LICA LONG TERM SOIL ACIDIFICATION MONITORING
TUCKER LAKE SITE - 2020

S.A. Abboud, Ph.D.

Abboud Research Consulting
Edmonton, Alberta

and

L.W. Turchenek, Ph.D.
Edmonton, Alberta

Prepared for:

Lakeland Industry and Community Association

January 2021

EXECUTIVE SUMMARY

The Lakeland Industry and Community Association (LICA) implemented a long term Acid Deposition monitoring program in 2010 with establishment of the Moose Lake site within Moose Lake Provincial Park. A second site, the Whitney Lakes long term soil acidification monitoring site, was established in 2011, and in 2012 a third site was set up near Tucker Lake. Soil sampling and laboratory analysis of soil samples to establish baseline soil chemistry data for these sites were completed during their respective site establishment years. The intended long term monitoring interval is four years. This report presents the data from the third sampling of the Tucker Lake site carried out in the fall of 2020 and compares the data with the results of previous sampling events.

The LICA monitoring system follows the protocols of Alberta Environment and Parks (AEP) in their Long Term Soil Acidification Monitoring Program. Background information, site selection and results of the first sampling event are described in *LICA Long Term Soil Acidification Monitoring - Tucker Lake Site Establishment* (Abboud and Turchenek, 2013).

Soil acidification parameters are soil attributes that can be directly affected by acidic inputs, and which in turn could affect other components of the ecosystem. These attributes include pH, exchangeable base saturation, aluminum (Al) concentration in soil solution, base cation (BC) concentration in soil solution, and the ratio of BC to Al concentrations. Associated attributes are levels of carbon (C), nitrogen (N) and sulphur (S) in surface soil horizons. In particular, S content can increase in the LFH and surface mineral soil layers due to deposition of sulphur oxides. Carbon and N are included with S analyses because the ratios of the three elements can reveal dynamics of these nutrients over a long term.

Soil acidification parameters were examined using descriptive statistics and analysis of variance procedures to determine variability in the data and to assess if there are statistically significant differences between the means of the measured chemical parameters from the 3 sampling periods (2012, 2016 and 2020) and from the two sampling sites (North and South). Base saturation and pHc (pH of soil mixed with $CaCl_2$ solution) were the least variable, while in some cases BC:Al ratio and some dissolved ion concentrations had coefficients of variation exceeding 1.0 (>100%; i.e., standard deviation greater than the mean value). Total C, N and S, as well as the ratios of these with each other, were highly variable, particularly in the upper mineral layers.

Data inferences among the three sampling events are considered to pertain primarily to natural variability of the soil properties. There were small decreases in pHc and C:S ratio, and increase in total S, which suggest minor acidification had occurred in the eight year (2012-2020) period of soil chemistry monitoring. However, this was not indicated in the two other main acidification indicators, namely base saturation percentage and BC:Al aluminum ratio. The changes are considered 'minor' as pHc differs by only 0.2 to 0.3 units, which is likely not sufficient to measurably affect vegetation and soil microflora. Overall, the data suggest that slow acidification may be occurring. Assessment of these trends requires further monitoring for longer periods, which is part of the design of the LICA soil monitoring program.

Table of Contents

List of Tables

Appendices

1.0 INTRODUCTION

The Lakeland Industry and Community Association (LICA) implemented a long term Acid Deposition monitoring program in 2010 with establishment of the Moose Lake site within Moose Lake Provincial Park. A second site, the Whitney Lakes long term soil acidification monitoring site, was established in 2011. The Tucker Lake site was established in 2012, with soil sampling and laboratory analysis of soil samples completed to provide baseline soil chemistry data for the site. The long term monitoring program entails re-sampling of sites at four year intervals. This report presents the data from the third sampling event carried out in fall of 2020.

Background information and site selection are described in *Long Term Soil Acidification Monitoring in the LICA Study Area* (Abboud and Turchenek 2011). Establishment of the Tucker Lake site and results of the initial two sampling events are presented in *LICA Long Term Soil Acidification Monitoring - Tucker Lake Site Establishment* (Abboud and Turchenek 2013), and *LICA Long Term Soil Acidification Monitoring, Tucker Lake Site – 2016* (Abboud and Turchenek, 2017). The LICA monitoring system follows the protocols of Alberta Environment and Parks (AEP)) in their Long Term Soil Acidification Monitoring Program (Roberts et al. 1989; Abboud et al. 2012). This program consists of eight monitoring sites established in the 1980s throughout the Province of Alberta. One of these sites is located within the LICA study area, thus providing a historical monitoring basis for the LICA program.

Each monitoring site consists of two sub-sites; these are referred to as the North and South sub-sites at the Tucker Lake monitoring site. The sub-sites are normally delineated by a 24 m by 24 m square area that is further subdivided into plots and subplots for replication purposes. At the Tucker Lake site, the South sub-site is 24 m by 24 m, but due to variability in topography only an 18 m by 18 m area of uniform slopes could be fitted into the North sub-site location. At each of the sub-sites (i.e., North and South), twelve replicates are taken of eight soil layers (LFH and 0-2, 2-5, 5-10, 10-15, 15-30, 30-45 and 45-60 cm layers). The report of Abboud and Turchenek (2011) should be consulted for further details of the monitoring protocol. Details of sampling methods and laboratory analysis are also provided in the report of the 2012 sampling event (Abboud and Turchenek 2013).

All soil chemical parameters were measured for all replicates and all layers in the initial monitoring events in 2010 (Moose Lake), 2011 (Whitney Lakes) and 2012 (Tucker Lake). The purpose was to establish the baseline for the entire depth of sampling. In the second and third sampling events, and in subsequent years, only the LFH, 0-2, 2-5, 5-10, and 10-15 cm depth samples will be analyzed. This is done in part to reduce the analytical costs associated with monitoring. In addition, it has been shown in the AEP long term monitoring program that any effects to date have occurred only in the surface soils layers (Abboud et al. 2012). Consequently, the long term aspect of monitoring entails determination of the acid chemistry of surface soil layers to 15 cm depth. All samples are archived and will be available for laboratory analysis in the future, should results indicate that changes are potentially occurring to depths greater than 15 cm.

2.0 METHODS

2.1 SOIL SAMPLING

Soil sampling was carried out as described in the 2011 site selection and soil monitoring report (Abboud and Turchenek (2011).

2.2 LABORATORY ANALYSES

Soil analyses were completed at the Soil Laboratory of the Northern Forestry Centre in Edmonton, Alberta. Samples submitted to the laboratory from the field were kept frozen if they could not be immediately processed. Sample processing consisted of drying at about 30°C and then sieving to obtain the <2 mm soil fraction. Methods are as described in the 2011 soil monitoring report (Abboud and Turchenek 2011), and method references are repeated below in Table 1.

Table 1. Analytical Methods Applied in Soil Analysis

Parameter	Method	Notes
pH ($CaCl_2$)	Method 3.11 in McKeague (1978)	The soil-to-solution ratio for litter (LFH) material is 1:4 and for mineral soil is 1:2. Solution is 0.1 M $CaCl_2$. Measurement is with a combination pH electrode.
Electrical Conductivity	Method 4.13 in McKeague (1978)	The EC and pH were measured in the saturated paste extract of a soil sample.
Soluble Ions	Method 3.21 in McKeague (1978)	By the saturated paste method and ICP-OES analysis of the extract for Na, K, Ca, Mg, Al, Fe, Mn and S.
Cation Exchange Capacity - Unbuffered	Method 18.2 in Carter and Gregorich (2008)	By unbuffered 0.1 M $BaCl_2$ extraction, and calculation of CEC as sum of exchangeable cations.
Exchangeable Cations	Method 18.2 in Carter and Gregorich (2008)	By ICP-OES analysis for Ca, Mg, Na, K, Fe, Mn, and Al in the unbuffered $BaCl_2$ extract from CEC analysis.
Total Carbon, Nitrogen, and Sulphur	Method 3.611 in McKeague (1978)	Combustion method using a LECO TruSpec CNS Carbon/Nitrogen/Sulphur Analyzer (LECO, 2006).

2.3 STATISTICS

Basic statistics (i.e., mean, standard deviation and coefficient of variability) were calculated for the acidification indicators and their input variables using MS Excel©. Coefficient of variation (CV) refers to the standard deviation divided by the mean. Analysis of variance (ANOVA) was performed on the main soil acidification variables, namely pH, base saturation, and base cation:aluminum (BC:Al) ratio, as well as some of the input variables. A two-factor ANOVA using MS Excel© was carried out to examine the differences between the two sub-sites (North and South) and the three sampling years (2012, 2016 and 2020). Tukey's Honest Significant Difference test (Steel and Torrie 1980, 1960) was subsequently applied to these attributes in order to determine whether differences in the data were statistically significant (α=0.05 level of confidence). The statistics were based on the 12 replicates from each sub-site.

3.0 RESULTS

3.1 SOIL ACIDIFICATION PARAMETERS

Soil acidification parameters are soil attributes that can be directly affected by acidic inputs, and which in turn could affect other components of the ecosystem. These attributes include pH, exchangeable base saturation, aluminum (Al) concentration in soil solution, base cation (BC) concentration in soil solution, and the ratio of BC to Al concentrations. A discussion of these is presented in the 2011 LICA soil monitoring report (Abboud and Turchenek 2011). Of the attributes, research has demonstrated that effects on vegetation are related mainly to base saturation percentage and base cation to aluminum ratio (Ulrich et al., 1984; Sverdrup and Warfvinge, 1993). Decreases in either of these attributes can occur with addition of acidic or acidifying substances to the soil. Likewise, pH is expected to decrease. Associated attributes are levels of carbon (C), nitrogen (N) and sulphur (S) in surface soil horizons. In particular, total S content can increase in the LFH and surface mineral soil layers due to deposition of sulphur oxides. Carbon and nitrogen are included in the analyses because the ratios of the three elements can reveal dynamics of these nutrients over a long term.

3.2 SOIL MONITORING RESULTS

Soil samples from the North and South Tucker Lake sub-sites were analyzed for various soil parameters, as described above. The complete data are provided in Appendices A and B. Data in Appendix A are presented with simple statistics for each soil attribute according to soil layer and soil sub-site. Appendix B presents a listing of lab and field numbers and the analyses associated with each sample.

Tables 2, 3 and 4 summarize the data for the main acidification indicators and the parameters from which they were calculated. These tables also include basic descriptive statistics and the results of the two factor ANOVA with the Tukey's extension to the ANOVA results. The following examines some aspects of the data.

3.2.1 pHc

The data show downward trends in pHc (pH of soil mixed with $CaCl_2$ solution) between 2012 and 2020 in all layers and in both sub-sites of the Tucker Lake monitoring site. However, there were few statistically significant differences in soil layers among the monitoring years. There was a significant difference of 0.31 pH units in the LFH layer of the South sub-site, but a difference of 0.25 units in the North sub-site was not statistically significant. Comparing pHc in 2012 and 2020, there was a decrease in the 0-2 cm layer of 0.16 pHc units in the South sub-site and 0.23 units in the North sub-site, but these differences were not significant. However, the lowest two layers (5-10 cm and 10-15 cm) showed significant differences in the North sub-site, but not the South sub-site. Variability is low, with coefficients of variation (CV) being 0.07 or lower. The significant differences in pHc among layers suggest decrease in pHc may be occurring, but the indications between sub-sites is not consistent. However, whether the differences are statistically different or not, the general trend in all layers is consistently downward.

