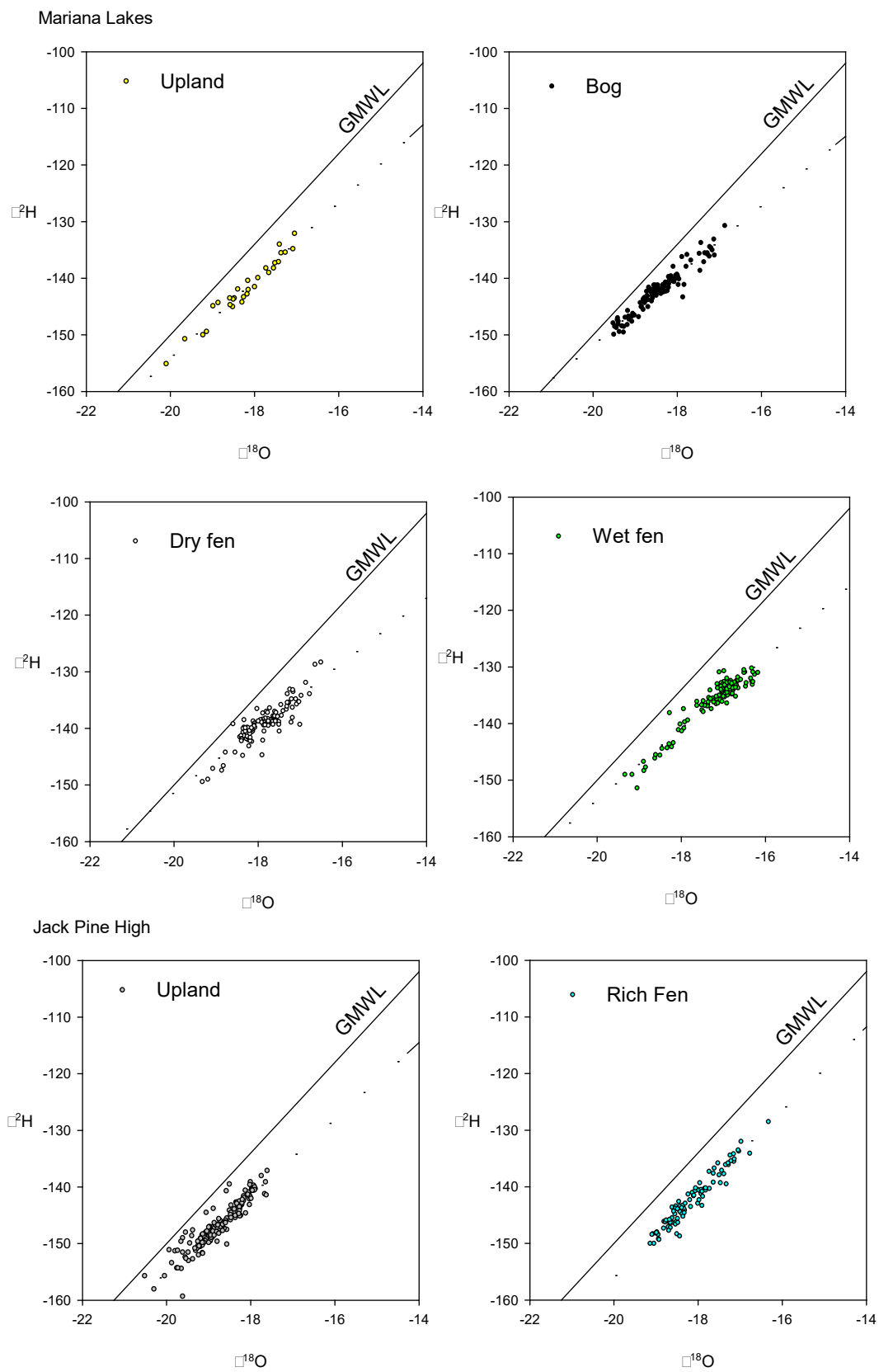


### **Supplementary Materials:**

Gibson et al. Hydrogeochemistry studies in the oil sands region to investigate the role of terrain conductivity in nitrogen critical loads.

