0.055 | 0.279 | 0.171 | 0.032 |
| 7-8 | 7.5 | 0.50 | 2.11 | 0.029 | 0.051 | 0.282 | 0.162 | 0.025 |
| 8-10 | 9 | 0.53 | 2.12 | 0.030 | 0.048 | 0.275 | 0.167 | 0.034 |
| 12-14 | 13 | 0.48 | 2.13 | 0.033 | 0.061 | 0.271 | 0.160 | 0.035 |
| 16-18 | 17 | 0.53 | 1.99 | 0.033 | 0.039 | 0.283 | 0.155 | 0.029 |
| 20-22 | 21 | 0.85 | 1.75 | 0.032 | 0.046 | 0.256 | 0.183 | 0.032 |
| 24-26 | 25 | 0.76 | 1.97 | 0.042 | 0.095 | 0.212 | 0.199 | 0.052 |
| 28-30 | 29 | 0.85 | 2.84 | 0.069 | 0.274 | 0.088 | 0.266 | 0.100 |
| 32-34 | 33 | 0.82 | 2.91 | 0.069 | 0.294 | 0.085 | 0.258 | 0.110 |
| **CORE BUT 6** | | | | | | | | |
| 0-0.5 | 0.25 | 0.90 | 3.02 | 0.053 | 0.240 | 0.160 | 0.203 | 0.087 |
| 0.5-1 | 0.75 | 0.98 | 3.10 | 0.053 | 0.282 | 0.177 | 0.213 | 0.079 |
| 1-1.5 | 1.25 | 1.01 | 3.25 | 0.054 | 0.283 | 0.175 | 0.210 | 0.080 |
| 1.5-2 | 1.75 | 1.16 | 3.70 | 0.051 | 0.342 | 0.222 | 0.214 | 0.064 |
| 2-3 | 2.5 | 1.28 | 3.92 | 0.049 | 0.373 | 0.264 | 0.195 | 0.043 |
| 3-4 | 3.5 | 1.28 | 3.73 | 0.048 | 0.372 | 0.262 | 0.201 | 0.039 |
| 4-5 | 4.5 | 1.31 | 3.63 | 0.048 | 0.390 | 0.262 | 0.202 | 0.033 |
| 5-6 | 5.5 | 1.21 | 3.54 | 0.048 | 0.377 | 0.255 | 0.205 | 0.038 |
| 6-8 | 7 | 1.28 | 3.54 | 0.049 | 0.380 | 0.264 | 0.211 | 0.060 |
| 8-10 | 9 | 1.27 | 3.42 | 0.047 | 0.362 | 0.258 | 0.211 | 0.047 |
| 12-14 | 13 | 0.91 | 2.80 | 0.041 | 0.276 | 0.259 | 0.202 | 0.036 |
| 16-18 | 17 | 0.91 | 2.69 | 0.039 | 0.248 | 0.265 | 0.182 | 0.031 |
| 18-21 | 19.5 | 0.83 | 2.57 | 0.037 | 0.229 | 0.270 | 0.183 | 0.030 |
| 21-24 | 22.5 | 1.01 | 2.80 | 0.040 | 0.246 | 0.261 | 0.189 | 0.038 |
| 27-30 | 28.5 | 0.71 | 2.66 | 0.038 | 0.266 | 0.271 | 0.187 | 0.044 |

## Table D-5

### Minor Element Composition of Buttle Lake Cores, Determined by XRF Analysis

| Sample Interval (cm) | Depth (cm) | Zr ppm | Sr ppm | Rb ppm | Pb ppm | Zn ppm | Cu ppm | Ni ppm | Co ppm | Mn ppm | V ppm | Cr ppm | Ba ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CORE BUT 2** | | | | | | | | | | | | | |
| 0-0.5 | 0.25 | 85 | 103 | 27 | 333 | 4262 | 1199 | 28 | 96 | 27147 | 254 | 70 | 2781 |
| 0.5-1 | 0.75 | 81 | 93 | 30 | 182 | 2403 | 913 | 7 | 57 | 10614 | 234 | 76 | 1860 |
| 1-1.5 | 1.25 | 76 | 80 | 26 | 186 | 3497 | 962 | 3 | 63 | 4268 | 211 | 70 | 1901 |
| 1.5-2 | 1.75 | 105 | 131 | 35 | 432 | 3722 | 1051 | 19 | 43 | 2126 | 265 | 68 | 4626 |
| 2-3 | 2.5 | 161 | 251 | 62 | 724 | 4166 | 1186 | 26 | 17 | 522 | 415 | 43 | 18229 |
| 3-4 | 3.5 | 146 | 251 | 54 | 783 | 4655 | 1381 | 22 | 13 | 440 | 433 | 52 | 21067 |
| 4-5 | 4.5 | 205 | 297 | 58 | 858 | 4872 | 2019 | 30 | 19 | 567 | 454 | 66 | 18315 |
| 5-6 | 5.5 | 204 | 289 | 52 | 882 | 4785 | 2159 | 29 | 19 | 716 | 447 | 69 | 17056 |
| 6-8 | 7 | 234 | 346 | 63 | 1138 | 5604 | 2188 | 26 | 13 | 428 | 499 | 47 | 21495 |
| 8-10 | 9 | 216 | 203 | 55 | 1281 | 6668 | 1778 | 17 | 10 | 493 | 417 | 50 | 13272 |
| 12-14 | 13 | 121 | 127 | 37 | 543 | 2192 | 1527 | 40 | 34 | 1955 | 301 | 96 | 3107 |
| 16-18 | 17 | 87 | 148 | 18 | 12 | 134 | 183 | 50 | 47 | 2598 | 284 | 131 | 545 |
| 22-26 | 24 | 91 | 151 | 18 | 13 | 147 | 195 | 57 | 46 | 2684 | 299 | 129 | 417 |
| 30-34 | 32 | 90 | 143 | 18 | 7 | 113 | 164 | 53 | 44 | 4992 | 268 | 130 | 315 |
| 38-42 | 40 | 85 | 140 | 16 | 9 | 103 | 170 | 50 | 45 | 2920 | 305 | 131 | 303 |
| 50-54 | 52 | 90 | 151 | 17 | 7 | 113 | 193 | 62 | 46 | 3088 | 292 | 131 | 304 |

