

TERTIARY WASTEWATER TREATMENT  
USING A NATURAL PEAT BOG

by

David J. Mechenich

A Thesis  
submitted in partial fulfillment  
of the requirements for the degree  
MASTER OF SCIENCE

College of Natural Resources

UNIVERSITY OF WISCONSIN  
Stevens Point, Wisconsin

May 1980

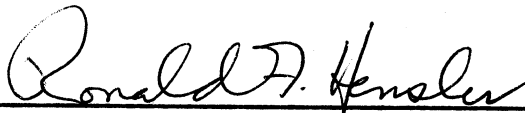


APPROVED BY THE GRADUATE COMMITTEE OF:



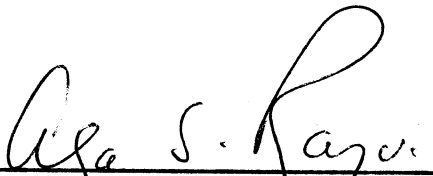
---

Dr. Byron Shaw, Committee Chairman  
Professor of Soil Science and Water Science



---

Dr. Ronald Hensler  
Associate Professor of Soil Science



---

Dr. Aga Razvi  
Assistant Professor of Soil Science and Water Science

## ABSTRACT

The water quality of a sphagnum peat bog system at Drummond, WI was monitored at 39 sampling sites from October, 1977, to November, 1979, in order to characterize the natural water chemistry and to evaluate the bog's initial ability to assimilate secondarily treated domestic sewage. Routine water analyses included pH, conductivity, chloride, COD, BOD, ortho and total phosphorus, and ammonia, nitrate-nitrite, and Kjeldahl nitrogen. Fecal coliforms, total suspended solids, dissolved oxygen, metals, hardness, and alkalinity were occasionally measured. Background values were generally typical of a perched, ombrotrophic bog. Significant background variability occurred across the bog, with depth, and over time.

From June through October, 1979, approximately 2.2 million gallons (8350 m<sup>3</sup>) of wastewater were filtered through the bog. The wastewater was secondary lagoon effluent diluted with lake water used for initial lagoon filling and sealing. Effluent BOD<sub>5</sub> and nitrogen were similar to the bog background. Effluent pH, chlorides, conductivity, alkalinity, hardness, phosphorus, and suspended solids were significantly higher, and COD was much lower. Analysis of water quality changes during the first 4.5 months of operation indicated an efficient assimilation of the effluent. Percent retention of nutrients from precipitation (1978) and precipitation plus effluent (1979) are listed below for the period from June through October:

	<u>% Phosphorus &amp; Nitrogen Retention</u> 1978 (Background)	<u>1979</u> (Eff. Discharged)	<u>% Of 1979</u> Loading Due To Effluent
Total P	-32%(release)	78%	38%
Ortho P	30%	88%	18%
Kjeldahl N	-46%(release)	53%	24%
Ammonia N	99%	97%	5%
NO <sub>2</sub> -NO <sub>3</sub> N	96%	100%	0%

Significant reductions in effluent concentrations of chloride (60%), alkalinity (100%), hardness (83%), phosphorus (80%), and total suspended solids (95%), were also noted based on differences between the effluent and bog outflow water quality during the effluent discharge period. Effluent pH and conductivity were also significantly reduced, while COD increased 204%.

Chloride tracing revealed that the effluent water primarily moved through the bog in the upper 0.5 meter. Other than chloride and conductivity increases, the most significant water quality changes within the bog appeared to be a drop in COD, BOD, phosphorus, and nitrogen below the established background levels at several well sites, and a reduction in background COD in the bog discharge.

Leaching studies using Drummond peat cores were used to estimate the long-term potential of the bog to remove nutrients by physical-chemical processes. Under the specific experimental conditions, net phosphorus removals up to .191 mg P/gram oven dry weight peat were found, which was equivalent to approximately 40 kg P/acre-foot of surface peat soil. Nitrogen and calcium removals of .45 and 4.5 mg/gram oven dry weight peat respectively were also found.

## ACKNOWLEDGEMENTS

I would especially like to thank my advisor, Dr. Byron Shaw, for allowing me to undertake this project and for his advice and support along the way. I would also like to express my appreciation to the other members of my graduate committee and to Bill Kappel for their interest and suggestions.

Special thanks go to the members of the Environmental Task Force, especially Dick Stephens, for their assistance in processing the water samples. The help of all friends who provided field assistance is gratefully acknowledged. Thanks are also given to Mike Marano and Louie Swalby for their help with computer data processing.

Appreciation is extended to the US Forest Service for providing hydrologic data, and to Glenn Spears and Jack Grande for sampling assistance. Funding for the project was provided by the Upper Great Lakes Regional Commission.

Finally, I want to thank my wife, Chris, for her constant help and encouragement and for sharing the long hours in the field and lab.

# TABLE OF CONTENTS

	<u>Page</u>
ABSTRACT . . . . .	iii
ACKNOWLEDGEMENTS . . . . .	v
LIST OF TABLES . . . . .	viii
LIST OF ILLUSTRATIONS . . . . .	ix
LIST OF APPENDICES . . . . .	xi
INTRODUCTION . . . . .	1
Objectives . . . . .	4
Description of Study Area . . . . .	5
Peatland Processes and Wastewater Treatment . . . . .	10
MATERIALS AND METHODS . . . . .	16
Field Sampling . . . . .	16
Water Quality Analysis . . . . .	20
Peat Analysis . . . . .	22
Leaching Studies . . . . .	23
Nutrient Budgeting . . . . .	24
Statistical Analysis . . . . .	25
RESULTS AND DISCUSSION . . . . .	26
Chloride . . . . .	28
Conductivity . . . . .	33
pH . . . . .	38
COD and BOD . . . . .	41
Phosphorus . . . . .	52
Nitrogen . . . . .	63
Metals . . . . .	72

TABLE OF CONTENTS, continued

	<u>Page</u>
Dissolved Oxygen . . . . .	73
Other Parameters . . . . .	75
Peat Core Nutrient Uptake Studies . . . . .	76
Phosphorus Removal . . . . .	77
Nitrogen Removal . . . . .	81
Calcium Removal . . . . .	83
pH and Conductivity . . . . .	84
CONCLUSIONS AND RECOMMENDATIONS . . . . .	86
LITERATURE CITED . . . . .	89
APPENDICES . . . . .	97

## LIST OF TABLES

		<u>Page</u>
Table 1.	Average background water quality of the bog discharge and the lagoon effluent discharged to the bog.	27
Table 2.	Average chloride concentrations for the Drummond system before and after effluent application.	29
Table 3.	Average conductivity for the Drummond system and % change after effluent application.	34
Table 4.	Average pH for the Drummond system before and after effluent application.	39
Table 5.	Average COD for the Drummond system and % change after effluent application.	42
Table 6.	Average BOD <sub>5</sub> for the Drummond system and % change after effluent application.	47
Table 7.	Average BOD <sub>20</sub> for the Drummond System before and after effluent application.	51
Table 8.	Average ortho and total phosphorus for the Drummond system and % change after effluent application.	53
Table 9.	Average metal content of 10 peat samples from the Drummond bog.	62
Table 10.	Average nitrite-nitrate, ammonia, and Kjeldahl nitrogen for the Drummond system and % change after effluent application.	64
Table 11.	Average metal concentrations in the lagoon effluent and the Drummond bog before and after effluent application.	73
Table 12.	Chemical characteristics of the eluants used in the peat core nutrient uptake studies.	77

## LIST OF ILLUSTRATIONS

	<u>Page</u>
Figure 1. A. Average water temperature in the Drummond bog. B. Average depth to the perched water table in the Drummond bog. C. Monthly precipitation.	6
Figure 2. The Drummond wastewater treatment system and water quality sampling sites.	9
Figure 3. Peatland processes related to wastewater treatment.	10
Figure 4. Location and depth of monitoring wells in the Drummond treatment bog.	17
Figure 5. Average chloride concentrations in the Drummond bog during the last half of the 1979 effluent discharge period.	30
Figure 6. Twenty mg/L chloride isolines in the Drummond bog at various times during the 1979 effluent discharge period.	31
Figure 7. Seasonal conductivity trends for the Drummond bog.	35
Figure 8. Average conductivity in the Drummond bog and % change after effluent application.	36
Figure 9. Seasonal pH trends for the Drummond bog.	40
Figure 10. Seasonal COD trends for the Drummond bog.	44
Figure 11. Average COD in the Drummond bog and % change after effluent application.	45
Figure 12. Seasonal BOD <sub>5</sub> trends for the Drummond bog.	48
Figure 13. Average BOD <sub>5</sub> in the Drummond bog and % change after effluent application.	50
Figure 14. Average ortho and total phosphorus in the Drummond bog and % change after effluent application.	55
Figure 15. Seasonal ortho and total phosphorus trends for the Drummond bog.	57

LIST OF ILLUSTRATIONS, continued

	<u>Page</u>
Figure 16. Total phosphorus on a transect across the Drummond bog before and after effluent application.	60
Figure 17. Seasonal ammonia and Kjeldahl nitrogen trends for the Drummond bog.	66
Figure 18. Average ammonia and Kjeldahl nitrogen in the Drummond bog and % change after effluent application.	68
Figure 19. Kjeldahl nitrogen on a transect across the Drummond bog before and after effluent application.	70
Figure 20. Seasonal dissolved oxygen trends in Weso Lake.	75
Figure 21. % phosphorus removal in peat cores from the Drummond bog (eluant P conc. = 1 mg/L).	78
Figure 22. % phosphorus removal in peat cores from the Drummond bog (eluant P conc. = 3.5 to 4.7 mg/L).	79
Figure 23. % nitrogen removal in peat cores from the Drummond bog.	82
Figure 24. % calcium removal in peat cores from the Drummond bog.	84

## LIST OF APPENDICES

	<u>Page</u>
Appendix A. Water quality data for the Drummond treatment bog.	97
Appendix B. Water quality data for the control bog.	125
Appendix C. Water quality data for the lower bog.	128
Appendix D. Water quality data for the regional groundwater.	129
Appendix E. Water quality data for the precipitation.	131
Appendix F. Water quality data for the Drummond lagoon effluent.	133
Appendix G. Water quality data for Weso Lake.	134

## INTRODUCTION

The Drummond experimental wastewater treatment system is an innovative design utilizing the assimilative capacity of a natural sphagnum peat bog for tertiary treatment of secondary lagoon effluent. The normal physical, chemical, and biological processes in the bog may remove pollutant nutrients to acceptable levels as the effluent filters through the wetland.

Research on other types of natural and artificial wetlands has indicated a strong potential for wastewater renovation. During pilot scale wastewater treatment operations on the Houghton Lake fen in central Michigan, Tilton and Kadlec (1979) reported 99, 77, and 95% removal by mass for nitrate-nitrite N, ammonia N, and total dissolved phosphorus respectively during the growing season. Kadlec (1979) reports very good results for the first year of full scale operation for the treatment of 65 million gallons of secondary effluent at the Houghton Lake site. Ninety percent N and P removal were typical within 100 meters of the effluent discharge. Kadlec (1979) also notes efficient nutrient removal by a forested wetland serving as a tertiary treatment system for the village of Bellaire, MI (population 1000). P and N concentrations were reduced 94-97% and 91-98% respectively.

In Florida, a mixed hardwood swamp is providing tertiary treatment for a town with a population of 2500. Boyt et al. (1977) reported a 98.1% reduction in total P and a 89.5% reduction in total N after 20 years of discharges to the swamp.

Fritz and Helle (1979) report excellent nutrient removal (98% of N and 97% of P) in cypress wetlands in Florida. The cypress treatment systems were shown to be cost effective, energy efficient, relatively reliable, and available for 35% of the wastewater treatment facilities in Florida. Hermann et al. (1979) found efficient tertiary treatment in experimental plots in a central Florida freshwater marsh. Reported P and N removals were 97.5 and 73.4% respectively. Steward and Ornes (1975) determined a limited capacity of an Everglades sawgrass marsh for nutrient assimilation.

Investigations by Fetter et al. (1978) on a Wisconsin Typha marsh receiving urban and agricultural runoff revealed significant improvement in water quality as water passed through the wetland. They reported concentration reductions of: BOD-80.1%, coliform bacteria-86.2%, nitrate-51.3%, COD-43.7%, ortho phosphorus-6.4%, and total phosphorus-13.4%.

Hartland-Rowe and Wright (1975) established that slightly treated sewage was substantially improved by passage through a northern swampland in the Northwest Territories, Canada. Hickok (1978) reported 77% removal of total P and 94% removal of total suspended solids from urban stormwater runoff by filtration through a wetland. Research by Turner et al. (1976) indicated a good potential for treating fish processing wastes by overland flow and marsh percolation in Louisiana wetlands. Whigham and Simpson (1976) experimented with wastewater application to a Delaware freshwater tidal marsh and found that vascular plants could act as nutrient sinks

during the summer months. Surakka and Kamppi (1971) reported success with peat infiltration systems in Finland to treat wastewater from small communities. N removals of 67-90%, P removals of 21-82%, and coliform bacteria removals over 99% were noted. Yonika and Lowry (1979) reported significant improvements in secondary effluent as it passed through a Massachusetts inland marsh. Reductions in BOD (67%), ammonia N (59%), nitrate N (21%), ortho P (49%), and total P (47%) were noted after a minimum of 16 years of effluent discharge to the marsh.

Small (1979) reported cost effective and energy efficient wastewater renovation using artificial marsh/pond and meadow/marsh/pond systems. Fetter et al. (1976) demonstrated the effectiveness of artificial marsh systems constructed in plastic lined trenches for seasonal treatment of septic tank effluent. The reported reductions in mass were: BOD-77%, COD-71%, ortho P-35%, total P-37%, nitrates-22%, and coliform bacteria-99.9%. Using artificial marshes to treat swine feed lot wastes, Werblan et al. (1979) reported removals of COD (80-90%), volatile solids (50-90%), nitrogen (60%), and phosphorus (50%). The Mt. View Sanitary District, CA, has successfully created freshwater wetlands with secondary effluent (Nute and Demgen 1979). In addition to producing wildlife habitat, the quality of the effluent was improved.

Farnham and Brown (1972) reported excellent performance of experimental peat filter systems for phosphorus, organic matter, and bacterial removal. The equivalent of over 2016

kg/ha of phosphorus was removed from the wastewater when filtered through 10-30 cm of peat. An application of the peat filter design by the Forest Service to treat campground wastes was highly effective (Stanlick 1976 and Parrott and Boelter 1977). Similarly, Silvo (1972) noted the potential of sphagnum peat filters for pretreatment of slaughterhouse wastewater to prevent adverse impacts on conventional domestic treatment plants. And finally, numerous researchers have demonstrated the potential of peat moss for industrial wastewater treatment to remove heavy metals and other pollutants (Chaney and Hundemann 1979, Coupal and Lalancette 1976, Lalancette and Coupal 1972, and Ruel et al. 1977).

### Objectives

The primary objective of this research was to determine the initial treatment efficiency of the Drummond bog, a typical wetland type in the northern lake states. This was accomplished by: 1. monitoring the baseline water chemistry of the Drummond bog system and the changes in water chemistry as effluent was discharged to the system, and 2. estimating potential nutrient removal based on nutrient uptake abilities of the peat soils as determined by laboratory leaching experiments.

Other research at the Drummond site included hydrologic budgeting (USFS), long-term studies of vegetation composition changes (USFS North Central Forest Experiment Station), vegetation nutrient and mineral content and uptake studies

(UW-Milwaukee and Stout), and impact studies on wildlife, invertebrates, and algal communities (UW-Stevens Point).

The compilation of this research should provide not only an evaluation of this type of wetland treatment system, but also a foundation for better understanding the component processes of wetland systems and the types and magnitude of impacts on wetland ecology. This knowledge is essential for responsible application of peatland treatment systems by other small communities.

#### Description of Study Area

Drummond is a small community of approximately 270 residents within the Chequamegon National Forest in northwestern Wisconsin (T.45N., R. 7W.). The landscape of the area reflects its glacial history. Precambrian bedrock (basaltic lava flows over granitic crystalline rock) is covered with thick deposits of clayey till and stratified sand and gravel in the characteristic end moraine knob and kettle topography (Young and Skinner 1974). Wetlands, often with thick deposits of organic peat soils, are common in the kettles and low lying areas.

Peat depths up to 10 meters have been found in the Drummond peatland. Sufficient precipitation to maintain a relatively high water table in the peat filled basin and cool temperatures through much of the year (Fig. 1) retard decomposition and promote peat formation (Gorham 1957).