**Figure S1.** Stable isotope plots for Mariana Lakes and Jack Pine High by terrain type.



**Table S1.** Runoff potential, mean nitrate, net N flux by year and statistics.

Terrain Unit	Type	Well #	Runoff Potential (mm)				NO <sub>3</sub> mg/L	Net Flux kg N/ha/yr				Net flux kg N/ha/yr			
			2011	2012	2014	2015		2011	2012	2014	2015	Interannual Average	Max	Min	Stdev
Rich Fen		JPH A	-386	286	-59	-91	0.06	-0.23	0.17	-0.04	-0.05				
		JPH B	-392	301	-43	-78	0.00	0.00	0.00	0.00	0.00				
		JPH C	-408	303	n.d.	n.d.	1.13	-4.61	3.42	n.d.	n.d.				
		JPH D	-428	303	n.d.	n.d.	0.98	-4.19	2.97	n.d.	n.d.				
		JPH E	-391	262	n.d.	n.d.	1.50	-5.87	3.93	n.d.	n.d.				
		JPH F	-332	267	n.d.	n.d.	1.80	-5.98	4.81	n.d.	n.d.				
		JPH G	-322	174	n.d.	n.d.	0.16	-0.52	0.28	n.d.	n.d.				
		<b>Average</b>	<b>-380</b>	<b>271</b>	<b>-51</b>	<b>-85</b>	<b>0.80</b>	<b>-3.06</b>	<b>2.23</b>	<b>-0.02</b>	<b>-0.03</b>	<b>-0.22</b>	<b>2.23</b>	<b>-3.06</b>	<b>2.17</b>
Poor Fen	Wet Fen	ML A	-245	77	-31	n.d.	0.44	-1.08	0.34	-0.14	n.d.				
		ML D	-164	-2	-31	-3	0.42	-0.69	-0.01	-0.13	-0.01				
		ML E	-169	69	-29	-12	0.00	0.00	0.00	0.00	0.00				
		ML N	-218	74	-31	-16	0.20	-0.44	0.15	-0.06	-0.03				
		ML Q	-267	68	-25	-70	0.18	-0.48	0.12	-0.05	-0.13				
		ML R	-217	75	-30	4	0.08	-0.17	0.06	-0.02	0.00				
		<b>Average</b>	<b>-213</b>	<b>60</b>	<b>-30</b>	<b>-19</b>	<b>0.22</b>	<b>-0.48</b>	<b>0.11</b>	<b>-0.07</b>	<b>-0.03</b>	<b>-0.12</b>	<b>0.11</b>	<b>-0.48</b>	<b>0.25</b>
	Dry Fen	ML B	-59	78	-24	-116	4.88	-2.88	3.81	-1.17	-5.66				
		ML S	-221	83	-36	1	0.50	-1.11	0.42	-0.18	0.01				
		ML T	-287	26	-67	n.d.	0.74	-2.12	0.19	-0.50	n.d.				
		ML U	-222	81	1	n.d.	0.00	0.00	0.00	0.00	n.d.				
		<b>Average</b>	<b>-197</b>	<b>67</b>	<b>-32</b>	<b>-58</b>	<b>1.53</b>	<b>-1.53</b>	<b>1.11</b>	<b>-0.46</b>	<b>-2.83</b>	<b>-0.93</b>	<b>1.11</b>	<b>-2.83</b>	<b>1.66</b>
Bog		ML C	-196	78	-23	n.d.	2.88	-5.64	2.25	-0.66	n.d.				
		ML F	-286	65	-72	-32	0.10	-0.29	0.07	-0.07	-0.03				
		ML M	-248	43	-68	2	0.50	-1.24	0.22	-0.34	0.01				
		ML O	-284	59	-68	-41	1.40	-3.98	0.83	-0.95	-0.57				
		ML P	-290	64	-76	-41	0.56	-1.62	0.36	-0.43	-0.23				
		ML V	-289	48	n.d.	n.d.	1.08	-3.12	0.52	n.d.	n.d.				
		<b>Average</b>	<b>-266</b>	<b>60</b>	<b>-61</b>	<b>-28</b>	<b>1.09</b>	<b>-2.65</b>	<b>0.71</b>	<b>-0.49</b>	<b>-0.21</b>	<b>-0.66</b>	<b>0.71</b>	<b>-2.65</b>	<b>1.42</b>

**Table S2.** Geochemical inventory of wells and piezometers by terrain unit. Depth categories include water table wells (WT), shallow (S), moderate (M), and deep (D) piezometers.