## Table D-6

### Minor Element Composition of Buttle Lake Cores, Determined by XRF Analysis

| Sample Interval (cm) | Depth (cm) | Zr ppm | Sr ppm | Rb ppm | Pb ppm | Zn ppm | Cu ppm | Ni ppm | Co ppm | Mn ppm | V ppm | Cr ppm | Ba ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CORE BUT 4** | | | | | | | | | | | | | |
| 0-0.5 | 0.25 | 88 | 119 | 30 | 209 | 2588 | 878 | 8 | 78 | 11552 | 221 | 63 | 1829 |
| 0.5-1 | 0.75 | 97 | 163 | 25 | 160 | 2283 | 792 | 13 | 64 | 6543 | 198 | 68 | 2352 |
| 1-1.5 | 1.25 | 93 | 140 | 27 | 138 | 1863 | 643 | 2 | 60 | 3083 | 216 | 62 | 2600 |
| 1.5-2 | 1.75 | 102 | 169 | 33 | 207 | 2145 | 565 | 11 | 37 | 1408 | 233 | 48 | 5327 |
| 2-3 | 2.5 | 223 | 366 | 67 | 715 | 4085 | 1122 | 35 | 16 | 243 | 471 | 52 | 21178 |
| 3-4 | 3.5 | 236 | 376 | 75 | 640 | 4345 | 1089 | 32 | 14 | 163 | 496 | 56 | 23996 |
| 4-5 | 4.5 | 244 | 377 | 68 | 667 | 5136 | 1159 | 33 | 12 | 219 | 492 | 62 | 23787 |
| 5-6 | 5.5 | 254 | 414 | 67 | 884 | 6039 | 1331 | 32 | 16 | 162 | 500 | 55 | 25458 |
| 6-8 | 7 | 244 | 416 | 66 | 739 | 5615 | 1484 | 34 | 17 | 215 | 526 | 55 | 25434 |
| 8-10 | 9 | 247 | 471 | 62 | 894 | 6152 | 1886 | 31 | 11 | 169 | 542 | 53 | 27120 |
| 10-12 | 11 | 252 | 439 | 63 | 1066 | 6561 | 1831 | 32 | 17 | 169 | 544 | 40 | 27597 |
| 16-18 | 17 | 211 | 312 | 53 | 1395 | 8520 | 2160 | 35 | 17 | 556 | 417 | 52 | 17281 |
| 18-22 | 20 | 205 | 263 | 50 | 1423 | 8346 | 2195 | 31 | 18 | 751 | 402 | 52 | 14870 |
| 26-30 | 28 | 90 | 159 | 25 | 77 | 509 | 239 | 19 | 36 | 2108 | 237 | 71 | 1621 |
| 38-42 | 40 | 91 | 171 | 25 | 34 | 236 | 150 | 21 | 36 | 1955 | 216 | 72 | 845 |
| 42-46 | 44 | 94 | 173 | 25 | 9 | 115 | 127 | 27 | 36 | 1974 | 223 | 76 | 511 |

## Table D-7

## Minor Element Composition of Buttle Lake Cores, Determined by XRF Analysis

| Sample Interval (cm) | Depth (cm) | Zr ppm | Sr ppm | Rb ppm | Pb ppm | Zn ppm | Cu ppm | Ni ppm | Co ppm | Mn ppm | V ppm | Cr ppm | Ba ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CORE BUT 5** | | | | | | | | | | | | | |
| 0-1 | 0.5 | 108 | 202 | 25 | 231 | 2515 | 798 | 16 | 35 | 2679 | 224 | 66 | 4798 |
| 1-2 | 1.5 | 219 | 371 | 57 | 632 | 4444 | 1025 | 29 | 16 | 588 | 436 | 57 | 20797 |
| 2-3 | 2.5 | 249 | 400 | 70 | 741 | 5292 | 1179 | 30 | 14 | 161 | 478 | 56 | 23761 |
| 3-4 | 3.5 | 266 | 419 | 64 | 772 | 5668 | 1214 | 31 | 10 | 147 | 477 | 56 | 25693 |
| 4-5 | 4.5 | 262 | 443 | 63 | 726 | 5547 | 1302 | 31 | 15 | 168 | 498 | 57 | 26254 |
| 5-6 | 5.5 | 253 | 461 | 60 | 761 | 6256 | 1387 | 30 | 14 | 183 | 490 | 54 | 27161 |
| 6-7 | 6.5 | 259 | 518 | 63 | 853 | 6693 | 1488 | 29 | 15 | 145 | 519 | 53 | 28442 |
| 7-8 | 7.5 | 254 | 540 | 62 | 891 | 6463 | 1565 | 33 | 19 | 145 | 542 | 49 | 29820 |
| 8-10 | 9 | 255 | 540 | 61 | 991 | 7118 | 1795 | 29 | 17 | 133 | 527 | 50 | 29781 |
| 12-14 | 13 | 247 | 482 | 57 | 985 | 6502 | 1428 | 28 | 14 | 204 | 528 | 38 | 29000 |
| 16-18 | 17 | 222 | 416 | 58 | 1387 | 9156 | 2159 | 31 | 13 | 198 | 489 | 47 | 24235 |
| 20-22 | 21 | 190 | 228 | 47 | 1304 | 10104 | 1826 | 26 | 17 | 550 | 341 | 54 | 11860 |
| 24-26 | 25 | 150 | 189 | 37 | 1251 | 7877 | 2752 | 41 | 28 | 792 | 321 | 81 | 8492 |
| 28-30 | 29 | 90 | 162 | 24 | 29 | 241 | 130 | 22 | 31 | 1357 | 232 | 77 | 1077 |
| 32-34 | 33 | 88 | 168 | 22 | 12 | 153 | 116 | 21 | 28 | 1452 | 219 | 73 | 737 |