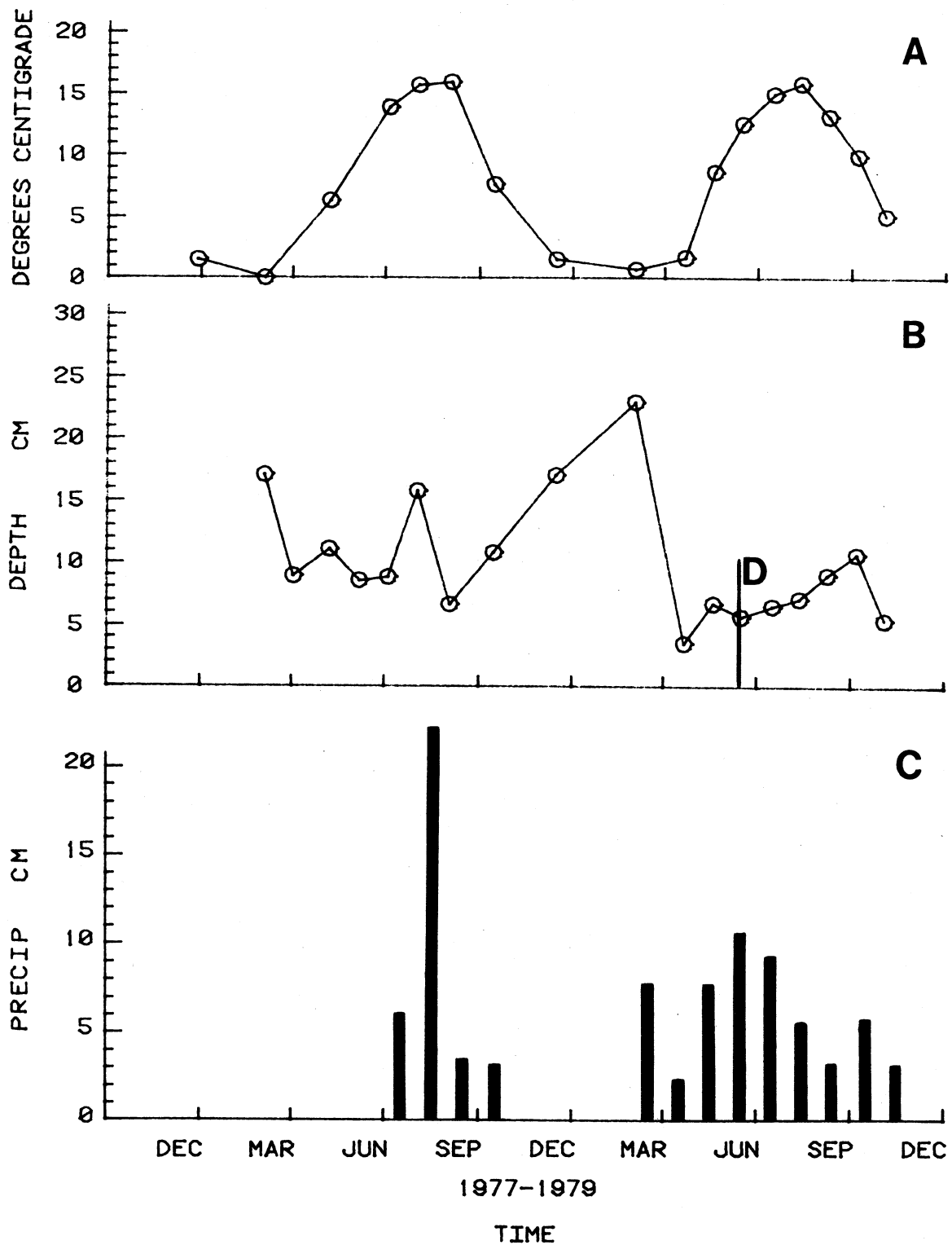


Figure 1. A. Average water temperature in Drummond monitoring wells 0.4 meters deep. B. Average depth to perched water table in the Drummond bog. C. Monthly precipitation as measured at the USFS weather station in Drummond. Data was obtained for the periods July through October, 1978, and March through November, 1979. The line marked "D" indicates the start of effluent discharges to the bog.

Two major types of peatlands are recognized in the lake states, primarily identified by water source or corresponding characteristic vegetation (Boelter and Verry 1977). Minerotrophic peatlands (fens) are ion rich, receiving water directly from the relatively mineral rich regional groundwater. Ombrotrophic peatlands (bogs) are ion poor because their primary water source is precipitation. The Drummond peatland is a bog; its water table is perched above the regional groundwater by relatively impermeable well decomposed peats and clayey glacial till. Well logs for deep drilled wells adjacent to the bog show dry sands and gravels interspersed with clay at a depth below the bottom of the bog. Also, soil core samples collected in and around the bog reveal a clay liner that should effectively seal the basin (Kappel 1979).

Vegetation in the Drummond peatland is generally typical for a perched, ombrotrophic bog (Bay 1967). Relatively low quality black spruce is the dominant tree cover, along with scattered tamarack. Ground cover is primarily ericaceous shrub species, including leatherleaf, Labrador tea, bog rosemary, and bog laurel, and sphagnum mosses, including S. recurvum, S. magellanicum, S. capillifolium, S. warnstorffii, S. fuscum, and S. fimbriatum (Bowers 1979).

The concept of using the bog for wastewater treatment developed when the town of Drummond constructed a lagoon wastewater treatment system because of the failure of individual soil absorption systems in the clayey glacial soils.

The lagoon system has a 180 day holding capacity, after which the secondary effluent is discharged to the 22 acre treatment bog (Fig. 2), rather than a direct discharge twice a year to the Long Lake Branch of the White River, a high quality trout stream, as originally planned. Gated irrigation pipe is used to disperse the effluent across the bog surface for maximum contact with the peat.

Effluent is added to the bog in 100,000 gallon increments during ice-free periods. Discharges are scheduled to prevent peak runoff or insufficient effluent retention time in the bog by taking advantage of the bog's ability to store short-term runoff (Bay 1969). Discharge criteria therefore include consideration of the bog outlet flow and antecedent and predicted precipitation. Theoretically, based on evapotranspiration measurements and water storage factors, 11 million gallons of effluent a year could be added to the bog if discharges were proportional to ET, with only a doubling of the normal bog runoff (Kappel 1979).

The bog system was first used in 1979, when 2.208 million gallons ( $8350 \text{ m}^3$ ) of effluent were discharged to the bog from June 14 to October 24. The bog outflow did not change significantly during the effluent discharge period compared to the 1978 baseline period. The average discharge was 0.06 cfs (0.0017 cms) for both periods. The perched water table actually dropped slightly during effluent application, also indicating effective assimilation of the effluent water (Fig. 1).

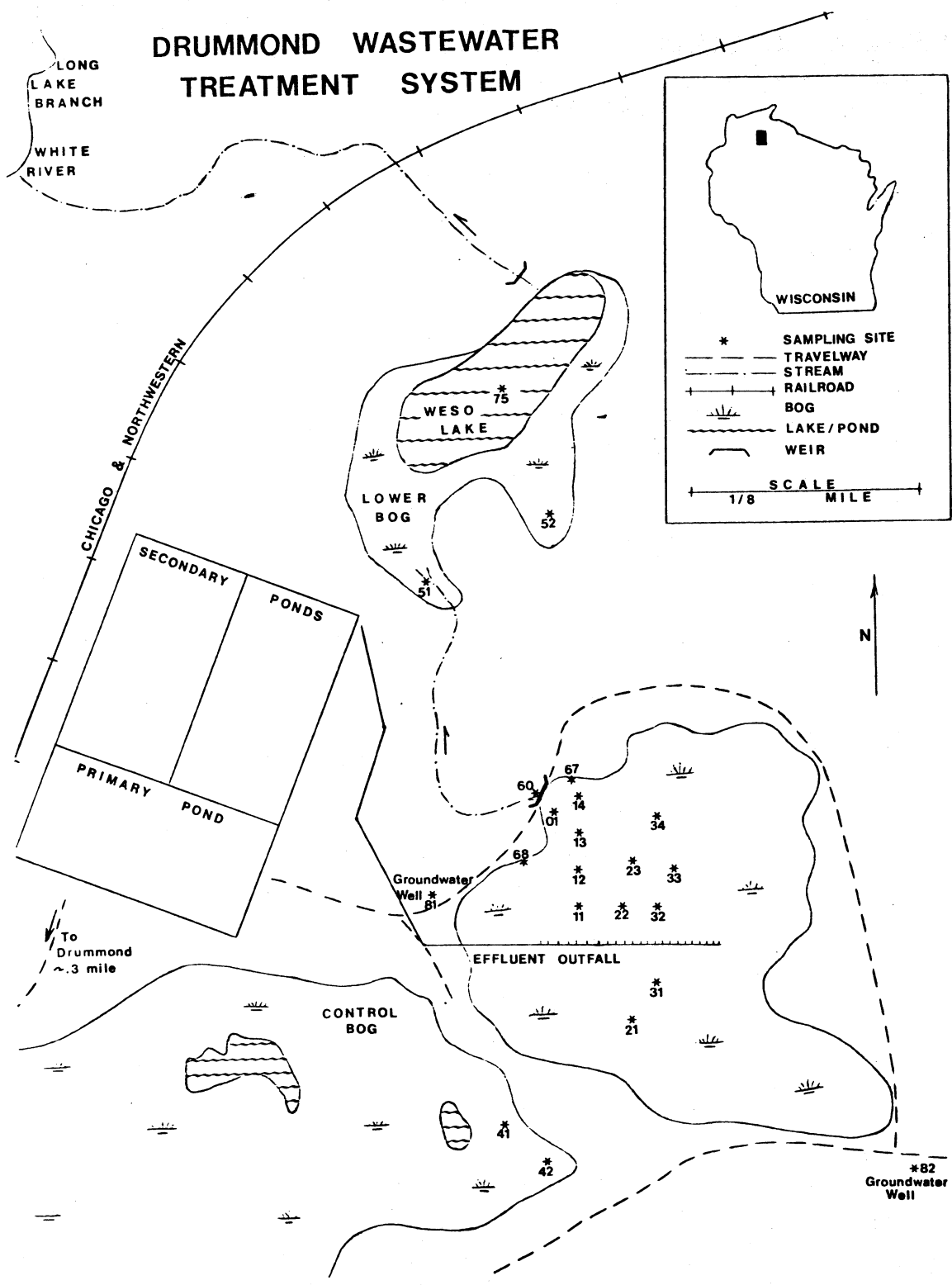


Figure 2. The Drummond wastewater treatment system and water quality sampling sites.

The normal water table trend for a perched bog is to reach a high in April and May with recharge from snowmelt and to then steadily decrease from ET and runoff, reaching a low prior to the next spring recharge (Boelter and Verry 1977). The uncharacteristic rise in the water table in August, 1978, reflects unusually high precipitation, including a 100 year storm. The effluent discharges did not interrupt the normal trend, although the rate of drop was probably less, and at no time during the effluent discharge period was the water table unnaturally high. A high water table, more consistently maintained by effluent discharges, could eventually adversely affect plant communities (Schwintzer 1978).

### Peatland Processes and Wastewater Treatment

The functions of the lagoons are to allow settling of particulate matter and to stabilize organic material. The bog may continue this clean-up process in a number of ways (Fig. 3). Hemic and sapric peats often have very low

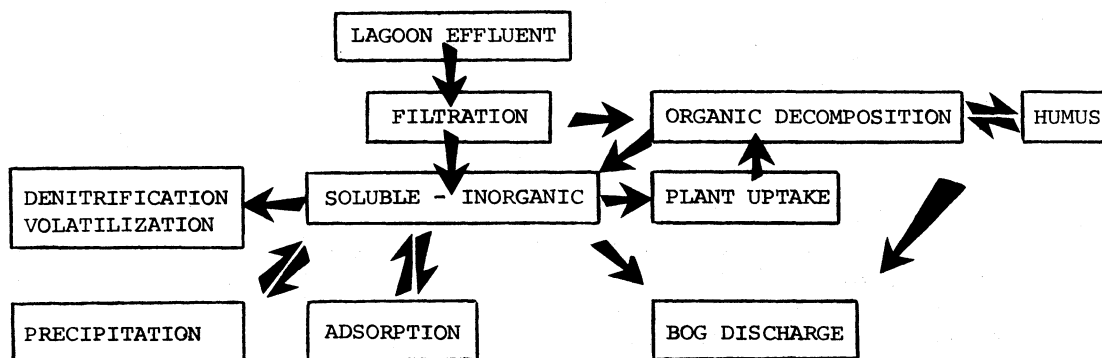


Figure 3. Peatland processes related to wastewater treatment.

permeability and hydraulic conductivity (Boelter 1965 and Boelter 1969), providing an ideal environment for entrapment and deposition of particulate materials.

Effluent organic material would enter natural cycles in the bog. Organic peat soils provide a good substrate for biological activity for the decomposition of easily oxidized materials. The cool, moist, generally anaerobic environment retards the decomposition of the more resistant organics, leading to a net accumulation of energy in the system.

Some organic nitrogen and phosphorus compounds can also accumulate in the humic sink. The average Kjeldahl N and total P of six peat samples from sites 11 and 14 in the treatment bog (Fig. 2) were 1.52% and 0.072% respectively. Black et al. (1955) found Kjeldahl N contents of 1.0 to 2.0% for Scottish peats, and Kaila (1956) reports N and P contents of 1.50% and 0.058% respectively for Finnish sphagnum peats.

Tertiary treatment, generally defined in terms of inorganic nitrogen and phosphorus removal, could be accomplished by utilizing the natural bog processes that regulate the pool of soluble inorganic nutrients.

Complex nitrogen cycles or transformations make a quantitative determination of the fate of applied nitrogen very difficult (Keeney 1973 and Tusneem and Patrick 1971). Nitrate nitrogen can be lost from the system through denitrification processes, although the rate is relatively slow in acid environments. Nitrates are biologically reduced in an anaerobic environment to gaseous nitrogen compounds, which

can then diffuse to the atmosphere (Bartlett et al. 1979, Bouldin et al. 1974, and Engler and Patrick 1974).

Ammonia nitrogen can be lost in a similar way if a suitable aerobic/anaerobic interface exists. Effluent ammonia or ammonia from mineralization of organic N in an anaerobic environment can migrate along concentration gradients to an aerated zone where biological oxidation to nitrite and finally nitrate can proceed. The nitrates then migrate to an anaerobic zone where denitrification processes are active (Patrick and Reddy 1976, Patrick and Tusneem 1972, and Patrick et al. 1976).

Obviously, hydrologic and climatological conditions that govern moisture conditions, oxygen availability, and temperature would be important considerations for nitrogen dynamics in a specific wetland at a specific time (Avnimelech 1971). Gosselink and Turner (1978) discuss the overall importance of the hydrologic regime in wetlands.

Ammonia is a cation and exists in solution in equilibrium with ammonia adsorbed to exchange sites. Higher ammonia loading to the bog, or lower hydrogen or other cation competition, would cause an equilibrium shift to the adsorbed phase, removing a portion of the ammonia. Humic materials typically develop a high cation exchange capacity from formation of acidic functional groups during decomposition (Puustjarvi 1956 and Walmsley 1977). The average CEC of 6 peat samples from sites 11 and 14 in the Drummond bog was 191.3 me/100 g (O.D.W.) peat. Ammonia removed by this process can generally

be mobilized if changing conditions cause the equilibrium to shift, such as precipitation dilution or plant uptake lowering the ammonia concentration in solution.

Organic peat soils also have a potential for fixing ammonia in a non-exchangeable organic form. Burge and Broadbent (1961) suggested that the fixation reaction involves ammonia reactions with phenolic hydroxyl groups. Ammonia volatilization at a pH above 8 has also been suggested as a primary mechanism for nitrogen removal (Bouldin et al. 1974). Because of the well buffered acidity of sphagnum peats, volatilization is probably not a significant consideration at present.

Soluble phosphorus can be removed from solution by adsorption, precipitation, and coprecipitation reactions, especially in association with Ca, Fe, and Al cations (Damman 1978, Doughty 1930, Kaila 1959, Larsen et al. 1958, Larsen et al. 1959, Pereverzev and Alekseyera 1965, and Wondrausch 1969). Phosphorus adsorption and precipitation equilibria can proceed in either direction depending on ambient conditions, such as pH, concentration of strong humic chelating agents, and redox conditions.

Maximum phosphorus fixation with Fe and Al occurs within the pH ranges of 2.5-3.5 and 3.5-4.0 respectively because of lower stability of iron and aluminum oxides (Bradley and Sieling 1953, Lucas and Davis 1961, and Swenson et al. 1949). While sphagnum bogs are generally very acidic, competition by soluble humic anions for metal cations would tend to increase

phosphorus solubility (Bradley and Sieling 1953, Deb and Datta 1967, Larsen et al. 1959, Struthers and Sieling 1950, Swenson et al. 1949, and Wondrausch 1969). On the other hand, enrichment of cations in the ombrotrophic bog by complexation with natural organic ligands may eventually increase phosphorus fixation through the formation of organo-metallic-phosphates (Sinha 1971). Soluble heavy metal complexing agent concentrations up to 59.1 mg/L Cu equivalent chelating capacity were found in the Drummond bog interstitial water (Mechenich 1979).