Site	Landscape	Depth	No. Obs.	Temp. C	pH --	Eh mV	Cond. uS/cm	Alk.* mg/L	DIC mg/L	DOC mg/L	NO <sub>3</sub> mg/L	DON mg/L	NH <sub>4</sub> mg/L	PO <sub>4</sub> mg/L	SO <sub>4</sub> mg/L	Fl mg/L	Cl mg/L	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	δ <sup>2</sup> H ‰	δ <sup>18</sup> O ‰	δ <sup>13</sup> C ‰	δ <sup>15</sup> N <sub>PM</sub> ‰	δ <sup>13</sup> C <sub>PM</sub> ‰	
JPH	Rich fen	WT	48	13.4	5.81	67.0	74	17.1	70.10	30.06	0.82	1.08	0.18	0.10	5.57	0.02	4.17	7.38	1.93	2.39	0.75	-138.08	-17.68	-18.49	1.42	-28.45	
		S	21	11.1	5.98	-122.1	74	28.8	107.38	31.69	1.49	1.11	0.10	0.31	7.26	0.02	4.76	7.38	1.65	2.19	0.19	-143.20	-18.22	-18.09	0.90	-28.05	
		M	21	9.4	6.24	-134.4	87	39.7	128.93	16.96	2.21	0.72	0.18	0.68	0.72	0.04	1.02	6.98	1.41	1.74	0.37	-141.62	-18.08	-17.32	---	-28.76	
		D	21	9.3	6.92	-106.3	203	93.7	233.55	8.75	0.82	0.40	0.14	0.58	0.95	0.05	0.22	26.05	5.09	2.51	0.68	-146.52	-18.66	-13.98	---	-27.08	
		Average		10.8	6.24	-74.0	109	44.8	134.99	21.86	1.34	0.83	0.15	0.42	3.62	0.03	2.54	11.94	2.52	2.21	0.50	-142.35	-18.16	-16.97	1.16	-28.08	
	Upland	S	60	12.9	5.96	143.1	41	10.8	35.94	2.14	1.16	0.57	0.02	0.12	8.28	0.01	0.32	4.21	1.01	0.85	0.52	-149.45	-19.10	-17.86	---	-28.67	
		M	56	11.2	5.86	137.9	44	15.8	56.21	1.78	1.38	0.16	0.01	0.18	7.82	0.01	0.20	3.87	0.80	1.25	0.59	-147.90	-18.95	-19.41	---	-28.97	
		D	56	10.1	6.19	-26.7	93	44.2	168.23	17.57	2.62	0.59	0.14	0.59	2.49	0.03	0.20	8.84	2.28	2.53	0.55	-142.74	-18.26	-13.99	-6.65	-31.27	
		Average		11.4	6.00	84.8	59	23.6	86.79	7.16	1.72	0.44	0.06	0.30	6.20	0.02	0.24	5.64	1.36	1.54	0.55	-146.70	-18.77	-17.09	-6.65	-29.64	
	ML	Bog	WT	44	15.0	4.28	176.9	29	5.6	114.09	67.15	1.03	1.58	0.07	0.27	0.26	0.01	0.36	1.33	0.47	0.83	0.81	-137.77	-17.80	-14.60	-1.47	-29.31
			S	30	12.3	4.89	138.2	47	9.9	242.53	58.94	0.66	5.81	1.89	0.48	0.31	0.01	0.54	4.05	0.60	1.07	0.55	-141.26	-18.27	-1.92	-3.03	-28.99
			M	30	12.4	5.58	98.1	126	51.5	319.30	54.08	0.06	11.98	9.47	1.12	0.22	0.02	0.53	9.74	1.90	0.98	0.81	-144.03	-18.77	4.22	-4.92	-34.36
			D	17	8.3	7.05	98.0	576	369.8	872.25	110.63	0.10	5.82	23.19	0.36	0.18	0.10	0.55	117.52	34.11	2.70	1.61	-142.54	-18.52	6.84	-0.65	-26.40
			Average		12.0	5.45	127.8	194	109.2	387.04	72.70	0.46	6.30	8.65	0.56	0.24	0.03	0.50	33.16	9.27	1.39	0.94	-141.40	-18.34	-1.36	-2.52	-29.77
		Dry Fen	WT	36	15.3	4.43	164.0	26	1.8	145.61	49.57	1.35	0.77	0.04	0.11	0.09	0.02	0.20	1.49	0.43	0.79	0.54	-137.47	-17.69	-11.37	-1.25	-29.58
S			43	11.9	5.18	142.6	90	21.5	387.05	77.26	0.21	12.00	5.34	0.70	0.11	0.02	0.52	7.32	1.52	1.25	0.67	-137.76	-17.73	1.47	-6.96	-27.77	
M			34	11.5	5.67	146.8	199	71.3	502.76	67.75	0.92	22.31	12.61	1.56	0.07	0.01	0.24	14.95	3.11	0.74	0.51	-139.06	-17.91	7.20	-4.47	-29.61	
D			25	12.2	7.94	113.7	2025	606.9	1058.72	56.72	0.18	21.20	24.47	0.15	0.53	0.06	0.64	142.46	31.33	3.04	2.59	-139.13	-17.69	9.92	-1.84	-30.68	
Average				12.7	5.81	141.8	585	175.4	523.54	62.82	0.66	14.07	10.62	0.63	0.20	0.03	0.40	41.56	9.10	1.45	1.08	-138.36	-17.76	1.80	-3.63	-29.41	
Wet Fen		WT	51	16.0	4.45	157.8	23	2.3	149.28	42.84	0.29	1.21	0.10	0.09	0.08	0.01	0.42	1.22	0.37	0.86	0.86	-136.31	-17.42	-6.50	-1.30	-30.78	
		S	34	12.8	4.95	109.1	61	15.7	343.73	64.96	0.21	6.27	3.30	0.69	0.08	0.03	0.25	5.16	1.13	0.88	0.53	-134.28	-17.00	3.42	-5.98	-28.60	
		M	35	14.1	5.73	131.0	94	43.2	330.57	62.70	1.18	5.22	5.11	2.17	0.55	0.03	1.28	7.77	1.85	2.07	0.95	-134.62	-16.95	7.23	-2.31	-27.45	
		D	26	11.5	6.65	-45.5	421	199.6	492.24	44.57	0.00	5.96	2.62	0.84	0.17	0.04	0.29	23.64	7.96	2.52	1.54	-132.80	-16.66	4.29	-1.15	-26.15	
		Average		13.6	5.45	88.1	150	65.2	328.95	53.77	0.42	4.66	2.78	0.95	0.22	0.03	0.56	9.45	2.83	1.58	0.97	-134.50	-17.01	2.11	-2.69	-28.25	
Edge Fen	S	23	16.3	6.30	29.7	245	68.9	426.53	26.23	1.01	1.98	0.01	0.50	0.36	0.14	0.39	22.25	7.74	4.33	0.30	-139.77	-17.92	-14.68	2.10	-26.29		
	M	24	19.7	8.75	27.0	355	209.7	557.61	30.77	1.07	3.69	---	---	0.66	0.37	0.75	201.58	24.13	36.11	1.83	-139.73	-18.01	-16.21	---	-26.49		
	Average		18.0	7.52	28.3	300	139.3	492.07	28.50	1.04	2.83	0.01	0.50	0.51	0.25	0.57	111.92	15.93	20.22	1.06	-139.75	-17.97	-15.45	2.10	-26.39		
Upland	S	28	12.3	7.06	76.0	176	19.1	100.89	6.85	0.48	3.37	0.22	0.19	3.12	0.06	0.78	5.52	1.22	1.60	0.49	-142.41	-18.31	-17.57	-1.00	-24.97		
	M	28		10.75	---	---	---	57.56	20.20	1.70	10.20	0.42	0.10	1.49	0.07	1.95	200.47	28.97	22.92	4.60	-139.90	-17.90	-20.86	---	---		
	Average		12.3	8.91	76.0	176	19.1	79.23	13.53	1.09	6.78	0.32	0.14	2.31	0.06	1.36	102.99	15.09	12.26	2.55	-141.16	-18.11	-19.21	-1.00	-24.97		