Table 2. pH, Base Saturation, Cation Exchange Capacity and Exchangeable Bases at the Tucker Lake Site - 2012, 2016 and 2020

pHc		**LFH**				**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**	4.41	c	0.28	0.06	4.56	b	0.25	0.06	4.57	a	0.24	0.05	4.58	b	0.19	0.04	4.59	c	0.16	0.04
2016	**North**	4.16	bc	0.26	0.06	4.25	ab	0.40	0.09	4.40	a	0.30	0.07	4.41	ab	0.21	0.05	4.43	abc	0.16	0.04
2020	**North**	4.15	bc	0.28	0.07	4.33	ab	0.28	0.06	4.40	a	0.25	0.06	4.31	a	0.16	0.04	4.32	a	0.16	0.04
2012	**South**	4.09	bc	0.16	0.04	4.36	ab	0.19	0.04	4.49	a	0.20	0.04	4.49	ab	0.21	0.05	4.55	bc	0.14	0.03
2016	**South**	4.13	bc	0.24	0.06	4.33	ab	0.29	0.07	4.38	a	0.21	0.05	4.34	a	0.12	0.03	4.38	ab	0.17	0.04
2020	**South**	3.78	a	0.24	0.06	4.18	a	0.25	0.06	4.31	a	0.22	0.05	4.31	a	0.13	0.03	4.41	abc	0.15	0.03
Base Saturation						**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**					**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**					0.84	b	0.12	0.15	0.74	a	0.13	0.18	0.68	abc	0.13	0.19	0.63	ab	0.13	0.20
2016	**North**					0.84	b	0.10	0.12	0.82	a	0.14	0.18	0.82	c	0.15	0.18	0.80	c	0.11	0.13
2020	**North**					0.85	b	0.10	0.12	0.80	a	0.13	0.16	0.74	abc	0.10	0.13	0.66	abc	0.15	0.23
2012	**South**					0.74	ab	0.10	0.14	0.70	a	0.12	0.17	0.62	a	0.12	0.19	0.54	a	0.11	0.20
2016	**South**					0.84	b	0.07	0.08	0.83	a	0.07	0.08	0.80	bc	0.07	0.08	0.75	bc	0.08	0.11
2020	**South**					0.70	a	0.11	0.15	0.71	a	0.16	0.22	0.66	ab	0.13	0.19	0.64	ab	0.13	0.21
Cation Exchange Capacity (cmol/kg)						**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**					**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**					5.24	a	4.29	0.82	1.94	a	1.13	0.58	1.08	ab	0.25	0.23	0.93	bc	0.12	0.13
2016	**North**					5.02	a	2.91	0.58	2.63	a	1.24	0.47	1.29	b	0.38	0.29	0.98	bc	0.18	0.18
2020	**North**					4.77	a	2.58	0.54	2.23	a	1.22	0.55	0.91	a	0.23	0.25	0.73	a	0.18	0.24
2012	**South**					4.06	a	1.94	0.48	2.03	a	0.93	0.46	1.16	ab	0.36	0.31	0.81	abc	0.15	0.19
2016	**South**					3.82	a	1.35	0.35	1.88	a	0.53	0.28	0.99	ab	0.17	0.17	0.75	ab	0.17	0.22
2020	**South**					2.67	a	0.67	0.25	1.57	a	0.35	0.22	0.89	a	0.17	0.19	0.68	a	0.14	0.21
Sum of Bases (cmol/kg)						**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**					**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**					4.70	a	4.30	0.92	1.55	a	1.13	0.73	0.75	ab	0.31	0.41	0.59	ab	0.16	0.28
2016	**North**					4.43	a	2.86	0.64	2.25	a	1.22	0.54	1.09	b	0.41	0.37	0.80	b	0.21	0.26
2020	**North**					4.26	a	2.51	0.59	1.89	a	1.18	0.62	0.68	a	0.21	0.31	0.48	a	0.19	0.39
2012	**South**					3.09	a	1.69	0.55	1.48	a	0.87	0.59	0.74	ab	0.38	0.51	0.44	a	0.14	0.33
2016	**South**					3.21	a	1.20	0.37	1.58	a	0.52	0.33	0.80	ab	0.18	0.22	0.57	a	0.15	0.26
2020	**South**					1.89	a	0.61	0.32	1.13	a	0.37	0.32	0.60	a	0.20	0.34	0.45	a	0.16	0.36

Abbreviations: SD–standard deviation CV – coefficient of variation

Sig - significance: a, b, ab, c, bc – significance indicators; means followed by the same letter do not differ significantly from one another at P=0.05 (Tukey's test).

Table 3. Water Soluble Ions and Base Cation:Aluminum Ratios at the Tucker Lake Site – 2012, 2016 and 2020

BC:Al Ratio		**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**	8.39	a	6.63	0.79	2.93	a	1.02	0.35	2.23	a	0.51	0.23	2.28	a	1.02	0.45
2016	**North**	7.67	a	4.00	0.52	4.74	ab	2.08	0.44	2.87	ab	0.96	0.34	3.09	a	1.20	0.39
2020	**North**	12.19	a	6.53	0.54	7.47	b	4.52	0.60	3.71	ab	0.76	0.20	3.68	a	0.98	0.27
2012	**South**	6.53	a	2.50	0.38	3.12	a	1.56	0.50	2.43	a	0.84	0.35	2.51	a	0.94	0.38
2016	**South**	10.92	a	9.16	0.84	4.64	ab	5.96	1.29	6.16	b	6.66	1.08	7.57	b	3.99	0.53
2020	**South**	6.17	a	2.66	0.43	4.05	ab	1.32	0.33	2.89	ab	0.45	0.15	2.72	a	0.67	0.24
K (mmol/L)		**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**	0.324	ab	0.129	0.40	0.147	ab	0.058	0.39	0.100	ab	0.055	0.55	0.076	ab	0.045	0.59
2016	**North**	0.509	b	0.325	0.64	0.290	b	0.179	0.62	0.178	ab	0.098	0.55	0.125	ab	0.069	0.55
2020	**North**	0.530	b	0.302	0.57	0.292	b	0.141	0.48	0.168	ab	0.096	0.57	0.113	ab	0.052	0.46
2012	**South**	0.381	ab	0.233	0.61	0.153	a	0.056	0.37	0.096	ab	0.037	0.38	0.066	ab	0.015	0.23
2016	**South**	0.272	ab	0.111	0.41	0.225	ab	0.138	0.61	0.201	b	0.166	0.83	0.143	b	0.114	0.80
2020	**South**	0.221	a	0.118	0.53	0.122	a	0.043	0.36	0.088	a	0.046	0.53	0.065	a	0.042	0.65
Ca (mmol/L)		**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**	0.682	a	0.232	0.34	0.434	a	0.213	0.49	0.279	a	0.095	0.34	0.225	a	0.074	0.33
2016	**North**	0.912	a	0.373	0.41	0.676	a	0.289	0.43	0.448	b	0.199	0.44	0.282	a	0.109	0.39
2020	**North**	1.024	a	0.466	0.45	0.673	a	0.312	0.46	0.393	ab	0.128	0.33	0.274	a	0.098	0.36
2012	**South**	0.798	a	0.364	0.46	0.496	a	0.201	0.41	0.337	ab	0.128	0.38	0.226	a	0.097	0.43
2016	**South**	0.786	a	0.409	0.52	0.441	a	0.182	0.41	0.300	ab	0.116	0.38	0.180	a	0.094	0.52
2020	**South**	0.632	a	0.187	0.30	0.420	a	0.086	0.20	0.265	a	0.051	0.19	0.195	a	0.051	0.26

Table 3. Water Soluble Ions and Base Cation:Aluminum Ratios at the Tucker Lake Site – 2012, 2016 and 2020 (Concluded)

Mg (mmol/L)		0-2 (cm)				2-5 (cm)				5-10 (cm)				10-15 (cm)			
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**	0.222	ab	0.076	0.34	0.148	ab	0.073	0.49	0.102	ab	0.044	0.43	0.091	abc	0.044	0.49
2016	**North**	0.268	ab	0.140	0.52	0.195	ab	0.110	0.56	0.137	b	0.077	0.56	0.093	bc	0.038	0.40
2020	**North**	0.335	b	0.130	0.39	0.218	b	0.093	0.43	0.141	b	0.049	0.35	0.108	c	0.025	0.23
2012	**South**	0.252	ab	0.094	0.37	0.158	ab	0.051	0.32	0.115	ab	0.037	0.32	0.084	abc	0.022	0.27
2016	**South**	0.205	ab	0.099	0.48	0.141	ab	0.056	0.40	0.099	ab	0.042	0.43	0.063	ab	0.033	0.53
2020	**South**	0.174	a	0.053	0.30	0.108	a	0.027	0.25	0.070	a	0.024	0.34	0.053	a	0.021	0.40
Al (mmol/L)		**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**	0.227	a	0.136	0.60	0.297	ab	0.131	0.44	0.256	ab	0.082	0.32	0.229	c	0.087	0.38
2016	**North**	0.267	a	0.111	0.41	0.273	ab	0.068	0.25	0.291	b	0.062	0.21	0.196	bc	0.049	0.25
2020	**North**	0.182	a	0.050	0.28	0.194	a	0.060	0.31	0.215	ab	0.052	0.24	0.169	b	0.054	0.32
2012	**South**	0.249	a	0.113	0.45	0.317	ab	0.095	0.30	0.298	b	0.112	0.38	0.210	c	0.075	0.36
2016	**South**	0.186	a	0.148	0.80	0.333	b	0.207	0.62	0.174	a	0.089	0.51	0.075	a	0.039	0.52
2020	**South**	0.192	a	0.046	0.24	0.190	a	0.042	0.22	0.170	a	0.026	0.15	0.137	ab	0.034	0.25

Abbreviations: K, Ca, Mg, Al – water soluble cations BC:Al – ratio of (K+Ca+Mg) concentration to Al concentration Mean – average of 12 replicates in each sub-site
SD–standard deviation CV – coefficient of variation
Sig - significance: a, b, ab, c, bc – significance indicators; means followed by the same letter do not differ significantly from one another at P=0.05 (Tukey's test).

Table 4. Total Carbon, Nitrogen and Sulphur at the Tucker Lake Site – 2012, 2016 and 2020

Total Carbon (%)		LFH				0-2 (cm)				2-5 (cm)				5-10 (cm)				10-15 (cm)			
2012	**North**	37.8	bc	7.63	0.20	2.39	ab	1.56	0.65	0.68	a	0.40	0.59	0.37	a	0.18	0.48	0.27	ab	0.07	0.27
2016	**North**	29.9	ab	10.07	0.34	2.46	ab	1.18	0.48	1.14	a	0.61	0.53	0.50	a	0.18	0.36	0.33	b	0.11	0.32
2020	**North**	39.9	c	9.10	0.23	4.07	b	3.44	0.84	1.23	a	0.75	0.61	0.38	a	0.14	0.37	0.21	a	0.04	0.19
2012	**South**	33.3	abc	4.60	0.14	2.57	ab	1.63	0.63	0.89	a	0.36	0.41	0.45	a	0.15	0.33	0.27	ab	0.06	0.24
2016	**South**	27.2	a	8.96	0.33	1.92	ab	0.76	0.39	0.86	a	0.23	0.27	0.49	a	0.07	0.13	0.34	b	0.10	0.30
2020	**South**	38.9	bc	7.58	0.19	1.84	a	0.75	0.41	0.91	a	0.34	0.38	0.49	a	0.14	0.28	0.29	ab	0.07	0.23
2020	**South**	38.9	bc	7.58	0.19	1.84	a	0.75	0.41	0.91	a	0.34	0.38	0.49	a	0.14	0.28	0.29	ab	0.07	0.23
Total Nitrogen (%)		**LFH**				**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**	1.140	a	0.287	0.25	0.070	a	0.059	0.84	0.014	a	0.009	0.60	0.010	a	0.001	0.06	0.010	a	0.000	0.00
2016	**North**	0.901	a	0.284	0.32	0.090	a	0.040	0.44	0.044	c	0.022	0.52	0.023	b	0.009	0.38	0.019	b	0.003	0.15
2020	**North**	0.985	a	0.309	0.31	0.117	a	0.084	0.72	0.045	c	0.020	0.45	0.023	b	0.008	0.34	0.018	b	0.007	0.39
2012	**South**	1.023	a	0.158	0.15	0.080	a	0.058	0.73	0.018	ab	0.012	0.66	0.010	a	0.000	0.03	0.010	a	0.000	0.00
2016	**South**	0.897	a	0.333	0.37	0.069	a	0.024	0.35	0.031	abc	0.008	0.26	0.020	b	0.004	0.23	0.012	a	0.005	0.43
2020	**South**	0.935	a	0.164	0.18	0.065	a	0.024	0.38	0.035	bc	0.009	0.24	0.025	b	0.007	0.28	0.021	b	0.005	0.26
Total Sulphur (%)		**LFH**				**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**	0.1121	a	0.0293	0.26	0.0068	ab	0.0049	0.72	0.0021	a	0.0012	0.56	0.0013	ab	0.0005	0.37	0.0012	a	0.0004	0.33
2016	**North**	0.0853	a	0.0215	0.25	0.0069	ab	0.0035	0.50	0.0034	a	0.0015	0.44	0.0019	bc	0.0008	0.41	0.0016	ab	0.0007	0.42
2020	**North**	0.1798	b	0.0679	0.38	0.0139	b	0.0108	0.78	0.0033	a	0.0034	1.04	0.0010	a	0.0000	0.00	0.0013	a	0.0006	0.50
2012	**South**	0.1013	a	0.0240	0.24	0.0069	ab	0.0038	0.54	0.0023	a	0.0009	0.38	0.0012	a	0.0004	0.33	0.0010	a	0.0000	0.00
2016	**South**	0.0816	a	0.0303	0.37	0.0057	a	0.0019	0.33	0.0031	a	0.0007	0.22	0.0022	c	0.0006	0.27	0.0020	b	0.0006	0.30
2020	**South**	0.2079	b	0.0365	0.18	0.0083	ab	0.0044	0.53	0.0029	a	0.0014	0.47	0.0015	abc	0.0007	0.45	0.0013	a	0.0007	0.49
C:N Ratio		**LFH**				**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**	33.7	a	4.0	0.12	39.6	c	10.4	0.26	47.3	b	14.6	0.31	38.4	ab	23.6	0.61	27.1	c	7.4	0.27
2016	**North**	33.0	a	3.1	0.09	27.1	a	3.5	0.13	26.2	a	5.3	0.20	22.3	a	4.2	0.19	18.1	ab	4.6	0.25
2020	**North**	41.9	b	8.0	0.19	32.5	abc	5.5	0.17	25.7	a	6.8	0.26	18.4	a	9.5	0.52	14.4	a	7.6	0.53
2012	**South**	32.7	a	2.9	0.09	35.4	abc	7.8	0.22	55.1	b	15.3	0.28	45.7	c	16.0	0.35	26.7	bc	6.3	0.24
2016	**South**	30.9	a	2.6	0.08	27.8	ab	5.2	0.19	28.5	a	5.8	0.20	26.0	ab	4.3	0.16	32.1	c	11.1	0.35
2020	**South**	42.0	b	6.7	0.16	28.3	ab	2.1	0.07	26.2	a	8.1	0.31	21.3	a	8.8	0.42	14.6	a	4.9	0.34