# Table D-8

## Minor Element Composition of Buttle Lake Cores, Determined by XRF Analysis

| Sample Interval (cm) | Depth (cm) | Zr ppm | Sr ppm | Rb ppm | Pb ppm | Zn ppm | Cu ppm | Ni ppm | Co ppm | Mn ppm | V ppm | Cr ppm | Ba ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CORE BUT 6** | | | | | | | | | | | | | |
| 0-0.5 | 0.25 | 141 | 299 | 30 | 386 | 3351 | 777 | 16 | 31 | 1164 | 292 | 55 | 12163 |
| 0.5-1 | 0.75 | 164 | 354 | 29 | 418 | 3572 | 796 | 20 | 25 | 914 | 324 | 52 | 15496 |
| 1-1.5 | 1.25 | 171 | 383 | 28 | 385 | 3344 | 732 | 17 | 28 | 737 | 335 | 48 | 17279 |
| 1.5-2 | 1.75 | 237 | 544 | 32 | 403 | 3309 | 608 | 20 | 22 | 459 | 424 | 51 | 26686 |
| 2-3 | 2.5 | 264 | 663 | 35 | 452 | 3691 | 621 | 30 | 17 | 273 | 485 | 42 | 32287 |
| 3-4 | 3.5 | 266 | 657 | 38 | 472 | 3850 | 644 | 28 | 18 | 294 | 471 | 43 | 31827 |
| 4-5 | 4.5 | 281 | 677 | 37 | 482 | 3979 | 631 | 25 | 13 | 286 | 510 | 39 | 34642 |
| 5-6 | 5.5 | 271 | 732 | 38 | 579 | 5066 | 754 | 31 | 15 | 283 | 528 | 34 | 35528 |
| 6-8 | 7 | 282 | 746 | 38 | 651 | 5105 | 785 | 29 | 21 | 280 | 551 | 28 | 37772 |
| 8-10 | 9 | 283 | 741 | 38 | 697 | 4794 | 822 | 31 | 21 | 302 | 549 | 27 | 35821 |
| 12-14 | 13 | 278 | 672 | 44 | 716 | 4256 | 859 | 30 | 23 | 343 | 514 | 34 | 31596 |
| 16-18 | 17 | 293 | 684 | 47 | 725 | 4595 | 853 | 33 | 18 | 319 | 559 | 27 | 34656 |
| 18-21 | 19.5 | 287 | 600 | 49 | 711 | 4156 | 898 | 29 | 18 | 332 | 520 | 35 | 29925 |
| 21-24 | 22.5 | 282 | 641 | 44 | 752 | 4241 | 929 | 31 | 16 | 353 | 529 | 27 | 32100 |
| 27-30 | 28.5 | 301 | 764 | 53 | 667 | 4128 | 865 | 34 | 15 | 264 | 571 | 40 | 33741 |
| 33-36 | 34.5 | 289 | 647 | 45 | 543 | 4678 | 744 | 38 | 15 | 334 | 508 | 58 | 30893 |