Reduction of ferric iron in anaerobic environments, and the corresponding mobilization of phosphorus, is well documented (Cole 1975 and Mortimer 1941). However, anaerobic soils can actually have a greater phosphorus fixation potential when soil phosphorus solutions are high (Khalid et al. 1977 and Patrick and Khalid 1974). Although reduced ferrous iron reacts less strongly with phosphorus, it apparently presents a greater reactive surface area than ferric iron.

Obviously the character of the effluent itself will have a continuing effect on phosphorus dynamics as change in pH, cation loading to the bog, and dilution of natural organic complexing agents occur.

Plant and microbial assimilation of inorganic nutrients and immobilization in organic form is an important seasonal process. Harvesting of plant biomass for nutrient removal from the system is often uneconomical or is inefficient (Spangler 1977), and therefore the return rate of nutrients

by decomposition could be a limiting factor. Some nutrients will be retained in humus or long-term storage in woody biomass. Damman (1978) and Pakarinen and Tolonen (1977) also showed that N and P are actively conserved by living sphagnum.

Changes in decomposition rates by wastewater application could have a considerable impact on the long-term net retention of nutrients. Increases in the decomposition rate could release large amounts of inorganic nutrients (Nicholls and MacCrimmon 1974 and Hortenstine and Forbes 1972). Wastewater application could eventually increase or decrease the decomposition rate according to the net effect of changes in such factors as bacterial populations, pH, and moisture conditions.

From the preceding discussion, it is apparent that considerable knowledge of the basic wetland processes is available, but a prediction of the functioning inter-relationships of the various peat/soil/water components under varying hydrologic and effluent loading conditions is difficult at this time. From extensive research on a sphagnum bog in northern Minnesota, Verry (1979) found that the peatland almost always retained, through the net effect of physical, chemical, and biological processes, a portion of the nutrient input, even during the spring runoff. Annual retention of P and N were 60% and 50% respectively.

## MATERIALS AND METHODS

### Field Sampling

Water quality samples were collected at 39 surface water and well monitoring sites (Fig. 2), including:

26 wells at three depths at 12 sites in the treatment bog (sites 01 to 34),

2 surface water lagg (moat) sites in the treatment bog (sites 67 and 68),

the treatment bog discharge (weir site 60),

2 wells in the lower wetland receiving runoff from the treatment bog (sites 51 and 52),

3 depths, surface, middle (~10 feet), and bottom (~18 feet), in Weso Lake (site 75),

3 wells at 2 depths in the control bog, hydrologically isolated from the treatment bog (sites 41 and 42), and

2 drilled wells to the regional groundwater (sites 81 and 82).

Sampling in the treatment bog concentrated on shallow interstitial water where maximum effluent impact was anticipated (Fig. 4). Wells sampling the upper peat at an average depth range of .15 to .6 meters were installed at each site, and wells at an average depth range of .4 to 1.0 meters were located at most sites. In addition, deeper wells at a 2.0 to 2.6 meter depth were located at sites 11, 14, and 32. Throughout this report, the three well depths will be simply referred to as .4, .7, and 2.3 meter wells respectively.

A .4 meter well was installed at both sites in the control bog and in the lower bog. A 2.3 meter control well was also located at site 42.

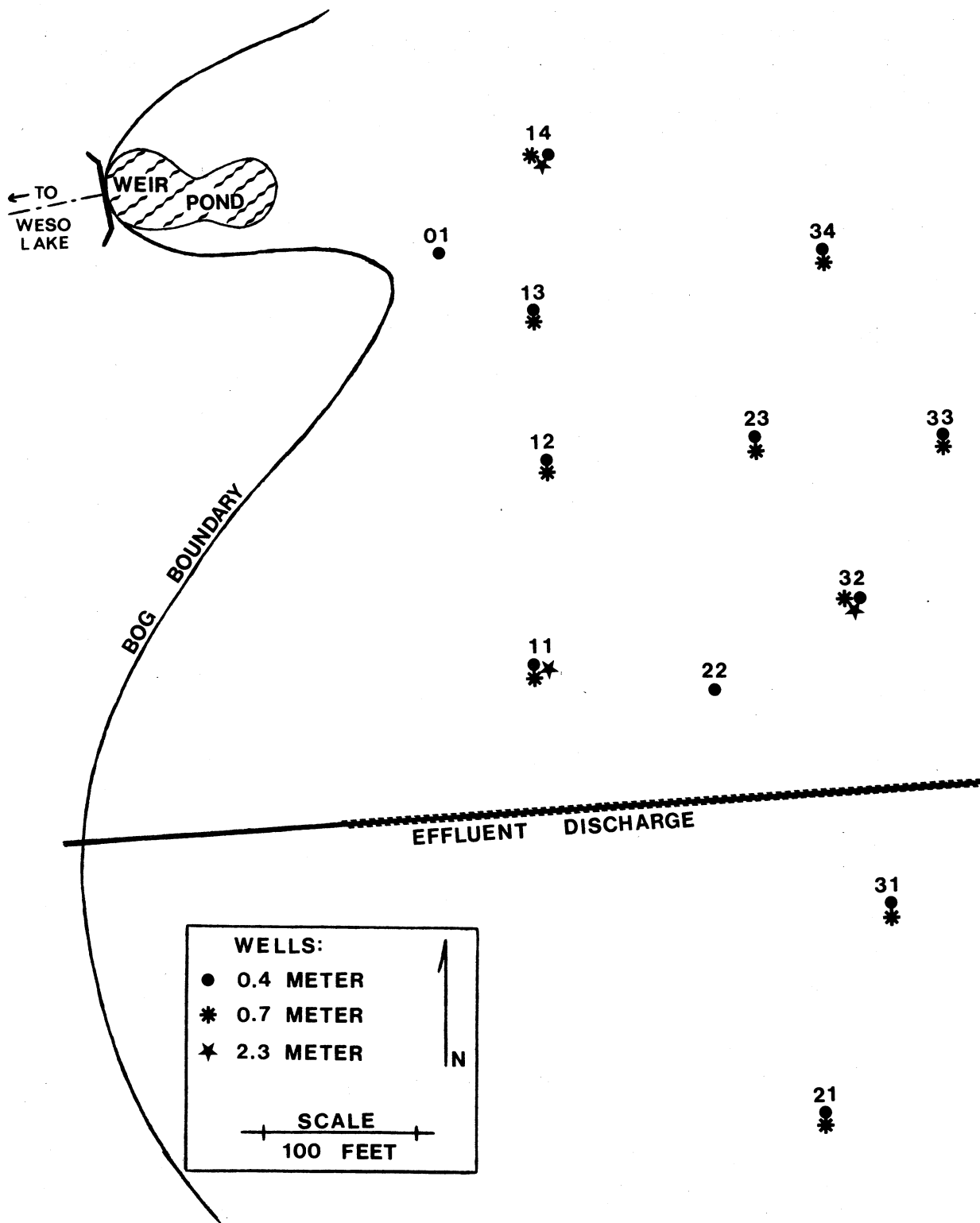


Figure 4. Location and depth of monitoring wells in the Drummond treatment bog. (See Figure 2. for location of other sampling sites.)

The 0.4 meter wells were constructed with 6 inch diameter PVC pipe with numerous large openings covered with 8x8 galvanized screen. The 0.7 and 2.3 meter wells were 1.5 inch diameter PVC pipe with narrow slits for water entry at the appropriate depth.

Samples from the bog wells were collected by pumping the wells dry with a small hand pump, then pumping a fresh sample the following day if sufficient recharge had occurred. Dissolved oxygen samples were collected when the wells were initially pumped, being careful to maintain airtight pump connections and to minimize disturbance when inserting the collection hose.

The two regional groundwater wells were 4 inch drilled wells. Sampling was best accomplished with a PVC bailer because of the depth to the static water level (85 feet at site 81 and 75 feet at site 82).

Grab samples were used for monitoring the bog discharge and the lagg sites. Samples from the appropriate depths in Weso Lake were collected with a van Dorn water sampler.

Precipitation samples, including dry fall, were also collected for chemical analysis for nutrient budgeting. Samples were collected at the USFS weather station in Drummond and frozen for analysis later. Several snow samples from the bog area were also included.

Composite samples of most lagoon effluent discharges to the bog were collected by the treatment system operator and frozen for analysis later. Grab samples from the primary

and final secondary lagoon were also taken on several occasions.

Sampling at most sites was conducted twice a month in summer and monthly in winter, weather permitting. Sampling began in October, 1977, and continued through 1978 and 1979. Data collected before December, 1977, is not included in the results and discussion because of nonuniform sampling or analytical procedure as methods were developed. Occasionally a sample could not be collected at a site because of insufficient seepage into the well during the sampling period. Very low hydraulic conductivity or low water table at the 2.3 meter 32 site and the .4 meter 52 site prevented regular sampling, and therefore the limited data from these sites is not included in the results.

Samples for general chemical analysis were collected in one liter polyethylene bottles, which had been stored filled with distilled water. Separate sterilized bottles were used for samples for bacteriological analysis. Acid washed polyethylene bottles were used when metal analyses were performed.

Samples were transported or sent to the Environmental Task Force Lab at the University of Wisconsin, Stevens Point, generally the day of collection. Samples were stored at 4° C until analyses were complete, usually within one week.

Along with water sample collection, temperature and depth to perched groundwater were often measured. The perched water table height in relation to the peat surface was estimated by inserting a meter stick into a well and noting the

distance to the water line. This measurement was corrected for the volume of the meter stick submerged and the distance from the peat surface to the well top. Only wells where the water level returned to the prepumping height within one day after pumping were used, indicating sufficient water movement to equilibrate the well water level to the general bog level. Also, only .7 and 2.3 meter wells were considered because these wells extended deep enough into the peat to minimize vertical movement of the well itself from expansion and contraction of the peat exposed to changing moisture conditions and from walking near the wells in the spongy peat soil.

Peat samples were collected with a PVC coring device with a piston to reduce compaction and to hold cores with high water content. The design and operation of the corer was similar to the peat corer described by Redfield (1975). Composite samples were collected from 3 random cores at each sampling location and stored in plastic bags at 4° C.

### Water Quality Analysis

Routine laboratory chemical analyses included pH, conductivity, chlorides, COD, BOD<sub>5</sub>, reactive and total P, and ammonia, nitrite-nitrate, and Kjeldahl N. Alkalinity, total and calcium hardness, dissolved oxygen, BOD<sub>20</sub>, fecal coliforms, fecal streptococcus, color, and total suspended solids were also determined on some samples.

All samples, except lagoon effluent, bog discharge, and

Weso Lake samples after April, 1979, were filtered through Whatman GF/C filters for COD, BOD, P, N, and metal analysis because of the high and irregular amounts of solids, especially in .4 meter well samples. Weso Lake samples before May, 1979, were filtered because of high turbidity from runoff from the lagoon construction site. Effluent samples were not filtered, except COD, total P, and Kjeldahl N were determined on filtered and unfiltered portions.

The nitrogen forms and total P were determined with a Technicon Autoanalyzer (Technicon 1977). Chlorides were determined with a specific ion electrode, and color was determined according to the proposed method of the Canadian Pulp and Paper Association (1974). Other tests followed procedures listed in Standard Methods (1976). Dissolved oxygen was determined by the azide modification of the Winkler method, reactive P was measured by the stannous chloride method, utilizing a partial color blank correction, and bacterial determinations were according to membrane filter techniques.

Biological oxygen demand was determined without seeding because values for 27 pairs of seeded and unseeded duplicate samples from bog wells were not significantly different at the .05 level. A significant BOD increase (60%) was noted for 19 seeded regional groundwater samples. Indigenous biological activity, indicated by strongly positive coliform tests, and the limited ability to adequately flush the wells,

led to the use of the unseeded values. Higher seeded values may have been caused by the introduction of organisms in the seed that were better suited for degradation of oil and grease pollutants evident from the well installation. While unseeded values were used in this report, seeded values for the regional groundwater can be calculated by the relationship: seeded BOD =  $0.453 + 1.30(\text{unseeded BOD})$ ,  $R^2=83.6\%$ .

Metal analyses were performed on acid preserved samples (5ml  $\text{HNO}_3$ :1liter sample) that were digested with nitric acid according to Standard Methods (1976). Sodium and potassium were determined by flame photometry and all other metals were determined with a Perkin Elmer Model 360 atomic absorption unit.

### Peat Analysis

Peat analysis for total Kjeldahl N by acid digestion followed by steam distillation was according to Bremner (1965). Wet samples as collected were used, and the results calculated to a dry weight basis according to % moisture determinations (at  $105^\circ\text{C}$ ) on other portions of the samples.

Peat digestion for total P and metals was by dry ashing and HCl extraction of the ash (Isaac and Kerber 1971). A wet sample was placed in a tared crucible, dried at  $105^\circ\text{C}$ , and weighed to determine exact dry weight before ashing. Phosphorus in the HCl extract was measured by the stannous chloride method (Standard Methods 1976), and metals were determined as described for water samples.

Cation exchange capacity was calculated by summation (Chapman 1965). Exchangeable base cations were determined on a 1N neutral ammonium acetate extract, generally according to Pratt (1965), and exchange acidity was determined by HCl titration of a  $\text{BaCl}_2$ -triethanolamine extract according to Peech (1965).

### Leaching Studies

Peat cores were collected using the coring device described for peat sampling. Separate transparent acrylic coring tubes were used for each core to minimize disturbance.

Wastewater leached through the cores was final, unchlorinated effluent from the Stevens Point, WI municipal treatment plant (activated sludge process), and the Junction City, WI sewage treatment lagoons. The effluent was leached through the cores by maintaining a head over the peat surface using a Mariotte siphon. Leachate was collected at the bottom of the cores through gravel filter beds. The experimental setup was similar to that of Lance and Whisler (1972), except no provision for gas collection was included.

Experiments were run in duplicate or triplicate at  $5^\circ\text{C}$  in a controlled environment chamber. Experimental variables that were investigated included: location of the peat cores within the bog, rate of leaching, effect of a dry (aeration) cycle, and effect of water flushing on retained nutrients.

Three separate leaching runs were made with the following conditions:

- Run #1: Three cores (average length=27 cm, diameter=8.8 cm), collected between sites 32 and 33 (black spruce wooded area), were continuously leached with Junction City effluent at the rate of approximately 1.25 bed volumes (amount equal to the volume of the core) per day. After approximately 20 bed volumes, the cores were drained to field capacity and then approximately 10 bed volumes of water were leached through the cores.
- Run #2: Three cores (average length=33 cm, diameter=3.45 cm), collected near site 11 (open wooded and brushy area), were leached with Junction City effluent at the rate of approximately 0.2 bed volumes per day until a total of 21 bed volumes were leached.
- Run #3: Two cores (average length=26 cm, diameter=8.8 cm), collected between sites 23 and 33 (wooded area with no brush), were leached with Stevens Point effluent at the rate of approximately 1.4 bed volumes per day until a total of about 15 bed volumes was reached. The cores were drained to field capacity, exposed to the air for one month, and then leached with Stevens Point effluent for approximately 10 bed volumes. Finally, the cores were leached with 15 bed volumes of water.

### Nutrient Budgeting

Sufficient hydrologic data was available from the USFS to calculate rough nutrient budgets for the treatment bog during the 1979 effluent discharge period and a corresponding 1978 baseline period. Because the bog appears isolated from the regional groundwater and has no defined surface inflow, the only nutrient inputs considered were precipitation and effluent discharges, and the only output was the weir overflow. Nutrients picked up in overland flow from the surrounding moraines were not measured but should be low for most of the precipitation events. Rainfall must exceed 1.25

inches within a 3 day period before significant runoff from the highland is included in the water budget (Kappel 1979). Omitting the overland input would tend to minimize calculated nutrient removals. The bog basin appears hydrologically tight, and therefore nutrient exit by underflow should have been insignificant.

Nutrient values not available for precipitation or effluent inputs were interpolated from available bracketing data. The bog discharge samples were collected approximately every 2 weeks and the associated discharge volume was generally the sum of flows  $\pm$  one week from the sampling date.

### Statistical Analysis

T-tests, regression analysis, and analysis of variance presented in this report were performed utilizing the Minitab statistical package (Ryan et al. 1976) on a Burroughs 6700 digital computer. A "two sample t-test" was used to compare means of before/after (effluent application) concentrations. This form of the t-test did not require the two populations to have equal variances, which in some cases were greatly different. Data populations compared with the t-test were restricted to similar times of the year to uniformly include normal seasonal changes.