Table 4. Total Carbon, Nitrogen and Sulphur at the Tucker Lake Site – 2012, 2016 and 2020 (Concluded)

C:S Ratio		**LFH**				**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**	343	b	40	0.12	374	a	94	0.25	354	ab	187	0.53	313	a	204	0.65	248	a	91	0.37
2016	**North**	347	b	70	0.20	359	a	76	0.21	323	ab	57	0.18	276	a	86	0.31	238	a	91	0.38
2020	**North**	249	a	110	0.44	512	a	560	1.09	512	b	313	0.61	381	a	142	0.37	188	a	51	0.27
2012	**South**	339	b	59	0.17	362	a	77	0.21	422	ab	137	0.32	405	a	140	0.35	267	a	63	0.24
2016	**South**	340	b	44	0.13	344	a	83	0.24	286	a	83	0.29	243	a	74	0.31	180	a	71	0.39
2020	**South**	188	a	26	0.14	273	a	141	0.52	363	ab	169	0.47	379	a	176	0.47	246	a	94	0.38
N:S Ratio		**LFH**				**0-2 (cm)**				**2-5 (cm)**				**5-10 (cm)**				**10-15 (cm)**			
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2012	**North**	10.18	b	0.73	0.07	9.77	a	2.55	0.26	7.51	a	2.95	0.39	8.16	a	2.41	0.29	9.17	ab	1.95	0.21
2016	**North**	10.45	b	1.48	0.14	13.23	a	1.95	0.15	12.85	ab	3.32	0.26	12.43	a	3.29	0.26	13.74	bc	5.94	0.43
2020	**North**	6.06	a	2.63	0.43	16.10	a	18.72	1.16	20.87	b	12.05	0.58	22.83	b	7.78	0.34	16.10	bc	7.80	0.48
2012	**South**	10.35	b	1.48	0.14	10.65	a	3.15	0.30	8.18	a	3.48	0.43	9.16	a	1.97	0.21	10.00	ab	0.00	0.00
2016	**South**	11.03	b	1.15	0.10	12.68	a	3.60	0.28	10.13	a	2.65	0.26	9.65	a	3.27	0.34	5.92	a	2.34	0.40
2020	**South**	4.52	a	0.51	0.11	9.82	a	5.53	0.56	15.51	ab	10.21	0.66	20.03	b	9.48	0.47	17.94	c	7.05	0.39

Abbreviations: C – Total Carbon; S – Total Sulphur; N – Total Nitrogen average of 12 replicates in each sub-site
SD–standard deviation CV – coefficient of variation
Sig - significance: a, b, ab, c, bc – significance indicators; means followed by the same letter do not differ significantly from one another at P=0.05 (Tukey's test).

3.2.2 Base Saturation

Base saturation (Table 2) is a key acidification indicator defined as the proportion of exchangeable base cations (K, Na, Ca and Mg) to the cation exchange capacity. There was a general decrease in base saturation between the first and third sampling events. Coefficients of variation range from 0.08 to 0.21 among the layers and sampling years. Significant differences occur in the 5-10 cm and 10-15 cm layers, and both increases and decreases occur among the sampling years. There were only a couple of statistically significant differences among years, but none of these were related to a decrease between the first and last monitoring events. An increase in values in the second (2016) sampling event seem to be similar to some occurrences in the provincial LTSAM program which were attributed to deposition of smoke particles from regional forest fires.

3.2.3 Cation Exchange Capacity (CEC) and Sum of Exchangeable Bases

Both CEC and sum of exchangeable base cations are variable, with CV ranging from 0.13 to 0.82 and 0.22 to 0.92, respectively (Table 2). There are no statistically significant differences in CEC or exchange bases levels among layers, except for one instance in the 5-10 cm and 10-15 cm layers of the North sub-site. These differences are not considered to be related to acidification, but rather to small differences in the composition of the soil geological parent material.

3.2.4 Base Cation to Aluminum Ratio (BC:Al) and Water Soluble Ions

The BC:Al ratios are quite variable as indicated by CV values ranging from 0.15 to 1.29 among all the soil layers and years (Table 3). Water soluble ions are likewise quite variable, with soluble Al and K having wide CV ranges up to 0.80 among all the layers, sites and years of sampling. The means of Al values among sites and years range from 0.07 to 0.33 mmol/L. The relatively high variability in these water soluble ions results in likewise highly variable ratios of base cations to aluminum.

Differences among BC:Al ratios are not significant in most layers. A significant difference in the 2-5 cm layer of the North sub-site arises from an increase (rather than a decrease) in the ratio in the 2020 samples. Relatively high ratios in 2016 samples of the 5-10 cm and 10-15 cm layers of the South sub-site also result in calculation of significant difference. With acidification, decreases of this ratio are expected; thus, the BC:Al ratios at the Tucker Lake soils show no indication of acidification.

Higher BC:Al ratios in the 0-2 cm and 2-5 cm layers, as compared to lower layers, might be a consequence of the higher base cation contents (K, Ca and Mg), which are associated with the higher organic carbon levels in the surface layers. The organic C reflects the amount of organic matter in the soil. With increasing organic matter content, there is increasing capacity to retain nutrients, including base cations. The organic matter decomposes slowly and releases nutrients, thus leading to relatively higher concentrations in the surface soil layers.

3.2.5 Total Carbon (TC)

The LFH layer is included in the analysis of TC, TN and TS because of potential for accumulation over time. Total C has relatively high variability, with CVs ranging from 0.14 to 0.84 among the sampling years and layers (Table 4). High C contents are typical of LFH layers in forest soils. Relatively higher C in the 0-2 cm and 2-5 cm mineral layers reflects the influence of the litter layer, whereby particulate or soluble C mixes or is translocated from the LFH into the upper mineral soil.

3.2.6 Total Nitrogen (TN) and Total Sulphur (TS)

As for TC, the levels of TN and TS in the mineral soil layers are highest in the 0-2 cm layer and then diminish with depth. TS is an important monitoring parameter, as sulphur can accumulate in the LFH layer and thus reflect the amount of deposition at a site. Both sub-sites show a significant increase of TS in the LFH layer in 2020 as compared to the previous two sampling events. The changes range from 0.07% to 0.011%. TN and TS contents are low in the mineral soil layers, and they display variability similar to TC (Table 4).

3.2.7 C:N, C:S and N:S Ratios

A significant decrease in the 2020 C:S and N:S ratios of the LFH horizon in both sub-sites corresponds with the increase in TS noted above. Significant N:S differences are indicated in the lower three soil layers at both sub-sites, but the ratios are increases rather than decreases in the ratio. These are difficult to explain in terms of possible deposition of TN and TS, and are more likely attributable to variability in site-specific conditions.

4.0 CONCLUSION

Soil acidification parameters were examined using descriptive statistics and analysis of variance procedures to determine variability in the data and to assess if there are statistically significant differences between the means of the measured chemical parameters from the 3 sampling periods (2012, 2016 and 2020) and from the two sampling sites (North and South). Base saturation and pHc were the least variable, while BC:Al ratio had CVs up to 1.29 (i.e., 129%). Total C, N and S were also examined, with ratios of TC and TN to TS calculated to observe possible trends in S accumulation over the long term. Levels of each of these were quite variable, particularly in the upper mineral layers.

TC, TN and TS contents are highest in the LFH layer and in upper mineral soil layers (0-2 cm and 2-5 cm). The TC reflects the amount of organic matter in the soil. Differences in other parameters such as cation exchange capacity, base cations, BC:Al ratio, TN and TS follow the TC differences because of the adsorptive capacity of organic matter for cations, and because TS and TN are generally in organic form in the soil.

The above observations of decreases in pHc, TS and C:S ratio suggest that minor acidification has occurred in the eight year (2012-2020) period of soil chemistry monitoring. However, this was not indicated in the two other main acidification indicators of base saturation percentage and base cation to aluminum ratio. The changes are considered small as pHc (in particular) differs by only 0.2 to 0.3 units, which is likely not sufficient to measurably affect vegetation and soil microflora. Overall, the data suggest that slow acidification may be occurring. Assessment of these trends requires further monitoring for longer periods, which is part of the design of the LICA soil monitoring program.

5.0 REFERENCES

Abboud, S.A. and Turchenek, L.W. 2011. Long Term Soil Acidification Monitoring in the LICA Study Area. *Prep. for* Lakeland Industry and Community Association, Bonnyville, AB.

Abboud, S.A. and Turchenek, L.W. 2013. LICA Long Term Soil Acidification Monitoring - Tucker Lake Site Establishment. *Prep. for* Lakeland Industry and Community Association, Bonnyville, AB.

Abboud, S.A. and Turchenek, L.W. 2017. LICA Long Term Soil Acidification Monitoring - Tucker Lake Site - 2016. *Prep. for* Lakeland Industry and Community Association, Bonnyville, AB.

Abboud, S.A., Schwarz, C. J., Dinwoodie, G. D., Byrtus, G. A. and Turchenek, L.W. 2012. Trends in Soil Acidification in Alberta Based on Long Term Soil Acidification Monitoring from 1981 to 2010. *Prep. for* Air, Land, and Waste Policy Branch, Alberta Environment and Water, Edmonton, AB.

Carter, M.R. and Gregorich, E.G. (eds). 2008. Soil Sampling and Methods of Analysis, 2nd ed. Canadian Society of Soil Science. CRC Press, Boca Raton, FL.

LECO. 2006. Leco TruSpec CN Carbon/Nitrogen Analyzer. Leco Co., St Joseph, MI.

McKeague, J.A. (ed.). 1978. Manual on Soil Sampling and Methods of Analysis, 2nd edition. Canadian Society of Soil Science, Ottawa, ON.

Roberts, T.L. Nason, G.E. and Regier, H. 1989. Long term soil acidification monitoring in Alberta from 1981 to 1988 (draft). Soil Protection Branch, Waste and Chemicals Division, Alberta Environment, Lethbridge, AB.

Steel, R.G.D. and Torrie, J.H. 1960 (1st Ed.). Principles and Procedures of Statistics, A Biometrical Approach. McGraw-Hill Book Company, New York.

Steel, R.G.D. and Torrie, J.H. 1980 (2nd Ed.). Principles and Procedures of Statistics, A Biometrical Approach. McGraw-Hill Book Company, New York.

Sverdrup, H. and P. Warfvinge. 1993. The effect of soil acidification on the growth of trees, grass and herbs as expressed by the (Ca+Mg+K)/Al ratio. Reports in Ecology and Environmental Engineering: 2. Lund University. 108 pp.

Ulrich, B., K.J. Miewes, N. Konig and P.K. Khanna. 1984. Untersuchungsverfahren und Kriterion zur Bewertung der Versauerung und ihrer Folgen in Waldboden. Forst. u. Holzwirt 39: 278-286.

APPENDIX A

DATA AND BASIC STATISTICS

TUCKER LAKE SOIL MONITORING SITE - 2020

Appendix Table A1. pHc, Cation Exchange Capacity and Exchangeable Ions - 2020 Data and Descriptive Statistics

Plot	Subplot/ Layer	pHc	Na	K	Ca	Mg	Al	Fe	Mn	TEC	Bases	Base Saturation
			(cmol/kg) #									
North	A3/LFH	4.6 #	*									
North	B3/LFH	4.2										
North	C3/LFH	4.2										
North	D3/LFH	4.4										
North	E3/LFH	4.3										
North	F3/LFH	4.4										
North	G3/LFH	4.1										
North	H3/LFH	3.8										
North	I3/LFH	4.2										
North	J3/LFH	4.1										
North	K3/LFH	3.9										
North	L3/LFH	3.6										
	Mean	4.15										
	SD	0.28										
	CV	0.07										
South	A3/LFH	3.3										
South	B3/LFH	3.8										
South	C3/LFH	3.9										
South	D3/LFH	3.5										
South	E3/LFH	4.0										
South	F3/LFH	4.0										
South	G3/LFH	3.7										
South	H3/LFH	3.8										
South	I3/LFH	3.8										
South	J3/LFH	3.6										
South	K3/LFH	4.2										
South	L3/LFH	3.8										
	Mean	3.78										
	SD	0.24										
	CV	0.06										

* LFH layers were analyzed only for pHc.

