LICA LONG TERM SOIL ACIDIFICATION MONITORING
MOOSE LAKE SITE - 2018

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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. Soil sampling and laboratory analysis of soil samples to establish baseline soil chemistry data for the site was completed at that time. The intended long term monitoring interval is four years. This report presents the data from the third sampling event carried out in fall of 2018.

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 *Long Term Soil Acidification Monitoring in the LICA Study Area* (Abboud and Turchenek 2011).

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, total sulphur content can increase in the LFH and surface mineral soil layers due to deposition of sulphur oxides. Carbon and nitrogen analyses are included in 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 to determine variability in the data. Base saturation and pHc were the least variable, while BC:Al ratio had CVs up to 0.78, dissolved ions had CVs mainly in the 0.3 to 0.7 range, with some spikes to higher values. Total C, N and S, as well as the ratios of these with each other, were highly variable, particularly in the upper mineral layers.

Differences in acidification parameters between sub-sites (East and West) were suggested by previous data in 2010 and 2014, but evidence for this is not as strong with the additional 2018 data. Significant differences were detected in some acidification parameters, but trends over time were not apparent. Differences among the three sampling years, spanning an eight year period, are attributed to natural variability of the soil properties.

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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. Soil sampling and laboratory analysis of soil samples to establish baseline soil chemistry data for the site was completed at that time. The long term monitoring was established to re-sample soils at four year intervals. Reports presenting monitoring results have been prepared for the first (2010) and second (2014) sampling events (Abboud and Turchenek, 2011; Abboud and Turchenek, 2015). This report presents the data from the third sampling event carried out in fall of 2018.

Background information, site selection and results of the first sampling event are described in Long Term Soil Acidification Monitoring in the LICA Study Area (Abboud and Turchenek 2011). The LICA monitoring system follows the protocols of Alberta Environment and Parks in their Long Term Soil Acidification Monitoring Program (Roberts et al. 1989). This program consists of eight monitoring sites established in the late 1980s throughout the Province of Alberta. One of these sites is located within the LICA study area, providing a historical monitoring basis for the LICA program. In addition to the site established at Moose Lake in 2010, two other sites were set up, one in Whitney Lakes Provincial Park in 2011, and one near Tucker Lake, northeast of the Town of Bonnyville, in 2012.

Each monitoring site consists of two sub-sites; these are referred to as the West and East sub-sites at the Moose Lake monitoring site. Each sub-site is delineated by a 24 m by 24 m area that is further subdivided into plots and subplots for replication purposes. At each of the sub-sites (i.e., East and West), twelve replicate samples are taken from 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 2011 report.

All soil chemical parameters (see Section 2.2) were measured for all replicates and all layers in the initial monitoring event in 2010. The purpose was to establish the baseline for the entire depth of sampling. In the second sampling event, and in subsequent years, only the LFH, 0-2, 2-5, 5-10, and 10-15 cm depth are being analyzed. This is done in part to reduce the analytical costs associated with monitoring. In addition, it has been shown that any effects to date have occurred only in the surface soil layers in the AEP long term monitoring program (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 occurring to depths greater than 15 cm.

2.0 METHODS

2.1 SOIL SAMPLING

Soil sampling was carried out as described in Section 4.2.2 of the 2011 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. Processing of samples consisted of drying at about 30°C and then passing them through a 2 mm sieve. 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 material is 1:4 and for mineral soil is 1:2. Solution is $CaCl_2$. 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 0.1 M $BaCl_2$ extraction, and measurement of Ba by ICP-OES.
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 CN Carbon/Nitrogen 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. 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 in order to examine differences between the two sub-sites (East and West) and the three sampling years (2010, 2014 and 2018). Tukey's test (Steel and Torrie 1980, 1960) was subsequently carried out on these attributes in order to determine whether differences in the data were statistically significant (at the 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 detailed discussion of these is presented in the 2011 LICA soil monitoring report (Abboud and Turchenek 2011). Of the attributes, research has demonstrated effects on vegetation mainly with respect 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 (TC), nitrogen (TN) and sulphur (TS) in surface soil horizons. In particular, sulphur content can increase in the LFH and surface mineral soil layers due to deposition of sulphur oxides. Carbon and nitrogen levels are included in 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 East and West Moose 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 analysis associated with each sample.

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

3.2.1 pHc

The data show significant differences in pHc (pH of soil mixed with $CaCl_2$ solution) in soil layers among the years 2010, 2014 and 2018. In the 0-2 cm layer of both the West and East sub-sites, a difference of 0.2 units is seen between 2010 and 2018 (Table 2). In the lower three mineral layers, a pH reduction of about 0.1 unit occurs only in the West sub-site. Variability is low, with coefficients of variation (CV) being 0.06 or lower.

3.2.2 Base Saturation

Base saturation is a key acidification indicator defined as the proportion of exchangeable base cations (K, Na, Ca and Mg) to the cation exchange capacity (Table 2). A small but statistically significant difference occurs only in the 2-5 cm layer in the West sub-site. Coefficients of variation range from 0.05 to 0.15 among the layers and sampling years.

Table 2. Soil pH, Base Saturation, Cation Exchange Capacity and Exchangeable Bases at the Moose Lake Site – 2010, 2014 and 2018

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**
2010	**West**	4.08	b	0.22	0.05	4.69	b	0.18	0.04	4.94	c	0.20	0.04	4.88	b	0.15	0.03	4.82	b	0.15	0.03
2014	**West**	3.79	a	0.13	0.03	4.34	a	0.20	0.05	4.53	a	0.20	0.04	4.62	a	0.18	0.04	4.72	ab	0.19	0.04
2018	**West**	4.19	bc	0.16	0.04	4.57	ab	0.26	0.06	4.70	ab	0.17	0.04	4.64	a	0.19	0.04	4.56	a	0.16	0.03
2010	**East**	4.33	c	0.23	0.05	4.68	b	0.19	0.04	4.81	bc	0.13	0.03	4.76	ab	0.16	0.03	4.73	ab	0.16	0.03
2014	**East**	4.18	bc	0.13	0.03	4.50	ab	0.24	0.05	4.70	ab	0.20	0.04	4.63	a	0.17	0.04	4.58	a	0.14	0.03
2018	**East**	3.90	ab	0.18	0.05	4.56	ab	0.11	0.02	4.80	bc	0.17	0.04	4.80	ab	0.14	0.03	4.80	b	0.10	0.02
Base Saturation (sum of exchangeable base cations as a proportion of CEC)																					
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2010	**West**	-	-	-	-	0.81	a	0.06	0.08	0.87	b	0.06	0.07	0.83	a	0.09	0.11	0.80	ab	0.10	0.12
2014	**West**	-	-	-	-	0.74	a	0.11	0.15	0.77	a	0.10	0.14	0.78	a	0.11	0.14	0.79	ab	0.11	0.14
2018	**West**					0.82	a	0.09	0.11	0.80	ab	0.08	0.10	0.77	a	0.07	0.09	0.73	a	0.07	0.09
2010	**East**	-	-	-	-	0.83	a	0.08	0.10	0.81	ab	0.06	0.08	0.74	a	0.08	0.11	0.72	a	0.08	0.11
2014	**East**	-	-	-	-	0.84	a	0.09	0.11	0.85	ab	0.07	0.09	0.79	a	0.09	0.11	0.74	a	0.07	0.10
2018	**East**					0.78	a	0.06	0.07	0.84	ab	0.05	0.06	0.84	a	0.06	0.07	0.86	b	0.04	0.05
Cation Exchange Capacity (cmol/kg)																					
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2010	**West**	-	-	-	-	3.56	a	0.96	0.27	2.26	ab	0.89	0.39	1.09	a	0.16	0.15	0.85	a	0.13	0.15
2014	**West**	-	-	-	-	3.77	a	1.63	0.43	2.28	ab	1.29	0.56	1.28	ab	0.35	0.27	1.01	a	0.22	0.22
2018	**West**					5.40	ab	1.80	0.33	2.72	ab	2.29	0.84	1.25	a	0.40	0.32	0.85	a	0.19	0.22
2010	**East**	-	-	-	-	3.91	a	0.92	0.24	2.71	ab	1.27	0.47	1.23	a	0.28	0.23	0.95	a	0.15	0.16
2014	**East**	-	-	-	-	6.20	b	3.22	0.52	3.49	b	1.07	0.31	1.84	b	0.96	0.52	1.09	a	0.35	0.32
2018	**East**					3.52	a	1.26	0.36	1.65	a	0.62	0.38	1.06	a	0.36	0.34	0.81	a	0.30	0.37
Sum of Bases (cmol/kg)																					
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2010	**West**	-	-	-	-	2.88	a	0.88	0.31	1.99	ab	0.89	0.45	0.91	a	0.19	0.21	0.69	a	0.17	0.25
2014	**West**	-	-	-	-	2.86	a	1.52	0.53	1.81	ab	1.19	0.65	1.02	ab	0.37	0.36	0.81	a	0.24	0.29
2018	**West**					4.51	ab	1.91	0.42	2.29	ab	2.28	0.99	0.97	ab	0.38	0.39	0.63	a	0.18	0.28
2010	**East**	-	-	-	-	3.06	a	1.00	0.33	2.24	ab	1.14	0.51	0.93	ab	0.28	0.30	0.69	a	0.16	0.24
2014	**East**	-	-	-	-	5.39	b	3.26	0.60	3.02	b	1.02	0.34	1.49	b	0.90	0.61	0.82	a	0.31	0.38
2018	**East**					2.79	a	1.12	0.40	1.38	a	0.56	0.40	0.89	a	0.30	0.34	0.69	a	0.25	0.37

Abbreviations: pHc – pH measured in 0.01M $CaCl_2$ Exch Bases – sum of exchangeable K, Na, Ca and Mg CEC – cation exchange capacity
BSat – base saturation (sum of exchangeable bases/CEC) 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 3. Water Soluble Ions and Base Cation:Aluminum Ratios at the Moose Lake Site – 2010, 2014 and 2018

