

A SUMMARY OF ATMOSPHERIC DEPOSITION MEASUREMENTS FOR NUTRIENTS
IN CENTRAL ALBERTA

(1982-86)

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1989

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INTRODUCTION

The former Water Quality Control Branch (WQCB) operated a number of deposition collectors around the province to determine the aeolian deposition rates of various substances to lakes. This deposition program was implemented in 1982 as part of the Wabamun Lake Eutrophication Study. Nine deposition collectors operated between 1982-86. The nine collectors were located at Nakamun East, Nakamun West, Dickson North, Dickson South, Smoke, Iosegun, and three collectors at Lake Wabamun: Wabamun (west of village), Seba (Jackpine Creek) and the Fish and Wildlife compound near Fallis .

METHODS

The collectors used were free-standing cabinets with a 0.25m² teflon-lined funnel at the top; a hose connected the funnel to a glass container within the cabinet. During the winter, the deposition collectors were sampled as time and personnel were available. During the remainder of the year the collectors were sampled on an event basis as soon after a rain event as possible.

Samples were frequently contaminated while the sample sat in the collector. The most common types of contamination were insects, dust, and bird feces. Total phosphorus (TP) and total nitrogen (TN) were of specific interest to the WQCB, because they are associated with nutrient enrichment of lakes. Unfortunately, these two parameters are very sensitive to contamination. Consequently, much of the data collected were unsuitable for loading estimates. Also, the nitrogen components within the samples are very dynamic and may change form rapidly.

To determine the deposition rates of phosphorus and nitrogen, the data were screened to determine which samples were contaminated, and these were discarded. Deposition rates were then calculated for those collectors where sufficient data remained that would encompass a reasonable portion of a year. To calculate the deposition rates, the mass of TP and TN was calculated for the individual periods of observation and summed for the year. The results were expressed as $\text{mg}\cdot\text{m}^{-2}\cdot\text{yr}^{-1}$.

RESULTS

Samples from five of the collectors were found to be suitable for determination of deposition rates. The five collectors were Wabamun, Seba, Fish and Wildlife, Smoke, and Iosegun.

Deposition rates were not calculated for 1985 because all phosphorus analyses that year are questionable. The following table lists the calculated loadings from the various collectors. For nitrogen deposition, TN was defined as the sum of total kjeldahl nitrogen plus the sum of nitrite and nitrate-nitrogen.

<u>Collector</u>	<u>From</u>	<u>To</u>	<u>TP</u> (mg·m ⁻² ·yr ⁻¹)	<u>TN</u> (mg·m ⁻² ·yr ⁻¹)
Wabamun	Nov. 23/82	Nov. 14/83	28.4	317.0
Wabamun	Nov. 14/83	Oct. 31/84	31.4	422.0
Fish & Wildlife	May 31/83	Dec. 19/83	34.1	333.0
Seba	Nov. 23/82	Nov. 14/83	25.7	308.0
Seba	Nov. 14/83	Oct. 31/84	23.7	407.0
Seba	Jan. 21/86	Jan. 8/87	18.1	353.0
Smoke	June 17/83	June 20/84	14.0	217.0
Iosegun	June 17/83	June 20/84	25.8	192.0

The samples from the Fish and Wildlife collector included only data for the period May 31 - December 19, 1983, but these were extrapolated to a full year based on the percentage that was deposited in Wabamun and Seba collectors during the late winter and spring.

Among the three collectors on Wabamun Lake, TP loading from the Wabamun and Fish and Wildlife collectors were slightly higher than from the Seba collector, but there appears to be little difference in TN loadings. The Wabamun collector is near a gravel road, coal mine activity and the power generating station. The value for the Fish and Wildlife collector is based on an extrapolation to a full year, and may not be representative.

The Seba collector in 1986 yielded the lowest TP loading ever for the collectors at Wabamun. A possible explanation is that the summer of 1986 was unusually wet, consequently, the amount of dust in the air was lower than normal. This may have accounted for a lower TP loading. The TN loading in 1986 from the Seba collector was higher than in 1982-83, but lower than in 1983-84. The reason for this is unclear.