\# cmol/kg – centimoles per kilogram soil; pHc – pH of soil sample suspended in 0.1 M $CaCl_2$

Appendix Table A1. pHc, Cation Exchange Capacity and Exchangeable Ions - 2020 Data and Descriptive Statistics (continued)

Plot	Subplot/ Layer	pHc	Na	K	Ca	Mg	Al	Fe	Mn	TEC	Bases	Base Saturation
			(cmol/kg)									
North	A3/0-2	4.6	0.010	0.131	6.40	0.748	0.054	0.001	0.462	7.81	7.29	0.93
North	B3/0-2	4.9	0.013	0.177	5.88	0.712	0.027	0.001	0.216	7.03	6.78	0.97
North	C3/0-2	4.4	0.012	0.115	3.02	0.362	0.169	0.003	0.384	4.07	3.51	0.86
North	D3/0-2	4.5	0.012	0.061	2.86	0.322	0.099	0.001	0.198	3.55	3.26	0.92
North	E3/0-2	4.4	0.010	0.090	2.08	0.311	0.169	0.002	0.255	2.91	2.49	0.85
North	F3/0-2	4	0.011	0.054	0.98	0.157	0.285	0.002	0.156	1.64	1.20	0.73
North	G3/0-2	4.4	0.011	0.261	5.13	0.633	0.120	0.004	0.454	6.61	6.04	0.91
North	H3/0-2	4.2	0.011	0.050	0.43	0.104	0.284	0.003	0.054	0.94	0.60	0.64
North	I3/0-2	4.2	0.010	0.107	4.01	0.435	0.258	0.004	0.296	5.12	4.56	0.89
North	J3/0-2	3.85	0.012	0.075	1.79	0.219	0.459	0.004	0.348	2.91	2.10	0.72
North	K3/0-2	4.3	0.008	0.162	4.11	0.460	0.094	0.007	0.376	5.22	4.74	0.91
North	L3/0-2	4.2	0.010	0.108	7.78	0.599	0.299	0.003	0.654	9.45	8.49	0.90
	Mean	4.33	0.011	0.116	3.71	0.422	0.193	0.003	0.321	4.77	4.26	0.85
	SD	0.28	0.001	0.061	2.27	0.215	0.126	0.002	0.161	2.58	2.51	0.10
	CV	0.06	0.117	0.524	0.61	0.509	0.653	0.538	0.502	0.54	0.59	0.12
South	A3/0-2	4.2	0.009	0.051	1.30	0.158	0.343	0.008	0.156	2.03	1.52	0.75
South	B3/0-2	3.6	0.012	0.063	1.37	0.152	0.946	0.007	0.486	3.04	1.60	0.53
South	C3/0-2	3.8	0.012	0.079	1.80	0.208	0.701	0.008	0.482	3.29	2.10	0.64
South	D3/0-2	4.2	0.011	0.072	1.93	0.232	0.482	0.003	0.584	3.31	2.24	0.68
South	E3/0-2	4.4	0.010	0.054	2.24	0.226	0.256	0.002	0.296	3.08	2.53	0.82
South	F3/0-2	4.3	0.010	0.055	2.47	0.283	0.222	0.001	0.284	3.32	2.81	0.85
South	G3/0-2	4.3	0.008	0.049	0.96	0.150	0.345	0.006	0.116	1.63	1.17	0.71
South	H3/0-2	4.3	0.009	0.036	1.09	0.142	0.412	0.002	0.253	1.94	1.28	0.66
South	I3/0-2	4.1	0.009	0.039	0.74	0.107	0.507	0.003	0.218	1.63	0.90	0.55
South	J3/0-2	4.4	0.010	0.038	2.21	0.192	0.351	0.002	0.330	3.13	2.45	0.78
South	K3/0-2	4.4	0.009	0.092	1.99	0.238	0.226	0.003	0.254	2.81	2.33	0.83
South	L3/0-2	4.1	0.020	0.053	1.52	0.180	0.514	0.003	0.534	2.82	1.77	0.63
	Mean	4.18	0.011	0.057	1.63	0.189	0.442	0.004	0.333	2.67	1.89	0.70
	SD	0.25	0.003	0.017	0.55	0.050	0.211	0.003	0.153	0.67	0.61	0.11
	CV	0.06	0.301	0.302	0.34	0.265	0.478	0.645	0.459	0.25	0.32	0.15

Appendix Table A1. pHc, Cation Exchange Capacity and Exchangeable Ions - 2020 Data and Descriptive Statistics (continued)

Plot	Subplot/ Layer	pHc	Na	K	Ca	Mg	Al	Fe	Mn	TEC	Bases	Base Saturation
			(cmol/kg)									
North	**A3/2-5**	4.9	0.009	0.062	3.23	0.328	0.040	<0.001	0.175	3.84	3.63	0.94
North	**B3/2-5**	4.7	0.013	0.099	2.91	0.382	0.072	0.002	0.119	3.60	3.40	0.95
North	**C3/2-5**	4.5	0.011	0.065	1.60	0.204	0.171	0.004	0.127	2.18	1.88	0.86
North	**D3/2-5**	4.5	0.011	0.032	0.70	0.101	0.130	0.003	0.033	1.01	0.84	0.84
North	**E3/2-5**	4.4	0.009	0.064	1.17	0.162	0.201	0.003	0.114	1.73	1.41	0.82
North	**F3/2-5**	4.1	0.012	0.037	0.30	0.050	0.333	0.002	0.067	0.80	0.39	0.50
North	**G3/2-5**	4.4	0.010	0.106	2.93	0.269	0.196	0.002	0.248	3.76	3.32	0.88
North	**H3/2-5**	4.4	0.007	0.054	0.47	0.093	0.211	0.001	0.045	0.89	0.63	0.71
North	**I3/2-5**	4.2	0.009	0.059	2.70	0.243	0.468	0.003	0.270	3.75	3.01	0.80
North	**J3/2-5**	4.1	0.011	0.043	0.58	0.088	0.271	0.002	0.130	1.13	0.73	0.64
North	**K3/2-5**	4.5	0.018	0.072	1.21	0.183	0.078	0.003	0.123	1.68	1.48	0.88
North	**L3/2-5**	4.1	0.011	0.050	1.78	0.133	0.279	0.004	0.156	2.42	1.98	0.82
	Mean	4.4	0.011	0.062	1.63	0.186	0.204	0.003	0.134	2.23	1.89	0.80
	SD	0.25	0.003	0.022	1.07	0.103	0.122	0.001	0.072	1.22	1.18	0.13
	CV	0.06	0.236	0.362	0.65	0.552	0.596	0.405	0.539	0.55	0.62	0.16
South	**A3/2-5**	4.4	0.007	0.041	1.19	0.151	0.219	0.003	0.061	1.67	1.39	0.83
South	**B3/2-5**	3.9	0.011	0.042	0.86	0.096	0.683	0.003	0.325	2.02	1.01	0.50
South	**C3/2-5**	4.1	0.010	0.035	1.07	0.102	0.564	0.002	0.230	2.02	1.22	0.61
South	**D3/2-5**	4.5	0.009	0.037	1.60	0.170	0.089	<0.001	0.110	2.02	1.82	0.90
South	**E3/2-5**	4.3	0.011	0.026	0.87	0.084	0.194	0.001	0.087	1.27	0.99	0.78
South	**F3/2-5**	4.3	0.010	0.037	0.97	0.116	0.243	0.003	0.097	1.47	1.13	0.77
South	**G3/2-5**	4.7	0.009	0.058	1.11	0.200	0.160	0.003	0.093	1.63	1.38	0.84
South	**H3/2-5**	4.2	0.009	0.024	0.59	0.086	0.436	0.003	0.130	1.28	0.71	0.56
South	**I3/2-5**	4.1	0.011	0.029	0.33	0.046	0.496	0.006	0.130	1.05	0.42	0.40
South	**J3/2-5**	4.5	0.008	0.033	1.09	0.108	0.155	0.001	0.114	1.51	1.24	0.82
South	**K3/2-5**	4.4	0.010	0.051	0.69	0.096	0.210	0.006	0.057	1.12	0.85	0.76
South	**L3/2-5**	4.3	0.008	0.042	1.16	0.147	0.243	0.002	0.155	1.76	1.36	0.77
	Mean	4.31	0.010	0.038	0.96	0.117	0.308	0.003	0.132	1.57	1.13	0.71
	SD	0.22	0.001	0.010	0.33	0.043	0.188	0.002	0.076	0.35	0.37	0.16
	CV	0.05	0.124	0.259	0.34	0.366	0.612	0.526	0.576	0.22	0.32	0.22

Appendix Table A1. pHc, Cation Exchange Capacity and Exchangeable Ions - 2020 Data and Descriptive Statistics (continued)

Plot	Subplot/ Layer	pHc	Na	K	Ca	Mg	Al	Fe	Mn	TEC	Bases	Base Saturation
			(cmol/kg)									
North	**A3/5-10**	4.5	0.010	0.035	0.51	0.086	0.091	0.005	0.012	0.75	0.64	0.86
North	**B3/5-10**	4.4	0.010	0.062	0.57	0.130	0.144	0.006	0.031	0.95	0.77	0.81
North	**C3/5-10**	4.1	0.012	0.047	0.57	0.111	0.370	0.027	0.018	1.16	0.74	0.64
North	**D3/5-10**	4.4	0.010	0.032	0.44	0.073	0.130	0.008	0.013	0.71	0.56	0.79
North	**E3/5-10**	4.2	0.010	0.046	0.44	0.075	0.225	0.005	0.032	0.83	0.57	0.68
North	**F3/5-10**	4.2	0.009	0.036	0.27	0.043	0.268	0.008	0.018	0.65	0.36	0.55
North	**G3/5-10**	4.4	0.010	0.052	0.93	0.095	0.103	0.001	0.054	1.25	1.09	0.87
North	**H3/5-10**	4.5	0.014	0.029	0.36	0.058	0.148	0.004	0.010	0.62	0.46	0.74
North	**I3/5-10**	4.3	0.014	0.036	0.69	0.073	0.250	0.008	0.023	1.09	0.81	0.74
North	**J3/5-10**	4.3	0.010	0.033	0.37	0.058	0.199	0.002	0.031	0.70	0.47	0.67
North	**K3/5-10**	4	0.012	0.068	0.63	0.118	0.309	0.024	0.043	1.20	0.83	0.69
North	**L3/5-10**	4.4	0.016	0.029	0.74	0.077	0.154	0.006	0.031	1.05	0.86	0.82
	Mean	4.31	0.011	0.042	0.54	0.083	0.199	0.009	0.026	0.91	0.68	0.74
	SD	0.16	0.002	0.013	0.19	0.026	0.087	0.008	0.013	0.23	0.21	0.10
	CV	0.04	0.198	0.309	0.34	0.313	0.436	0.930	0.510	0.25	0.31	0.13
South	**A3/5-10**	4.4	0.008	0.039	0.88	0.127	0.204	0.004	0.033	1.29	1.05	0.81
South	**B3/5-10**	4.1	0.010	0.027	0.42	0.059	0.355	0.003	0.070	0.95	0.52	0.55
South	**C3/5-10**	4.2	0.008	0.029	0.35	0.042	0.301	0.005	0.032	0.77	0.43	0.56
South	**D3/5-10**	4.2	0.011	0.032	0.66	0.099	0.245	0.003	0.037	1.09	0.80	0.74
South	**E3/5-10**	4.3	0.012	0.025	0.52	0.055	0.224	0.006	0.027	0.87	0.61	0.70
South	**F3/5-10**	4.3	0.010	0.029	0.45	0.067	0.253	0.005	0.026	0.84	0.56	0.66
South	**G3/5-10**	4.6	0.009	0.074	0.42	0.138	0.158	0.003	0.070	0.87	0.64	0.74
South	**H3/5-10**	4.3	0.010	0.021	0.35	0.062	0.326	0.007	0.036	0.81	0.44	0.55
South	**I3/5-10**	4.2	0.012	0.017	0.20	0.028	0.382	0.009	0.042	0.69	0.26	0.37
South	**J3/5-10**	4.4	0.009	0.026	0.55	0.073	0.159	0.002	0.036	0.86	0.66	0.77
South	**K3/5-10**	4.4	0.008	0.036	0.38	0.060	0.198	0.012	0.016	0.71	0.49	0.68
South	**L3/5-10**	4.3	0.010	0.036	0.54	0.099	0.178	0.012	0.025	0.90	0.69	0.76
	Mean	4.31	0.010	0.033	0.48	0.076	0.248	0.006	0.038	0.89	0.60	0.66
	SD	0.13	0.001	0.014	0.17	0.034	0.076	0.004	0.017	0.17	0.20	0.13
	CV	0.03	0.146	0.442	0.36	0.443	0.307	0.602	0.441	0.19	0.34	0.19