## RESULTS AND DISCUSSION

The overall baseline water quality of the bog discharge (Table 1) was generally representative of a perched, ombrotrophic bog (Boelter and Verry 1977, Gorham 1956, and Verry 1975). Especially notable were the low pH and conductivity (ion poor water). The Sphagnum mosses typical in perched bogs are acidic, exchanging hydrogen ions for base cations in solution (Bell 1959, Clymo 1964, and Clymo 1966). Puustjarvi (1968) reported cation exchange capacities ranging from 95 to 141 me/100g for several Sphagnum species. Peat soils derived from Sphagnum mosses are also acidic from production of organic acids during decomposition. The high chemical oxygen demand reflects the production of soluble organic acids. These dissolved organic materials are generally very resistant, as indicated by the low BOD. Nitrogen and phosphorus leaving the bog was primarily in a soluble organic form.

The secondary effluent discharged to the bog in 1979 was probably not representative of what the effluent will be in the future because the lagoons were initially diluted with water from Lake Drummond. Although N and P were low in the effluent, comparison to the bog discharge revealed significant differences (Table 1). In the effluent, phosphorus was slightly higher, pH, chlorides, conductivity, and suspended solids were considerably higher, while COD was much lower.

An evaluation of individual parameters is presented in the following sections. A baseline characterization and an

Table 1. Average water quality of the bog discharge (baseline sampling from December, 1977, to June, 1979) and the lagoon effluent discharged to the bog (June through October, 1979). Effluent averages are flow weighted.

Parameter	Bog Discharge (Weir site 60)			Lagoon Effluent	
	Mean	S.D.	N	Mean	N
pH	4.11	.14	17	8.27	15
Conductivity umhos/cm	42	6	17	273	15
Alkalinity mgCaCO <sub>3</sub> /L	0	0	6	73	15
Total Hardness mgCaCO <sub>3</sub> /L	9.0	2.6	5	93	15
Ca Hardness mgCaCO <sub>3</sub> /L	6.8	1.8	5	59	15
Chloride mg/L	<1.0	-	15	45	15
COD mg/L	114	27	17	28(20)	15
BOD5 mg/L	1.2	.4	16	1.9	15
BOD20 mg/L	2.1	.8	3	7.1	3
Ortho P mg/L	.018	.010	16	.047	15
Total P mg/L	.042	.021	17	.163(.092)	15
NH <sub>4</sub> N mg/L	.03	.04	16	.06	15
NO <sub>2-3</sub> N mg/L	.01	.02	17	<.02	15
Kjeldahl N mg/L	1.00	.38	17	1.15(0.95)	14
Fecal Coliform col/100ml	.7	1.5	7	5 <sup>†</sup>	5
Total Suspended Solids mg/L	1.7	3.3	9	20.6	12

† Average of grab samples from secondary lagoon.  
( ) Denotes filtered value.

evaluation of the effluent impact and treatment efficiency were made. The baseline evaluation is especially important in order to quantify effluent impacts and also to facilitate comparisons to other potential sites.

### Chloride

Chloride ions are mobile and could be used to trace where and how fast the effluent moved in the bog. Chloride increases were a sensitive indicator of the presence of effluent because all sites, except for the regional groundwater wells, had very low average baseline chlorides, often below the detection limit of 1.0 mg/L (Table 2). No significant trends with season, location in bog, or depth in peat were noted.

Analysis of chloride concentration increases at treatment bog sites in the last half of the 1979 effluent discharge period indicated that the effluent primarily moved horizontally across the bog. Average chlorides at the 0.4 meter sites increased to 24.7 mg/L, while the 0.7 meter sites increased to only 4.7 mg/L. No change was seen at the 2.3 meter sites. A high water table throughout the 1979 summer (Fig. 1), and low hydraulic conductivity in the deeper, more decomposed peat, probably limited vertical flow.

Six 0.7 meter sites eventually experienced significant chloride increases, although lower than at 0.4 meter sites (Figure 5). Increases in 0.7 meter wells near the effluent discharge probably reflected vertical movement induced by

Table 2. Average chloride concentrations (mg/L) for the Drummond system. Averages for the effluent discharge period were based on samples collected in the last half of the 1979 discharge period.

Site	Baseline			Effluent Discharged		
	Mean	S.D.	N	Mean	N	
Treatment Bog:	0.4 Meter	1.1	0.7	284	24.7	72
	0.7 Meter	<1.0	0.6	216	4.7	60
	2.3 Meter	1.0	0.8	48	<1.0	9
Lagg:	Site 67	<1.0	-	1	1.6	6
	Site 68	1.1	1.4	6	8.0	5
Bog Discharge:	Site 60	<1.0	0.4	15	18.2	6
Lower Bog:	Site 51	1.2	0.7	16	11.5	6
Weso Lake:	Surface	1.1	0.5	5	1.6	5
	Mid	1.0	0.2	5	1.0	5
	Bottom	1.0	0.2	5	1.0	5
Control Bog:	0.4 Meter	1.1	0.6	47	<1.0	12
	2.3 Meter	<1.0	0.3	25	<1.0	6
Regional Groundwater:	Sites 81 and 82	6.9	5.7	33	3.1	9

effluent mounding near the discharge pipe. Other increases may have resulted from vertical movement in localized areas of less dense peat. The increase at the 0.4 meter 21 site was the smallest for any 0.4 meter site. Site 21 was the farthest from the normal drainage to the bog outlet and apparently very little effluent backed up to that location.

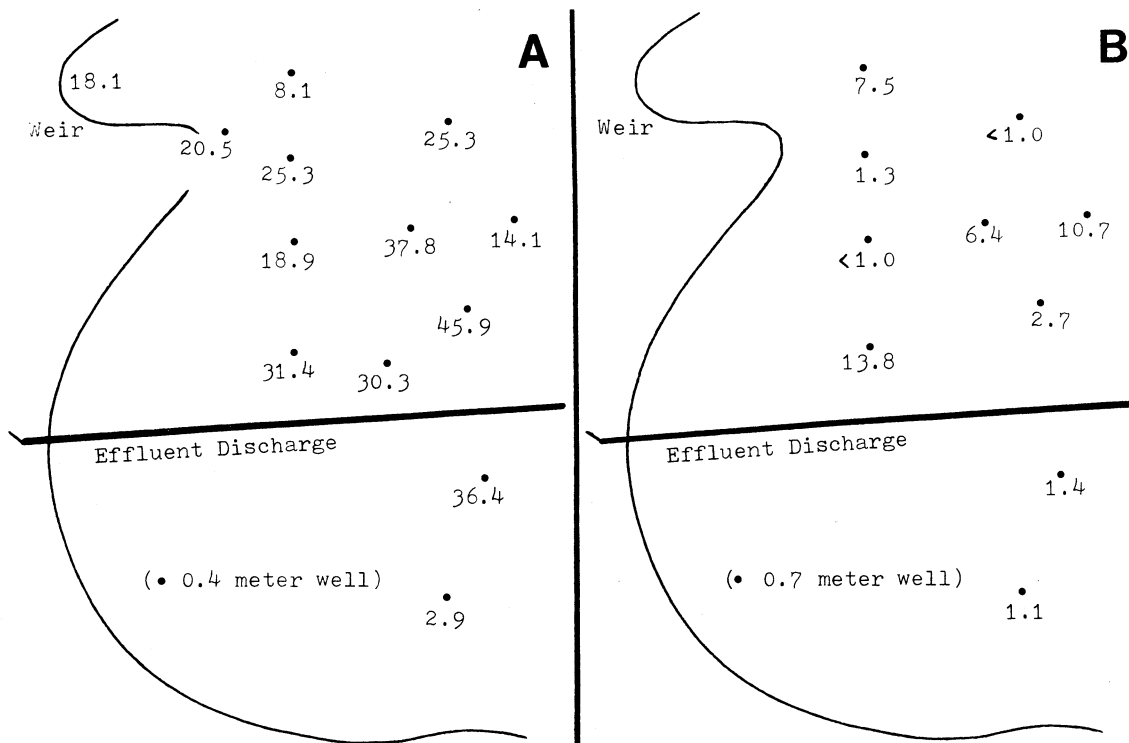


Figure 5. Average chloride concentrations (mg/L) in the Drummond bog at 0.4 meter sites (A) and 0.7 meter sites (B) during the last half of the 1979 effluent discharge period. All baseline concentrations were approximately 1 mg/L.

A time analysis of the horizontal flow was made by plotting the 20 mg/L chloride isoline for various sampling dates based on the 0.4 meter well values (Fig. 6). The effluent moved from the gated discharge pipe to the bog outlet, with a major flow path on a northwest diagonal through sites 32, 23, and 13. Surface flow in the lagg zone did not adversely affect the effluent dispersion, as indicated by lower chloride increases at the lagg sampling sites than at the 0.4 meter sites. However, effluent flow into the lagg zone adjacent to the weir pond was noted. Effluent

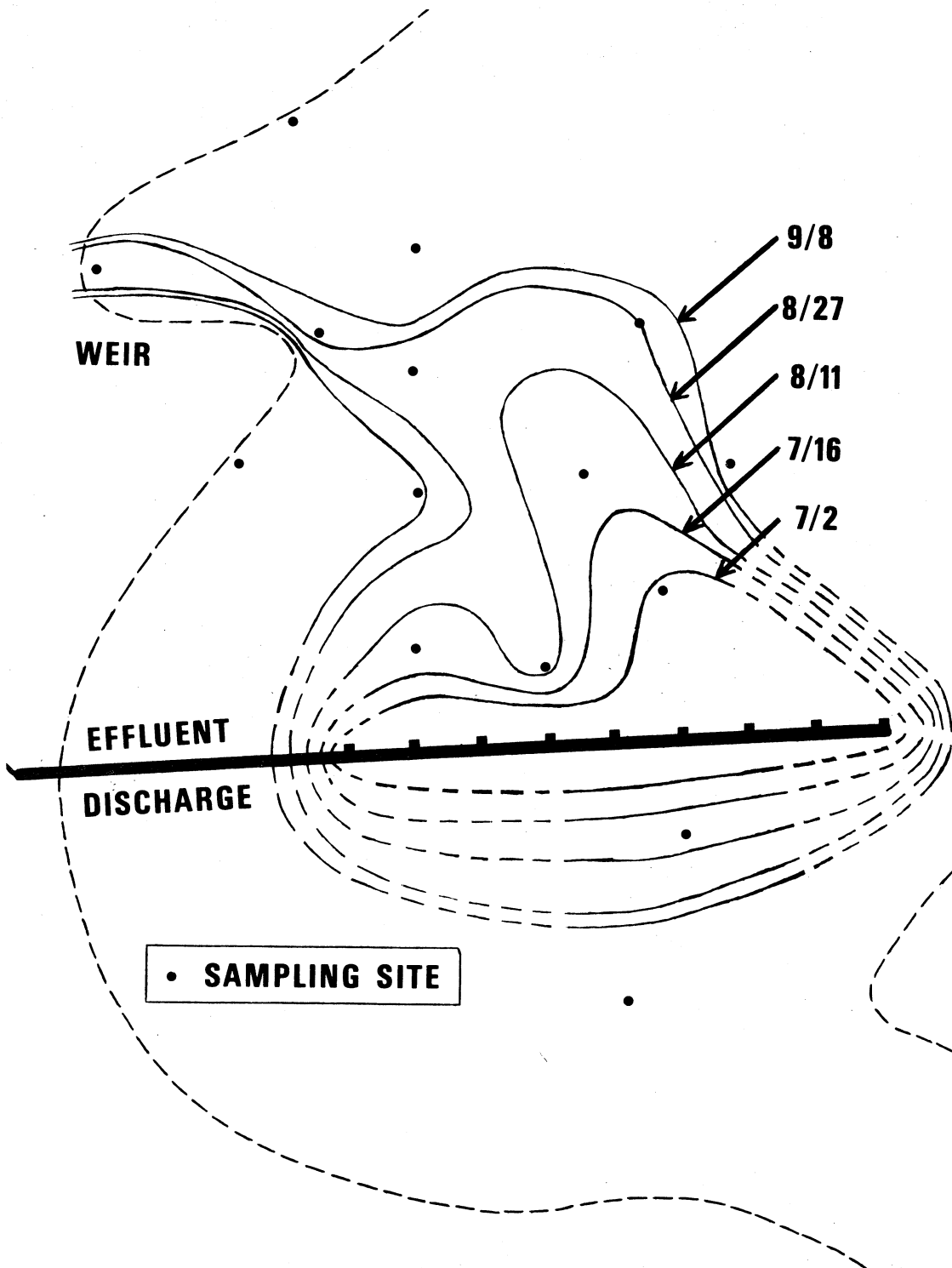


Figure 6. Twenty mg/L chloride isolines (based on 0.4 meter sites) in the Drummond bog at various times during the 1979 effluent discharge period.

dispersion within the bog can be influenced by local differences in vegetation density, slope, peat hydraulic conductivity, hummocky topography, and uneven distribution of effluent from the gated irrigation pipe. Effluent dispersion at the Drummond site appeared adequate for treatment purposes.

The bog discharge chloride concentration increased from less than detection to 18.2 mg/L during the effluent discharge period, which still represented a 60% reduction of the average effluent chloride concentration. The high reduction indicates a large volume of water was available for dilution. Based on total effluent and precipitation loading, a 56% retention of chlorides was achieved by the bog during the 1979 discharge period. Future dilution potential will reflect the combination of precipitation, evapotranspiration, and flow from parts of the watershed not included in the treatment process.

The effluent impact on Weso Lake was minimal because of the large volume of water available for dilution compared to the flow from the treatment bog. A slight chloride increase in surface waters was noted (Table 2), although it was not statistically significant. A chloride increase from 1.2 to 11.5 mg/L was measured at the 0.4 meter 51 site in the lower bog.

The time period used for calculating the baseline averages for Weso Lake was limited to the period from June through October when the Lake was stratified. Complete

turnover did not occur until November in 1978 and 1979; therefore the restricted baseline period represented a relatively static lake condition facilitating comparisons to detect effluent impacts. This baseline for Weso Lake will be consistently used throughout this report.

Chloride concentrations did not change significantly in the control bog or in the regional groundwater.

### Conductivity

Conductivity is a measure of the water's ability to conduct an electric current, and is therefore an index of the amount of dissolved ionic solids. Conductivity of the interstitial bog water was low but typical for an ion poor perched bog (Table 3). Weso Lake had the low conductivity characteristic of a dystrophic bog lake.

Conductivity decreased with depth in the treatment bog. Greater ionic activity near the peat surface could reflect the flux of materials in the plant uptake - decomposition cycle. The relatively high conductivity at 0.4 meter sites also reflected contamination from the wells themselves. Lab tests found conductivity increases up to 52 umhos from corrosion of the galvanized screen used in the wells. The exact amount of contamination is unknown and therefore the conductivity measurements at 0.4 meter sites should only be used for analyzing relative changes after effluent addition.

Table 3. Average conductivity (umhos/cm) for the Drummond system and % change after effluent application based on average values for the last half of the 1979 effluent discharge period and the corresponding 1978 baseline period.

Site	Baseline			% Change	
	Mean	S.D.	N		
Treatment Bog:	0.4 Meter	89	44	299	+58%†
	0.7 Meter	48	10	226	+19%†
	2.3 Meter	40	7	53	+13%
Bog Discharge:	Site 60	42	6	17	+89%**
Lower Bog:	Site 51	54	22	16	+15%
Weso Lake:	Surface	23	3	5	0%
	Mid	27	1	5	+4%
	Bottom	34	2	5	-1%
Control Bog:	0.4 Meter	124	54	51	-2%
	2.3 Meter	40	4	25	-2%
Regional Groundwater	Sites 81 and 82	113	52	35	+5%

† See Figure 8. for significance of individual % changes.

\* Significant at 0.05 level.

\*\* Significant at 0.01 level.

The 0.4 meter well contamination is also reflected by the large conductivity difference between the bog discharge and the 0.4 meter sites. The low conductivity of the bog discharge could also reflect flow from the lag zones, which had an average conductivity of 35 umhos/cm, although the bog discharge phosphorus concentrations did not reflect a significant lag impact.