The TP loading calculated for the Smoke collector and TN for Iosegun were the lowest of the data set.

There was no relationship observed between the TP and TN loadings. The calculated loadings are within the range of other reported loading estimates in Alberta. The average annual TP loading calculated for collectors in relatively undisturbed areas (Seba, Smoke, Iosegun) is $21.5 \text{ mg.m}^{-2}.\text{yr}^{-1}$ (s.d.=5.21). This value is very similar to the average annual loading calculated from eight collectors located at the water's edge at Wabamun Lake in 1980 and 1981 ($21.9 \text{ mg.m}^{-2}.\text{yr}^{-1}$). The average annual TN loading for undisturbed areas during 1982-1986 is $295 \text{ mg.m}^{-2}.\text{yr}^{-1}$ (s.d.=90.5).

The raw data are summarized in Tables 1-8.

Table 1. Aeolian deposition data collected at Wabamun Lake (Wabamun) for the period from Nov. 23, 1982 to Nov. 14, 1983. Values in brackets are extrapolations.

Sampling Period	Volume (L)	pH	TP (mg/L)	TN (mg/L)	NH ₃ (mg/L)	NO ₃ +NO ₂ (mg/L)	TP (mg)	TN (mg)
Nov. 23-Feb. 15	1,472	7.07	0.2206	1.72	0.450	0.360	0.324	2,532
Feb. 15-Mar. 08	2,662	6.67	0.3223	[1.16]	—	—	0.858	[3,07]
Mar. 08-Apr. 14	8,040	6.0	0.0421	0.590	0.510	0.150	0.338	4,744
Apr. 14-May 12	1,780	7.17	0.253	4.040	2.150	1.04	0.450	7,191
May 12-May 31	0,901	7.16	0.840	3.070	1.32	0.07	0.756	2,766
May 31-June 13	3,354	5.93	0.1220	1.470	0.310	0.370	0.409	4,930
June 13-June 20	11,620	5.13	0.01214	0.115	0.028	0.045	0.141	1,336
June 20-June 23	4,528	4.84	0.02947	0.275	0.118	0.075	0.133	1,245
June 23-June 27	6,229	4.94	0.02562	0.680	0.260	0.100	0.160	4,236
June 27-July 04	6,136	5.53	0.02364	0.730	0.400	0.190	0.145	4,725
July 04-July 07	4,240	5.10	0.04049	0.770	0.330	0.250	0.172	3,265
July 07-July 18	14,795	5.2	0.04419	0.417	0.190	0.097	0.653	6,170
July 18-July 21	0,174	6.66	0.18856	[0.75]	—	—	0.033	[0.13]
July 21-July 25	2,043	5.08	0.07507	1.080	0.280	0.240	0.149	2,206
July 25-Aug. 11	9,280	6.5 ^a	0.03	0.520	0.130	0.140	0.278	4,826
Aug. 11-Aug. 22	2,491	7.0 ^a	0.21123	2.200	0.970	0.440	0.526	5,480
Aug. 22-Sep. 06	2,835	5.9 ^a	0.12561	0.960	0.270	0.320	0.356	2,722
Sep. 06-Sep. 16	6,870	6.1 ^a	0.03505	0.720	0.300	0.160	0.241	4,948
Sep. 16-Sep. 22	3,383	6.7 ^a	0.01691	0.293	0.110	0.053	0.057	0,991
Sep. 22-Oct. 14	2,597	6.1 ^a	0.12256	1.780	0.670	0.480	0.318	4,623
Oct. 14-Nov. 14	6,550	6.7 ^a	0.0663	0.803	0.300	0.183	0.434	5,260
TOTAL							6.931	77,394

Note: ^a sample analysis by Alberta Environmental Centre, Vegreville

Table 2. Aeolian deposition data collected at Wabamun Lake (Wabamun) for the period from Nov. 14, 1983 to Oct. 31, 1984. Values in brackets are extrapolations.