## Appendix E

# CNS Analyses of Cores

Rescan

## APPENDIX E: CNS ANALYSES OF CORES

### Table E-1

### Carbonate, Organic Carbon, Nitrogen and Sulphur Data for Buttle Lake Cores

| Sample Interval (cm) | Depth (cm) | Carbonate-C Wt. % | $CaCO_3$ Wt. % | Total C Wt. % | Organic C Wt. % | Total N Wt. % | Org. C/N | S Wt. % |
|---|---|---|---|---|---|---|---|---|
| **CORE BUT 2** | | | | | | | | |
| 0-0.5 | 0.25 | 0.14 | 1.17 | 7.55 | 7.41 | 0.48 | 15.4 | 0.33 |
| 0.5-1 | 0.75 | 0.05 | 0.42 | 6.35 | 6.30 | 0.40 | 15.9 | 0.19 |
| 1-1.5 | 1.25 | 0.03 | 0.25 | 6.56 | 6.53 | 0.44 | 14.9 | 0.33 |
| 1.5-2 | 1.75 | 0.01 | 0.08 | 5.03 | 5.02 | 0.31 | 16.4 | 0.52 |
| 2-3 | 2.5 | 0.01 | 0.08 | 1.44 | 1.43 | 0.08 | 17.1 | 1.83 |
| 3-4 | 3.5 | 0.01 | 0.05 | 1.32 | 1.31 | 0.07 | 17.7 | 2.02 |
| 4-5 | 4.5 | 0.01 | 0.08 | 1.88 | 1.88 | 0.10 | 18.0 | 1.74 |
| 5-6 | 5.5 | 0.02 | 0.17 | 2.56 | 2.54 | 0.14 | 18.3 | 1.91 |
| 6-8 | 7 | 0.02 | 0.17 | 1.53 | 1.51 | 0.08 | 18.7 | 2.32 |
| 8-10 | 9 | 0.04 | 0.33 | 0.87 | 0.83 | 0.05 | 15.6 | 5.40 |
| 12-14 | 13 | 0.02 | 0.17 | 3.86 | 3.84 | 0.20 | 18.9 | 1.63 |
| 16-18 | 17 | 0.01 | 0.04 | 4.83 | 4.83 | 0.25 | 19.0 | 0.08 |
| 22-26 | 24 | 0.02 | 0.17 | 4.82 | 4.80 | 0.26 | 18.5 | 0.08 |
| 30-34 | 32 | 0.01 | 0.09 | 4.46 | 4.45 | 0.23 | 19.2 | 0.05 |
| 38-42 | 40 | 0.02 | 0.17 | 5.06 | 5.04 | 0.26 | 19.4 | 0.06 |
| 50-54 | 52 | 0.04 | 0.33 | 4.80 | 4.76 | 0.24 | 20.1 | 0.09 |
| **CORE BUT 4** | | | | | | | | |
| 0-0.5 | 0.25 | 0.05 | 0.42 | 6.76 | 6.71 | 0.40 | 16.6 | 0.36 |
| 0.5-1 | 0.75 | 0.03 | 0.25 | 5.07 | 5.04 | 0.31 | 16.5 | 0.36 |
| 1-1.5 | 1.25 | 0.02 | 0.17 | 4.86 | 4.84 | 0.29 | 16.9 | 0.36 |
| 1.5-2 | 1.75 | 0.01 | 0.08 | 4.60 | 4.59 | 0.25 | 18.4 | 0.62 |
| 2-3 | 2.5 | 0.05 | 0.42 | 1.01 | 0.96 | 0.06 | 16.3 | 2.86 |
| 3-4 | 3.5 | 0.04 | 0.33 | 0.52 | 0.48 | 0.04 | 13.7 | 3.33 |
| 4-5 | 4.5 | 0.05 | 0.42 | 0.74 | 0.69 | 0.04 | 16.4 | 3.22 |
| 5-6 | 5.5 | 0.04 | 0.33 | 0.71 | 0.67 | 0.04 | 18.5 | 3.41 |
| 6-8 | 7 | 0.04 | 0.33 | 0.87 | 0.83 | 0.04 | 18.8 | 2.94 |
| 8-10 | 9 | 0.04 | 0.33 | 1.04 | 1.00 | 0.06 | 17.8 | 3.36 |
| 12-14 | 13 | 0.08 | 0.67 | 0.97 | 0.89 | 0.04 | 21.2 | 3.90 |
| 16-18 | 17 | 0.15 | 1.25 | 0.65 | 0.50 | 0.03 | 18.0 | 7.30 |
| 18-22 | 20 | 0.17 | 1.42 | 0.67 | 0.50 | 0.03 | 19.3 | 8.16 |
| 26-30 | 28 | 0.02 | 0.17 | 7.54 | 7.52 | 0.32 | 23.9 | 0.39 |
| 34-38 | 36 | 0.01 | 0.08 | 5.94 | 5.93 | 0.30 | 19.6 | 0.18 |
| 38-42 | 40 | 0.01 | 0.05 | 5.33 | 5.32 | 0.26 | 20.9 | 0.06 |

## Table E-2

### Carbonate, Organic Carbon, Nitrogen and Sulphur Data for Buttle Lake Cores

| Sample Interval (cm) | Depth (cm) | Carbonate-C Wt. % | $CaCO_3$ Wt. % | Total C Wt. % | Organic C Wt. % | Total N Wt. % | Org. C/N | S Wt. % |
|---|---|---|---|---|---|---|---|---|
| **CORE BUT 5** | | | | | | | | |
| 0-1 | 0.5 | 0.01 | 0.08 | 5.12 | 5.11 | 0.26 | 19.7 | 1.18 |
| 1-2 | 1.5 | 0.02 | 0.17 | 1.75 | 1.73 | 0.09 | 19.9 | 3.17 |
| 2-3 | 2.5 | 0.04 | 0.33 | 0.58 | 0.54 | 0.03 | 15.9 | 3.73 |
| 3-4 | 3.5 | 0.05 | 0.42 | 0.60 | 0.55 | 0.03 | 17.8 | 3.59 |
| 4-5 | 4.5 | 0.05 | 0.42 | 0.77 | 0.72 | 0.04 | 19.4 | 3.49 |
| 5-6 | 5.5 | 0.08 | 0.67 | 0.87 | 0.79 | 0.04 | 19.7 | 3.98 |
| 6-7 | 6.5 | 0.13 | 1.08 | 0.64 | 0.51 | 0.03 | 18.3 | 4.14 |
| 7-8 | 7.5 | 0.13 | 1.08 | 0.69 | 0.56 | 0.04 | 15.2 | 4.11 |
| 8-10 | 9 | 0.08 | 0.67 | 0.97 | 0.89 | 0.04 | 20.7 | 4.61 |
| 12-14 | 13 | 0.12 | 1.00 | 1.29 | 1.17 | 0.05 | 24.5 | 3.96 |
| 16-18 | 17 | 0.11 | 0.92 | 0.49 | 0.38 | 0.02 | 16.5 | 5.56 |
| 20-22 | 21 | 0.21 | 1.75 | 0.69 | 0.48 | 0.03 | 14.9 | 10.74 |
| 24-26 | 25 | 0.07 | 0.58 | 2.40 | 2.33 | 0.11 | 20.8 | 6.21 |
| 28-30 | 29 | 0.02 | 0.17 | 6.09 | 6.07 | 0.31 | 19.5 | 0.23 |
| 32-34 | 33 | 0.02 | 0.17 | 6.39 | 6.37 | 0.31 | 20.7 | 0.12 |
| **CORE BUT 6** | | | | | | | | |
| 0-0.5 | 0.25 | 0.14 | 1.17 | 5.40 | 5.26 | 0.21 | 24.6 | 3.92 |
| 0.5-1 | 0.75 | 0.30 | 2.50 | 5.07 | 4.77 | 0.18 | 26.7 | 5.05 |
| 1-1.5 | 1.25 | 0.30 | 2.50 | 4.19 | 3.89 | 0.15 | 26.5 | 5.39 |
| 1.5-2 | 1.75 | 0.54 | 4.50 | 2.28 | 1.74 | 0.07 | 26.7 | 7.47 |
| 2-3 | 2.5 | 0.68 | 5.67 | 0.95 | 0.27 | 0.01 | 22.1 | 9.44 |
| 3-4 | 3.5 | 0.72 | 6.00 | 0.89 | 0.17 | 0.01 | 24.6 | 9.71 |
| 4-5 | 4.5 | 0.73 | 6.08 | 1.00 | 0.27 | 0.01 | 24.8 | 9.83 |
| 5-6 | 5.5 | 0.73 | 6.08 | 0.93 | 0.20 | 0.01 | 25.3 | 9.91 |
| 6-8 | 7 | 0.74 | 6.17 | 0.93 | 0.19 | 0.01 | 16.9 | 10.23 |
| 8-10 | 9 | 0.72 | 6.00 | 0.89 | 0.17 | 0.01 | 16.5 | 10.12 |
| 12-14 | 13 | 0.65 | 5.42 | 1.05 | 0.40 | 0.02 | 23.5 | 8.31 |
| 16-18 | 17 | 0.64 | 5.33 | 0.78 | 0.14 | 0.01 | 12.0 | 8.79 |
| 18-21 | 20 | 0.61 | 5.08 | 0.72 | 0.11 | 0.01 | 15.7 | 8.52 |
| 21-24 | 23 | 0.60 | 5.00 | 0.67 | 0.07 | 0.01 | 10.6 | 9.27 |
| 27-30 | 29 | 0.68 | 5.67 | 0.77 | 0.09 | 0.01 | 15.3 | 6.78 |
| 33-36 | 35 | 0.83 | 6.92 | 0.94 | 0.11 | 0.01 | 14.1 | 8.82 |