Appendix Table A1. pHc, Cation Exchange Capacity and Exchangeable Ions - 2020 Data and Descriptive Statistics (concluded)

Plot	Subplot/ Layer	pHc	Na	K	Ca	Mg	Al	Fe	Mn	TEC	Bases	Base Saturation
			(cmol/kg)									
North	**A3/10-15**	4.5	0.011	0.045	0.72	0.152	0.206	0.014	0.007	1.16	0.93	0.80
North	**B3/10-15**	4.5	0.010	0.039	0.27	0.079	0.112	0.005	0.008	0.52	0.40	0.76
North	**C3/10-15**	4.1	0.013	0.037	0.39	0.085	0.374	0.032	0.008	0.93	0.52	0.56
North	**D3/10-15**	4.3	0.011	0.036	0.34	0.057	0.208	0.017	0.005	0.67	0.44	0.66
North	**E3/10-15**	4.2	0.012	0.031	0.26	0.045	0.228	0.014	0.006	0.59	0.35	0.58
North	**F3/10-15**	4.2	0.009	0.033	0.24	0.038	0.309	0.015	0.007	0.65	0.32	0.49
North	**G3/10-15**	4.4	0.010	0.046	0.54	0.073	0.080	0.003	0.013	0.76	0.67	0.87
North	**H3/10-15**	4.4	0.010	0.026	0.24	0.036	0.192	0.010	0.003	0.52	0.31	0.61
North	**I3/10-15**	4.3	0.009	0.028	0.36	0.049	0.235	0.013	0.008	0.70	0.44	0.63
North	**J3/10-15**	4.4	0.009	0.041	0.42	0.076	0.185	0.010	0.006	0.75	0.55	0.73
North	**K3/10-15**	4	0.009	0.045	0.17	0.047	0.438	0.035	0.005	0.75	0.27	0.36
North	**L3/10-15**	4.5	0.009	0.021	0.48	0.065	0.118	0.011	0.007	0.71	0.57	0.81
	Mean	4.32	0.010	0.036	0.37	0.067	0.224	0.015	0.007	0.73	0.48	0.66
	SD	0.16	0.001	0.008	0.16	0.031	0.106	0.010	0.003	0.18	0.19	0.15
	CV	0.04	0.117	0.223	0.42	0.470	0.473	0.638	0.378	0.24	0.39	0.23
South	**A3/10-15**	4.3	0.009	0.032	0.36	0.077	0.225	0.009	0.011	0.72	0.48	0.66
South	**B3/10-15**	4.5	0.010	0.020	0.42	0.052	0.180	0.011	0.009	0.70	0.50	0.71
South	**C3/10-15**	4.2	0.009	0.029	0.35	0.047	0.366	0.019	0.014	0.83	0.43	0.52
South	**D3/10-15**	4.6	0.012	0.035	0.66	0.130	0.111	0.003	0.017	0.97	0.84	0.86
South	**E3/10-15**	4.6	0.016	0.022	0.29	0.043	0.142	0.009	0.007	0.53	0.38	0.70
South	**F3/10-15**	4.35	0.013	0.028	0.32	0.052	0.224	0.010	0.012	0.66	0.41	0.63
South	**G3/10-15**	4.4	0.013	0.066	0.36	0.104	0.249	0.006	0.038	0.84	0.55	0.65
South	**H3/10-15**	4.5	0.008	0.021	0.23	0.051	0.198	0.006	0.011	0.53	0.31	0.59
South	**I3/10-15**	4.1	0.008	0.019	0.12	0.022	0.348	0.024	0.009	0.55	0.17	0.31
South	**J3/10-15**	4.4	0.013	0.028	0.46	0.058	0.164	0.004	0.019	0.75	0.56	0.75
South	**K3/10-15**	4.5	0.008	0.032	0.27	0.050	0.174	0.008	0.012	0.55	0.36	0.65
South	**L3/10-15**	4.5	0.010	0.029	0.29	0.060	0.168	0.018	0.002	0.58	0.39	0.68
	Mean	4.41	0.011	0.030	0.35	0.062	0.212	0.011	0.013	0.68	0.45	0.64
	SD	0.15	0.002	0.013	0.13	0.029	0.077	0.007	0.009	0.14	0.16	0.13
	CV	0.03	0.227	0.416	0.38	0.466	0.364	0.630	0.671	0.21	0.36	0.21

Appendix Table A2. Water Soluble Ions and Base Cation:Aluminum Ratio – 2020 Data and Descriptive Statistics

Sub-Site	Subplot/ Layer	Sat'n * (%)	pH (Ext.)	E.C. (dS/m)	Na	K	Ca	Mg	Al	Fe	Mn	S	BC:Al Ratio
					(mg/L)								
North	**A3/0-2**	89.0	5.0	0.28	1.02	10.1	20.5	3.19	6.52	3.62	1.94	3.70	3.9
North	**B3/0-2**	58.0	5.2	0.31	2.26	36.5	66.2	12.1	4.73	3.09	3.06	10.8	18.2
North	**C3/0-2**	52.8	4.8	0.29	1.94	26.0	56.0	10.8	5.40	5.22	9.57	14.0	13.0
North	**D3/0-2**	54.4	5.0	0.19	1.68	13.8	35.6	7.09	2.82	2.66	3.40	7.86	15.4
North	**E3/0-2**	49.6	4.8	0.21	1.76	20.2	36.5	9.54	4.40	4.11	5.51	7.78	11.6
North	**F3/0-2**	54.8	4.5	0.15	1.77	12.1	25.5	6.16	6.41	5.58	5.70	5.78	5.4
North	**G3/0-2**	73.7	4.8	0.29	2.31	43.4	47.0	10.4	3.25	3.43	5.27	11.6	23.3
North	**H3/0-2**	39.2	4.6	0.10	2.14	9.25	13.5	4.24	7.11	5.26	2.43	3.24	3.2
North	**I3/0-2**	60.8	4.6	0.21	1.88	14.5	42.3	8.48	4.43	3.91	3.75	8.23	11.3
North	**J3/0-2**	50.2	4.4	0.16	2.84	12.7	24.4	5.62	5.68	4.46	6.39	7.37	6.1
North	**K3/0-2**	69.0	4.7	0.36	1.61	36.0	74.0	13.3	4.67	4.83	8.55	14.9	19.6
North	**L3/0-2**	94.3	4.7	0.26	1.40	14.1	51.3	6.70	3.48	1.85	4.18	8.95	15.3
	Mean	62.2	4.8	0.23	1.88	20.72	41.1	8.14	4.91	4.00	4.98	8.68	12.19
	SD	16.5	0.2	0.08	0.47	11.83	18.7	3.16	1.36	1.14	2.35	3.65	6.53
	CV	0.26	0.05	0.33	0.25	0.57	0.5	0.39	0.28	0.28	0.47	0.42	0.54
South	**A3/0-2**	44.0	4.8	0.12	1.31	5.90	17.9	2.90	5.58	4.01	3.25	4.06	3.7
South	**B3/0-2**	60.4	4.2	0.14	1.64	7.52	14.6	2.32	5.45	3.37	6.64	5.00	3.6
South	**C3/0-2**	51.6	4.3	0.18	1.51	8.57	25.9	4.07	5.97	4.11	7.68	6.98	5.0
South	**D3/0-2**	55.6	4.7	0.20	1.75	10.2	29.7	5.36	5.97	3.06	9.87	7.01	5.9
South	**E3/0-2**	47.6	4.9	0.15	1.35	5.55	24.0	3.49	3.27	2.14	3.43	4.25	7.8
South	**F3/0-2**	54.4	4.7	0.19	1.49	11.6	30.4	5.44	3.01	2.18	3.41	6.01	12.0
South	**G3/0-2**	44.4	4.7	0.15	1.87	8.12	20.9	3.87	7.82	5.85	3.63	4.14	3.3
South	**H3/0-2**	37.3	4.7	0.13	1.41	4.48	19.2	3.47	4.90	2.88	4.85	4.40	4.4
South	**I3/0-2**	40.8	4.5	0.14	2.13	4.28	18.1	3.16	4.75	2.65	6.31	4.32	4.5
South	**J3/0-2**	52.8	4.7	0.21	1.99	7.01	38.2	4.74	4.92	2.35	6.39	7.07	7.8
South	**K3/0-2**	50.4	4.8	0.24	1.50	21.5	35.7	6.71	5.17	3.41	5.20	7.29	9.3
South	**L3/0-2**	49.2	4.5	0.23	3.30	8.90	29.4	5.19	5.25	2.56	12.7	8.79	6.8
	Mean	49.0	4.6	0.17	1.77	8.63	25.3	4.23	5.17	3.21	6.11	5.78	6.17
	SD	6.6	0.2	0.04	0.55	4.61	7.5	1.28	1.25	1.06	2.89	1.61	2.66
	CV	0.13	0.05	0.23	0.31	0.53	0.3	0.30	0.24	0.33	0.47	0.28	0.43

* Sat'n – percentage by weight of water in saturated paste used to measure E.C. and to extract ions; E.C. – electrical conductivity; pH (Ext.) – pH of the extract from a saturated paste sample of soil; mg/L – milligrams per litre; BC:Al – ratio of the sum of K, CA and Mg to Al, after conversion of units in mg/L to millimoles/L

Appendix Table A2. Water Soluble Ions and Base Cation:Aluminum Ratio – 2020 Data and Descriptive Statistics (continued)

Sub-Site	Subplot/ Layer	Sat'n (%)	pH (Ext.)	E.C. (dS/m)	Na	K	Ca	Mg	Al	Fe	Mn	S	BC:Al Ratio
					(mg/L)								
North	**A3/2-5**	44.0	5.5	0.18	0.909	8.12	38.9	5.80	2.37	1.10	2.40	6.61	16.6
North	**B3/2-5**	42.4	5.0	0.19	2.03	17.8	39.2	7.94	5.41	3.83	1.88	7.91	9.2
North	**C3/2-5**	39.2	4.8	0.20	2.28	11.6	42.0	8.07	7.94	6.93	4.92	9.55	6.0
North	**D3/2-5**	38.8	5.0	0.09	2.02	4.75	16.6	3.52	4.50	4.11	1.24	3.17	4.6
North	**E3/2-5**	42.0	4.9	0.13	2.10	10.5	23.5	5.45	6.75	5.56	3.10	4.99	4.7
North	**F3/2-5**	40.8	4.6	0.07	2.07	6.31	9.04	2.61	4.92	3.85	2.83	2.45	3.2
North	**G3/2-5**	47.6	5.0	0.18	2.62	18.8	32.8	5.87	3.65	2.75	3.03	7.93	12.2
North	**H3/2-5**	38.0	5.0	0.08	2.02	8.48	10.6	3.50	6.01	4.13	1.38	2.44	3.2
North	**I3/2-5**	57.0	4.6	0.18	2.19	15.6	32.5	5.55	4.73	4.16	4.06	8.00	8.7
North	**J3/2-5**	42.0	4.6	0.10	2.77	7.76	14.2	3.72	7.61	5.40	3.78	4.20	2.9
North	**K3/2-5**	42.0	4.9	0.22	1.78	20.9	42.7	9.27	4.21	6.72	5.96	7.82	13.2
North	**L3/2-5**	40.8	4.8	0.13	1.47	6.16	22.0	2.24	4.62	3.14	2.33	4.97	5.0
	Mean	42.9	4.9	0.15	2.02	11.40	27.0	5.29	5.23	4.31	3.08	5.84	7.47
	SD	5.1	0.3	0.05	0.49	5.52	12.5	2.27	1.62	1.65	1.41	2.45	4.52
	CV	0.12	0.05	0.36	0.24	0.48	0.5	0.43	0.31	0.38	0.46	0.42	0.60
South	**A3/2-5**	41.2	5.0	0.09	0.808	3.76	14.0	2.22	2.47	1.88	0.996	2.70	6.3
South	**B3/2-5**	46.4	4.4	0.11	1.73	4.91	13.3	1.96	5.81	3.03	6.01	3.87	2.8
South	**C3/2-5**	42.4	4.5	0.15	1.82	5.72	21.4	2.99	5.71	3.51	5.89	5.65	4.2
South	**D3/2-5**	37.2	5.2	0.12	1.45	3.22	19.9	2.83	3.96	2.28	1.62	2.97	5.2
South	**E3/2-5**	38.4	4.9	0.09	1.53	3.02	15.1	1.79	5.91	3.80	1.89	2.44	2.7
South	**F3/2-5**	40.4	4.8	0.15	2.20	8.57	22.2	3.35	5.23	3.72	2.85	3.90	5.2
South	**G3/2-5**	38.8	5.2	0.12	1.60	5.47	16.3	3.84	5.87	3.70	1.73	3.18	3.6
South	**H3/2-5**	47.2	4.7	0.11	1.66	2.78	13.6	2.36	6.14	3.03	3.89	3.31	2.5
South	**I3/2-5**	39.2	4.5	0.12	3.26	4.13	12.2	1.93	5.45	2.80	5.97	3.11	3.1
South	**J3/2-5**	38.4	5.1	0.11	1.55	3.70	19.3	2.32	5.49	2.71	2.25	3.04	3.6
South	**K3/2-5**	37.6	4.9	0.11	1.61	6.68	15.4	2.43	5.95	3.39	1.97	2.88	3.3
South	**L3/2-5**	40.4	4.9	0.14	1.69	5.33	19.6	3.34	3.67	2.30	3.86	3.95	6.2
	Mean	40.6	4.8	0.12	1.74	4.77	16.9	2.61	5.14	3.01	3.24	3.42	4.05
	SD	3.3	0.3	0.02	0.57	1.70	3.4	0.65	1.15	0.64	1.84	0.85	1.32
	CV	0.08	0.06	0.16	0.33	0.36	0.2	0.25	0.22	0.21	0.57	0.25	0.33