Sampling Period	Volume (L)	pH ^a	TP (mg/L)	TN (mg/L)	NH ₃ (mg/L)	NO ₃ +NO ₂ (mg/L)	TP (mg)	TN (mg)
Nov. 14-Nov. 30	1,071	5.2	0.12685	1.520	0.600	0.540	0.136	1,628
Nov. 30-Dec. 19	2,230	6.0	0.0180	0.600	0.200	0.300	0.040	1,388
Dec. 19-Jan. 23	2,275	—	0.03988	[0.600]	—	—	0.091	[1.37]
Jan. 23-Apr. 17	3,538	—	0.1557	[2.006]	—	—	0.551	[7.09]
Apr. 17-May 22	15,938	6.7	0.1524	2.006	1.100	0.226	2,429	31,972
May 22-May 28	2,095	5.7	0.0518	0.539	0.176	0.179	0.109	1,129
May 28-June 15	17,853	—	[0.0602]	[0.78]	—	—	[1.06]	[13.79]
June 15-June 26	5,249	5.7	0.0686	1.022	0.118	0.222	0.360	5,364
June 26-July 23	11,557	6.0	[0.0766]	[0.93]	—	—	[0.88]	[10.72]
July 23-Aug. 09	6,649	6.3	0.0845	0.833	0.250	0.263	0.562	5,539
Aug. 09-Aug. 15	3,105	6.2	0.0917	1.312	0.460	0.312	0.285	4,074
Aug. 15-Sep. 21	29,645	6.0	0.0251	0.450	0.240	0.150	0.744	13,340
Sep. 21-Oct. 04	2,946	6.2	0.0205	0.500	0.200	0.120	0.060	1,473
Oct. 04-Oct. 16	1,714	6.2	0.0729	0.470	0.090	0.150	0.125	0,806
Oct. 16-Oct. 31	3,942	6.0	0.0287	0.470	0.140	0.160	0.113	1,853
TOTAL							7.545	101.49

Note: ^a sample analyses by Alberta Environmental Centre, Vegreville

Table 3. Aeolian deposition data collected at Wabamun Lake (Fish and Wildlife) for the period from May 31 to Dec. 19, 1983. Values in brackets are extrapolations.

Sampling Period	Volume (L)	pH	TP (mg/L)	TN ^a (mg/L)	NH ₃ ^a (mg/L)	NO ₃ + NO ₂ ^a (mg/L)	TP (mg)	TN (mg)
May 31 - June 13	4.825	5.75	0.1490	1.470	0.430	0.270	0.719	7.093
June 13 - June 20	10.477	5.49	0.06103	0.392	0.083	0.052	0.639	4.107
June 20 - June 23	2.814	4.79	0.02504	0.365	0.110	0.085	0.070	1.027
June 23 - June 27	4.743	4.74	0.02214	0.440	0.180	0.100	0.105	2.087
June 27 - July 04	5.587	5.54	0.11383	1.270	0.620	0.150	0.636	7.095
July 04 - July 07	2.812	5.65	0.08240	1.350	1.03	0.250	0.232	3.796
July 07 - July 18	14.985	5.08	0.06065	0.590	0.015	0.110	0.909	8.841
July 18 - July 21	0.490	6.03	0.15419	[0.775]	—	—	0.076	[0.380]
July 21 - Aug. 11	7.776	6.6 ^a	0.0740	0.950	0.480	0.160	0.575	7.465
Aug. 11 - Aug. 22	1.552	7.0 ^a	[0.104]	[1.03]	—	—	[0.161]	[1.600]
Aug. 22 - Sep. 06	3.013	5.9 ^a	0.13430	1.100	0.370	0.240	0.405	3.314
Sep. 06 - Sep. 16	4.349	6.2 ^a	0.06323	1.150	0.550	0.250	0.275	5.001
Sep. 16 - Sep. 22	3.061	6.5 ^a	0.05247	0.425	0.071	0.085	0.161	1.301
Sep. 22 - Oct. 14	2.519	5.9 ^a	0.17898	1.280	0.880	0.400	0.451	3.224
Oct. 14 - Nov. 14	0.783	—	0.11162	1.523	0.590	0.183	0.086	1.193
Nov. 14 - Nov. 30	1.481	6.3 ^a	0.05687	1.290	0.580	0.450	0.084	1.910
Nov. 30 - Dec. 19	2.150	5.6 ^a	0.0180	0.620	0.220	0.320	0.039	1.290
TOTAL							5.62	60.72