Very little seasonal conductivity variation was noted for 0.7 and 2.3 meter wells and the bog discharge, which facilitates identifying effluent impacts (Fig. 7). The 0.4 meter wells were more variable, with dilution during the spring snowmelt period the most apparent change. Well contamination was also a likely source of variation, especially in reference to spatial variation between the

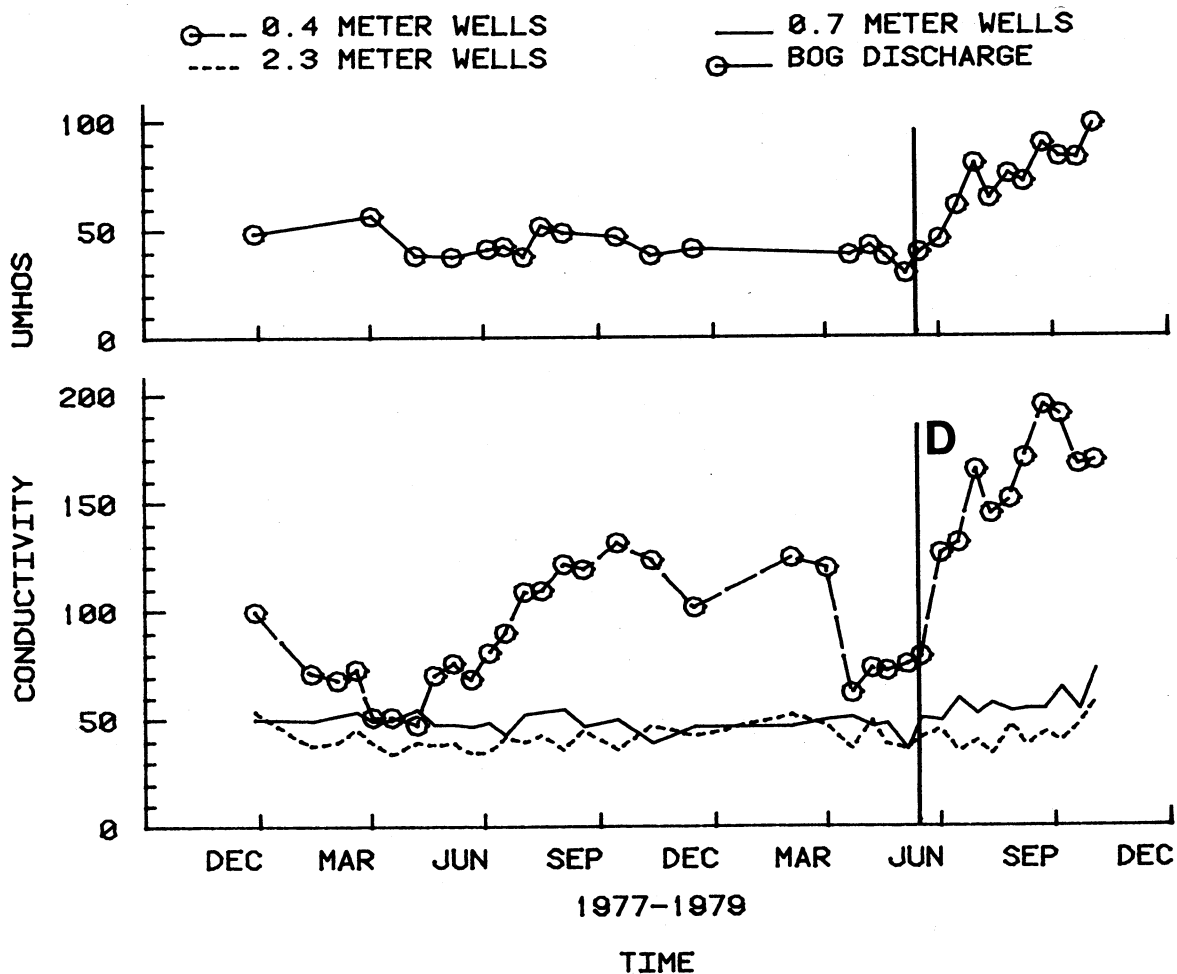


Figure 7. Seasonal conductivity trends for the Drummond bog. The line marked "D" indicates the start of effluent discharges to the bog.

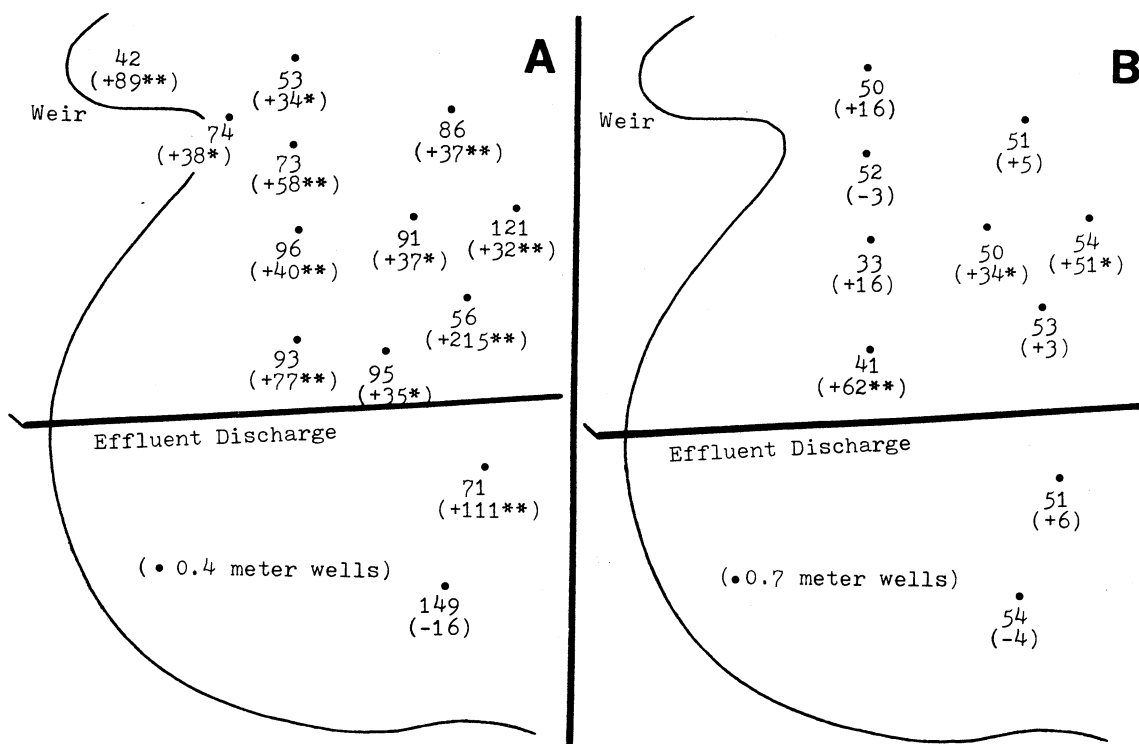


Figure 8. Average baseline conductivity (umhos/cm) in the Drummond bog at 0.4 meter sites (A) and 0.7 meter sites (B) and % change ( ) after effluent application based on average values for the last half of the 1979 baseline period. (\* % change significant at 0.05 level, \*\* significant at 0.01 level.)

0.4 meter wells (Fig. 8). Little spatial variability was observed at 0.7 meter sites, except for lower values at sites 11 and 12.

The conductivity of the effluent (273 umhos/cm) was much higher than the peatland background. Much of this conductivity was due to the activity of mobile ions such as  $\text{Na}^+$  and  $\text{Cl}^-$ . Therefore, conductivity increases in the bog system mirrored the chloride changes after effluent application.

All 0.4 meter sites, except site 21, had a significant conductivity increase (Fig. 8). Three 0.7 meter sites significantly increased, corresponding to the larger chloride increases noted at that depth. The 2.3 meter sites did not change significantly.

Conductivity could therefore be used as a general and easily measured index of the amount of effluent interaction. For example, conductivity increases quickly identified effluent water leaving the bog as well as the effluent impact at the 0.4 meter sites in the bog (Fig. 7).

Although the bog discharge conductivity increased 89%, the effluent conductivity was reduced 70% by passage through the bog. Since a considerable portion of the effluent conductivity was related to chloride activity, dilution was the primary reduction mechanism. With the large water content of peat soils (Boelter 1964), a volume of water at least equal to the 6.8 acre-feet of effluent discharged to the bog was available in the bog for dilution.

There was little effluent impact on conductivity outside of the treatment bog, as indicated by the lack of significant conductivity changes in the regional groundwater, the control bog, and at sites below the treatment bog (Table 3). The conductivity at site 51, the first site below the treatment bog, increased, but not significantly within the normal variation.

pH

The high pH, characteristic of lagoon effluent, could have a severe impact on the biological communities in the receiving system. Highly acidic peat bogs have a characteristic flora and fauna adapted to the low pH. Effluent applications therefore have the long-term potential to drastically alter the structure and composition of existing peatlands (Bevis and Kadlec 1979). Also, more immediate changes in pH could affect adsorption and precipitation equilibria important to the wastewater treatment potential of the peatland.

The Drummond bog appears to have a large acidic buffering capacity to resist pH changes. In addition to active ion exchange by the mosses, in which some cations are preferentially absorbed and hydrogen ions released, the peat and soluble organic materials also have considerable exchange acidity. An average exchange acidity of 178 me/100g O.D.W. peat was found for 6 composite peat samples collected at sites 11 and 14. Therefore, little effluent impact on the bog pH was expected during the first year of operation, even though the average effluent pH was 8.27.

The baseline pH at 0.7 and 2.3 meter sites and the bog discharge was the characteristic low pH of a perched bog (Table 4). Similar to conductivity, the higher pH at 0.4 meter sites was apparently a sampling anomaly caused by a reaction between the acid water and the galvanized screening used in the wells. Lab tests measured pH increases of 2 to 3

Table 4. Average pH for the Drummond system during the baseline period and the last half of the 1979 effluent discharge period. The values enclosed in parentheses are baseline values restricted to the 1978 time period corresponding to the last half of the effluent discharge period.

Site	Overall Baseline			Effluent Discharged	
	Mean	S.D.	N	Mean	
Treatment Bog:	0.4 Meter	5.66	.54	299	6.47 (6.39)
	0.7 Meter	4.09	.24	266	4.08 (4.20)
	2.3 Meter	4.88	.37	53	4.89 (4.99)
Bog Discharge:	Site 60	4.11	.14	17	4.06 (4.18)
Lower Bog:	Site 51	5.90	.39	16	6.15 (6.23)
Weso Lake:	Surface	5.77	.18	5	5.88 (5.86)
	Mid	5.63	.18	5	5.71 (5.71)
	Bottom	5.96	.18	5	6.03 (6.03)
Control Bog:	0.4 Meter	5.79	.53	51	6.32 (6.24)
	2.3 Meter	4.39	.19	25	4.57 (4.54)
Regional Groundwater	Sites 81 and 82	8.53	.62	35	9.30 (9.18)

units in acid bog water when placed in contact with the screen for one day. Field pH measurements of interstitial water near the peat surface adjacent to 0.4 meter wells yielded an average value of 3.63 compared to the baseline average of 5.66 at 0.4 meter sites. The pH is generally lowest near the peat surface because of cation exchange by the live mosses and possibly greater production of organic acids (see section on COD).

Little seasonal variation was noted for the 0.7 and 2.3 meter wells and the bog discharge (Fig. 9). The 0.4 meter sites were more variable. There appeared to be a net overall increase at the 0.4 meter sites across the baseline period, which may indicate increased interference as well screening deteriorated.

From the chloride and conductivity analysis, it was apparent that the 0.4 meter sites would show any effluent

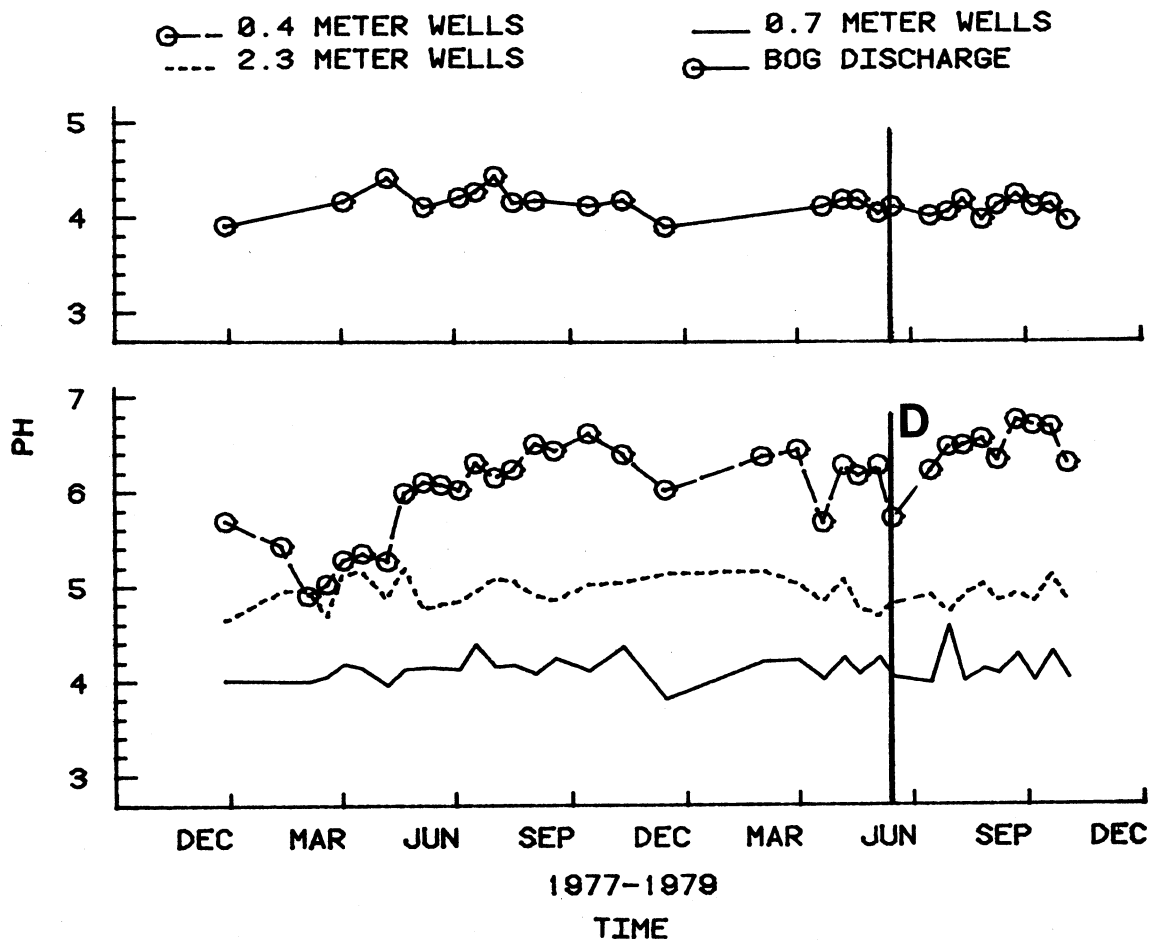


Figure 9. Seasonal pH trends for the Drummond bog. The line marked "D" indicates the start of effluent discharges to the bog.

impact first. A slight pH increase was noted for the 0.4 meter well average (Table 4), although the increase may have been a continuation of the rising baseline trend. The largest pH increases at the 0.4 meter sites generally did not correspond to the sites that had the largest chloride increases, which implies that the changes were not directly related to the effluent. The pH of the 0.7 and 2.3 meter sites and the bog discharge decreased slightly during the 1979 effluent discharge period.

The control bog, the regional groundwater, and the sites below the treatment bog also had little pH change.

#### COD and BOD

Chemical and biological oxygen demand are important components of wastewater discharges to receiving waters because of the adverse impact lowering the dissolved oxygen could have on the natural biological communities.  $BOD_5$  is an index of the immediate oxygen stress on the receiving water, while COD represents a long-term impact, often equated to ultimate BOD.

COD in the interstitial bog water was high, as would be expected in a highly organic system (Table 5). The 0.4 and 0.7 meter sites had statistically higher COD, at the .05 level, than the 2.3 meter sites, indicating greater production of soluble humic materials in the upper, younger peat horizons. The dark brown color characteristic of bogs is

Table 5. Average COD (mg/L) for the Drummond system and % change after effluent application based on average values for the last half of the 1979 effluent discharge period and the corresponding 1978 baseline period.

Site	Baseline			% Change	
	Mean	S.D.	N		
Treatment Bog:	0.4 Meter	145	32	298	-45%†
	0.7 Meter	139	27	225	-14%†
	2.3 Meter	119	46	53	-17%
Bog Discharge:	Site 60	114	27	17	-37%**
Lower Bog:	Site 51	78	22	16	-29%
Weso Lake:	Surface	44	17	5	+3%
	Mid	60	48	5	-12%
	Bottom	69	40	5	-6%
Control Bog:	0.4 Meter	156	33	51	-10%
	2.3 Meter	135	17	25	-1%
Regional Groundwater	Sites 81 and 82	7	5	34	+33%

† See Figure 11. for significance of individual % changes.

\* Significant at 0.05 level.

\*\* Significant at 0.01 level.

primarily caused by resistant soluble organic material included in the COD determination. The average color for the 0.4, 0.7, and 2.3 meter sites was 486, 311, and 205 PtCo color units respectively, based on limited sample collection in April and August, 1978. The bog discharge was comparable to the 2.3 meter sites. Settling of organic materials and

aerobic oxidation in the weir pond and restricted transport of high molecular weight organic compounds through dense peat could have prevented a greater similarity to the higher COD of shallower interstitial water.

Wells in the control bog followed the same pattern with depth, although values were slightly higher overall. The control bog was a younger system and active formation of soluble humic acids was greater.