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**
2010	**West**	3.38	a	1.09	0.32	2.68	a	1.69	0.63	1.53	a	0.42	0.27	1.51	a	0.57	0.38
2014	**West**	8.21	ab	4.25	0.52	4.72	ab	1.82	0.39	3.40	ab	1.21	0.36	3.68	bc	1.97	0.54
2018	**West**	7.82	ab	3.29	0.42	4.91	ab	3.84	0.78	3.00	a	0.79	0.26	2.48	ab	0.84	0.34
2010	**East**	9.30	b	5.64	0.61	5.02	ab	2.82	0.56	2.77	a	1.24	0.45	2.08	ab	0.77	0.37
2014	**East**	11.25	b	8.33	0.74	6.31	b	2.14	0.34	5.26	b	3.85	0.73	4.80	c	2.81	0.59
2018	**East**	6.42	ab	1.99	0.31	3.40	a	1.14	0.33	2.52	a	0.75	0.30	2.12	ab	0.57	0.27
K (mmol/L)																	
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2010	**West**	0.16	a	0.07	0.42	0.09	a	0.04	0.43	0.06	a	0.03	0.52	0.05	a	0.02	0.44
2014	**West**	0.27	ab	0.14	0.51	0.17	ab	0.07	0.42	0.11	ab	0.04	0.35	0.08	ab	0.03	0.33
2018	**West**	0.38	b	0.18	0.47	0.25	b	0.14	0.57	0.20	b	0.17	0.89	0.12	b	0.11	0.84
2010	**East**	0.24	ab	0.12	0.50	0.10	a	0.04	0.37	0.07	ab	0.05	0.75	0.04	a	0.03	0.68
2014	**East**	0.40	b	0.17	0.42	0.22	b	0.10	0.47	0.19	b	0.14	0.75	0.11	ab	0.07	0.68
2018	**East**	0.30	ab	0.14	0.46	0.18	ab	0.08	0.43	0.09	ab	0.03	0.33	0.06	ab	0.03	0.48
Ca (mmol/L)																	
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2010	**West**	0.46	a	0.17	0.37	0.35	ab	0.12	0.34	0.21	ab	0.07	0.32	0.14	a	0.06	0.44
2014	**West**	0.43	ab	0.20	0.46	0.29	a	0.13	0.44	0.23	ab	0.09	0.40	0.18	a	0.06	0.35
2018	**West**	0.70	ab	0.22	0.32	0.43	ab	0.21	0.48	0.27	ab	0.10	0.39	0.16	a	0.08	0.48
2010	**East**	0.87	b	0.50	0.58	0.50	b	0.23	0.45	0.25	ab	0.08	0.32	0.15	a	0.04	0.28
2014	**East**	0.83	b	0.27	0.32	0.47	ab	0.13	0.27	0.31	b	0.11	0.34	0.20	a	0.08	0.41
2018	**East**	0.42	a	0.15	0.36	0.30	a	0.12	0.40	0.20	a	0.07	0.37	0.14	a	0.04	0.27

Table 3. Water Soluble Ions and Base Cation:Aluminum Ratios at the Moose Lake Site – 2010, 2014 and 2018 (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**
2010	**West**	0.14	ab	0.05	0.38	0.11	ab	0.04	0.33	0.08	ab	0.03	0.38	0.06	ab	0.02	0.39
2014	**West**	0.13	a	0.05	0.39	0.09	ab	0.04	0.42	0.07	a	0.03	0.39	0.06	ab	0.02	0.41
2018	**West**	0.23	bc	0.09	0.39	0.14	ab	0.09	0.64	0.09	ab	0.05	0.56	0.05	a	0.03	0.60
2010	**East**	0.26	c	0.12	0.45	0.16	b	0.07	0.42	0.10	ab	0.04	0.38	0.07	ab	0.03	0.40
2014	**East**	0.28	c	0.08	0.30	0.16	b	0.05	0.28	0.12	b	0.04	0.35	0.09	b	0.02	0.28
2018	**East**	0.13	a	0.04	0.33	0.08	a	0.03	0.42	0.05	a	0.02	0.46	0.04	a	0.02	0.46
Al (mmol/L)																	
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2010	**West**	0.23	a	0.05	0.22	0.24	b	0.08	0.35	0.23	b	0.07	0.28	0.17	a	0.07	0.42
2014	**West**	0.17	a	0.22	1.30	0.13	a	0.05	0.37	0.13	a	0.06	0.44	0.12	a	0.08	0.68
2018	**West**	0.19	a	0.07	0.39	0.19	ab	0.06	0.31	0.19	ab	0.09	0.45	0.15	a	0.09	0.59
2010	**East**	0.18	a	0.06	0.33	0.19	ab	0.10	0.54	0.18	ab	0.09	0.49	0.13	a	0.04	0.32
2014	**East**	0.24	a	0.19	0.79	0.15	a	0.06	0.37	0.14	ab	0.06	0.45	0.11	a	0.07	0.63
2018	**East**	0.15	a	0.04	0.27	0.17	ab	0.05	0.26	0.14	0.a	0.04	0.26	0.12	a	0.03	0.26

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 Soil Carbon, Nitrogen and Sulphur at the Moose Lake Site – 2010, 2014 and 2018

Total Carbon (%)		LFH (cm)				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**
2010	West	29.92	a	8.24	0.28	1.48	a	0.38	0.25	0.80	ab	0.32	0.40	0.33	a	0.07	0.20	0.26	a	0.04	0.16
2014	West	32.70	a	11.03	0.34	2.00	ab	0.86	0.43	0.94	ab	0.43	0.45	0.43	a	0.14	0.32	0.28	ab	0.08	0.28
2018	West	35.81	abc	5.64	0.16	2.69	bc	0.68	0.25	1.15	ab	0.85	0.74	0.38	a	0.13	0.25	0.32	ab	0.06	0.18
2010	East	41.48	b	3.70	0.09	2.63	bc	1.05	0.40	1.07	ab	0.70	0.65	0.44	a	0.15	0.34	0.26	ab	0.03	0.11
2014	East	37.85	ab	5.87	0.16	3.15	c	1.14	0.36	1.39	b	0.53	0.38	0.75	b	0.39	0.52	0.38	b	0.20	0.53
2018	East	32.14	a	6.46	0.20	1.76	ab	0.54	0.31	0.61	a	0.20	0.33	0.60	ab	0.14	0.36	0.26	ab	0.06	0.23
Total Nitrogen (%)																					
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2010	West	0.74	a	0.28	0.38	0.02	a	0.01	0.25	0.01	a	0.00	0.51	0.01	a	0.00	0.00	0.01	a	0.00	0.00
2014	West	0.91	ab	0.26	0.28	0.08	b	0.03	0.32	0.04	c	0.01	0.29	0.03	c	0.00	0.17	0.02	c	0.00	0.16
2018	West	1.06	b	0.20	0.19	0.09	b	0.02	0.26	0.04	bc	0.02	0.63	0.02	b	0.00	0.22	0.01	ab	0.01	0.47
2010	East	1.18	b	0.19	0.16	0.08	b	0.04	0.51	0.02	ab	0.02	1.04	0.01	a	0.00	0.00	0.01	a	0.00	0.00
2014	East	1.11	b	0.17	0.15	0.13	c	0.04	0.32	0.07	d	0.02	0.29	0.04	d	0.01	0.30	0.03	d	0.01	0.28
2018	East	0.95	ab	0.24	0.25	0.06	b	0.01	0.22	0.02	a	0.00	0.26	0.01	ab	0.00	0.56	0.01	b	0.01	0.64
Total Sulphur (%)																					
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2010	West	0.090	a	0.028	0.32	0.004	a	0.001	0.22	0.002	a	0.000	0.21	0.002	a	0.001	0.33	0.001	a	0.001	0.36
2014	West	0.079	a	0.025	0.32	0.004	a	0.001	0.35	0.002	a	0.001	0.51	0.002	a	0.001	0.45	0.001	a	0.000	0.27
2018	West	0.097	ab	0.023	0.24	0.007	ab	0.004	0.51	0.004	a	0.003	0.66	0.002	a	0.001	0.47	0.002	a	0.001	0.43
2010	East	0.126	b	0.022	0.17	0.007	ab	0.002	0.34	0.004	a	0.001	0.29	0.002	a	0.001	0.25	0.002	a	0.000	0.26
2014	East	0.097	ab	0.017	0.17	0.008	b	0.004	0.45	0.004	a	0.002	0.56	0.003	a	0.001	0.52	0.002	a	0.001	0.53
2018	East	0.097	ab	0.029	0.30	0.005	ab	0.001	0.22	0.002	a	0.001	0.43	0.002	a	0.001	0.30	0.002	a	0.001	0.53
C:N Ratio																					
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2010	West	43.98	b	14.96	0.34	64.61	c	11.26	0.17	115.2	c	30.16	0.26	66.56	b	13.03	0.20	51.23	c	8.21	0.16
2014	West	35.61	ab	5.02	0.14	24.08	a	3.77	0.16	21.27	a	5.64	0.26	16.02	a	5.45	0.34	12.43	a	3.34	0.27
2018	West	34.08	a	2.95	0.09	29.60	ab	2.78	0.09	29.19	a	4.68	0.16	33.31	b	6.32	0.19	34.58	b	16.61	0.48
2010	East	35.92	ab	6.19	0.17	37.51	b	9.50	0.25	70.60	b	27.10	0.38	88.56	c	30.11	0.34	52.81	c	5.85	0.11
2014	East	34.28	a	4.17	0.12	24.41	a	3.12	0.13	20.77	a	3.30	0.16	17.15	a	4.76	0.28	12.43	a	3.46	0.28
2018	East	34.35	a	4.11	0.12	29.79	ab	6.18	0.21	35.22	a	12.13	0.34	53.65	b	23.00	0.43	35.51	b	24.20	0.68

Table 4. Total Soil Carbon, Nitrogen and Sulphur at the Moose Lake Site – 2010, 2014 and 2018 (Concluded)

C:S Ratio																					
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2010	West	347	a	96	0.28	379	a	60	0.16	341	a	99	0.29	238	a	106	0.44	203	ab	76	0.38
2014	West	413	a	70	0.17	531	a	293	0.55	539	a	374	0.69	338	a	189	0.56	267	ab	84	0.31
2018	West	379	a	64	0.17	434	a	160	0.37	364	a	217	0.60	280	a	122	0.44	194	ab	89	0.46
2010	East	338	a	62	0.18	369	a	88	0.24	292	a	100	0.34	222	a	81	0.37	165	a	63	0.38
2014	East	394	a	57	0.15	458	a	227	0.50	488	a	383	0.78	327	a	274	0.84	306	b	212	0.69
2018	East	340	a	53	0.16	339	a	132	0.39	362	a	289	0.80	207	a	101	0.49	192	ab	84	0.44
N:S Ratio																					
Year	**Sub-site**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**	**Mean**	**Sig**	**SD**	**CV**
2010	West	8.23	a	2.25	0.27	6.02	a	1.34	0.22	3.02	a	0.97	0.32	3.54	a	1.29	0.36	3.96	a	1.29	0.33
2014	West	11.59	d	0.87	0.07	21.45	c	10.06	0.47	24.11	c	12.00	0.50	20.22	b	5.76	0.28	21.83	b	4.59	0.21
2018	West	11.10	cd	1.58	0.14	14.71	bc	5.20	0.35	12.27	ab	6.89	0.56	8.28	a	3.02	0.37	6.65	a	3.80	0.57
2010	East	9.41	ab	0.35	0.04	10.28	ab	3.36	0.33	5.08	a	3.39	0.67	2.57	a	0.83	0.32	3.13	a	1.13	0.36
2014	East	11.48	d	0.64	0.06	18.56	bc	8.61	0.46	23.27	bc	17.80	0.77	18.39	b	9.44	0.51	23.92	b	11.67	0.49
2018	East	9.89	bc	0.87	0.09	11.39	ab	3.25	0.29	9.97	a	5.86	0.59	4.88	a	4.05	0.83	8.40	a	6.85	0.82

Abbreviations: See previous table.