\* mg/L CaCO<sub>3</sub>; S - 0.8 to 3.0 m-depth, M - 2.1 to 4.7m-depth, D - 4.6 to 7.8 m-depth.

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**Table S3.** Mariana Lakes nitrogen inventory including NH<sub>4</sub> and DON.

(a) Linear regressions		Bog	dry fen	wet fen	all data
NH <sub>4</sub> versus depth	slope	3.55	2.31	2.05	2.42
	intercept	-1.77	1.21	-0.73	-0.78
	r <sup>2</sup>	0.81	0.58	0.75	0.47
DON versus depth	slope	1.65	4.24	1.55	2.59
	intercept	2 .59	2.49	1.53	2.13
	r <sup>2</sup>	0.30	0.54	0.26	0.31

(b) Inventories kg N/ha		Bog	dry fen	wet fen	all data
<u>NH<sub>4</sub>-N</u>					
0 to 3 m		65	91	45	57
3 to 5 m		174	146	106	125
5 to 7 m		273	211	162	192
Total		512	448	313	374

<u>DON-N</u>					
0 to 3 m		82	219	84	139
3 to 5 m		165	350	139	225
5 to 7 m		225	501	241	225
Total		472	1070	464	589

<u>NH<sub>4</sub>+DON</u>					
0 to 3 m		147	310	129	196
3 to 5 m		339	496	245	350
5 to 7 m		498	712	403	417
Total		984	1518	777	963