Downstream from the treatment bog, COD was much lower at site 51 and still lower in Weso Lake. Site 51 was located in an area of shallow organic soil over clay and the inorganic nature of the soil was evident compared to the peat soils of the treatment bog.

The regional groundwater, in a glacial sand and gravel aquifer, had very low COD as would be expected.

An analysis of seasonal COD trends revealed greatest variation at 0.4 meter sites (Fig. 10). Dilution during spring runoff was especially pronounced at that depth. The response in deeper wells was muted because of less water movement. During the early spring periods, the 0.7 meter sites actually had higher COD than the 0.4 meter sites. Through the 1978 summer, COD increased probably as a result of greater biological activity with warmer temperatures (Fig. 1), leading to an accumulation of resistant partial decomposition products. In the fall, a drop in production and possibly flushing by precipitation lowered COD levels.

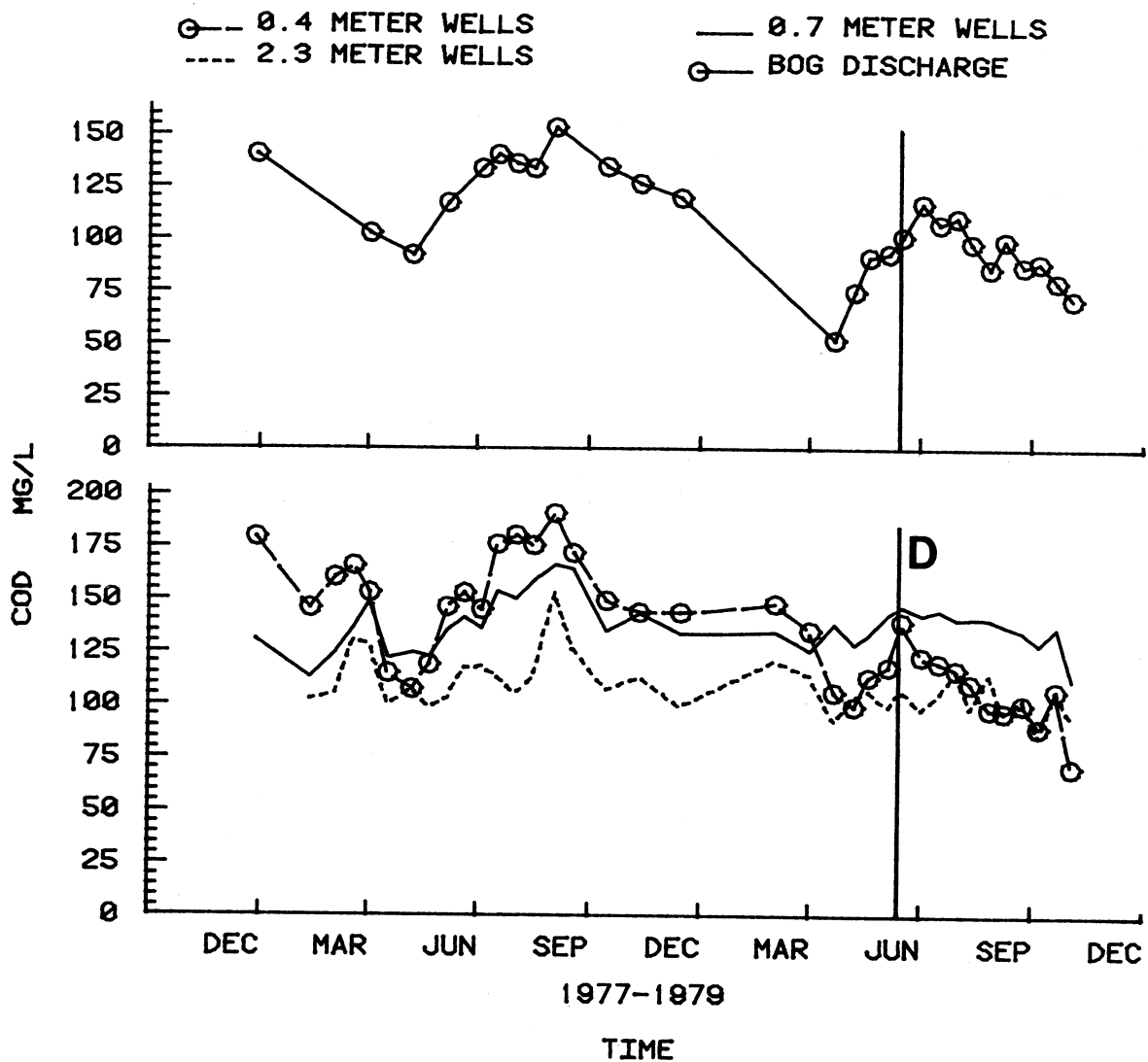


Figure 10. Seasonal COD trends for the Drummond bog. The line marked "D" indicates the start of effluent discharges to the bog.

Significant COD spatial variability, at the 0.05 level, was also an important baseline characteristic (Fig. 11). Baseline averages at 0.4 meter sites ranged from 126 to 166 mg/L, and 0.7 meter sites ranged from 95 to 163 mg/L. Different biological activity and peat characteristics that

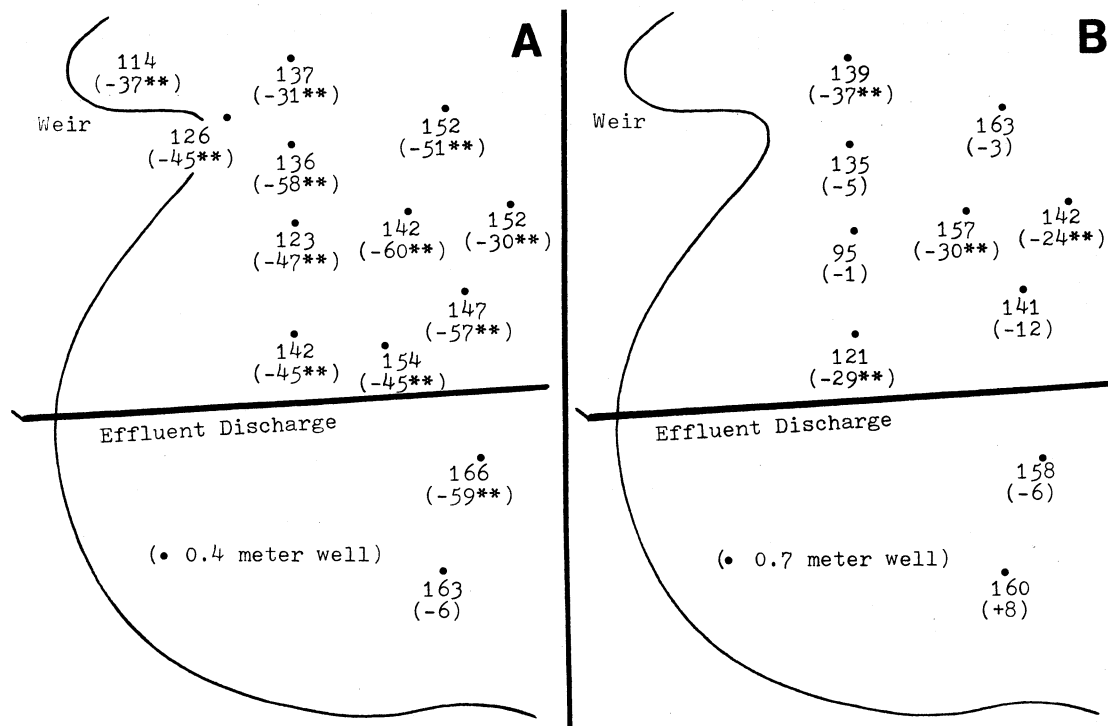


Figure 11. Average baseline COD (mg/L) in the Drummond bog at 0.4 meter sites (A) and 0.7 meter sites (B) and % change ( ) after effluent application based on average values for the last half of the 1979 effluent discharge period and the corresponding 1978 baseline period. (\* % change significant at 0.05 level, \*\* significant at 0.01 level.)

influenced COD concentrations may also result in localized differences in wastewater treatment.

The effluent COD (28 mg/L) was much lower than the bog background and dilution of COD in the bog was apparent. Immediately after effluent applications began, the 0.4 meter well average dropped, eventually below the 0.7 meter well average (Fig. 10). This was consistent with the effluent movement through the surface peat as described by the chlorides. The decline in the bog discharge COD concentration was

also apparent after a short lag time.

All 0.4 meter sites dropped significantly, except site 21 (Fig. 11). Less effluent mixing at greater depths was reflected by fewer significant decreases at 0.7 meter sites. The bog discharge COD concentration decreased 37% to an average value of 85 mg/L, which represents a 204% increase for effluent COD.

COD changes were not significant in the control bog, the regional groundwater, or at sites below the treatment bog (Table 5).

Total 1979 effluent COD loading to the bog was only 243 kg (185 filtrable), compared to the discharge of 2580 kg of COD from the bog during the 1978 summer/fall baseline period. During the 1979 effluent discharge period, approximately 2000 kg of COD left the bog, or approximately 78% of the 1978 baseline discharge. While effluent COD loading was insignificant, the timing and amount of precipitation appeared to be the most important factor in the COD budget. The greater baseline discharge probably reflected high runoff and material transport in response to the high precipitation in August, 1978 (Fig. 1), whereas the carefully scheduled effluent discharges did not exceed the assimilative capacity of the bog.

BOD<sub>5</sub> was much lower than COD in the bog system (Table 6). The high average COD:BOD ratio (74:1) indicated that most dissolved organic material was very resistant to biological breakdown.

BOD<sub>5</sub> concentrations in the interstitial bog water were

Table 6. Average BOD<sub>5</sub> (mg/L) for the Drummond system and % change after effluent application based on average values for the last half of the 1979 effluent discharge period and the corresponding 1978 baseline period.

Site	Baseline			% Change
	Mean	S.D.	N	
Treatment Bog: 0.4 Meter	2.7	2.1	286	-38%†
0.7 Meter	1.1	0.7	215	+10%†
2.3 Meter	1.3	0.5	50	+47%
Bog Discharge: Site 60	1.2	0.4	16	+6%
Lower Bog: Site 51	2.3	2.0	16	-21%
Weso Lake: Surface	0.8	0.2	5	+39%
Mid	0.7	0.3	5	+21%
Bottom	1.1	0.3	5	+16%
Control Bog: 0.4 Meter	5.3	4.9	47	-11%
2.3 Meter	1.3	0.7	25	-8%
Regional Groundwater Sites 81 and 82	1.2	0.7	33	-14%

† See Figure 13. for significance of individual % changes.

\* Significant at 0.05 level.

\*\* Significant at 0.01 level.

statistically highest at 0.4 meter sites because of fresher organic matter depositions, especially recent litter fall. The bog discharge reflected the lower values of the deeper wells in the bog, similar to COD. Some BOD compounds may have been degraded in the weir pond. Slightly higher BOD at 0.4 meter control sites reflected the youthfulness of that system. Weso Lake BOD was low, with the highest values found

in the hypolimnion because of settling of organic materials and anaerobic conditions. The average regional groundwater BOD was slightly higher than would be expected, possibly because the wells could not be thoroughly flushed before collecting each sample.

Seasonal trends were apparent at 0.4 meter sites in the treatment bog (Fig. 12). A buildup of BOD compounds occurred

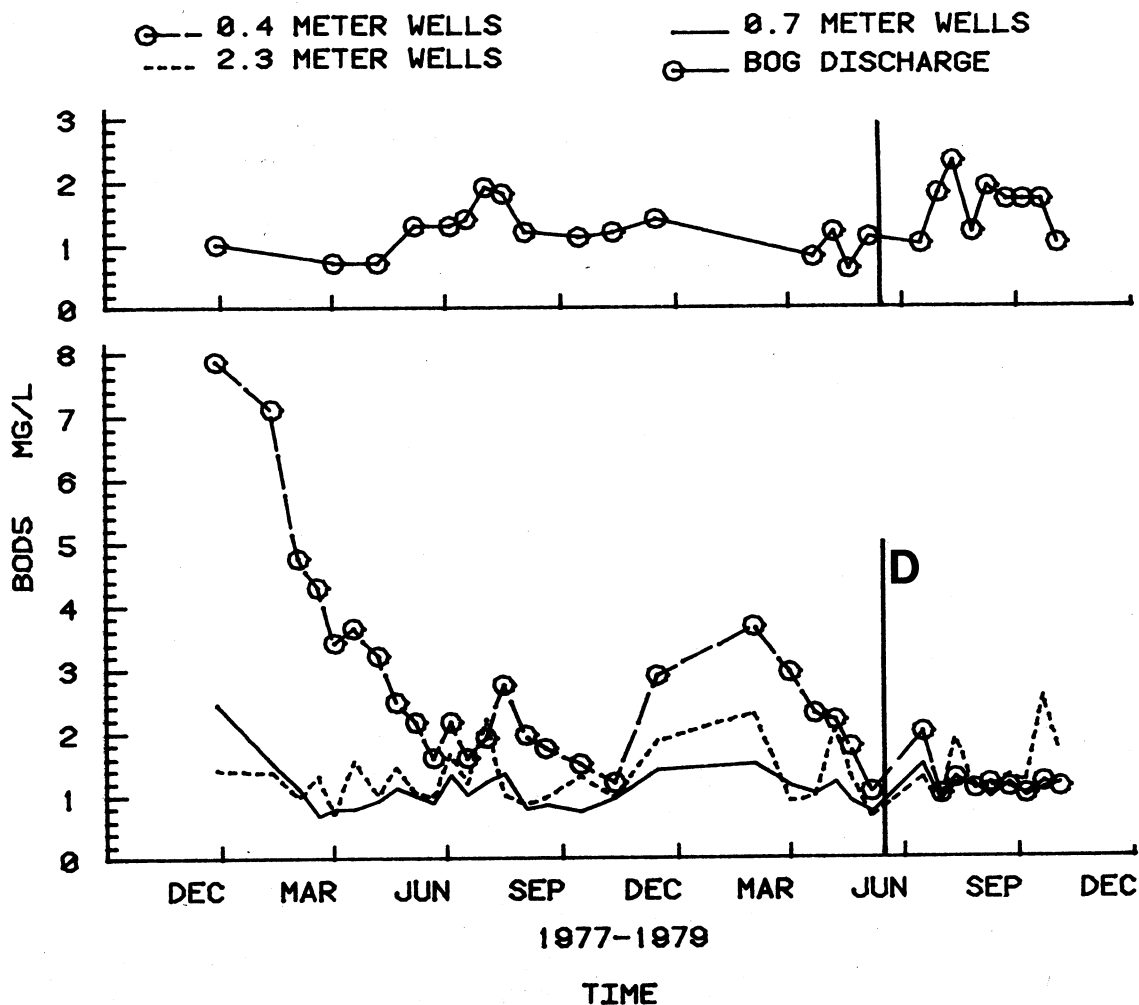


Figure 12. Seasonal BOD<sub>5</sub> trends for the Drummond bog. The line marked "D" indicates the start of effluent discharges to the bog.

in the winter, when flows were low and biological decomposition was slow from low temperatures (Fig. 1) and enforced anaerobic conditions. BOD decreases in spring and summer reflected snowmelt dilution and increased decomposition of easily degraded organic material with higher summertime temperatures. The high in August 1978 may reflect leaching of BOD materials from the litter zone during large precipitation events. Although the trend in deeper wells appeared to follow the 0.4 meter wells, the significance of the changes was hard to define within the standard error of the test and the low baseline values. The bog discharge trend was also difficult to interpret because changes were relatively small. The 1978 summer peak may reflect a runoff-flushing event.

Little spatial variability was measured; most sites were consistently low (Fig. 13). The 0.4 meter wells ranged from 1.6 to 2.3 mg/L, and the 0.7 meter wells ranged from 0.8 to 1.5 mg/L.