Appendix F

# Mineralogy by X-Ray Diffractometry

Rescan

# APPENDIX F: MINERALOGY BY X-RAY DIFFRACTOMETRY

## Buttle Lake Sediments

The table below lists the minerals identified in each sample. the minerals are listed in decreasing abundance which is a function of the overall intensities of the most prominent peaks.

| Sample Identification | Minerals Present | Sample Identification | Minerals Present |
|---|---|---|---|
| BUT 2 0.5-1 | Quartz<br>Feldspar (Albite)<br>Clay (Chlorite)<br>Clay (Muscovite),<br>trace amounts | BUT 5 0-1 | Quartz<br>Feldspar (Albite)<br>Clay (Chlorite)<br>Clay (Muscovite),<br>minor amounts<br>Pyrite, trace amounts |
| BUT 2 8-10 | Quartz<br>Pyrite<br>Clay (Muscovite)<br>Clay (Chlorite)<br>Feldspar (Albite) | BUT 5 32-34 | Quartz<br>Feldspar (Albite)<br>Clay (Chlorite)<br>Clay (Muscovite),<br>trace amounts<br>Calcite,<br>trace amounts |
| BUT 4 2-3 | Quartz<br>Clay (Muscovite)<br>Clay (Chlorite)<br>Feldspar (Albite)<br>Pyrite, minor amounts | BUT 6 0-0.5 | Quartz<br>Feldspar (Albite)<br>Clay (Chlorite)<br>Pyrite<br>Clay (Muscovite)<br>Calcite,<br>trace amounts |
| BUT 4 16-18 | Quartz<br>Pyrite<br>Clay (Muscovite)<br>Clay (Chlorite)<br>Feldspar (Albite) | BUT 6 12-14 | Quartz<br>Clay (Muscovite)<br>Clay (Chlorite)<br>Calcite<br>Pyrite<br>Feldspar (Albite) |

All of the tailings samples (BUT 2 8-10 cm, BUT 4 16-18 cm, BUT 6 12-14 cm) contain abundant quartz, clays, pyrite, and feldspar. It should be noted that the abundance of feldspar is less in these samples than in the sample of natural sediments and mine tailings (BUT 2 0.5-1 cm, BUT 4 2-3 cm, BUT 5 0-1 cm, BUT 6 0-0.5 cm). The natural sediments mixed with tailings also contained quartz, feldspar, clays, and pyrite. In these samples the abundance of clay minerals and pyrite was less than those samples of the tailings. The sample of natural sediment (pre-mining) contained abundant quartz, feldspar, and the clay mineral chlorite along with trace amounts of calcite. Pyrite was absent. It should also be noted that the only other two samples that were found to contain calcite were BUT 6 0-0.5 cm and BUT 6 12-14 cm.

Appendix G

# Metal Analyses in Pore Water

Rescan

## APPENDIX G: METAL ANALYSES IN PORE WATER

### Table G-1

### Dissolved Metal Concentrations in Buttle Lake Pore Waters (ppb)

| Horizon (cm) | Mid Depth (cm) | Zn (ppb) | Fe (ppb) | Mn (ppb) | Cd (ppb) | Cu (ppb) | Pb (ppb) |
|---|---|---|---|---|---|---|---|
| **CORE BUT 2** | | | | | | | |
| Supernat. | -0.25 | 62.6 | 8.8 | 246 | 0.47 | 2.6 | 0.32 |
| 0-0.5 | 0.25 | 120 | 68.8 | 2400 | 1.03 | 15 | 1.9 |
| 0.5-1.0 | 0.75 | 63.8 | 81.6 | 3830 | 0.55 | 5.6 | 0.31 |
| 1.0-1.5 | 1.25 | 102 | 2550 | 3470 | 0.1 | 5 | 0.69 |
| 1.5-2.0 | 1.75 | 115 | 850 | 2620 | 0.045 | 3.2 | 3.0 |
| 2-3 | 2.5 | 85.2 | 4400 | 4300 | 0.013 | 3.2 | 5.3 |
| 3-4 | 3.5 | 133 | 7850 | 3620 | 0.043 | 2.9 | 5.5 |
| 4-5 | 4.5 | 138 | 10000 | 4420 | 0.031 | 1.7 | 4.0 |
| 5-6 | 5.5 | 132 | 14500 | 5490 | 0.025 | 2.3 | 3.5 |
| 6-8* | 7 | 462 | 28200 | 6230 | 0.27 | 135 | 137 |
| 8-10* | 9 | 449 | 34000 | 8400 | 0.217 | 281 | 262 |
| 12-14 | 13 | 12.9 | 30900 | 11700 | 0.014 | 8.4 | 6.0 |
| 16-18 | 17 | 9.5 | 26400 | 11900 | 0.014 | 2.8 | 0.58 |
| 22-26 | 24 | 4.2 | 35100 | 16300 | 0.011 | 4.8 | 0.76 |
| 30-34 | 32 | 4.4 | 40500 | 16600 | 0.021 | 2.8 | 0.23 |
| 38-42 | 40 | 2.2 | 45900 | 16300 | 0.008 | 1.8 | 0.12 |
| 50-54 | 52 | 2.4 | 52400 | 15900 | 0.028 | 5.2 | 0.21 |