Appendix Table A2. Water Soluble Ions and Base Cation:Aluminum Ratio – 2020 Data and Descriptive Statistics (continued)

Sub-Site	Subplot/ Layer	Sat'n	pH	E.C.	Na	K	Ca	Mg	Al	Fe	Mn	S	BC:Al Ratio
		(%)	(Ext.)	(dS/m)	(mg/L)								
North	**A3/5-10**	36.8	4.9	0.09	1.63	3.88	17.5	3.15	5.88	3.39	0.595	2.35	3.4
North	**B3/5-10**	37.2	4.8	0.14	2.42	10.9	20.7	5.21	6.44	4.78	1.58	8.40	4.7
North	**C3/5-10**	40.4	4.6	0.11	1.88	5.06	18.1	4.04	6.45	5.69	1.03	4.93	3.5
North	**D3/5-10**	37.2	4.9	0.07	1.75	4.14	11.9	2.76	4.83	4.04	0.671	2.19	3.3
North	**E3/5-10**	38.4	4.7	0.09	2.63	7.89	14.6	3.63	6.96	5.74	1.66	3.32	3.2
North	**F3/5-10**	38.0	4.6	0.07	2.17	6.18	9.02	2.66	5.76	4.16	0.965	1.78	2.8
North	**G3/5-10**	39.2	5.0	0.11	2.18	8.29	19.9	3.93	6.13	4.02	1.54	4.01	4.2
North	**H3/5-10**	37.6	5.0	0.06	2.31	4.15	9.49	2.62	4.58	3.58	0.415	1.78	3.2
North	**I3/5-10**	38.0	4.8	0.08	2.24	4.10	13.6	2.77	3.86	3.47	0.796	2.60	4.6
North	**J3/5-10**	39.2	4.8	0.07	2.41	4.87	10.4	2.61	6.18	4.08	1.19	2.54	2.6
North	**K3/5-10**	38.0	4.5	0.17	2.59	16.1	25.8	5.92	8.76	9.68	3.41	5.37	4.4
North	**L3/5-10**	37.2	4.8	0.10	1.13	3.50	18.0	1.77	3.79	2.68	0.991	2.62	4.7
	Mean	38.1	4.8	0.09	2.11	6.59	15.8	3.42	5.80	4.61	1.24	3.49	3.71
	SD	1.1	0.2	0.03	0.44	3.74	5.1	1.19	1.40	1.83	0.79	1.94	0.76
	CV	0.03	0.03	0.34	0.21	0.57	0.3	0.35	0.24	0.40	0.64	0.56	0.20
South	**A3/5-10**	39.2	5.1	0.08	1.07	3.59	11.4	1.95	5.32	3.33	0.701	2.08	2.6
South	**B3/5-10**	37.6	4.8	0.06	1.12	1.88	6.96	0.86	3.29	2.00	1.60	1.25	2.5
South	**C3/5-10**	37.6	4.7	0.09	1.48	3.93	11.5	1.28	4.47	2.56	1.45	2.30	3.0
South	**D3/5-10**	36.8	4.7	0.09	1.67	2.41	13.2	1.94	5.58	3.08	1.12	1.98	2.6
South	**E3/5-10**	38.0	4.9	0.07	1.29	2.39	11.6	1.22	4.72	2.85	0.869	1.54	2.6
South	**F3/5-10**	38.4	4.8	0.08	1.65	2.75	11.5	1.65	4.72	3.06	1.02	1.96	2.8
South	**G3/5-10**	37.6	5.1	0.09	1.52	8.37	7.50	3.06	5.11	2.71	1.72	2.88	3.1
South	**H3/5-10**	38.4	4.7	0.08	1.59	2.43	10.2	1.87	3.99	2.07	1.76	2.23	3.1
South	**I3/5-10**	39.2	4.6	0.08	2.32	2.00	7.99	1.08	4.49	1.94	2.29	1.81	2.4
South	**J3/5-10**	37.2	4.8	0.08	1.30	2.65	12.8	1.54	5.45	2.62	1.29	2.00	2.5
South	**K3/5-10**	37.6	5.0	0.09	1.48	4.89	11.5	1.85	4.15	2.66	0.839	2.84	3.6
South	**L3/5-10**	37.2	4.8	0.08	1.38	3.77	11.5	2.11	3.82	2.66	0.949	2.06	3.7
	Mean	37.9	4.8	0.08	1.49	3.42	10.6	1.70	4.59	2.63	1.30	2.08	2.89
	SD	0.8	0.2	0.01	0.32	1.80	2.1	0.58	0.70	0.44	0.47	0.46	0.45
	CV	0.02	0.03	0.11	0.22	0.53	0.2	0.34	0.15	0.17	0.36	0.22	0.15

Appendix Table A2. Water Soluble Ions and Base Cation:Aluminum Ratio – 2020 Data and Descriptive Statistics (concluded)

Sub-Site	Subplot/ Layer	Sat'n	pH	E.C.	Na	K	Ca	Mg	Al	Fe	Mn	S	BC:Al Ratio
		(%)	(Ext.)	(dS/m)	(mg/L)								
North	**A3/10-15**	36.4	4.8	0.11	1.78	2.86	20.9	3.55	6.94	3.87	0.409	2.71	3.2
North	**B3/10-15**	36.0	4.8	0.09	2.68	6.17	10.2	3.04	2.95	2.15	0.54	7.14	6.0
North	**C3/10-15**	36.8	4.7	0.09	2.40	3.94	13.7	3.42	4.11	3.72	0.531	4.60	4.5
North	**D3/10-15**	38.0	4.8	0.06	1.79	4.33	9.34	2.27	4.36	3.61	0.326	1.95	3.2
North	**E3/10-15**	37.6	4.6	0.06	2.50	4.29	9.11	2.29	4.40	3.63	0.445	1.96	3.3
North	**F3/10-15**	37.2	4.8	0.05	2.22	3.88	6.87	2.08	3.06	2.37	0.337	1.36	4.0
North	**G3/10-15**	37.2	5.1	0.07	2.26	6.21	14.2	3.15	6.46	4.65	0.484	2.42	3.1
North	**H3/10-15**	37.2	5.0	0.04	2.53	2.48	6.32	2.01	2.62	2.15	0.12	1.18	4.3
North	**I3/10-15**	37.2	4.9	0.06	2.19	2.75	9.48	2.38	3.17	2.76	0.419	1.52	4.3
North	**J3/10-15**	37.6	4.9	0.06	2.15	4.55	10.2	2.65	5.05	3.79	0.271	2.09	3.1
North	**K3/10-15**	37.2	4.5	0.09	2.05	9.25	8.95	3.00	5.57	4.22	0.56	2.82	3.3
North	**L3/10-15**	37.6	5.0	0.08	1.48	2.08	12.6	1.58	5.92	3.46	0.304	1.81	2.3
	Mean	37.2	4.8	0.07	2.17	4.40	11.0	2.62	4.55	3.37	0.40	2.63	3.70
	SD	0.6	0.2	0.02	0.35	2.01	3.9	0.61	1.45	0.82	0.13	1.68	0.97
	CV	0.01	0.04	0.27	0.16	0.46	0.4	0.23	0.32	0.24	0.33	0.64	0.26
South	**A3/10-15**	38.4	4.8	0.06	1.09	2.54	6.41	1.28	4.35	2.75	0.357	1.36	2.0
South	**B3/10-15**	36.4	5.1	0.05	1.51	1.10	7.34	0.78	4.32	2.69	0.294	1.01	1.9
South	**C3/10-15**	37.6	4.7	0.07	1.32	3.07	9.46	1.13	3.82	2.58	0.57	1.81	3.0
South	**D3/10-15**	36.4	5.1	0.08	1.30	1.73	12.1	2.15	3.34	2.03	0.493	1.63	4.0
South	**E3/10-15**	37.6	5.2	0.05	1.07	1.18	5.99	0.664	2.46	1.49	0.207	0.924	2.8
South	**F3/10-15**	38.0	4.8	0.06	1.27	2.20	8.27	1.22	3.30	2.07	0.503	1.51	3.0
South	**G3/10-15**	38.4	4.9	0.09	2.01	7.32	7.89	2.31	4.98	2.68	1.09	2.61	3.1
South	**H3/10-15**	38.0	4.9	0.06	1.11	1.71	6.63	1.30	3.40	1.81	0.563	1.60	2.5
South	**I3/10-15**	36.8	4.7	0.05	1.71	1.65	4.49	0.638	2.83	1.47	0.556	1.24	2.4
South	**J3/10-15**	36.8	4.9	0.07	1.18	2.25	10.4	1.20	5.44	2.74	0.65	1.55	2.1
South	**K3/10-15**	37.2	5.0	0.07	1.45	3.45	7.36	1.21	3.25	1.77	0.627	1.95	3.2
South	**L3/10-15**	36.8	4.9	0.06	1.40	2.33	7.48	1.43	2.83	1.95	0.129	1.57	3.5
	Mean	37.4	4.9	0.06	1.37	2.54	7.8	1.28	3.69	2.17	0.50	1.56	2.78
	SD	0.7	0.2	0.01	0.28	1.66	2.1	0.52	0.91	0.49	0.25	0.44	0.62
	CV	0.02	0.03	0.19	0.20	0.65	0.3	0.40	0.25	0.23	0.50	0.28	0.22

Appendix Table A3. Total Carbon, Nitrogen and Sulphur – 2020 Data and Descriptive Statistics

Sub-site	Subplot/ Layer	pHc *	Total C (%)	Total N (%)	Total S (%)	C:N Ratio	C:S Ratio	N:S Ratio
North	A3/LFH	4.6	40.6	1.300	0.140	31.2	290	9.3
North	B3/LFH	4.2	22.2	0.648	0.160	34.3	139	4.1
North	C3/LFH	4.2	52.2	1.120	0.322	46.6	162	3.5
North	D3/LFH	4.4	38.7	1.150	0.160	33.7	242	7.2
North	E3/LFH	4.3	50.2	1.260	0.239	39.8	210	5.3
North	F3/LFH	4.4	48.1	0.913	0.227	52.7	212	4.0
North	G3/LFH	4.1	29.3	0.655	0.167	44.7	175	3.9
North	H3/LFH	3.8	33.9	0.753	0.060	45.0	565	12.6
North	I3/LFH	4.2	38.3	0.720	0.146	53.2	262	4.9
North	J3/LFH	4.1	34.5	0.715	0.132	48.3	261	5.4
North	K3/LFH	3.9	49.3	1.620	0.244	30.4	202	6.6
North	L3/LFH	3.6	41.8	0.963	0.160	43.4	261	6.0
	Mean	4.15	39.9	0.985	0.180	41.9	249	6.1
	SD	0.28	9.10	0.309	0.068	8.0	110	2.6
	CV	0.07	0.23	0.31	0.38	0.19	0.44	0.43
South	A3/LFH	3.3	49.4	0.893	0.233	55	212	3.8
South	B3/LFH	3.8	42.1	1.110	0.232	38	181	4.8
South	C3/LFH	3.9	37.9	1.185	0.255	32	149	4.6
South	D3/LFH	3.5	35.4	0.846	0.217	42	163	3.9
South	E3/LFH	4.0	34.3	0.994	0.177	35	194	5.6
South	F3/LFH	4.0	52.1	1.120	0.230	47	227	4.9
South	G3/LFH	3.7	34.55	0.712	0.155	49	223	4.6
South	H3/LFH	3.8	31.9	0.879	0.195	36	164	4.5
South	I3/LFH	3.8	40.2	0.880	0.187	46	215	4.7
South	J3/LFH	3.6	26.2	0.632	0.150	41	175	4.2
South	K3/LFH	4.2	35.9	0.951	0.202	38	178	4.7
South	L3/LFH	3.8	46.8	1.020	0.262	46	179	3.9
	Mean	3.78	38.9	0.935	0.208	42.0	188	4.5
	SD	0.24	7.58	0.164	0.037	6.7	25.6	0.51
	CV	0.06	0.19	0.18	0.18	0.16	0.14	0.11