The average effluent BOD<sub>5</sub> (1.9 mg/L) was within the normal range for 0.4 meter sites, although a reduction by filtration and biological oxidation probably led to the decrease in BOD<sub>5</sub> at most 0.4 meter sites (Figures 12 and 13) during effluent application. High natural variation at some sites, such as site 11, made it impossible to define the significance of apparent drops in BOD. No significant changes were observed at 0.7 meter sites, except for a 57% increase at site 31. Low BOD<sub>5</sub> in the corresponding 0.4 meter well at the same time implied no direct effluent impact,

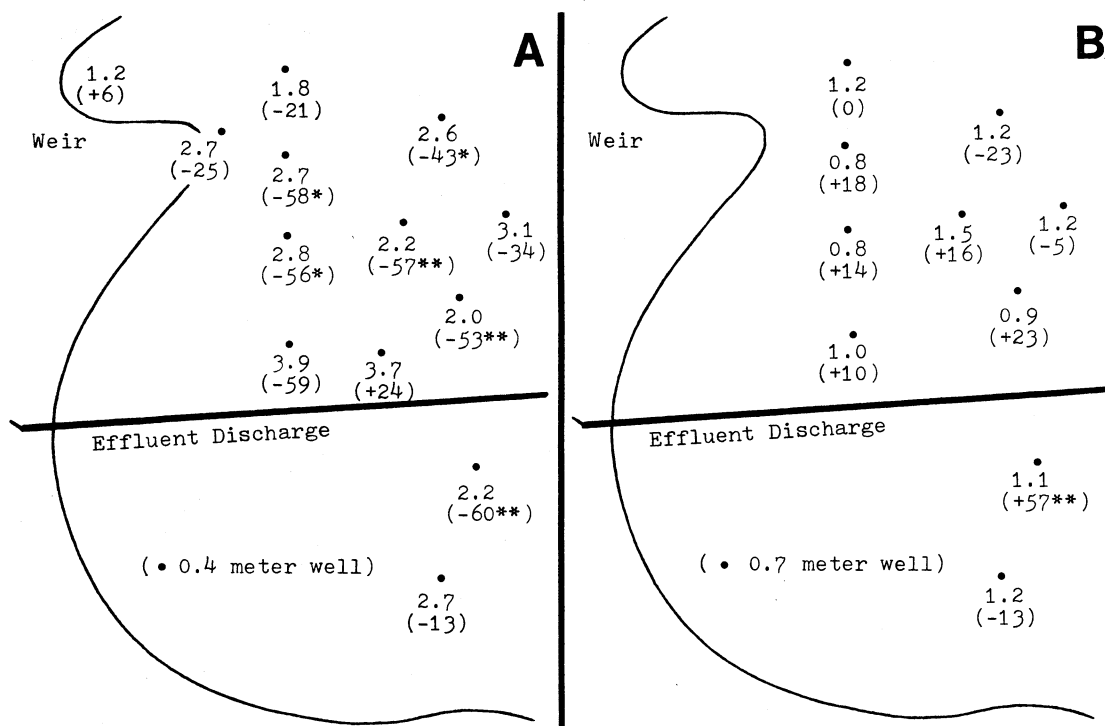


Figure 13. Average baseline BOD<sub>5</sub> (mg/L) in the Drummond bog at 0.4 meter sites (A) and 0.7 meter sites (B) and % change ( ) after effluent application based on average values for the last half of the 1979 effluent discharge period and the corresponding 1978 baseline period. (\* % change significant at 0.05 level, \*\* significant at 0.01 level.)

although leaching of BOD materials from the upper peat because of the additional hydraulic head from the effluent discharges could have been involved.

No significant BOD changes after effluent application occurred at 2.3 meter sites in the treatment bog, the bog discharge, the sites below the treatment bog, the control bog, or the regional groundwater (Table 6).

The average bog discharge concentration for the last half of the effluent discharge period was 1.5 mg/L, representing a 21% reduction for the effluent BOD<sub>5</sub>. During the

1979 effluent discharge period, 26.7 kg of BOD<sub>5</sub> was discharged by the bog compared to 25.0 kg during the corresponding baseline period. Total effluent loading in 1979 was 16.3 kg, considerably more than the increase in the bog discharge indicating efficient BOD removal.

BOD<sub>20</sub> was also measured on several occasions to determine the relationship to BOD<sub>5</sub> and the potential of the effluent to alter discharge of long-term BOD. The average background BOD<sub>20</sub>, based on samples collected in February, May, and October, 1978, and May, 1979, ranged from 2.1 mg/L in the bog discharge to 11.3 mg/L in the control bog, compared to 7.1 mg/L for the effluent (Table 7). BOD<sub>20</sub>:BOD<sub>5</sub> ratios ranged from 2.0:1 to 3.1:1, with an effluent ratio of 3.0:1. The effluent average reflects only 3 samples collected in

Table 7. Average BOD<sub>20</sub> (mg/L) for the Drummond system for baseline conditions and after effluent application.

Site	Baseline		Effluent Discharged	
	Mean	BOD <sub>20</sub> :5	Mean	BOD <sub>20</sub> :5
Treatment Bog: 0.4 Meter	5.2	2.0	2.2	2.1
0.7 Meter	2.7	3.1	3.0	2.7
2.3 Meter	2.8	2.3	3.6	2.2
Bog Discharge: Site 60	2.1	2.6	3.0	3.0
Lower Bog: Site 51	3.1	1.8	2.7	1.8
Control Bog:	11.3	2.4	3.2	2.8
Regional Groundwater:	2.2	3.0	2.6	2.5

October, 1979, and therefore was probably not representative. Applying the effluent ratio to the average effluent BOD5 concentration yielded a calculated average effluent BOD20 of 5.7 mg/L. Based on one determination in November, 1979, after effluent application, no significant increases were noted for BOD20 levels or BOD20:BOD5 ratios.

### Phosphorus

Phosphorus is an important and often limiting nutrient for plant communities in surface waters. Tertiary treatment reduces phosphorus to prevent unwanted growth of macrophytic and algal communities and the resultant problems from accelerated eutrophication.

The baseline phosphorus chemistry for the bog system exhibited a high degree of natural variability relating to differences with depth, location, and time of year. Soluble total P concentrations were statistically different at three sampling depths in the treatment bog, and decreased with depth (Table 8). Ortho P was significantly higher only in 0.4 meter wells. Higher P in shallow interstitial water may reflect the conservation and cycling of nutrients by the plant communities in ombrotrophic bogs.

Like BOD and COD, P in the bog discharge did not reflect the higher values of the 0.4 meter sites. Phosphorus concentrations in the bog discharge were also considerably less than in the lagg zone, which had average baseline ortho and total

Table 8. Average ortho/total P (mg/L) for the Drummond system and % change after effluent application based on average values for the last half of the 1979 effluent discharge period and the corresponding 1978 baseline period.

Site	Baseline			% Change	
	Mean	S.D.	N		
Treatment Bog:	0.4 Meter	.040	.036	279	-18%†
		.085	.053	298	-30%†
	0.7 Meter	.013	.016	208	+5%†
		.042	.038	225	-8%†
	2.3 Meter	.015	.013	49	+31%
		.037	.022	52	+22%
Bog Discharge: Site 60	.018	.010	16	-52%*	
	.042	.021	17	-37%	
Lower Bog: Site 51	.028	.017	15	+29%	
	.054	.021	15	+13%	
Weso Lake:	Surface	.011	.007	5	-10%
		.032	.014	5	--
	Mid	.025	.010	5	-57%
		.052	.030	5	--
	Bottom	.093	.026	5	+24%
		.119	.040	4	--
Control Bog:	0.4 Meter	.019	.013	47	-4%
		.077	.028	51	-17%
	2.3 Meter	.067	.022	23	+73%*
		.114	.044	25	+37%
Regional Groundwater	Sites 81 and 82	.004	.004	32	+130%
		.018	.022	33	+176%

† See Figure 14. for significance of individual % changes.

\* Significant at 0.05 level.

\*\* Significant at 0.01 level.

P concentrations of .039 and .094 mg/L respectively. The weir pond may have acted as a sediment trap, or removed inorganic P through precipitation reactions favored by a more aerobic environment. Slow percolation of water through the bog was probably inefficient for transporting large organic P compounds.

Phosphorus concentrations at other bog sampling sites were generally similar to the treatment bog. Highest P was found in hypolimnetic Weso Lake water from sedimentation and reducing conditions during summer stratification. Phosphorus levels may have been unnaturally high because of the erosion from the lagoon and weir construction sites. Weso Lake has many of the characteristics typical of a dystrophic bog lake. Lowest P was found in the regional groundwater in the sand and gravel aquifer.

Statistically significant spatial variability of P within the treatment bog (Figure 14) indicated the importance of local conditions, such as microcosms of plant species and density, microbial activity, peat composition, and hydrologic conditions. This variability may have important implications for the wastewater treatment efficiency of various parts of the Drummond bog as well as other peat bogs that may be used for wastewater renovation.

Seasonally, soluble total P was low in spring from dilution and biological uptake, increased through the later growing season when decomposition was greater, decreased through

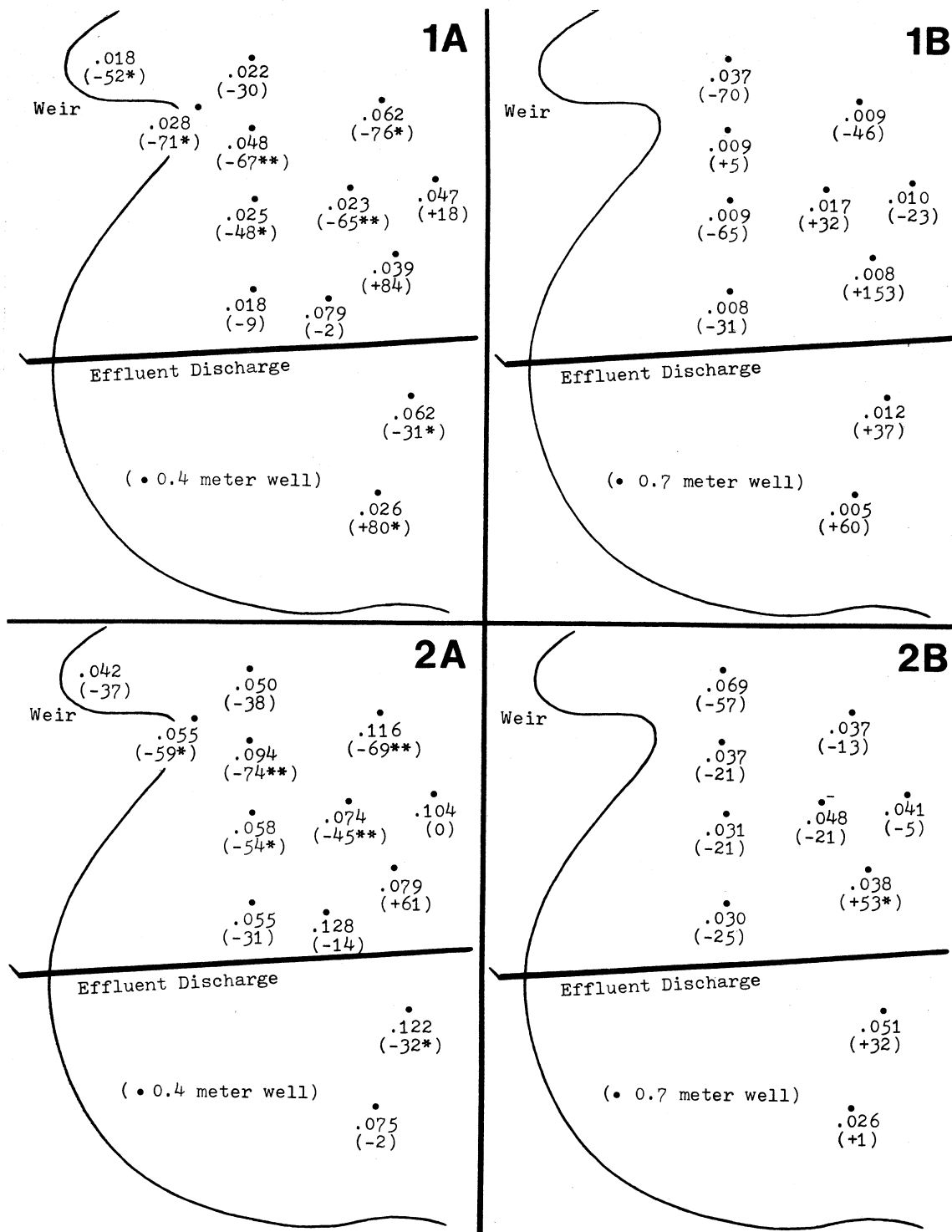


Figure 14. Average baseline ortho P (1) and total P (2) (mg/L) in the Drummond bog at 0.4 meter sites (A) and 0.7 meter sites (B) and % change ( ) after effluent application based on average values for the last half of the 1979 effluent discharge period and the corresponding 1978 baseline period. (\* % change significant at 0.05 level, \*\* significant at 0.01 level.)

the fall, possibly by flushing and lower biological activity, and finally increased through winter with stagnant conditions (Figure 15). Seasonal total P trends were muted in deeper wells because of less biological activity and water movement.

Hydrologic conditions appeared to be a major factor in the bog discharge of total P. The high in August, 1978 correlated to high precipitation runoff (Figure 1) at a time when P was high in the interstitial bog water. Dilution during spring runoff was apparent in 1979, but not in 1978.

Ortho P seasonal trends in 0.4 meter wells mirrored total P trends. Deeper sites appeared to follow an opposite trend through spring and summer. A possible explanation is the theory that plants can act as P pumps, removing P from the root zone and eventually transferring it to the fresh litter (Prentki et al. 1978). Similar P trends were noted by Bentley (1969) and Kadlec (1976).

No consistent trend was apparent for the bog discharge of ortho P, except for a general decrease through summer and fall. Ortho P did not peak in the bog discharge corresponding to the peak total P discharge from the August 1978 precipitation event. Ortho P was only 13% of the total P during the runoff event compared to the average of 43%. This indicated that accumulations of organic P compounds were susceptible to flushing in high discharge periods, which could be a limiting factor for overall treatment efficiency. During the background period from June through October, 1978,

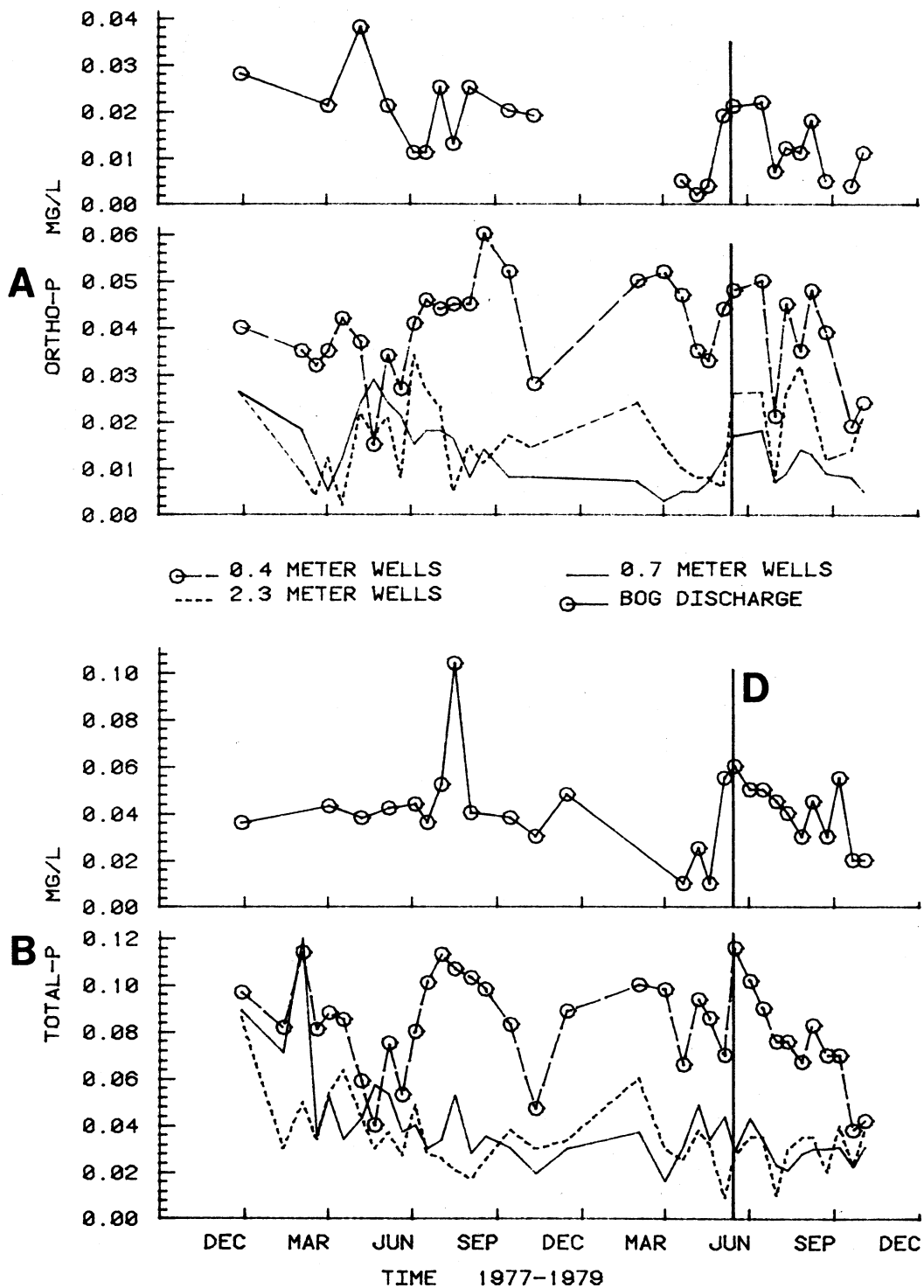


Figure 15. Seasonal ortho P (A) and total P (B) trends for the Drummond bog. The letter "D" indicates the start of effluent discharges to the bog.