*** Humic acid precipitate**

## Table G-2

### Dissolved Metal Concentrations in Buttle Lake Pore Waters ($\mu$mol/L and nmol/L)

| Horizon (cm) | Mid Depth (cm) | Zn $\mu$mol/L | Fe $\mu$mol/L | Mn $\mu$mol/L | Cd nmol/L | Cu $\mu$mol/L | Pb $\mu$mol/L |
|---|---|---|---|---|---|---|---|
| **CORE BUT 2** | | | | | | | |
| Supernat. | -0.25 | 0.96 | 0.16 | 4.48 | 4.2 | 0.041 | 0.0015 |
| 0-0.5 | 0.25 | 1.84 | 1.23 | 43.7 | 9.2 | 0.24 | 0.0092 |
| 0.5-1.0 | 0.75 | 0.98 | 1.46 | 69.7 | 4.9 | 0.088 | 0.0015 |
| 1.0-1.5 | 1.25 | 1.56 | 45.7 | 63.2 | 0.89 | 0.079 | 0.0033 |
| 1.5-2.0 | 1.75 | 1.76 | 15.2 | 47.7 | 0.40 | 0.050 | 0.014 |
| 2-3 | 2.5 | 1.30 | 78.8 | 78.3 | 0.12 | 0.050 | 0.026 |
| 3-4 | 3.5 | 2.03 | 141 | 65.9 | 0.38 | 0.046 | 0.027 |
| 4-5 | 4.5 | 2.11 | 179 | 80.5 | 0.28 | 0.027 | 0.019 |
| 5-6 | 5.5 | 2.02 | 260 | 99.9 | 0.22 | 0.036 | 0.017 |
| 6-8* | 7 | 7.07 | 505 | 113 | 2.40 | 2.12 | 0.661 |
| 8-10* | 9 | 6.87 | 609 | 153 | 1.93 | 4.42 | 1.265 |
| 12-14 | 13 | 0.20 | 553 | 213 | 0.12 | 0.13 | 0.029 |
| 16-18 | 17 | 0.15 | 473 | 217 | 0.12 | 0.044 | 0.0028 |
| 22-26 | 24 | 0.064 | 628 | 297 | 0.098 | 0.076 | 0.0037 |
| 30-34 | 32 | 0.067 | 725 | 302 | 0.19 | 0.044 | 0.0011 |
| 38-42 | 40 | 0.034 | 822 | 297 | 0.071 | 0.028 | 0.0006 |
| 50-54 | 52 | 0.037 | 938 | 289 | 0.25 | 0.082 | 0.0010 |

* Humic acid precipitate

## Table G-3

## Dissolved Metal Concentrations in Buttle Lake Pore Waters (ppb)

| Horizon (cm) | Mid Depth (cm) | Zn (ppb) | Fe (ppb) | Mn (ppb) | Cd (ppb) | Cu (ppb) | Pb (ppb) |
|---|---|---|---|---|---|---|---|
| **CORE BUT 4** | | | | | | | |
| Supernat. | -0.25 | 133 | 11 | 16.8 | 0.48 | 2.2 | 0.67 |
| 0-0.5 | 0.25 | 220 | 230 | 521 | 0.88 | 16.7 | 3.9 |
| 0.5-1.0 | 0.75 | 231 | 71 | 1680 | 0.73 | 8.1 | 1.2 |
| 1.0-1.5 | 1.25 | 300 | 479 | 1670 | 0.52 | 6.8 | 1.6 |
| 1.5-2.0 | 1.75 | 263 | 823 | 1320 | 0.39 | 3.9 | 2.2 |
| 2-3 | 2.5 | 287 | 2680 | 1690 | 0.32 | 5.9 | 5.3 |
| 3-4 | 3.5 | 390 | 4220 | 1440 | 0.21 | 15.7 | 16.4 |
| 4-5 | 4.5 | 348 | 6600 | 1140 | 0.13 | 6.5 | 8.4 |
| 5-6 | 5.5 | 357 | 15800 | 1490 | 0.019 | 5 | 4.6 |
| 6-8* | 7 | 1568 | 30100 | 1720 | 0.74 | 206 | 149 |
| 8-10* | 9 | 455 | 32400 | 2030 | 0.049 | 6.8 | 6.6 |
| 12-14 | 13 | 176 | 40000 | 2350 | 0.053 | 15.1 | 5.8 |
| 16-18 | 17 | 338 | 56100 | 4710 | 0.31 | 84.6 | 38 |
| 18-22 | 20 | 976 | 57200 | 4530 | 1.1 | 323 | 153 |
| 26-30 | 28 | 35.2 | 47200 | 8380 | 0.13 | 7.4 | 5.9 |
| 34-38 | 36 | 9.4 | 28800 | 8800 | 0.084 | 5.3 | 1.9 |
| 42-46 | 44 | 8.2 | 33900 | 9950 | 0.05 | 6.1 | 0.59 |