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

Both parameters are variable, with CV ranging from 0.15 to 0.56 for CEC, and 0.15 to 0.84 for sum of bases (Table 2). In the 0-2 cm layer, both CEC and sum of bases are higher in the East sub-site than in the West sub-site. This is consistent among the three sampling years.

The cation exchange capacity values are not acidification indicators but are inputs for base saturation calculations. Differences in CEC and sum of bases are attributable to natural variability, and they may therefore contribute variability to the base saturation calculations.

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

The BC:Al ratios were consistently higher in 2014 as compared to 2010, in all soil layers (Table 3), but values in 2018 show some rebound toward the earlier values. This also applies to some extent to the Ca and Mg levels. Variability in BC:Al ratios is relatively high as indicated by CV values up to 0.78. Concentrations of water soluble ions are likewise quite variable, generally between 0.3 and 0.7, but with some spikes in values. While statistical significance is indicated in some cases, trends are not apparent.

3.2.5 Total Carbon (TC)

The LFH layer is included in the analysis of TC, TN and TS because of potential for accumulation of these over time. TC has relatively high variability, with CV ranging from 0.12 to 0.74 among all the layers (Table 4). However, CV values occur mainly in the lower part of the range. TC in the LFH and 0-2 cm layers was found in the 2014 sampling to be somewhat higher in the East sub-site as compared to the West sub-site. The 2018 TC levels in the East sub-site are lower than in the previous two sampling years, and thus do not provide further evidence of the earlier observations. Whether or not the TC levels differ between sites is of interest because, as noted previously, higher levels of carbon, reflecting higher organic matter content, are likely associated with the relatively higher CEC, bases and BC:Al ratios.

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

TN and TS contents are highest in the LFH layers, are very low in the mineral soil layers, and display variability similar to that for TC (Table 4). As for TC, the 2018 data as compared to 2014 and 2010 show lower values for TN and TS in some cases. There is no definite evidence of differences between sites, nor of trends over time.

As with TC, Total S levels in the mineral soil layers are highest in the 0-2 cm layers and with a couple exceptions, there are generally no significant differences among 2010, 2014 and 2018 sampling events. This parameter is of importance in monitoring over time, as sulphur can accumulate in the LFH layer and thus reflect the amount of deposition at a site. TS levels in the LFH layer show significant differences with some levels greater in the East sub-site as compared to the West sub-site. However, no trends over time are evident.

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

Of these ratios, C:S is of particular interest for the same reasons as indicated for TS above. If TS increases in the soil surface layers, it is expected that C:S would decrease. The C:S ratios are quite high, and variability is high. Significant differences are not apparent except in the 10-15 cm layer, although no definite trend is apparent.

4.0 CONCLUSION

Soil acidification parameters were examined using descriptive statistics and analysis of variance to determine variability in the data. Base saturation and pHc were the least variable, while BC:Al ratios had CVs up to 0.78, and individual dissolved ions were mainly in the range of 0.2 to 0.7, with Al up to 1.3 in one case. Total C, N and S were also examined as total S and the ratios of TC and TN to TS can indicate S accumulation over the long term. Levels of each of these were quite variable, particularly in the upper mineral layers.

Differences in acidification parameters between sub-sites (East and West) and among the three sampling years (2010, 2014 and 2018) are generally attributable to natural variability.

While significant differences were detected in some parameters, trends over time were not apparent. Differences among the three sampling years, spanning an eight year period, are attributed to natural variability of the soil properties.

5.0 REFERENCES

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APPENDIX A

DATA AND BASIC STATISTICS

MOOSE LAKE SOIL MONITORING SITE – 2018

Appendix Table A1. pHc, Cation Exchange Capacity and Exchangeable Ions - 2018 Data and Descriptive Statistics

Plot	Subplot/ Layer	pHc	Na (cmol/kg)	K	Ca	Mg	Al	Fe	Mn	TEC	Bases	Base Saturation
West	**A3/0-2**	4.6	0.062	0.136	2.22	0.327	0.168	<0.001	0.226	3.14	2.74	0.87
West	**B3/0-2**	5.1	0.079	0.228	7.58	0.995	0.022	<0.001	0.315	9.22	8.89	0.96
West	**C3/0-2**	4.0	0.062	0.159	2.86	0.345	0.997	<0.001	0.925	5.35	3.43	0.64
West	**D3/0-2**	4.8	0.060	0.118	5.84	0.695	0.100	<0.001	0.437	7.25	6.71	0.93
West	**E3/0-2**	4.6	0.062	0.085	3.75	0.445	0.307	<0.001	0.560	5.21	4.34	0.83
West	**F3/0-2**	4.3	0.061	0.116	4.06	0.531	0.612	<0.001	0.830	6.21	4.77	0.77
West	**G3/0-2**	4.5	0.064	0.086	1.83	0.179	0.349	<0.001	0.598	3.10	2.16	0.69
West	**H3/0-2**	4.7	0.065	0.179	4.66	0.539	0.163	<0.001	0.696	6.30	5.44	0.86
West	**I3/0-2**	4.6	0.064	0.094	2.78	0.265	0.261	<0.001	0.641	4.11	3.21	0.78
West	**J3/0-2**	4.5	0.083	0.121	2.18	0.248	0.249	<0.001	0.547	3.43	2.63	0.77
West	**K3/0-2**	4.6	0.059	0.107	4.17	0.479	0.248	<0.001	0.513	5.57	4.81	0.86
West	**L3/0-2**	4.5	0.058	0.092	4.40	0.392	0.372	<0.001	0.581	5.89	4.94	0.84
	Mean	4.6	0.065	0.127	3.86	0.453	0.321	<0.001	0.572	5.40	4.51	0.82
	Std Dev	0.3	0.008	0.043	1.67	0.224	0.260		0.196	1.80	1.91	0.09
	CV #	0.06	0.12	0.34	0.43	0.49	0.81		0.34	0.33	0.42	0.11
East	**A3/0-2**	4.6	0.058	0.096	2.03	0.197	0.330	<0.001	0.583	3.29	2.38	0.72
East	**B3/0-2**	4.7	0.074	0.110	1.75	0.197	0.215	<0.001	0.321	2.66	2.13	0.80
East	**C3/0-2**	4.6	0.045	0.097	3.83	0.368	0.438	<0.001	0.436	5.22	4.34	0.83
East	**D3/0-2**	4.6	0.035	0.180	3.22	0.344	0.435	0.000	0.548	4.77	3.78	0.79
East	**E3/0-2**	4.5	0.050	0.118	1.36	0.195	0.300	<0.001	0.331	2.36	1.73	0.73
East	**F3/0-2**	4.5	0.050	0.051	1.72	0.222	0.241	<0.001	0.326	2.61	2.04	0.78
East	**G3/0-2**	4.5	0.054	0.158	2.90	0.383	0.179	<0.001	0.490	4.16	3.49	0.84
East	**H3/0-2**	4.6	0.057	0.105	1.13	0.161	0.196	<0.001	0.236	1.89	1.46	0.77
East	**I3/0-2**	4.5	0.054	0.097	1.20	0.195	0.258	<0.001	0.368	2.17	1.54	0.71
East	**J3/0-2**	4.6	0.058	0.073	4.27	0.352	0.300	<0.001	0.698	5.75	4.75	0.83
East	**K3/0-2**	4.7	0.045	0.150	2.87	0.293	0.100	<0.001	0.394	3.86	3.36	0.87
East	**L3/0-2**	4.3	0.054	0.088	2.17	0.190	0.576	<0.001	0.493	3.57	2.50	0.70
	Mean	4.6	0.053	0.110	2.37	0.258	0.297	<0.000	0.435	3.52	2.79	0.78
	Std Dev	0.1	0.009	0.037	1.04	0.083	0.132		0.132	1.26	1.12	0.06
	CV #	0.02	0.18	0.33	0.44	0.32	0.44		0.30	0.36	0.40	0.07

Value of CV (St Dev/Mean) differs from calculations using Std Dev and Mean in this table because they are taken from the database calculations where data have additional decimal places.