Note: ^asample analysis by Alberta Environmental Centre, Vegreville

Table 4. Aeolian deposition data collected at Wabamun Lake (Seba Beach) for the period from Nov. 23, 1982 to Nov. 14, 1983. Values in brackets are extrapolations.

Sampling Period	Volume (L)	pH	TP (mg/L)	TN (mg/L)	NH ₃ (mg/L)	NO ₃ +NO ₂ (mg/L)	TP (mg)	TN (mg)
Nov. 23 - Feb. 15	1,779	6.25	0.0978	2.56	—	—	0.176	4.554
Feb. 15 - Mar. 08	5,009	5.45	0.0519	0.65	0.490	0.010	0.260	3.256
Mar. 08 - Apr. 14	7,540	5.42	0.1002	0.73	0.460	0.120	0.756	5.504
Apr. 14 - May 12	2,054	6.7	0.5230	3.48	—	—	1.075	7.148
May 12 - June 13	5,000	4.98-6.94 ^b	0.1530	1.73	0.280	0.330	0.765	8.65
June 13 - June 20	9,358	4.82	0.02011	0.230	0.039	0.050	0.188	2.152
June 20 - June 23	2,737	4.45	0.01343	0.290	0.098	0.090	0.037	0.794
June 23 - June 27	5,912	4.38	0.07752	0.580	0.340	0.160	0.458	3.429
June 27 - July 04	8,530	4.35	0.01957	0.620	0.330	0.200	0.167	5.289
July 04 - July 07	2,440	4.56	0.04595	1.030	0.420	0.250	0.112	2.513
July 07 - July 18	16,762	4.8	0.02593	0.333	0.089	0.093	0.435	5.582
July 18 - July 21	0,445	5.6	0.07548	[0.58]	—	—	0.034	[0.26]
July 21 - Aug. 11	11,112	6.3 ^a	0.056	0.830	0.480	0.170	0.622	9.223
Aug. 11 - Aug. 22	1,551	6.9 ^a	0.17218	1.640	0.590	0.340	0.267	2.544
Aug. 22 - Sep. 06	2,889	6.3 ^a	[0.0609]	[1.14]	—	—	[0.176]	[3.29]
Sep. 06 - Sep. 16	3,115	5.8 ^a	0.06090	1.140	0.550	0.220	0.190	3.551
Sep. 16 - Sep. 22	2,318	6.5 ^a	0.01840	0.338	0.120	0.078	0.043	0.783
Sep. 22 - Oct. 14	2,702	5.8 ^a	0.07401	1.130	0.460	0.350	0.200	3.053
Oct. 14 - Nov. 14	5,971	6.3 ^a	0.05185	0.592	0.160	0.132	0.310	3.535
TOTAL							6.26	75.11

Notes: ^a sample analysis by Alberta Environmental Centre, Vegreville; ^b two sampling intervals

Table 5. Aeolian deposition data collected at Wabamun Lake (Seba Beach) for the period from Nov. 14, 1983 to Oct. 31, 1984. Values in brackets are extrapolations.