* pHc data are repeated here from Appendix Table A1

Appendix Table A3. Total Carbon, Nitrogen and Sulphur – 2020 Data and Descriptive Statistics (continued)

Sub-site	Subplot/ Layer	pHc *	Total C (%)	Total N (%)	Total S (%)	C:N Ratio	C:S Ratio	N:S Ratio
North	A3/0-2	4.6	4.84	0.138	0.030	35	161	4.6
North	B3/0-2	4.9	7.28	0.198	0.011	37	662	18.0
North	C3/0-2	4.4	2.23	0.079	0.012	28	186	6.6
North	D3/0-2	4.5	2.00	0.068	0.001	29	2000	68.0
North	E3/0-2	4.4	1.49	0.050	0.005	30	298	10.0
North	F3/0-2	4.0	1.24	0.038	0.001	33	1240	38.0
North	G3/0-2	4.4	4.47	0.130	0.018	34	248	7.2
North	H3/0-2	4.2	0.61	0.022	0.002	28	304	11.0
North	I3/0-2	4.2	7.68	0.174	0.024	44	320	7.3
North	J3/0-2	3.9	2.45	0.081	0.011	30	223	7.4
North	K3/0-2	4.3	2.38	0.101	0.021	24	113	4.8
North	L3/0-2	4.2	12.2	0.322	0.031	38	394	10.4
	Mean	4.33	4.07	0.117	0.014	32.5	512	16.1
	SD	0.28	3.44	0.084	0.011	5.5	560	18.7
	CV	0.06	0.84	0.72	0.78	0.17	1.09	1.16
South	A3/0-2	4.2	1.23	0.042	0.005	29	246	8.4
South	B3/0-2	3.6	1.72	0.055	0.015	31	115	3.7
South	C3/0-2	3.8	2.09	0.068	0.009	31	232	7.6
South	D3/0-2	4.2	2.10	0.074	0.013	28	162	5.7
South	E3/0-2	4.4	1.85	0.077	0.009	24	206	8.6
South	F3/0-2	4.3	1.88	0.066	0.006	28	313	11.0
South	G3/0-2	4.3	1.00	0.037	0.003	27	333	12.3
South	H3/0-2	4.3	1.12	0.039	0.003	29	373	13.0
South	I3/0-2	4.1	1.29	0.050	0.002	26	645	25.0
South	J3/0-2	4.4	1.57	0.057	0.011	28	143	5.2
South	K3/0-2	4.4	2.44	0.088	0.011	28	222	8.0
South	L3/0-2	4.1	3.75	0.123	0.013	30	288	9.5
	Mean	4.18	1.84	0.065	0.008	28.3	273	9.8
	SD	0.25	0.75	0.024	0.004	2.1	141	5.5
	CV	0.06	0.41	0.38	0.53	0.07	0.52	0.56

Appendix Table A3. Total Carbon, Nitrogen and Sulphur – 2020 Data and Descriptive Statistics (continued)

Sub-site	Subplot/ Layer	pHc *	Total C (%)	Total N (%)	Total S (%)	C:N Ratio	C:S Ratio	N:S Ratio
North	A3/2-5	4.9	2.26	0.078	0.005	29	452	16
North	B3/2-5	4.7	1.89	0.059	0.002	32	945	30
North	C3/2-5	4.5	1.20	0.048	0.001	25	1200	48
North	D3/2-5	4.5	0.502	0.026	0.001	19	502	26
North	E3/2-5	4.4	0.86	0.025	0.003	35	288	8
North	F3/2-5	4.1	0.387	0.026	0.001	15	387	26
North	G3/2-5	4.4	2.22	0.077	0.005	29	444	15
North	H3/2-5	4.4	0.477	0.030	0.002	16	239	15
North	I3/2-5	4.2	2.36	0.066	0.013	36	182	5
North	J3/2-5	4.1	0.616	0.027	0.002	23	308	14
North	K3/2-5	4.5	0.824	0.033	0.001	25	824	33
North	L3/2-5	4.1	1.13	0.045	0.003	25	377	15
	Mean	4.40	1.23	0.045	0.003	25.7	512	20.9
	SD	0.25	0.75	0.020	0.003	6.8	313	12.1
	CV	0.06	0.61	0.453	1.04	0.26	0.61	0.58
South	A3/2-5	4.4	1.00	0.028	0.002	36	499	14
South	B3/2-5	3.9	1.60	0.051	0.003	31	533	17
South	C3/2-5	4.1	1.54	0.044	0.004	35	385	11
South	D3/2-5	4.5	0.783	0.023	0.004	34	196	6
South	E3/2-5	4.3	0.653	0.034	0.002	19	327	17
South	F3/2-5	4.3	0.707	0.035	0.001	20	707	35
South	G3/2-5	4.7	0.845	0.022	0.003	38	282	7
South	H3/2-5	4.2	0.699	0.036	0.003	19	233	12
South	I3/2-5	4.1	0.692	0.031	0.003	22	231	10
South	J3/2-5	4.5	0.745	0.037	0.003	20	248	12
South	K3/2-5	4.4	0.539	0.037	0.001	15	539	37
South	L3/2-5	4.3	1.06	0.044	0.006	24	177	7
	Mean	4.31	0.91	0.035	0.003	26.2	363	15.5
	SD	0.22	0.34	0.009	0.001	8.1	169	10.2
	CV	0.05	0.38	0.24	0.47	0.31	0.47	0.66

Appendix Table A3. Total Carbon, Nitrogen and Sulphur – 2020 Data and Descriptive Statistics (continued)

Sub-site	Subplot/ Layer	pHc *	Total C (%)	Total N (%)	Total S (%)	C:N Ratio	C:S Ratio	N:S Ratio
North	A3/5-10	4.5	0.215	0.011	0.001	20	215	11
North	B3/5-10	4.4	0.358	0.018	0.001	20	358	18
North	C3/5-10	4.1	0.405	0.021	0.001	19	405	21
North	D3/5-10	4.4	0.331	0.027	0.001	12	331	27
North	E3/5-10	4.2	0.429	0.010	0.001	43	429	10
North	F3/5-10	4.2	0.253	0.029	0.001	9	253	29
North	G3/5-10	4.4	0.571	0.032	0.001	18	571	32
North	H3/5-10	4.5	0.203	0.024	0.001	8	203	24
North	I3/5-10	4.3	0.493	0.025	0.001	20	493	25
North	J3/5-10	4.3	0.207	0.019	0.001	11	207	19
North	K3/5-10	4.0	0.507	0.036	0.001	14	507	36
North	L3/5-10	4.4	0.596	0.022	0.001	27	596	22
	Mean	4.31	0.381	0.023	0.001	18.4	381	22.8
	SD	0.16	0.142	0.008	0.000	9.5	142	7.8
	CV	0.04	0.37	0.341	0.000	0.52	0.37	0.34
South	A3/5-10	4.4	0.684	0.029	0.001	24	684	29
South	B3/5-10	4.1	0.718	0.026	0.001	28	718	26
South	C3/5-10	4.2	0.389	0.025	0.001	16	389	25
South	D3/5-10	4.2	0.436	0.017	0.002	26	218	9
South	E3/5-10	4.3	0.351	0.008	0.002	44	176	4
South	F3/5-10	4.3	0.343	0.021	0.001	16	343	21
South	G3/5-10	4.6	0.468	0.031	0.003	15	156	10
South	H3/5-10	4.3	0.688	0.027	0.002	25	344	14
South	I3/5-10	4.2	0.572	0.030	0.002	19	286	15
South	J3/5-10	4.4	0.438	0.028	0.001	16	438	28
South	K3/5-10	4.4	0.375	0.034	0.001	11	375	34
South	L3/5-10	4.3	0.419	0.026	0.001	16	419	26
	Mean	4.31	0.490	0.025	0.0015	21.3	378.8	20.0
	SD	0.13	0.139	0.007	0.0007	8.8	176.2	9.5
	CV	0.03	0.28	0.28	0.45	0.42	0.47	0.47

Appendix Table A3. Total Carbon, Nitrogen and Sulphur – 2020 Data and Descriptive Statistics – (concluded)

Sub-site	Subplot/ Layer	pHc *	Total C (%)	Total N (%)	Total S (%)	C:N Ratio	C:S Ratio	N:S Ratio
North	A3/10-15	4.5	0.253	0.009	0.002	28	127	5
North	B3/10-15	4.5	0.145	0.008	0.001	18	145	8
North	C3/10-15	4.1	0.267	0.023	0.003	12	89	8
North	D3/10-15	4.3	0.201	0.022	0.001	9	201	22
North	E3/10-15	4.2	0.185	0.006	0.001	31	185	6
North	F3/10-15	4.2	0.242	0.024	0.001	10	242	24
North	G3/10-15	4.4	0.239	0.026	0.001	9	239	26
North	H3/10-15	4.4	0.142	0.014	0.001	10	142	14
North	I3/10-15	4.3	0.242	0.018	0.001	14	242	18
North	J3/10-15	4.4	0.202	0.022	0.001	9	202	22
North	K3/10-15	4.0	0.219	0.024	0.001	9	219	24
North	L3/10-15	4.5	0.228	0.018	0.001	13	228	18
	Mean	4.32	0.214	0.018	0.0013	14.4	188	16.1
	SD	0.16	0.040	0.007	0.0006	7.6	51	7.8
	CV	0.04	0.19	0.39	0.50	0.53	0.27	0.48
South	A3/10-15	4.3	0.417	0.027	0.001	15	417	27
South	B3/10-15	4.5	0.252	0.013	0.001	19	252	13
South	C3/10-15	4.2	0.317	0.022	0.002	14	159	11
South	D3/10-15	4.6	0.283	0.028	0.003	10	94	9
South	E3/10-15	4.6	0.182	0.021	0.001	9	182	21
South	F3/10-15	4.35	0.298	0.021	0.001	14	298	21
South	G3/10-15	4.4	0.324	0.016	0.002	20	162	8
South	H3/10-15	4.5	0.386	0.017	0.001	23	386	17
South	I3/10-15	4.1	0.285	0.025	0.001	11	285	25
South	J3/10-15	4.4	0.263	0.026	0.001	10	263	26
South	K3/10-15	4.5	0.216	0.025	0.001	9	216	25
South	L3/10-15	4.5	0.233	0.012	0.001	19	233	12
	Mean	4.41	0.288	0.021	0.0013	14.6	246	17.9
	SD	0.15	0.067	0.005	0.0007	4.9	93.6	7.1
	CV	0.03	0.23	0.26	0.49	0.34	0.38	0.39

APPENDIX B

SAMPLE IDENTIFICATION

TUCKER LAKE SOIL MONITORING SITE - 2020

Table B1. Lab Report - Sample Identification

Project: Permanent Site -Acid Deposition -Tucker Lake *

Project Leader: Salim Abboud; Project Contact: Larry Turchenek

Date Received: Oct. 13, 2020

Date Sampled	Site	Plot	Field Id.	Lab I.D. (2020)	pH (CaCl2)	C.E.C. (BaCl2)	Total Carbon	Total Nitrogen	Total Sulfur	Sat.Paste(pH,E.C.,Sat'n, Ca,Mg,Na,K,Al,Fe,Mn,S)
09-Oct-2020	Tucker Lake	North	A3/LFH	385	1		1	1	1	
10-Oct-2020	Tucker Lake	North	A3/0-2	386	1	1	1	1	1	1
	Tucker Lake	North	A3/2-5	387	1	1	1	1	1	1
	Tucker Lake	North	A3/5-10	388	1	1	1	1	1	1
	Tucker Lake	North	A3/10-15	389	1	1	1	1	1	1
	Tucker Lake	North	A3/15-30	390						
	Tucker Lake	North	A3/30-45	391						
	Tucker Lake	North	A3/45-60	392						
	Tucker Lake	North	B3/LFH	393	1		1	1	1	
	Tucker Lake	North	B3/0-2	394	1	1	1	1	1	1
	Tucker Lake	North	B3/2-5	395	1	1	1	1	1	1
	Tucker Lake	North	B3/5-10	396	1	1	1	1	1	1
	Tucker Lake	North	B3/10-15	397	1	1	1	1	1	1
	Tucker Lake	North	B3/15-30	398						
	Tucker Lake	North	B3/30-45	399						
	Tucker Lake	North	B3/45-60	400						
	Tucker Lake	North	C3/LFH	401	1		1	1	1	
	Tucker Lake	North	C3/0-2	402	1	1	1	1	1	1
	Tucker Lake	North	C3/2-5	403	1	1	1	1	1	1
	Tucker Lake	North	C3/5-10	404	1	1	1	1	1	1
	Tucker Lake	North	C3/10-15	405	1	1	1	1	1	1
	Tucker Lake	North	C3/15-30	406						
	Tucker Lake	North	C3/30-45	407						
	Tucker Lake	North	C3/45-60	408						
	Tucker Lake	North	D3/LFH	409	1		1	1	1	
	Tucker Lake	North	D3/0-2	410	1	1	1	1	1	1
	Tucker Lake	North	D3/2-5	411	1	1	1	1	1	1
	Tucker Lake	North	D3/5-10	412	1	1	1	1	1	1
	Tucker Lake	North	D3/10-15	413	1	1	1	1	1	1
	Tucker Lake	North	D3/15-30	414						
	Tucker Lake	North	D3/30-45	415						
	Tucker Lake	North	D3/45-60	416						
	Tucker Lake	North	E3/LFH	417	1		1	1	1	