Appendix Table A1. pHc, Cation Exchange Capacity and Exchangeable Ions - 2018 Data and Descriptive Statistics (continued)

Plot	Subplot/ Layer	pHc	Na	K	Ca	Mg	Al	Fe	Mn	TEC	Bases	Base Saturation
			(cmol/kg)									
West	**A3/2-5**	4.7	0.064	0.091	1.24	0.202	0.145	<0.001	0.167	1.90	1.59	0.84
West	**B3/2-5**	5.1	0.061	0.160	8.03	1.028	0.049	<0.001	0.392	9.73	9.28	0.95
West	**C3/2-5**	4.5	0.063	0.078	0.778	0.100	0.311	<0.001	0.216	1.55	1.02	0.66
West	**D3/2-5**	4.8	0.060	0.080	2.35	0.327	0.118	<0.001	0.335	3.27	2.82	0.86
West	**E3/2-5**	4.6	0.066	0.049	1.46	0.169	0.223	<0.001	0.285	2.26	1.75	0.77
West	**F3/2-5**	4.6	0.060	0.048	1.04	0.151	0.195	<0.001	0.232	1.73	1.30	0.75
West	**G3/2-5**	4.6	0.062	0.034	0.798	0.085	0.230	<0.001	0.161	1.37	0.98	0.71
West	**H3/2-5**	4.5	0.066	0.161	1.71	0.253	0.259	<0.001	0.395	2.85	2.19	0.77
West	**I3/2-5**	4.7	0.061	0.038	0.858	0.096	0.155	<0.001	0.211	1.42	1.05	0.74
West	**J3/2-5**	4.7	0.058	0.068	1.56	0.169	0.227	<0.001	0.371	2.46	1.86	0.76
West	**K3/2-5**	4.7	0.059	0.061	1.02	0.165	0.129	<0.001	0.120	1.56	1.31	0.84
West	**L3/2-5**	4.9	0.061	0.049	2.02	0.198	0.110	<0.001	0.187	2.62	2.32	0.89
	Mean	4.7	0.062	0.076	1.91	0.245	0.179	<0.001	0.256	2.72	2.29	0.80
	Std Dev	0.2	0.003	0.043	1.99	0.256	0.074		0.097	2.29	2.28	0.08
	CV	0.04	0.04	0.57	1.05	1.04	0.41		0.38	0.84	0.99	0.10
East	**A3/2-5**	4.9	0.060	0.040	0.898	0.118	0.079	<0.001	0.127	1.32	1.12	0.84
East	**B3/2-5**	4.8	0.064	0.049	0.609	0.081	0.095	<0.001	0.094	0.99	0.80	0.81
East	**C3/2-5**	4.6	0.026	0.057	1.26	0.156	0.347	0.005	0.079	1.93	1.50	0.78
East	**D3/2-5**	4.6	0.037	0.115	1.60	0.202	0.391	<0.001	0.189	2.53	1.95	0.77
East	**E3/2-5**	4.8	0.041	0.060	0.729	0.105	0.097	<0.001	0.063	1.10	0.94	0.85
East	**F3/2-5**	4.6	0.055	0.044	0.948	0.151	0.196	<0.001	0.143	1.54	1.20	0.78
East	**G3/2-5**	4.7	0.054	0.079	1.10	0.174	0.112	<0.001	0.141	1.66	1.41	0.85
East	**H3/2-5**	4.7	0.056	0.061	0.634	0.092	0.158	<0.001	0.054	1.05	0.84	0.80
East	**I3/2-5**	4.8	0.054	0.065	0.903	0.137	0.108	<0.001	0.134	1.40	1.16	0.83
East	**J3/2-5**	5.1	0.057	0.043	2.29	0.203	0.039	<0.001	0.187	2.82	2.59	0.92
East	**K3/2-5**	5.0	0.024	0.043	0.833	0.095	0.021	<0.001	0.064	1.08	1.00	0.92
East	**L3/2-5**	5.0	0.054	0.049	1.86	0.135	0.065	<0.001	0.158	2.32	2.09	0.90
	Mean	4.8	0.049	0.059	1.14	0.138	0.142	<0.001	0.119	1.65	1.38	0.84
	Std Dev	0.2	0.013	0.021	0.52	0.041	0.116		0.048	0.62	0.56	0.05
	CV	0.04	0.27	0.36	0.46	0.30	0.82		0.40	0.38	0.40	0.06

Appendix Table A1. pHc, Cation Exchange Capacity and Exchangeable Ions - 2018 Data and Descriptive Statistics (continued)

Plot	Subplot/ Layer	pHc	Na	K	Ca	Mg	Al	Fe	Mn	TEC	Bases	Base Saturation
			(cmol/kg)									
West	**A3/5-10**	4.5	0.058	0.072	0.689	0.135	0.219	<0.001	0.119	1.29	0.95	0.74
West	**B3/5-10**	4.9	0.061	0.061	1.64	0.245	0.116	<0.001	0.159	2.28	2.00	0.88
West	**C3/5-10**	4.7	0.060	0.044	0.559	0.072	0.157	<0.001	0.059	0.95	0.73	0.77
West	**D3/5-10**	4.6	0.060	0.084	0.659	0.128	0.168	0.005	0.101	1.21	0.93	0.77
West	**E3/5-10**	4.5	0.061	0.030	0.574	0.074	0.222	<0.001	0.079	1.04	0.74	0.71
West	**F3/5-10**	4.7	0.063	0.036	0.783	0.121	0.171	<0.001	0.135	1.31	1.00	0.77
West	**G3/5-10**	4.6	0.061	0.026	0.436	0.062	0.209	<0.001	0.031	0.82	0.58	0.71
West	**H3/5-10**	4.3	0.067	0.172	0.644	0.169	0.312	0.011	0.133	1.51	1.05	0.70
West	**I3/5-10**	4.6	0.057	0.020	0.403	0.050	0.180	<0.001	0.039	0.75	0.53	0.71
West	**J3/5-10**	4.8	0.061	0.035	0.694	0.096	0.089	<0.001	0.124	1.10	0.89	0.81
West	**K3/5-10**	4.5	0.045	0.048	0.771	0.136	0.287	<0.001	0.088	1.38	1.00	0.73
West	**L3/5-10**	5.0	0.055	0.028	0.978	0.124	0.063	<0.001	0.078	1.33	1.18	0.89
	Mean	4.6	0.059	0.055	0.74	0.118	0.183	0.002	0.095	1.25	0.97	0.77
	Std Dev	0.2	0.005	0.042	0.32	0.054	0.074	0.003	0.040	0.40	0.38	0.07
	CV	0.04	0.09	0.76	0.44	0.46	0.40	1.82	0.42	0.32	0.39	0.09
East	**A3/5-10**	4.6	0.064	0.031	0.428	0.079	0.152	<0.001	0.046	0.80	0.60	0.75
East	**B3/5-10**	4.8	0.054	0.027	0.405	0.059	0.079	<0.001	0.013	0.64	0.54	0.86
East	**C3/5-10**	4.6	0.023	0.062	1.03	0.121	0.426	0.021	0.026	1.71	1.23	0.72
East	**D3/5-10**	4.8	0.042	0.070	1.20	0.183	0.147	0.002	0.052	1.70	1.50	0.88
East	**E3/5-10**	4.9	0.067	0.042	0.744	0.111	0.132	0.001	0.018	1.11	0.96	0.86
East	**F3/5-10**	4.8	0.054	0.043	0.559	0.109	0.109	<0.001	0.026	0.90	0.77	0.85
East	**G3/5-10**	4.7	0.053	0.050	0.604	0.112	0.129	<0.001	0.050	1.00	0.82	0.82
East	**H3/5-10**	4.7	0.053	0.045	0.499	0.071	0.129	<0.001	0.032	0.83	0.67	0.81
East	**I3/5-10**	4.9	0.055	0.048	0.729	0.121	0.084	<0.001	0.076	1.11	0.95	0.86
East	**J3/5-10**	5.1	0.055	0.030	0.938	0.107	0.044	<0.001	0.050	1.22	1.13	0.92
East	**K3/5-10**	4.8	0.019	0.022	0.401	0.052	0.052	<0.001	0.013	0.56	0.49	0.88
East	**L3/5-10**	4.9	0.053	0.034	0.843	0.096	0.079	<0.001	0.052	1.16	1.03	0.89
	Mean	4.8	0.049	0.042	0.70	0.102	0.130	<0.001	0.038	1.06	0.89	0.84
	Std Dev	0.1	0.015	0.014	0.26	0.035	0.100		0.020	0.36	0.30	0.06
	CV	0.03	0.30	0.34	0.38	0.34	0.77		0.52	0.34	0.34	0.07

Appendix Table A1. pHc, Cation Exchange Capacity and Exchangeable Ions - 2018 Data and Descriptive Statistics (concluded)

Plot	Subplot/ Layer	pHc	Na	K	Ca	Mg	Al	Fe	Mn	TEC	Bases	Base Saturation
			(cmol/kg)									
West	**A3/10-15**	4.4	0.062	0.063	0.544	0.114	0.309	0.005	0.031	1.13	0.78	0.69
West	**B3/10-15**	4.7	0.066	0.052	0.475	0.100	0.110	<0.001	0.055	0.86	0.69	0.81
West	**C3/10-15**	4.5	0.060	0.026	0.385	0.053	0.223	<0.001	0.018	0.76	0.52	0.68
West	**D3/10-15**	4.5	0.061	0.077	0.564	0.104	0.249	0.020	0.021	1.10	0.81	0.74
West	**E3/10-15**	4.5	0.061	0.032	0.434	0.064	0.201	<0.001	0.024	0.82	0.59	0.72
West	**F3/10-15**	4.5	0.063	0.036	0.465	0.090	0.246	<0.001	0.046	0.94	0.65	0.69
West	**G3/10-15**	4.5	0.053	0.021	0.285	0.040	0.190	0.003	0.009	0.60	0.40	0.66
West	**H3/10-15**	4.3	0.067	0.100	0.260	0.094	0.250	0.015	0.012	0.80	0.52	0.65
West	**I3/10-15**	4.6	0.062	0.018	0.290	0.041	0.148	0.004	0.008	0.57	0.41	0.72
West	**J3/10-15**	4.7	0.062	0.022	0.416	0.061	0.125	<0.001	0.058	0.74	0.56	0.75
West	**K3/10-15**	4.6	0.059	0.034	0.418	0.075	0.161	<0.001	0.025	0.77	0.59	0.76
West	**L3/10-15**	4.9	0.057	0.028	0.813	0.124	0.082	<0.001	0.036	1.14	1.02	0.90
	Mean	4.6	0.061	0.042	0.45	0.080	0.191	0.004	0.028	0.85	0.63	0.73
	Std Dev	0.2	0.004	0.026	0.15	0.028	0.068	0.006	0.017	0.19	0.18	0.07
	CV	0.03	0.06	0.60	0.34	0.35	0.35	1.54	0.60	0.22	0.28	0.09
East	**A3/10-15**	4.7	0.059	0.023	0.331	0.065	0.103	0.001	0.008	0.59	0.48	0.81
East	**B3/10-15**	4.7	0.048	0.024	0.346	0.055	0.111	<0.001	0.004	0.59	0.47	0.81
East	**C3/10-15**	4.6	0.034	0.047	0.664	0.091	0.197	0.015	0.005	1.05	0.84	0.79
East	**D3/10-15**	4.8	0.037	0.056	0.993	0.174	0.181	0.009	0.018	1.47	1.26	0.86
East	**E3/10-15**	4.9	0.040	0.021	0.392	0.061	0.056	<0.001	0.001	0.57	0.51	0.90
East	**F3/10-15**	4.8	0.051	0.044	0.569	0.103	0.106	0.001	0.011	0.88	0.77	0.87
East	**G3/10-15**	4.9	0.057	0.045	0.554	0.111	0.080	<0.001	0.015	0.86	0.77	0.89
East	**H3/10-15**	4.7	0.055	0.048	0.456	0.075	0.133	<0.001	0.022	0.79	0.63	0.80
East	**I3/10-15**	4.9	0.054	0.032	0.609	0.108	0.061	<0.001	0.040	0.90	0.80	0.89
East	**J3/10-15**	4.9	0.054	0.022	0.624	0.092	0.061	<0.001	0.023	0.88	0.79	0.90
East	**K3/10-15**	4.8	0.007	0.013	0.195	0.025	0.033	<0.001	<0.001	0.27	0.24	0.88
East	**L3/10-15**	4.9	0.053	0.022	0.594	0.090	0.054	<0.001	0.013	0.82	0.76	0.92
	Mean	4.8	0.046	0.033	0.53	0.087	0.098	<0.0025	0.015	0.81	0.69	0.86
	Std Dev	0.1	0.015	0.014	0.21	0.037	0.052	0.005	0.011	0.30	0.25	0.04
	CV	0.02	0.32	0.43	0.39	0.42	0.53	1.85	0.76	0.37	0.37	0.05