* Humic acid precipitate

## Table G-4

### Dissolved Metal Concentrations in Buttle Lake Pore Waters (μmol/L and nmol/L)

| Horizon (cm) | Mid Depth (cm) | Zn μmol/L | Fe μmol/L | Mn μmol/L | Cd nmol/L | Cu μmol/L | Pb μmol/L |
|---|---|---|---|---|---|---|---|
| **CORE BUT 4** | | | | | | | |
| Supernat. | -0.25 | 2.03 | 0.20 | 0.306 | 4.3 | 0.03 | 0.003 |
| 0-0.5 | 0.25 | 3.37 | 4.12 | 9.48 | 7.8 | 0.26 | 0.019 |
| 0.5-1.0 | 0.75 | 3.53 | 1.27 | 30.6 | 6.5 | 0.13 | 0.006 |
| 1.0-1.5 | 1.25 | 4.59 | 8.58 | 30.4 | 4.6 | 0.11 | 0.008 |
| 1.5-2.0 | 1.75 | 4.02 | 14.7 | 24.0 | 3.5 | 0.06 | 0.011 |
| 2-3 | 2.5 | 4.39 | 48.0 | 30.8 | 2.8 | 0.09 | 0.026 |
| 3-4 | 3.5 | 5.97 | 75.6 | 62.2 | 1.9 | 0.25 | 0.079 |
| 4-5 | 4.5 | 5.32 | 118 | 20.7 | 1.2 | 0.10 | 0.041 |
| 5-6 | 5.5 | 5.46 | 283 | 27.1 | 0.17 | 0.08 | 0.022 |
| 6-8* | 7 | 24.0 | 539 | 31.3 | 6.6 | 3.24 | 0.72 |
| 8-10* | 9 | 6.96 | 580 | 36.9 | 0.44 | 0.11 | 0.032 |
| 12-14 | 13 | 2.69 | 716 | 42.8 | 0.47 | 0.24 | 0.028 |
| 16-18 | 17 | 5.17 | 1004 | 85.7 | 2.8 | 1.33 | 0.18 |
| 18-22 | 20 | 14.9 | 1024 | 82.5 | 9.8 | 5.08 | 0.74 |
| 26-30 | 28 | 0.54 | 845 | 153 | 1.2 | 0.12 | 0.028 |
| 34-38 | 36 | 0.14 | 516 | 160 | 0.75 | 0.083 | 0.009 |
| 42-46 | 44 | 0.13 | 607 | 181 | 0.44 | 0.096 | 0.003 |

* Humic acid precipitate

## Table G-5

## Dissolved Metal Concentrations in Buttle Lake Pore Waters (ppb)

| Horizon (cm) | Mid Depth (cm) | Zn (ppb) | Fe (ppb) | Mn (ppb) | Cd (ppb) | Cu (ppb) | Pb (ppb) |
|---|---|---|---|---|---|---|---|
| **CORE BUT 5** | | | | | | | |
| Supernat. | -0.5 | 63.3 | 19.8 | 155 | 0.19 | 2.8 | 1.5 |
| 0-1 | 0.5 | 108 | 1400 | 3050 | 0.06 | 5.4 | 2.8 |
| 1-2 | 1.5 | 116 | 1710 | 3000 | 0.048 | 7.9 | 6.5 |
| 2-3 | 2.5 | 404 | 8040 | 1920 | 0.099 | 1.1 | 1.5 |
| 4-Mar | 3.5 | 524 | 8420 | 1330 | 0.3 | 0.62 | 0.51 |
| 4-5* | 4.5 | 827 | 13900 | 1220 | 1.04 | 87.8 | 73.3 |
| 5-6 | 5.5 | 343 | 14900 | 1240 | 0.24 | 0.79 | 1.6 |
| 6-7 | 6.5 | 432 | 17000 | 1320 | 0.29 | 0.71 | 2.7 |
| 7-8 | 7.5 | 332 | 17200 | 1060 | 0.21 | 0.76 | 1.2 |
| 8-10 | 9 | 900 | 48600 | 1220 | 0.037 | 1.2 | 2.3 |
| 12-14 | 13 | 176 | 54900 | 1200 | 0.035 | 25.3 | 11.2 |
| 16-18 | 17 | 564 | 71200 | 1590 | 0.18 | 115 | 41.9 |
| 20-22 | 21 | 308 | 76200 | 2420 | 0.23 | 77.6 | 34.8 |
| 24-26* | 25 | 244 | 60200 | 4160 | 0.83 | 137 | 151 |
| 28-30 | 29 | 7.6 | 38600 | 3680 | 0.052 | 5.9 | 3.1 |
| 32-34 | 33 | 2.9 | 42600 | 4930 | 0.018 | 2.4 | 0.78 |

*** Humic acid precipitate**

## Table G-6

## Dissolved Metal Concentrations in Buttle Lake Pore Waters (μmol/L and nmol/L)

| Horizon (cm) | Mid Depth (cm) | Zn μmol/L | Fe μmol/L | Mn μmol/L | Cd nmol/L | Cu μmol/L | Pb μmol/L |
|---|---|---|---|---|---|---|---|
| **CORE BUT 5** | | | | | | | |
| Supernat. | -0.5 | 63.3 | 19.8 | 155 | 0.19 | 2.8 | 1.5 |
| 0-1 | 0.5 | 108 | 1400 | 3050 | 0.06 | 5.4 | 2.8 |
| 1-2 | 1.5 | 116 | 17100 | 3000 | 0.048 | 7.9 | 6.5 |
| 2-3 | 2.5 | 404 | 8040 | 1920 | 0.099 | 1.1 | 1.5 |
| 4-Mar | 3.5 | 524 | 8420 | 1330 | 0.3 | 0.62 | 0.51 |
| 4-5* | 4.5 | 827 | 13900 | 1220 | 1.04 | 87.8 | 73.3 |
| 5-6 | 5.5 | 348 | 14900 | 1240 | 0.24 | 0.79 | 1.6 |
| 6-7 | 6.5 | 432 | 17000 | 1320 | 0.29 | 0.71 | 2.7 |
| 7-8 | 7.5 | 332 | 17200 | 1060 | 0.21 | 0.76 | 1.2 |
| 8-10 | 9 | 900 | 48600 | 1220 | 0.037 | 1.2 | 2.3 |
| 12-14 | 13 | 176 | 54900 | 1200 | 0.035 | 25.3 | 11.2 |
| 16-18 | 17 | 564 | 71200 | 1590 | 0.18 | 115 | 41.9 |
| 20-22 | 21 | 308 | 76200 | 2420 | 0.23 | 77.6 | 34.8 |
| 24-26* | 25 | 244 | 60200 | 4160 | 0.83 | 137 | 151 |
| 28-30 | 29 | 7.6 | 38600 | 3680 | 0.052 | 5.9 | 3.1 |
| 32-34 | 33 | 2.9 | 42600 | 4930 | 0.018 | 2.4 | 0.78 |