Sampling Period	Volume (L)	pH _s	TP (mg/L)	TN (mg/L)	NH ₃ (mg/L)	NO ₃ +NO ₂ (mg/L)	TP (mg)	TN (mg)
Nov. 14-Nov. 30	14,475	6.3	0.05549	1.37	0.700	0.430	0.803	19,831
Nov. 30-Dec. 19	2,972	5.2	0.0160	0.550	0.200	0.270	0.048	1,635
Dec. 19-Jan. 23	3,564	5.5	0.03583	0.760	0.300	0.340	0.128	2,708
Jan. 23-Apr. 17	0,180	—	0.2678	[0.68]	—	—	0.048	[0.12]
Apr. 17-May 22	20,256	5.6	0.0489	0.602	0.300	0.142	0.991	12,194
May 22-May 28	2,031	3.7	[0.0407]	[0.57]	—	—	[0.08]	[1.16]
May 28-June 15	14,541	5.1	0.0324	0.544	0.240	0.144	0.471	7,910
June 15-June 26	6,953	5.4	0.0894	0.811	0.106	0.111	0.622	5,639
June 26-July 23	9,525	5.4	0.0604	0.994	0.280	0.194	0.766	9,468
July 23-Aug. 09	3,907	6.0	0.1139	1.706	0.680	0.426	0.445	6,665
Aug. 09-Aug. 15	3,065	5.7	0.0477	1.149	0.330	0.249	0.146	3,522
Aug. 15-Sep. 21	27,686	—	[0.0340]	[0.82]	—	—	[0.94]	[22.70]
Sep. 21-Oct. 04	2,085	6.0	0.0197	0.500	0.194	0.120	0.041	1,043
Oct. 04-Oct. 16	0,952	5.9	0.0739	0.780	—	—	0.070	0,743
Oct. 16-Oct. 31	5,828	5.7	0.0168	0.430	0.080	0.150	0.098	2,506
TOTAL							5.70	97.84

Note: a sample analyses by Alberta Environmental Centre, Vegreville

Table 6. Aeolian deposition data collected at Wabamun Lake (Seba Beach) for the period from Jan. 21, 1986 to Jan. 8, 1987. Values in brackets are extrapolations.

Sampling Period	Volume (L)	pH _a	TP (mg/L)	TN (mg/L)	NH ₃ (mg/L)	NO ₃ + NO ₂ (mg/L)	TP (mg)	TN (mg)
Jan. 21 - Mar. 06	4.238	6.1	0.0792	1.156	0.350	0.496	0.336	4.899
Mar. 06 - Apr. 22	9.078	6.0	0.0782	1.168	0.410	0.368	0.710	10.603
Apr. 22 - May 20	8.650	4.9	0.0236	1.806	0.500	0.256	0.206	15.622
May 20 - June 11	5.851	6.1	0.1258	1.379	0.277	0.329	0.736	8.069
June 11 - June 24	9.714	4.7	[0.0795]	[0.99]	—	—	[0.78]	[9.66]
June 24 - July 10	9.187	5.8	0.0332	0.610	0.140	0.170	0.305	5.604
July 10 - July 15	11.250	5.0	0.0092	0.208	0.040	0.068	0.103	2.340
July 15 - July 17	16.075	6.1	0.0037	0.159	0.065	0.039	0.023	0.966
July 17 - July 21	16.850	6.1	0.0105	0.130	0.004	0.020	0.177	2.191
July 21 - Aug. 06	10.500	5.6	0.0319	0.477	0.120	0.097	0.335	5.009
Aug. 06 - Sep. 30	20.650	6.2	0.0200	0.423	0.150	0.143	0.413	8.735
Sep. 30 - Oct. 23	5.600	—	[0.0244]	[0.98]	—	—	[0.134]	[5.49]
Oct. 23 - Jan. 08	3.890	—	0.0288	1.540	0.560	0.360	0.112	5.990
TOTAL							4.37	85.18

Note: a sample analyses by Alberta Environmental Centre, Vegreville

Table 7. Aeolian deposition data collected at Smoke Lake for the period from June 17, 1983 to June 20, 1984.
 Values in brackets are extrapolations.