Appendix Table A2. Water Soluble Ions and Base Cation:Aluminum Ratio – 2018 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)								
West	**A3/0-2**	44.4	5.3	0.15	0.825	16.5	16.4	3.90	7.54	4.40	2.08	4.18	3.7
West	**B3/0-2**	61.2	5.7	0.30	0.805	28.9	43.1	10.5	4.97	3.17	2.51	7.92	12.4
West	**C3/0-2**	63.6	4.7	0.16	0.434	14.2	14.9	3.08	3.14	1.55	4.15	7.16	7.6
West	**D3/0-2**	60.8	5.4	0.21	0.411	11.0	31.4	6.34	2.47	1.33	2.17	6.01	14.7
West	**E3/0-2**	54.0	5.2	0.17	0.925	7.52	22.8	4.49	2.89	1.54	2.95	5.13	9.2
West	**F3/0-2**	57.6	4.8	0.22	0.992	13.5	30.7	6.63	5.11	2.64	6.36	7.88	7.5
West	**G3/0-2**	47.6	5.1	0.21	1.620	10.7	26.7	4.31	8.23	5.48	11.0	5.32	3.9
West	**H3/0-2**	63.6	5.3	0.31	1.630	23.7	39.8	7.98	5.43	3.31	6.30	8.90	9.9
West	**I3/0-2**	63.6	5.2	0.18	1.310	9.70	25.5	3.66	5.48	3.38	6.05	5.01	5.4
West	**J3/0-2**	55.2	5.1	0.29	1.090	23.7	36.8	6.95	7.27	5.87	10.9	9.05	6.9
West	**K3/0-2**	54.0	5.3	0.16	0.404	9.33	20.0	4.02	2.64	1.35	2.17	5.51	9.4
West	**L3/0-2**	57.2	5.1	0.19	0.670	9.36	30.8	4.56	5.66	3.20	3.97	5.24	5.8
	Mean	56.9	5.2	0.21	0.926	14.8	28.24	5.54	5.07	3.10	5.05	6.44	8.04
	Std Dev	6.3	0.3	0.06	0.429	6.95	8.92	2.19	1.97	1.55	3.19	1.66	3.30
	CV #	0.11	0.05	0.27	0.46	0.47	0.32	0.39	0.39	0.50	0.63	0.26	0.41
East	**A3/0-2**	48.0	5.2	0.14	0.480	9.10	16.0	2.79	3.59	1.95	3.95	3.50	5.8
East	**B3/0-2**	44.0	5.5	0.09	0.394	6.68	9.32	1.58	3.35	1.85	1.88	2.26	3.9
East	**C3/0-2**	46.0	5.2	0.11	0.481	5.85	13.9	2.42	2.41	1.32	1.77	3.10	6.9
East	**D3/0-2**	52.0	5.1	0.16	0.371	13.5	19.2	3.16	5.53	4.07	3.74	4.07	4.7
East	**E3/0-2**	42.8	5.2	0.12	0.372	11.9	9.58	2.05	3.23	1.81	2.48	3.82	5.4
East	**F3/0-2**	45.2	5.2	0.12	0.491	5.33	14.8	2.98	4.54	2.54	3.04	3.96	3.9
East	**G3/0-2**	50.8	5.1	0.20	0.581	18.4	22.2	4.96	4.49	2.78	3.33	5.84	7.5
East	**H3/0-2**	45.2	5.2	0.16	0.459	15.8	12.9	2.58	2.99	1.54	2.91	4.48	7.7
East	**I3/0-2**	44.4	5.2	0.15	0.457	12.4	12.9	2.90	2.64	1.30	3.46	4.80	8.0
East	**J3/0-2**	57.6	5.2	0.19	1.33	8.27	27.7	4.21	4.31	2.29	4.03	5.74	7.1
East	**K3/0-2**	55.2	5.3	0.22	0.639	23.7	27.4	4.41	5.56	3.75	4.71	5.47	7.3
East	**L3/0-2**	54.4	5.0	0.16	0.556	11.3	18.0	2.66	4.67	3.00	4.65	4.37	5.0
	Mean	48.8	5.2	0.15	0.551	11.85	16.99	3.06	3.94	2.35	3.33	4.28	6.10
	Std Dev	5.0	0.1	0.04	0.259	5.46	6.17	0.99	1.06	0.91	0.96	1.08	1.49
	CV #	0.10	0.02	0.25	0.47	0.46	0.36	0.33	0.27	0.39	0.29	0.25	0.24

Value of CV (St Dev/Mean) differs from calculations using Std Dev and Mean in this table because they are taken from the database calculations where data have additional decimal places.

Appendix Table A2. Water Soluble Ions and Base Cation:Aluminum Ratio – 2018 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)								
West	**A3/2-5**	38.0	5.4	0.12	0.697	12.8	12.6	3.01	7.08	3.77	1.95	2.85	3.0
West	**B3/2-5**	59.6	5.5	0.26	0.803	17.0	37.6	9.18	2.89	1.35	2.11	6.91	16.7
West	**C3/2-5**	40.0	5.1	0.09	0.556	9.16	7.61	1.23	4.32	2.20	2.41	2.49	3.1
West	**D3/2-5**	41.2	5.5	0.16	0.677	11.0	19.7	4.31	3.68	1.85	2.50	3.44	7.2
West	**E3/2-5**	42.0	5.2	0.12	1.28	6.69	14.4	2.46	3.63	1.89	2.62	2.79	5.1
West	**F3/2-5**	40.8	5.2	0.15	1.19	9.20	18.5	3.61	7.11	3.48	4.58	3.59	3.4
West	**G3/2-5**	37.6	5.2	0.08	1.28	3.34	9.58	1.27	3.65	1.85	2.12	1.73	3.2
West	**H3/2-5**	45.6	5.1	0.23	1.99	22.7	23.0	5.24	7.22	4.70	6.92	6.83	5.4
West	**I3/2-5**	40.8	5.3	0.10	1.53	4.08	12.3	1.77	5.39	2.60	3.90	2.52	2.8
West	**J3/2-5**	45.6	5.3	0.15	0.937	8.90	18.4	3.16	4.51	2.17	4.50	3.99	5.1
West	**K3/2-5**	39.8	5.5	0.09	0.394	6.22	9.38	2.08	4.37	2.14	1.47	2.38	3.1
West	**L3/2-5**	42.0	5.5	0.15	0.97	6.17	23.5	3.66	6.60	3.24	2.54	3.04	3.8
	Mean	42.8	5.3	0.14	1.025	9.77	17.21	3.41	5.04	2.60	3.14	3.54	5.16
	Std Dev	5.9	0.2	0.05	0.452	5.56	8.33	2.18	1.58	0.99	1.56	1.66	3.87
	CV	0.14	0.03	0.39	0.44	0.57	0.48	0.64	0.31	0.38	0.50	0.47	0.75
East	**A3/2-5**	39.6	5.7	0.10	0.92	5.19	10.8	1.98	3.80	2.09	1.73	1.75	3.7
East	**B3/2-5**	37.2	5.6	0.08	0.535	5.02	7.23	1.07	3.22	1.77	1.52	1.39	3.2
East	**C3/2-5**	39.2	5.1	0.06	0.615	2.54	7.10	0.929	4.68	2.63	0.869	1.15	1.8
East	**D3/2-5**	39.6	5.2	0.12	0.475	9.65	12.2	2.08	5.76	3.41	2.13	2.16	3.1
East	**E3/2-5**	38.8	5.5	0.10	0.421	9.57	8.72	1.71	5.18	2.89	1.16	2.41	2.9
East	**F3/2-5**	39.6	5.3	0.10	2.43	4.25	9.24	1.98	5.49	3.35	1.78	2.27	2.6
East	**G3/2-5**	39.6	5.3	0.16	0.803	13.5	17.9	3.99	6.89	4.06	2.62	3.41	3.9
East	**H3/2-5**	36.4	5.3	0.08	0.376	7.14	6.57	0.989	3.51	1.93	0.935	1.44	3.1
East	**I3/2-5**	36.8	5.6	0.11	0.539	7.59	10.8	1.94	2.92	1.35	1.93	2.25	5.2
East	**J3/2-5**	41.4	5.8	0.13	1.25	3.99	20.2	2.83	4.01	2.14	2.10	2.83	5.2
East	**K3/2-5**	41.2	5.9	0.11	1.06	8.23	14.7	2.32	5.73	3.30	1.51	2.28	3.4
East	**L3/2-5**	44.4	5.7	0.14	0.728	7.79	19.2	2.20	3.96	2.05	2.04	2.91	5.5
	Mean	39.5	5.5	0.10	0.846	7.04	12.06	2.00	4.60	2.58	1.69	2.19	3.62
	Std Dev	2.2	0.3	0.03	0.566	3.05	4.85	0.85	1.22	0.82	0.52	0.67	1.15
	CV	0.06	0.05	0.27	0.67	0.43	0.40	0.42	0.26	0.32	0.31	0.31	0.32