* Humic acid precipitate

## Table G-7

## Dissolved Metal Concentrations in Buttle Lake Pore Waters (ppb)

| Horizon (cm) | Mid Depth (cm) | Zn (ppb) | Fe (ppb) | Mn (ppb) | Cd (ppb) | Cu (ppb) | Pb (ppb) |
|---|---|---|---|---|---|---|---|
| **CORE BUT 6** | | | | | | | |
| Supernat. | -0.25 | 64.8 | 53.5 | 152 | 0.062 | 2.9 | 2.7 |
| 0-0.5 | 0.25 | 19.8 | 512 | 2260 | 0.013 | 2.2 | 1.8 |
| 0.5-1.0 | 0.75 | 13 | 263 | 1840 | 0.009 | 3.8 | 1.9 |
| 1.0-1.5 | 1.25 | 21 | 2850 | 1260 | 0.063 | 12.7 | N.S. |
| 1.5-2.0 | 1.75 | 12.6 | 1150 | 1060 | 0.01 | 2 | 1.1 |
| 2-3 | 2.5 | 23.4 | 165 | 376 | 0.017 | 3 | 4.2 |
| 3-4 | 3.5 | 7 | 29.1 | 156 | N.S. | 2 | 3.8 |
| 4-5 | 4.5 | 12.6 | 38.2 | 102 | 0.002 | 1.3 | 5 |
| 5-6 | 5.5 | 10.2 | 49.1 | 178 | 0.002 | 2 | 3.7 |
| 6-8 | 7 | 15.4 | 38.9 | 102 | 0.019 | 5.4 | 8.1 |
| 8-10 | 9 | 22.8 | 67.7 | 84 | 0.011 | 6.4 | 11.2 |
| 12-14 | 13 | 54 | 226 | 155 | 0.041 | 11.7 | 16.6 |
| 16-18 | 17 | 7.8 | 12.5 | 83 | 0.005 | 1.6 | 3.4 |
| 18-21 | 19.5 | 10.9 | 16.5 | 51 | 0.006 | 2.2 | 4.3 |
| 21-24 | 22.5 | 25.4 | 52.6 | 37.1 | 0.01 | 5.2 | 9.2 |
| 27-30 | 28.5 | 390 | 1250 | 25.1 | 0.39 | 74.3 | 88.5 |
| 33-36 | 34.5 | 308 | 690 | 12.1 | 0.39 | 29.2 | 42.4 |

*** Humic acid precipitate**

## Table G-8

### Dissolved Metal Concentrations in Buttle Lake Pore Waters ($\mu$mol/L and nmol/L)

| Horizon (cm) | Mid Depth (cm) | Zn $\mu$mol/L | Fe $\mu$mol/L | Mn $\mu$mol/L | Cd nmol/L | Cu $\mu$mol/L | Pb $\mu$mol/L |
|---|---|---|---|---|---|---|---|
| **CORE BUT 6** | | | | | | | |
| Supernat. | -0.25 | 0.99 | 0.96 | 2.77 | 0.55 | 0.046 | 0.013 |
| 0-0.5 | 0.25 | 0.30 | 9.17 | 41.1 | 0.12 | 0.035 | 0.009 |
| 0.5-1.0 | 0.75 | 0.20 | 4.71 | 33.5 | 0.08 | 0.060 | 0.009 |
| 1.0-1.5 | 1.25 | 0.32 | 51.0 | 22.9 | 0.56 | 0.200 | N.S. |
| 1.5-2.0 | 1.75 | 0.19 | 20.6 | 19.3 | 0.09 | 0.031 | 0.005 |
| 2-3 | 2.5 | 0.36 | 2.95 | 6.84 | 0.15 | 0.047 | 0.020 |
| 3-4 | 3.5 | 0.11 | 0.52 | 2.84 | N.S. | 0.031 | 0.018 |
| 4-5 | 4.5 | 0.19 | 0.68 | 1.86 | 0.02 | 0.020 | 0.024 |
| 5-6 | 5.5 | 0.16 | 0.88 | 3.24 | 0.02 | 0.031 | 0.018 |
| 6-8 | 7 | 0.24 | 0.70 | 1.86 | 0.17 | 0.085 | 0.039 |
| 8-10 | 9 | 0.35 | 1.21 | 1.53 | 0.10 | 0.101 | 0.054 |
| 12-14 | 13 | 0.83 | 4.05 | 2.82 | 0.36 | 0.184 | 0.080 |
| 16-18 | 17 | 0.12 | 0.22 | 1.51 | 0.04 | 0.025 | 0.016 |
| 18-21 | 19.5 | 0.17 | 0.30 | 0.93 | 0.05 | 0.035 | 0.021 |
| 21-24 | 22.5 | 0.39 | 0.94 | 0.68 | 0.09 | 0.082 | 0.044 |
| 27-30 | 28.5 | 5.97 | 22.4 | 0.46 | 3.47 | 1.169 | 0.427 |
| 33-36 | 34.5 | 4.71 | 12.4 | 0.22 | 3.47 | 0.460 | 0.205 |

* Humic acid precipitate