Date Sampled	Site	Plot	Field Id.	Lab I.D. (2020)	pH (CaCl2)	C.E.C. (BaCl2)	Total Carbon	Total Nitrogen	Total Sulfur	Sat.Paste(pH,E.C.,Sat'n, Ca,Mg,Na,K,Al,Fe,Mn,S)
	Tucker Lake	North	E3/2-5	419	1	1	1	1	1	1
	Tucker Lake	North	E3/5-10	420	1	1	1	1	1	1
	Tucker Lake	North	E3/10-15	421	1	1	1	1	1	1
	Tucker Lake	North	E3/15-30	422						
	Tucker Lake	North	E3/30-45	423						
	Tucker Lake	North	E3/45-60	424						
	Tucker Lake	North	F3/LFH	425	1		1	1	1	
	Tucker Lake	North	F3/0-2	426	1	1	1	1	1	1
	Tucker Lake	North	F3/2-5	427	1	1	1	1	1	1
	Tucker Lake	North	F3/5-10	428	1	1	1	1	1	1
	Tucker Lake	North	F3/10-15	429	1	1	1	1	1	1
	Tucker Lake	North	F3/15-30	430						
	Tucker Lake	North	F3/30-45	431						
	Tucker Lake	North	F3/45-60	432						
	Tucker Lake	North	G3/LFH	433	1		1	1	1	
	Tucker Lake	North	G3/0-2	434	1	1	1	1	1	1
	Tucker Lake	North	G3/2-5	435	1	1	1	1	1	1
	Tucker Lake	North	G3/5-10	436	1	1	1	1	1	1
	Tucker Lake	North	G3/10-15	437	1	1	1	1	1	1
	Tucker Lake	North	G3/15-30	438						
	Tucker Lake	North	G3/30-45	439						
	Tucker Lake	North	G3/45-60	440						
	Tucker Lake	North	H3/LFH	441	1		1	1	1	
	Tucker Lake	North	H3/0-2	442	1	1	1	1	1	1
	Tucker Lake	North	H3/2-5	443	1	1	1	1	1	1
	Tucker Lake	North	H3/5-10	444	1	1	1	1	1	1
	Tucker Lake	North	H3/10-15	445	1	1	1	1	1	1
	Tucker Lake	North	H3/15-30	446						
	Tucker Lake	North	H3/30-45	447						
	Tucker Lake	North	H3/45-60	448						
	Tucker Lake	North	I3/LFH	449	1		1	1	1	
	Tucker Lake	North	I3/0-2	450	1	1	1	1	1	1
	Tucker Lake	North	I3/2-5	451	1	1	1	1	1	1
	Tucker Lake	North	I3/5-10	452	1	1	1	1	1	1
	Tucker Lake	North	I3/10-15	453	1	1	1	1	1	1
	Tucker Lake	North	I3/15-30	454						
	Tucker Lake	North	I3/30-45	455						
	Tucker Lake	North	I3/45-60	456						
	Tucker Lake	North	J3/LFH	457	1		1	1	1	
	Tucker Lake	North	J3/0-2	458	1	1	1	1	1	1
	Tucker Lake	North	J3/2-5	459	1	1	1	1	1	1

Date Sampled	Site	Plot	Field Id.	Lab I.D. (2020)	pH (CaCl2)	C.E.C. (BaCl2)	Total Carbon	Total Nitrogen	Total Sulfur	Sat.Paste(pH,E.C.,Sat'n, Ca,Mg,Na,K,Al,Fe,Mn,S)
	Tucker Lake	North	J3/10-15	461	1	1	1	1	1	1
	Tucker Lake	North	J3/15-30	462						
	Tucker Lake	North	J3/30-45	463						
	Tucker Lake	North	J3/45-60	464						
	Tucker Lake	North	K3/LFH	465	1		1	1	1	
	Tucker Lake	North	K3/0-2	466	1	1	1	1	1	1
	Tucker Lake	North	K3/2-5	467	1	1	1	1	1	1
	Tucker Lake	North	K3/5-10	468	1	1	1	1	1	1
	Tucker Lake	North	K3/10-15	469	1	1	1	1	1	1
	Tucker Lake	North	K3/15-30	470						
	Tucker Lake	North	K3/30-45	471						
	Tucker Lake	North	K3/45-60	472						
	Tucker Lake	North	L3/LFH	473	1		1	1	1	
	Tucker Lake	North	L3/0-2	474	1	1	1	1	1	1
	Tucker Lake	North	L3/2-5	475	1	1	1	1	1	1
	Tucker Lake	North	L3/5-10	476	1	1	1	1	1	1
	Tucker Lake	North	L3/10-15	477	1	1	1	1	1	1
	Tucker Lake	North	L3/15-30	478						
	Tucker Lake	North	L3/30-45	479						
	Tucker Lake	North	L3/45-60	480						
	Tucker Lake	South	A3/LFH	481	1		1	1	1	
	Tucker Lake	South	A3/0-2	482	1	1	1	1	1	1
	Tucker Lake	South	A3/2-5	483	1	1	1	1	1	1
	Tucker Lake	South	A3/5-10	484	1	1	1	1	1	1
	Tucker Lake	South	A3/10-15	485	1	1	1	1	1	1
	Tucker Lake	South	A3/15-30	486						
	Tucker Lake	South	A3/30-45	487						
	Tucker Lake	South	A3/45-60	488						
	Tucker Lake	South	B3/LFH	489	1		1	1	1	
	Tucker Lake	South	B3/0-2	490	1	1	1	1	1	1
	Tucker Lake	South	B3/2-5	491	1	1	1	1	1	1
	Tucker Lake	South	B3/5-10	492	1	1	1	1	1	1
	Tucker Lake	South	B3/10-15	493	1	1	1	1	1	1
	Tucker Lake	South	B3/15-30	494						
	Tucker Lake	South	B3/30-45	495						
	Tucker Lake	South	B3/45-60	496						
	Tucker Lake	South	C3/LFH	497	1		1	1	1	
	Tucker Lake	South	C3/0-2	498	1	1	1	1	1	1
	Tucker Lake	South	C3/2-5	499	1	1	1	1	1	1
	Tucker Lake	South	C3/5-10	500	1	1	1	1	1	1
	Tucker Lake	South	C3/10-15	501	1	1	1	1	1	1

Date Sampled	Site	Plot	Field Id.	Lab I.D. (2020)	pH (CaCl2)	C.E.C. (BaCl2)	Total Carbon	Total Nitrogen	Total Sulfur	Sat.Paste(pH,E.C.,Sat'n, Ca,Mg,Na,K,Al,Fe,Mn,S)
	Tucker Lake	South	C3/30-45	503						
	Tucker Lake	South	C3/45-60	504						
	Tucker Lake	South	D3/LFH	505	1		1	1	1	
	Tucker Lake	South	D3/0-2	506	1	1	1	1	1	1
	Tucker Lake	South	D3/2-5	507	1	1	1	1	1	1
	Tucker Lake	South	D3/5-10	508	1	1	1	1	1	1
	Tucker Lake	South	D3/10-15	509	1	1	1	1	1	1
	Tucker Lake	South	D3/15-30	510						
	Tucker Lake	South	D3/30-45	511						
	Tucker Lake	South	D3/45-60	512						
	Tucker Lake	South	E3/LFH	513	1		1	1	1	
	Tucker Lake	South	E3/0-2	514	1	1	1	1	1	1
	Tucker Lake	South	E3/2-5	515	1	1	1	1	1	1
	Tucker Lake	South	E3/5-10	516	1	1	1	1	1	1
	Tucker Lake	South	E3/10-15	517	1	1	1	1	1	1
	Tucker Lake	South	E3/15-30	518						
	Tucker Lake	South	E3/30-45	519						
	Tucker Lake	South	E3/45-60	520						
	Tucker Lake	South	F3/LFH	521	1		1	1	1	
	Tucker Lake	South	F3/0-2	522	1	1	1	1	1	1
	Tucker Lake	South	F3/2-5	523	1	1	1	1	1	1
	Tucker Lake	South	F3/5-10	524	1	1	1	1	1	1
	Tucker Lake	South	F3/10-15	525	1	1	1	1	1	1
	Tucker Lake	South	F3/15-30	526						
	Tucker Lake	South	F3/30-45	527						
	Tucker Lake	South	F3/45-60	528						
	Tucker Lake	South	G3/LFH	529	1		1	1	1	
	Tucker Lake	South	G3/0-2	530	1	1	1	1	1	1
	Tucker Lake	South	G3/2-5	531	1	1	1	1	1	1
	Tucker Lake	South	G3/5-10	532	1	1	1	1	1	1
	Tucker Lake	South	G3/10-15	533	1	1	1	1	1	1
	Tucker Lake	South	G3/15-30	534						
	Tucker Lake	South	G3/30-45	535						
	Tucker Lake	South	G3/45-60	536						
	Tucker Lake	South	H3/LFH	537	1		1	1	1	
	Tucker Lake	South	H3/0-2	538	1	1	1	1	1	1
	Tucker Lake	South	H3/2-5	539	1	1	1	1	1	1
	Tucker Lake	South	H3/5-10	540	1	1	1	1	1	1
	Tucker Lake	South	H3/10-15	541	1	1	1	1	1	1
	Tucker Lake	South	H3/15-30	542						
	Tucker Lake	South	H3/30-45	543						

Date Sampled	Site	Plot	Field Id.	Lab I.D. (2020)	pH (CaCl2)	C.E.C. (BaCl2)	Total Carbon	Total Nitrogen	Total Sulfur	Sat.Paste(pH,E.C.,Sat'n, Ca,Mg,Na,K,Al,Fe,Mn,S)
	Tucker Lake	South	I3/LFH	545	1		1	1	1	
	Tucker Lake	South	I3/0-2	546	1	1	1	1	1	1
	Tucker Lake	South	I3/2-5	547	1	1	1	1	1	1
	Tucker Lake	South	I3/5-10	548	1	1	1	1	1	1
	Tucker Lake	South	I3/10-15	549	1	1	1	1	1	1
	Tucker Lake	South	I3/15-30	550						
	Tucker Lake	South	I3/30-45	551						
	Tucker Lake	South	I3/45-60	552						
	Tucker Lake	South	J3/LFH	553	1		1	1	1	
	Tucker Lake	South	J3/0-2	554	1	1	1	1	1	1
	Tucker Lake	South	J3/2-5	555	1	1	1	1	1	1
	Tucker Lake	South	J3/5-10	556	1	1	1	1	1	1
	Tucker Lake	South	J3/10-15	557	1	1	1	1	1	1
	Tucker Lake	South	J3/15-30	558						
	Tucker Lake	South	J3/30-45	559						
	Tucker Lake	South	J3/45-60	560						
	Tucker Lake	South	K3/LFH	561	1		1	1	1	
	Tucker Lake	South	K3/0-2	562	1	1	1	1	1	1
	Tucker Lake	South	K3/2-5	563	1	1	1	1	1	1
	Tucker Lake	South	K3/5-10	564	1	1	1	1	1	1
	Tucker Lake	South	K3/10-15	565	1	1	1	1	1	1
	Tucker Lake	South	K3/15-30	566						
	Tucker Lake	South	K3/30-45	567						
	Tucker Lake	South	K3/45-60	568						
	Tucker Lake	South	L3/LFH	569	1		1	1	1	
	Tucker Lake	South	L3/0-2	570	1	1	1	1	1	1
	Tucker Lake	South	L3/2-5	571	1	1	1	1	1	1
	Tucker Lake	South	L3/5-10	572	1	1	1	1	1	1
	Tucker Lake	South	L3/10-15	573	1	1	1	1	1	1
	Tucker Lake	South	L3/15-30	574						
	Tucker Lake	South	L3/30-45	575						
	Tucker Lake	South	L3/45-60	576						
				Total Ana=	120	96	120	120	120	96

* as received from laboratory