Appendix Table A2. Water Soluble Ions and Base Cation:Aluminum Ratio – 2018 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)								
West	**A3/5-10**	36.8	5.1	0.10	0.849	9.36	9.4	2.24	5.65	2.85	2.13	2.39	2.9
West	**B3/5-10**	38.8	5.5	0.14	0.997	8.21	17.2	4.28	4.38	2.56	1.89	3.40	5.3
West	**C3/5-10**	37.6	5.4	0.07	0.637	5.28	6.23	0.760	3.57	1.82	0.827	1.36	2.6
West	**D3/5-10**	38.0	5.0	0.15	1.06	13.7	15.9	3.89	8.92	4.74	2.95	2.86	2.9
West	**E3/5-10**	38.8	5.1	0.09	1.40	5.12	9.80	1.52	3.79	1.73	1.85	1.95	3.6
West	**F3/5-10**	39.2	5.2	0.12	1.49	4.93	14.5	2.74	6.76	3.24	3.01	2.91	2.7
West	**G3/5-10**	37.2	5.2	0.06	1.06	2.58	6.44	0.871	2.36	1.13	0.755	0.96	3.5
West	**H3/5-10**	40.4	4.9	0.19	3.71	26.9	10.0	3.81	8.54	4.71	3.05	7.07	4.0
West	**I3/5-10**	36.4	5.2	0.07	1.27	3.28	6.04	0.804	2.43	1.24	0.926	1.13	3.6
West	**J3/5-10**	39.2	5.5	0.10	1.03	4.07	11.1	1.89	3.35	1.58	2.40	2.06	4.1
West	**K3/5-10**	37.6	5.2	0.07	0.562	4.85	6.41	1.31	4.01	1.88	1.10	1.91	2.4
West	**L3/5-10**	39.6	5.6	0.10	0.941	3.69	15.7	2.56	7.48	3.81	1.56	2.10	2.3
	Mean	38.3	5.2	0.10	1.251	7.66	10.73	2.22	5.10	2.61	1.87	2.51	3.31
	Std Dev	1.2	0.2	0.04	0.821	6.82	4.16	1.26	2.31	1.28	0.86	1.61	0.86
	CV	0.03	0.04	0.38	0.66	0.89	0.39	0.56	0.45	0.49	0.46	0.64	0.26
East	**A3/5-10**	37.2	5.3	0.07	1.01	3.09	6.59	1.42	2.43	1.22	1.05	1.02	3.8
East	**B3/5-10**	36.8	5.5	0.04	0.458	1.99	3.99	0.42	2.89	1.72	0.239	0.699	1.8
East	**C3/5-10**	38.0	5.3	0.04	0.526	1.90	4.63	0.315	2.41	1.39	0.258	0.832	2.2
East	**D3/5-10**	37.6	5.4	0.08	0.464	5.09	9.61	1.72	4.53	2.63	0.780	1.44	2.7
East	**E3/5-10**	37.6	5.4	0.06	0.443	3.05	6.53	0.977	3.41	1.92	0.297	0.938	2.4
East	**F3/5-10**	36.8	5.6	0.06	0.389	3.56	5.54	1.19	3.90	2.33	0.413	1.32	2.0
East	**G3/5-10**	37.6	5.4	0.09	0.777	5.71	9.78	2.16	5.39	3.12	1.13	2.26	2.6
East	**H3/5-10**	36.4	5.5	0.07	0.417	5.13	5.68	0.742	3.29	1.81	0.63	1.05	2.6
East	**I3/5-10**	36.4	5.5	0.08	0.506	4.18	7.73	1.27	4.50	2.08	1.09	1.37	2.2
East	**J3/5-10**	38.4	5.7	0.10	0.965	2.99	13.9	2.07	3.16	1.84	1.15	1.84	4.7
East	**K3/5-10**	39.2	5.6	0.08	0.718	4.33	9.46	1.65	3.75	2.10	0.634	1.54	3.2
East	**L3/5-10**	39.2	5.5	0.08	0.737	3.46	10.5	1.36	4.83	2.48	0.969	1.40	2.5
	Mean	37.6	5.5	0.07	0.618	3.71	7.83	1.27	3.71	2.05	0.72	1.31	2.73
	Std Dev	1.0	0.1	0.02	0.217	1.21	2.89	0.59	0.95	0.53	0.36	0.44	0.83
	CV	0.03	0.02	0.25	0.35	0.33	0.37	0.46	0.26	0.26	0.50	0.34	0.30

Appendix Table A2. Water Soluble Ions and Base Cation:Aluminum Ratio – 2018 Data and Descriptive Statistics (concluded)

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)								
West	**A3/10-15**	36.6	5.0	0.08	0.912	8.26	6.77	1.58	5.22	2.79	0.645	1.80	2.5
West	**B3/10-15**	37.6	5.3	0.08	0.879	4.94	6.53	1.91	2.67	1.57	1.17	2.26	4.1
West	**C3/10-15**	36.8	5.2	0.05	0.818	2.90	4.36	0.489	3.53	1.81	0.326	1.00	1.8
West	**D3/10-15**	37.2	5.0	0.14	1.32	13.7	13.2	3.04	9.97	4.37	0.839	2.32	2.3
West	**E3/10-15**	37.6	5.2	0.07	1.23	3.38	7.08	1.01	3.29	1.57	0.635	1.35	2.9
West	**F3/10-15**	36.4	5.0	0.09	1.41	4.20	8.80	1.83	3.20	1.42	1.37	3.31	3.9
West	**G3/10-15**	36.8	5.1	0.05	1.06	2.18	4.57	0.600	2.29	1.11	0.291	0.75	2.8
West	**H3/10-15**	37.2	5.0	0.10	4.28	11.6	3.05	1.39	2.87	1.49	0.246	4.70	5.8
West	**I3/10-15**	36.4	5.2	0.04	0.916	1.25	3.40	0.452	2.32	1.30	0.225	0.765	2.0
West	**J3/10-15**	40.8	5.3	0.06	0.891	1.60	5.85	0.857	2.19	0.928	1.21	1.16	3.2
West	**K3/10-15**	37.2	5.4	0.05	0.539	2.56	4.26	0.664	2.90	1.50	0.391	1.18	2.1
West	**L3/10-15**	37.6	5.5	0.08	0.896	2.03	11.3	1.94	6.70	3.50	0.707	1.46	1.8
	Mean	37.4	5.2	0.07	1.263	4.88	6.60	1.31	3.93	1.95	0.67	1.84	2.95
	Std Dev	1.2	0.2	0.03	0.980	4.11	3.14	0.78	2.32	1.05	0.40	1.17	1.17
	CV	0.03	0.03	0.36	0.78	0.84	0.48	0.60	0.59	0.54	0.60	0.64	0.40
East	**A3/10-15**	36.8	5.4	0.05	0.956	1.55	4.63	0.917	1.87	1.03	0.226	0.79	3.4
East	**B3/10-15**	37.6	5.3	0.03	0.526	1.46	3.18	0.293	2.45	1.44	0.0949	0.597	1.7
East	**C3/10-15**	38.0	5.3	0.04	0.518	2.03	4.10	0.418	2.59	1.57	0.107	0.695	2.0
East	**D3/10-15**	37.6	5.4	0.06	0.412	3.20	7.32	1.31	4.67	2.71	0.292	1.13	1.9
East	**E3/10-15**	37.2	5.7	0.04	0.361	1.25	4.72	0.623	2.45	1.44	0.067	0.620	2.1
East	**F3/10-15**	36.8	5.7	0.06	0.431	3.74	5.32	1.04	3.83	2.30	0.200	1.36	2.0
East	**G3/10-15**	37.6	5.6	0.08	0.843	4.36	8.41	1.87	3.47	2.00	0.395	1.80	3.4
East	**H3/10-15**	36.4	5.5	0.06	0.401	4.50	4.85	0.649	2.52	1.37	0.404	0.884	3.0
East	**I3/10-15**	36.4	5.6	0.05	0.449	2.16	5.70	0.847	4.14	1.98	0.489	0.874	1.6
East	**J3/10-15**	38.8	5.5	0.06	0.731	1.54	7.13	1.04	3.42	2.04	0.44	0.988	2.3
East	**K3/10-15**	39.2	5.5	0.06	0.657	2.64	6.61	1.13	2.81	1.66	0.111	1.06	3.0
East	**L3/10-15**	37.6	5.7	0.05	0.726	1.39	6.03	0.867	3.63	2.04	0.246	0.852	1.9
	Mean	37.5	5.5	0.05	0.584	2.49	5.67	0.92	3.15	1.80	0.26	0.97	2.36
	Std Dev	0.9	0.1	0.01	0.194	1.19	1.50	0.42	0.83	0.46	0.15	0.34	0.64
	CV	0.02	0.03	0.22	0.33	0.48	0.27	0.46	0.26	0.26	0.58	0.35	0.27

Appendix Table A3. Total Carbon, Nitrogen and Sulphur – 2018 Data and Descriptive Statistics