Sampling Period	Volume (L)	pH	TP (mg/L)	TN (mg/L)	NH ₃ (mg/L)	NO ₃ +NO ₂ (mg/L)	TP (mg)	TN (mg)
June 17 - June 21	20,637	4.43	0.01171	0.147	0.018	0.047	0.241	3,034
June 21 - June 28	5,487	4.18	0.0117	0.330	0.104	0.130	0.064	1,811
June 28 - July 06	8,250	4.26	0.01384	0.149	0.040	0.089	0.114	1,229
July 06 - July 15	13,087	4.32	0.01572	0.197	0.077	0.077	0.206	2,578
July 15 - July 22	8,445	4.44	0.01806	0.653	0.055	0.053	0.153	5,515
July 22 - July 29	21,590	4.4 ^a	0.02013	0.237	0.031	0.097	0.435	5,117
July 29 - Aug. 19	3,454	6.6 ^a	[0.0207]	[0.19]	—	—	[0.073]	[0.656]
Aug. 19 - Sep. 09	11,049	4.7 ^a	0.02135	0.141	0.033	0.001	0.236	1,558
Sep. 09 - Sep. 22	5,334	5.1 ^a	0.01006	0.216	0.060	0.056	0.054	1,152
Sep. 22 - Nov. 07	8,671	6.1 ^a	0.05779	0.682	0.022	0.062	0.501	5,914
Nov. 07 - Dec. 05	3,215	6.1 ^a	0.0857	0.364	0.160	0.104	0.276	1,170
Dec. 05 - Jan. 13	7,613	5.0 ^a	0.01785	0.300	0.062	0.140	0.136	2,284
Jan. 13 - Apr. 27	12,632	—	0.0242	[0.29]	—	—	0.306	[3.64]
Apr. 27 - May 24	22,542	4.9 ^a	0.0267	0.276	0.084	0.076	0.602	6,222
May 24 - June 20	11,684	5.6 ^a	[0.0267]	1.331	0.118	0.131	[0.32]	15,318
TOTAL							3.72	54.16

Note: ^asample analysis by Alberta Environmental Centre, Vegreville

Table 8. Aeolian deposition data collected at Iosegun Lake for the period from June 17, 1983 to June 20, 1984.
 Values in brackets are extrapolations.

Sampling Period	Volume (L)	pH	TP (mg/L)	TN (mg/L)	NH ₃ (mg/L)	NO ₃ + NO ₂ (mg/L)	TP (mg)	TN (mg)
June 17 - June 21	17,397	4.41	0.04434	0.151	0.016	0.051	0.771	2,627
June 21 - June 28	9,201	4.80	0.0177	0.220	0.058	0.080	0.163	2,024
June 28 - July 06	13,740	4.96	0.0733	0.130	0.030	0.090	1,007	1,786
July 06 - July 15	14,657	4.52	0.01257	0.156	0.042	0.056	0.184	2,284
July 15 - July 22	7,460	4.68	0.02448	0.963	0.071	0.083	0.183	7,184
July 22 - July 29	22,735	4.5 ^a	0.02721	0.237	0.018	0.097	0.619	5,368
July 29 - Aug. 19	5,304	6.9 ^a	0.0360	0.450	0.140	0.130	0.191	2,387
Aug. 19 - Sep. 09	12,382	5.1 ^a	0.0256	0.201	0.003	0.081	0.317	2,489
Sep. 09 - Sep. 22	5,555	5.4 ^a	0.03181	0.243	0.057	0.043	0.177	1,350
Sep. 22 - Nov. 07	7,194	6.0 ^a	0.07122	0.334	0.002	0.054	0.512	2,403
Nov. 07 - Dec. 05	3,473	4.9 ^a	0.02887	0.560	0.180	0.160	0.100	1,945
Dec. 05 - Jan. 13	6,643	4.8 ^a	0.06086	0.460	0.044	0.180	0.404	3,050
Jan. 13 - Apr. 27	5,000	—	[0.06086]	[0.46]	—	—	[0.305]	[2.30]
Apr. 27 - May 24	—	4.9 ^a	—	—	—	—	—	—
May 24 - June 20	11,684	5.2 ^a	0.0955	0.664	0.028	0.104	1.115	7,758
TOTAL							6.048	44,975

Note: ^a sample analysis by Alberta Environmental Centre, Vegreville