Sub-site	Subplot/ Layer	pHc *	Total C (%)	Total N (%)	Total S (%)	C:N Ratio	C:S Ratio	N:S Ratio
West	**A3/LFH**	3.9	39.6	1.12	0.102	35.4	388	11
West	**B3/LFH**	4.2	34.1	0.970	0.082	35.2	416	12
West	**C3/LFH**	3.9	39.2	1.18	0.076	33.2	516	16
West	**D3/LFH**	4.3	41.6	1.14	0.103	36.5	404	11
West	**E3/LFH**	4.3	35.7	1.07	0.117	33.4	305	9
West	**F3/LFH**	4.2	37.6	1.25	0.111	30.1	339	11
West	**G3/LFH**	4.1	33.5	0.885	0.080	37.9	419	11
West	**H3/LFH**	4.2	43.7	1.44	0.150	30.3	291	10
West	**I3/LFH**	4.4	23.3	0.647	0.061	36.0	382	11
West	**J3/LFH**	4.3	33.4	0.949	0.087	35.2	384	11
West	**K3/LFH**	4.2	29.1	1.01	0.099	28.8	294	10
West	**L3/LFH**	4.3	38.9	1.05	0.095	37.0	409	11
	Mean	4.2	35.81	1.06	0.10	34.1	379	11
	Std Dev	0.2	5.64	0.198	0.02	2.95	64.2	1.6
	CV #	0.04	0.16	0.19	0.24	0.09	0.17	0.14
East	**A3/LFH**	3.7	29.7	0.815	0.085	36.4	349	10
East	**B3/LFH**	3.8	18.7	0.604	0.060	31.0	312	10
East	**C3/LFH**	3.9	22.5	0.693	0.073	32.5	308	9
East	**D3/LFH**	4.1	35.2	1.16	0.122	30.3	289	10
East	**E3/LFH**	3.6	30.0	0.762	0.084	39.4	357	9
East	**F3/LFH**	3.9	42.2	1.44	0.166	29.3	254	9
East	**G3/LFH**	4.2	34.4	0.882	0.076	39.0	453	12
East	**H3/LFH**	3.9	31.0	0.754	0.077	41.1	403	10
East	**I3/LFH**	3.9	37.9	1.15	0.123	33.0	308	9
East	**J3/LFH**	4.1	35.9	0.962	0.095	37.3	378	10
East	**K3/LFH**	4.0	32.9	1.10	0.096	29.9	343	11
East	**L3/LFH**	3.7	35.3	1.07	0.107	33.0	330	10
	Mean	3.9	32.14	0.949	0.097	34.4	340	10
	Std Dev	0.2	6.46	0.242	0.03	4.11	53.4	0.9
	CV #	0.05	0.20	0.25	0.30	0.12	0.16	0.09

* pHc data are presented for the LFH layer; pHc for all other layers are repeated here from Appendix Table A1

\# Value of CV (St Dev/Mean) differs from calculations using Std Dev and Mean in this table because they are taken from the database calculations where data have additional decimal places.

Appendix Table A3. Total Carbon, Nitrogen and Sulphur – 2018 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
West	**A3/0-2**	4.6	1.43	0.052	0.003	27.5	477	17
West	**B3/0-2**	5.1	3.04	0.094	0.014	32.3	217	7
West	**C3/0-2**	4.0	2.94	0.110	0.006	26.7	490	18
West	**D3/0-2**	4.8	4.02	0.135	0.013	29.8	309	10
West	**E3/0-2**	4.6	3.09	0.099	0.004	31.2	773	25
West	**F3/0-2**	4.3	2.80	0.084	0.005	33.3	560	17
West	**G3/0-2**	4.5	2.15	0.064	0.008	33.6	269	8
West	**H3/0-2**	4.7	3.04	0.112	0.009	27.1	338	12
West	**I3/0-2**	4.6	1.95	0.071	0.004	27.5	488	18
West	**J3/0-2**	4.5	2.11	0.071	0.004	29.7	528	18
West	**K3/0-2**	4.6	2.72	0.108	0.011	25.2	259	10
West	**L3/0-2**	4.5	2.99	0.096	0.006	31.1	498	16
	Mean	4.6	2.69	0.091	0.007	29.6	434	15
	Std Dev	0.3	0.68	0.024	0.004	2.78	159.8	5.2
	CV #	0.06	0.25	0.26	0.51	0.09	0.37	0.35
East	**A3/0-2**	4.6	2.06	0.056	0.003	36.8	687	19
East	**B3/0-2**	4.7	1.23	0.043	0.007	28.8	175	6
East	**C3/0-2**	4.6	1.83	0.067	0.006	27.3	305	11
East	**D3/0-2**	4.6	1.87	0.051	0.005	36.7	374	10
East	**E3/0-2**	4.5	1.16	0.059	0.004	19.7	290	15
East	**F3/0-2**	4.5	1.19	0.041	0.005	29.0	238	8
East	**G3/0-2**	4.5	2.59	0.082	0.006	31.6	432	14
East	**H3/0-2**	4.6	1.10	0.057	0.005	19.3	236	12
East	**I3/0-2**	4.5	1.31	0.048	0.005	27.5	261	10
East	**J3/0-2**	4.6	2.32	0.059	0.006	39.3	387	10
East	**K3/0-2**	4.7	2.42	0.081	0.007	29.8	345	12
East	**L3/0-2**	4.3	2.06	0.065	0.006	31.7	343	11
	Mean	4.6	1.76	0.059	0.005	29.8	339	11
	Std Dev	0.1	0.54	0.013	0.001	6.18	131.6	3.3
	CV	0.02	0.31	0.22	0.22	0.21	0.39	0.29

Appendix Table A3. Total Carbon, Nitrogen and Sulphur – 2018 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
West	**A3/2-5**	4.7	0.863	0.032	0.004	27.0	216	8
West	**B3/2-5**	5.1	3.707	0.110	0.010	33.8	371	11
West	**C3/2-5**	4.5	0.747	0.036	0.006	20.8	125	6
West	**D3/2-5**	4.8	1.010	0.038	0.005	26.6	202	8
West	**E3/2-5**	4.6	1.250	0.041	0.002	30.5	625	21
West	**F3/2-5**	4.6	0.741	0.027	0.001	27.4	741	27
West	**G3/2-5**	4.6	0.756	0.022	0.001	34.4	756	22
West	**H3/2-5**	4.5	1.340	0.046	0.005	29.1	268	9
West	**I3/2-5**	4.7	0.600	0.022	0.002	26.9	300	11
West	**J3/2-5**	4.7	1.230	0.046	0.005	26.7	246	9
West	**K3/2-5**	4.7	0.482	0.017	0.002	28.4	241	9
West	**L3/2-5**	4.9	1.100	0.028	0.004	38.8	275	7
	Mean	4.7	1.152	0.039	0.004	29.2	364	12
	Std Dev	0.2	0.849	0.024	0.003	4.68	217	6.9
	CV	0.04	0.74	0.63	0.66	0.16	0.60	0.56
East	**A3/2-5**	4.9	0.611	0.022	0.002	27.8	306	11
East	**B3/2-5**	4.8	0.432	0.020	0.004	21.6	108	5
East	**C3/2-5**	4.6	0.394	0.017	0.002	23.2	197	9
East	**D3/2-5**	4.6	0.603	0.014	0.002	43.1	302	7
East	**E3/2-5**	4.8	0.580	0.020	0.003	29.0	193	7
East	**F3/2-5**	4.6	0.535	0.021	0.001	25.5	535	21
East	**G3/2-5**	4.7	0.584	0.011	0.001	53.1	584	11
East	**H3/2-5**	4.7	0.505	0.011	0.003	45.9	168	4
East	**I3/2-5**	4.8	0.562	0.027	0.003	20.8	187	9
East	**J3/2-5**	5.1	1.14	0.022	0.001	51.8	1140	22
East	**K3/2-5**	5.0	0.556	0.016	0.003	34.8	185	5
East	**L3/2-5**	5.0	0.877	0.019	0.002	46.2	439	10
	Mean	4.8	0.615	0.018	0.002	35.2	362	10
	Std Dev	0.2	0.203	0.005	0.001	12.13	288.7	5.9
	CV	0.04	0.33	0.26	0.43	0.34	0.80	0.59

Appendix Table A3. Total Carbon, Nitrogen and Sulphur – 2018 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
West	**A3/5-10**	4.5	0.578	0.020	0.004	28.9	145	5
West	**B3/5-10**	4.9	0.826	0.017	0.002	48.6	413	9
West	**C3/5-10**	4.7	0.456	0.014	0.004	32.6	114	4
West	**D3/5-10**	4.6	0.471	0.018	0.003	26.2	157	6
West	**E3/5-10**	4.5	0.594	0.021	0.002	29.0	297	10
West	**F3/5-10**	4.7	0.433	0.012	0.001	36.1	433	12
West	**G3/5-10**	4.6	0.292	0.009	0.001	32.4	292	9
West	**H3/5-10**	4.3	0.565	0.018	0.002	31.4	283	9
West	**I3/5-10**	4.6	0.572	0.014	0.002	40.9	286	7
West	**J3/5-10**	4.8	0.605	0.019	0.002	31.8	303	10
West	**K3/5-10**	4.5	0.403	0.015	0.003	26.9	151	6
West	**L3/5-10**	5.0	0.490	0.014	0.001	35.0	490	14
	Mean	4.6	0.524	0.016	0.00	33.3	280	8
	Std Dev	0.2	0.133	0.003	0.00	6.32	122.0	3.0
	CV	0.04	0.25	0.22	0.47	0.19	0.44	0.37
East	**A3/5-10**	4.6	0.279	0.004	0.001	69.8	279	4
East	**B3/5-10**	4.8	0.211	0.003	0.002	70.3	106	2
East	**C3/5-10**	4.6	0.227	0.005	0.002	45.4	114	3
East	**D3/5-10**	4.8	0.462	0.016	0.001	28.9	462	16
East	**E3/5-10**	4.9	0.284	0.006	0.002	51.5	142	3
East	**F3/5-10**	4.8	0.409	0.012	0.002	34.1	205	6
East	**G3/5-10**	4.7	0.380	0.013	0.002	29.2	190	7
East	**H3/5-10**	4.7	0.324	0.008	0.002	40.5	162	4
East	**I3/5-10**	4.9	0.315	0.004	0.003	78.8	105	1
East	**J3/5-10**	5.1	0.667	0.009	0.003	74.1	222	3
East	**K3/5-10**	4.8	0.427	0.016	0.002	26.7	214	8
East	**L3/5-10**	4.9	0.567	0.006	0.002	94.5	284	3
	Mean	4.8	0.379	0.008	0.00	53.6	207	5
	Std Dev	0.1	0.137	0.005	0.00	23.00	101.1	4.0
	CV	0.03	0.36	0.56	0.30	0.43	0.49	0.83

Appendix Table A3. Total Carbon, Nitrogen and Sulphur – 2018 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
West	**A3/10-15**	4.4	0.476	0.013	0.002	36.6	238	7
West	**B3/10-15**	4.7	0.328	0.015	0.001	21.9	328	15
West	**C3/10-15**	4.5	0.364	0.016	0.002	22.8	182	8
West	**D3/10-15**	4.5	0.344	0.009	0.002	38.2	172	5
West	**E3/10-15**	4.5	0.279	0.013	0.002	21.5	140	7
West	**F3/10-15**	4.5	0.319	0.006	0.001	53.2	319	6
West	**G3/10-15**	4.5	0.272	0.011	0.001	24.7	272	11
West	**H3/10-15**	4.3	0.302	0.004	0.003	75.5	101	1
West	**I3/10-15**	4.6	0.275	0.008	0.001	34.4	275	8
West	**J3/10-15**	4.7	0.347	0.023	0.003	15.1	116	8
West	**K3/10-15**	4.6	0.278	0.009	0.003	30.9	93	3
West	**L3/10-15**	4.9	0.282	0.007	0.003	40.3	94	2
	Mean	4.6	0.322	0.011	0.00	34.6	194	7
	Std Dev	0.2	0.058	0.005	0.00	16.61	88.9	3.8
	CV	0.03	0.18	0.47	0.43	0.48	0.46	0.57
East	**A3/10-15**	4.7	0.221	0.004	0.002	55.3	111	2
East	**B3/10-15**	4.7	0.169	0.002	0.001	84.5	169	2
East	**C3/10-15**	4.6	0.326	0.009	0.001	36.2	326	9
East	**D3/10-15**	4.8	0.325	0.006	0.002	54.2	163	3
East	**E3/10-15**	4.9	0.173	0.015	0.004	11.5	43	4
East	**F3/10-15**	4.8	0.373	0.010	0.002	37.3	187	5
East	**G3/10-15**	4.9	0.250	0.022	0.001	11.4	250	22
East	**H3/10-15**	4.7	0.281	0.009	0.002	31.2	141	5
East	**I3/10-15**	4.9	0.227	0.025	0.002	9.1	114	13
East	**J3/10-15**	4.9	0.292	0.018	0.001	16.2	292	18
East	**K3/10-15**	4.8	0.249	0.004	0.001	62.3	249	4
East	**L3/10-15**	4.9	0.256	0.015	0.001	17.1	256	15
	Mean	4.8	0.262	0.012	0.00	35.5	192	8
	Std Dev	0.1	0.061	0.007	0.00	24.20	84.0	6.9
	CV	0.02	0.23	0.64	0.53	0.68	0.44	0.82

APPENDIX B

SAMPLE IDENTIFICATION

MOOSE LAKE SOIL MONITORING SITE - 2018

Table B1. Lab Report - Sample Identification

Project: Permanent Site -Acid Deposition -Moose Lake

Project Leader: Salim Abboud; Project Contact: Larry Turchenek

Date Received: Oct., 2018

Date Sampled	Site	Plot	Field Id.	Lab I.D. (2018)	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)
Oct., 2018	Moose Lake	West	A3/LFH	385	1		1	1	1	
	Moose Lake	West	A3/0-2	386	1	1	1	1	1	1
	Moose Lake	West	A3/2-5	387	1	1	1	1	1	1
	Moose Lake	West	A3/5-10	388	1	1	1	1	1	1
	Moose Lake	West	A3/10-15	389	1	1	1	1	1	1
	Moose Lake	West	B3/LFH	393	1		1	1	1	
	Moose Lake	West	B3/0-2	394	1	1	1	1	1	1
	Moose Lake	West	B3/2-5	395	1	1	1	1	1	1
	Moose Lake	West	B3/5-10	396	1	1	1	1	1	1
	Moose Lake	West	B3/10-15	397	1	1	1	1	1	1
	Moose Lake	West	C3/LFH	401	1		1	1	1	
	Moose Lake	West	C3/0-2	402	1	1	1	1	1	1
	Moose Lake	West	C3/2-5	403	1	1	1	1	1	1
	Moose Lake	West	C3/5-10	404	1	1	1	1	1	1
	Moose Lake	West	C3/10-15	405	1	1	1	1	1	1
	Moose Lake	West	D3/LFH	409	1		1	1	1	
	Moose Lake	West	D3/0-2	410	1	1	1	1	1	1
	Moose Lake	West	D3/2-5	411	1	1	1	1	1	1
	Moose Lake	West	D3/5-10	412	1	1	1	1	1	1
	Moose Lake	West	D3/10-15	413	1	1	1	1	1	1
	Moose Lake	West	E3/LFH	417	1		1	1	1	

	Moose Lake	**West**	**E3/0-2**	**418**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**E3/2-5**	**419**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**E3/5-10**	**420**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**E3/10-15**	**421**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**F3/LFH**	**425**	**1**		**1**	**1**	**1**	
	Moose Lake	**West**	**F3/0-2**	**426**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**F3/2-5**	**427**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**F3/5-10**	**428**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**F3/10-15**	**429**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**G3/LFH**	**433**	**1**		**1**	**1**	**1**	
	Moose Lake	**West**	**G3/0-2**	**434**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**G3/2-5**	**435**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**G3/5-10**	**436**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**G3/10-15**	**437**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**H3/LFH**	**441**	**1**		**1**	**1**	**1**	
	Moose Lake	**West**	**H3/0-2**	**442**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**H3/2-5**	**443**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**H3/5-10**	**444**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**H3/10-15**	**445**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**I3/LFH**	**449**	**1**		**1**	**1**	**1**	
	Moose Lake	**West**	**I3/0-2**	**450**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**I3/2-5**	**451**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**I3/5-10**	**452**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**I3/10-15**	**453**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**J3/LFH**	**457**	**1**		**1**	**1**	**1**	
	Moose Lake	**West**	**J3/0-2**	**458**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**J3/2-5**	**459**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**West**	**J3/5-10**	**460**	**1**	**1**	**1**	**1**	**1**	**1**

	Moose Lake	West	J3/10-15	461	1	1	1	1	1	1
	Moose Lake	West	K3/LFH	465	1		1	1	1	
	Moose Lake	West	K3/0-2	466	1	1	1	1	1	1
	Moose Lake	West	K3/2-5	467	1	1	1	1	1	1
	Moose Lake	West	K3/5-10	468	1	1	1	1	1	1
	Moose Lake	West	K3/10-15	469	1	1	1	1	1	1
	Moose Lake	West	L3/LFH	473	1		1	1	1	
	Moose Lake	West	L3/0-2	474	1	1	1	1	1	1
	Moose Lake	West	L3/2-5	475	1	1	1	1	1	1
	Moose Lake	West	L3/5-10	476	1	1	1	1	1	1
	Moose Lake	West	L3/10-15	477	1	1	1	1	1	1
	Moose Lake	East	A3/LFH	481	1		1	1	1	
	Moose Lake	East	A3/0-2	482	1	1	1	1	1	1
	Moose Lake	East	A3/2-5	483	1	1	1	1	1	1
	Moose Lake	East	A3/5-10	484	1	1	1	1	1	1
	Moose Lake	East	A3/10-15	485	1	1	1	1	1	1
	Moose Lake	East	B3/LFH	489	1		1	1	1	
	Moose Lake	East	B3/0-2	490	1	1	1	1	1	1
	Moose Lake	East	B3/2-5	491	1	1	1	1	1	1
	Moose Lake	East	B3/5-10	492	1	1	1	1	1	1
	Moose Lake	East	B3/10-15	493	1	1	1	1	1	1
	Moose Lake	East	C3/LFH	497	1		1	1	1	
	Moose Lake	East	C3/0-2	498	1	1	1	1	1	1
	Moose Lake	East	C3/2-5	499	1	1	1	1	1	1
	Moose Lake	East	C3/5-10	500	1	1	1	1	1	1
	Moose Lake	East	C3/10-15	501	1	1	1	1	1	1
	Moose Lake	East	D3/LFH	505	1		1	1	1	
	Moose Lake	East	D3/0-2	506	1	1	1	1	1	1

	Moose Lake	**East**	**D3/2-5**	**507**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**D3/5-10**	**508**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**D3/10-15**	**509**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**E3/LFH**	**513**	**1**		**1**	**1**	**1**	
	Moose Lake	**East**	**E3/0-2**	**514**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**E3/2-5**	**515**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**E3/5-10**	**516**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**E3/10-15**	**517**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**F3/LFH**	**521**	**1**		**1**	**1**	**1**	
	Moose Lake	**East**	**F3/0-2**	**522**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**F3/2-5**	**523**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**F3/5-10**	**524**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**F3/10-15**	**525**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**G3/LFH**	**529**	**1**		**1**	**1**	**1**	
	Moose Lake	**East**	**G3/0-2**	**530**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**G3/2-5**	**531**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**G3/5-10**	**532**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**G3/10-15**	**533**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**H3/LFH**	**537**	**1**		**1**	**1**	**1**	
	Moose Lake	**East**	**H3/0-2**	**538**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**H3/2-5**	**539**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**H3/5-10**	**540**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**H3/10-15**	**541**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**I3/LFH**	**545**	**1**		**1**	**1**	**1**	
	Moose Lake	**East**	**I3/0-2**	**546**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**I3/2-5**	**547**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**I3/5-10**	**548**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**I3/10-15**	**549**	**1**	**1**	**1**	**1**	**1**	**1**

	Moose Lake	**East**	**J3/LFH**	**553**	**1**		**1**	**1**	**1**	
	Moose Lake	**East**	**J3/0-2**	**554**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**J3/2-5**	**555**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**J3/5-10**	**556**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**J3/10-15**	**557**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**K3/LFH**	**561**	**1**		**1**	**1**	**1**	
	Moose Lake	**East**	**K3/0-2**	**562**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**K3/2-5**	**563**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**K3/5-10**	**564**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**K3/10-15**	**565**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**L3/LFH**	**569**	**1**		**1**	**1**	**1**	
	Moose Lake	**East**	**L3/0-2**	**570**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**L3/2-5**	**571**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**L3/5-10**	**572**	**1**	**1**	**1**	**1**	**1**	**1**
	Moose Lake	**East**	**L3/10-15**	**573**	**1**	**1**	**1**	**1**	**1**	**1**
				Total Ana=	**120**	**96**	**120**	**120**	**120**	**96**