1 kg of total P left the bog compared to the 0.8 kg precipitation input, resulting in a net P release of 32%. The bog achieved a 30% ortho P retention for the same baseline period, discharging 0.35 kg of the 0.50 kg precipitation input.

Effluent P loading was low throughout the 1979 effluent discharge period. Effluent discharges to the bog added a total of 0.44 kg of ortho P and 1.49 kg of total P, in addition to natural precipitation loading of 1.94 kg of ortho P and 2.46 kg of total P. In the same time period, the bog discharged 0.30 kg of ortho P and 0.85 kg of total P, resulting in 88% retention of ortho P and 78% retention of total P inputs from effluent and precipitation. Without large runoff events, as in 1978, there was a net retention of total P in 1979 even though P loading increased from 0.8 kg in 1978 to 4.0 kg in 1979 from effluent and greater precipitation inputs.

Average 1979 effluent total P and ortho P concentrations were .163 and .047 mg/L respectively. Based on comparisons between the effluent P concentrations and the bog outflow P concentrations, an 80% average reduction in total P concentration and a 79% average reduction in ortho P concentration were also achieved by the bog system. It should be noted that this discussion of P removal reflects only the first 4.5 months of operation of the peatland treatment system.

Although the effluent total P values were higher than the bog background, no statistically significant total P increase was noted for any sampling group (Table 8 and Fig. 14). Changes in total P for Weso Lake were not statistically analyzed because 1978 samples were filtered while 1979 samples were not. Since chloride concentrations did not significantly increase, there was little potential for other effluent impacts.

Within the treatment bog, the largest effluent impact appeared to be a reduction of the 0.4 meter well average. After effluent applications began, the average 0.4 meter total P concentration quickly decreased (Fig. 14 and 15).

This decrease was analyzed by comparing total P levels during the effluent discharge period to the corresponding 1978 baseline values for the 0.4 meter wells along a transect away from the effluent discharge pipe (Fig. 16). Although the transect did not reflect the major effluent flow path (Fig. 6), it was chosen because of completeness and representativeness of data to illustrate general P dynamics. Effluent P was quickly lowered, greater than dilution could account for, within 25 meters of the discharge pipe to less than 0.04 mg/L during the entire discharge period. Peat filtration of the effluent particulate P could account for a drop to approximately 0.09 mg/L. It was very unlikely that any effluent particulates could have moved through the bog and were therefore not included in

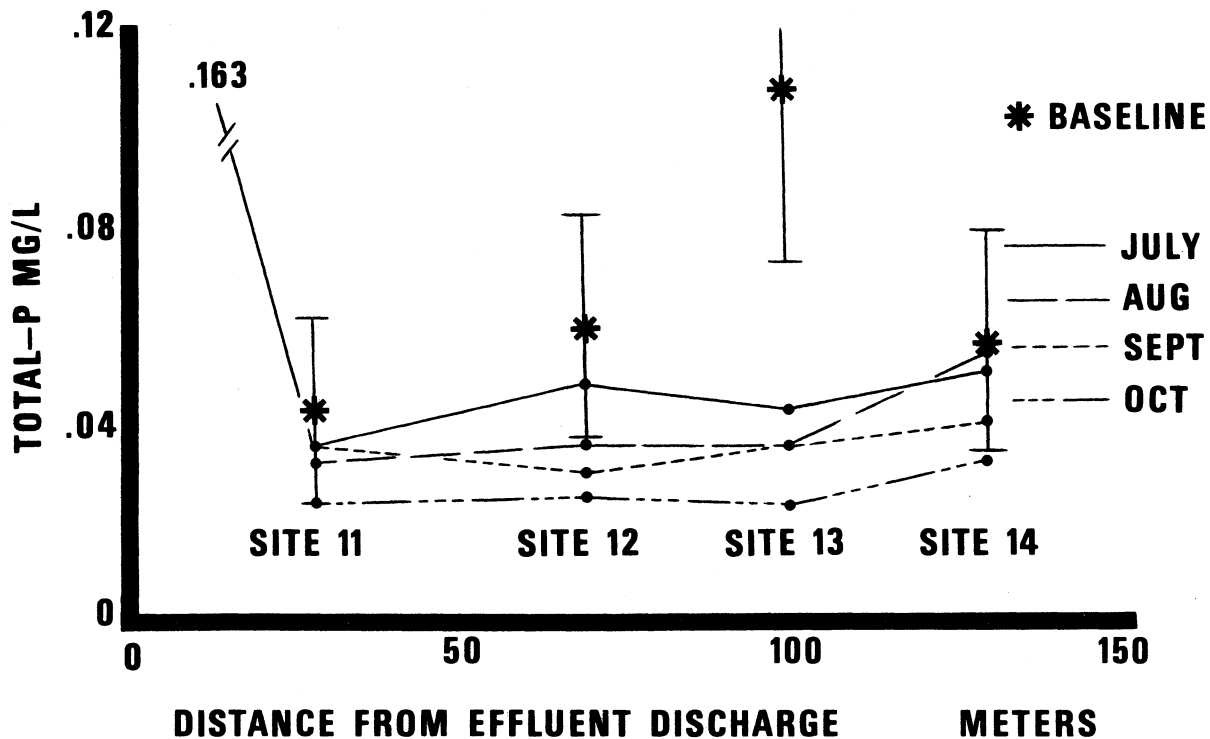


Figure 16. Total P on a transect across the Drummond bog at 0.4 meter sites from July through October during the 1979 effluent discharge period and the corresponding 1978 baseline period. Bracketed baseline plots are  $\pm$  one std. dev.

the filtered well samples. The P decreases were most pronounced at sites with higher natural P levels, such as site 13.

Only one 0.4 meter site in the treatment bog, site 32, experienced a total P increase, and that increase could be explained by natural variability (Fig. 14). Apparently the effluent P was reduced to near the normal bog baseline by natural regulatory processes and dilution when passing through the peat, and the controlling or limiting factor was the zone of lowest natural P it passed through. The volume

of effluent moving through the bog was then sufficient to dilute P values to below normal levels at sites below the limiting zone. It is also possible that the effluent was a factor in determining the limiting zone, as noted in the introduction. Dilution by precipitation was not significant because precipitation was not above normal and evapotranspiration generally exceeds precipitation during the discharge period.

Total P changes at 0.7 meter sites were not significant, except for an increase also at site 32. Phosphorus increases at site 32 either had natural causes or represented a P front due to the saturation or absence of a limiting zone above the site. According to chloride increases (Fig. 5), the 0.4 meter 32 site had the greatest effluent impact, although only minimal impact at the 0.7 meter 32 site was noted.

Because effluent ortho P concentrations were near the bog background for many sites and also because of high natural variability, evaluation of effluent induced changes was impossible. For example, the ortho P increase of 84% at the 0.4 meter 32 site could be explained by natural variability, while the 80% increase at the 0.4 meter 21 site was significant although chloride changes indicated minimal effluent impact at that site (Fig. 5). No ortho P changes were significant at 0.7 or 2.3 meter sites, except for an increase at the 2.3 meter control site (Table 8), again reflective of the natural yearly variation possible.

Drops in ortho P in mid and surface Weso Lake waters (Table 8) could reflect sedimentation of erosional materials introduced during the 1978 lagoon construction period. From 1978 to 1979, a 37% decrease in total suspended solids and a 38% increase in secchi disc readings were noted.

Ten Drummond peat samples were analyzed for background metals (Table 9) that could relate to the initial potential for phosphorus removal by adsorption and precipitation.

Table 9. Average metal content of 10 peat samples from the Drummond bog. Values are expressed as mg/g oven dry weight peat.

Metal	Mean	S.D.
Al	2.38	1.28
Ca	3.61	.77
Cd	<.001	--
Cr	.015	.010
Cu	.003	.001
Fe	1.06	.34
K	.253	.122
Mg	.386	.104
Mn	.031	.016
Na	.054	.034
Ni	<.005	--
Pb	.025	.014
Zn	.025	.015

The analyses were done to provide a general characterization of the metal content of the peat which, in conjunction with the phosphorus removal measured at the Drummond bog, may help evaluate the potential of other peatland treatment sites. The values are generally within normal ranges for an ombrotrophic bog, except Al and Ca appear slightly high (Damman 1978, Gore and Allen 1956, Sillanpaa 1972, and Walmsley 1977).

### Nitrogen

Like phosphorus, nitrogen exhibited considerable natural variability. Total soluble N significantly increased with depth in the interstitial waters of the treatment bog (Table 10). Relatively large increases in ammonia N were responsible for this trend because soluble organic N actually decreased with depth, similar to the decreases noted for COD and P. Low ammonia at 0.4 meter sites probably reflected biological uptake or conversion to nitrate at the aerobic/anaerobic interface. Ammonia N is the reduced inorganic decomposition product and the buildup at deeper depths reflected the enforced anaerobic conditions with a consistently high water table.

Except for samples collected in December, 1977, no nitrite-nitrate N was found at any depth. Apparently nitrates in precipitation (average 0.38 mg/L) and nitrates from conversion of ammonia N were removed by biological uptake or denitrification processes.

Table 10. Average nitrite-nitrate N/ammonia N/and Kjeldahl N (mg/L) for the Drummond system and % change after effluent application based on average values for the last half of the 1979 effluent discharge period and the corresponding 1978 baseline period.

Site	Baseline			% Change		
	Mean	S.D.	N			
Treatment Bog:	0.4 Meter	<0.02	-	299	0%	
		0.28	.27	287	-36%†	
		1.54	.56	297	-35%†	
	0.7 Meter	<0.02	-	226	0%	
		0.62	.48	216	+17%†	
		1.76	.67	220	-12%†	
	2.3 Meter	<0.02	-	53	0%	
		1.66	.52	50	+29%	
		2.63	.62	47	+2%	
Bog Discharge: Site 60	<0.02	-	17	0%		
	0.03	.04	16	0.01#		
	1.00	.38	17	-35%		
Lower Bog: Site 51	<0.02	-	16	0%		
	0.06	.09	16	+29%		
	0.83	.28	15	-11%		
Weso Lake:	Surface	<0.02	-	5	0%	
		0.03	.02	5	+28%	
		0.62	.27	5	+27%	
	Mid	<0.02	-	5	0%	
		0.01	.01	5	0.04#	
		0.59	.34	5	+60%	
	Bottom	<0.02	-	5	0%	
		0.69	.21	5	+9%	
		1.43	.48	5	+27%	
	Control Bog:	0.4 Meter	<0.02	-	51	0%
			0.08	.05	49	+151%
			1.36	.47	51	-18%
2.3 Meter		<0.02	-	25	0%	
		1.44	.43	24	+36%***	
		2.69	.35	23	-8%	
Regional Groundwater Sites 81 and 82	<0.02	-	34	0%		
	0.06	.06	34	+160%		
	0.28	.13	33	+59%		

† See Figure 18. for significance of individual % changes.

The average baseline organic N concentration in the bog discharge was 0.97 mg/L, while inorganic N averaged only 0.03 mg/L. Biological uptake and denitrification in the bog and weir pond could account for the low inorganic N. Detectable nitrite-nitrate N was found in the bog discharge during the runoff event for the high precipitation in August, 1978. Direct runoff as surface flow in the lagg zones was probably the source.

Nitrogen in the control bog was similar to the treatment bog. Site 51 in the lower bog had slightly lower Kjeldahl N, similar to the lower COD noted at that site. The regional groundwater generally had low N.

In Weso Lake, ammonia was low except for the anaerobic bottom site, and nitrates were below detection at all depths during the stratified period. Algal uptake lowered inorganic N in surface waters, and reduced conditions in the hypolimnion caused an accumulation of ammonia N. Nitrates were found in measurable concentrations only during the spring thaw and fall overturn periods (Appendix G). Kjeldahl N increased with depth, reflecting the increased ammonia and settled organic N.

Seasonal N trends were difficult to describe because of the complexity of nitrogen transformations and their relationship to variable moisture conditions. Kjeldahl N in the treatment bog did not appear to follow defined seasonal cycles as phosphorus did, except possibly for lows at shallower sites during spring runoff (Fig. 17). The bog discharge

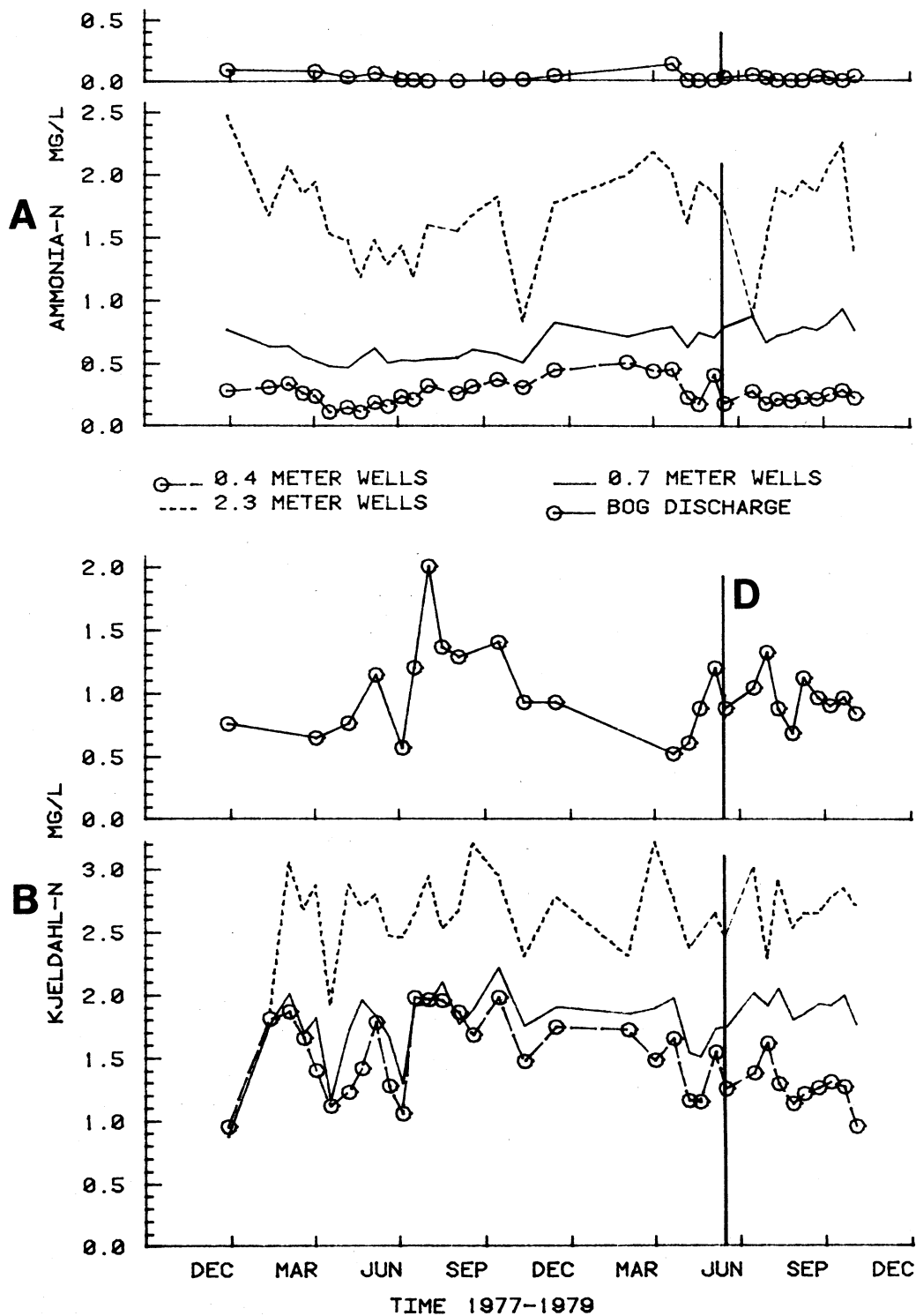


Figure 17. Seasonal ammonia N (A) and Kjeldahl N (B) trends for the Drummond bog. The line marked "D" indicates the start of effluent discharges to the bog.

Kjeldahl N trend paralleled the interstitial water changes. The peak Kjeldahl N discharge in early August, 1978, did not correspond to the peak total P discharge, indicating different organic sources. Ammonia trends were subdued at 0.4 and 0.7 meter sites and the bog discharge. The 2.3 meter sites varied considerably over time, although no consistent trend was apparent.

Spatial variability was very high, significant at the 0.01 level, for N in the treatment bog (Figure 18). This again indicated the complexities of wetland N dynamics and the difficulties involved in predicting wastewater treatment potential. Ammonia N variability was greatest, ranging from 0.02 to 0.68 mg/L at 0.4 meter sites, and from 0.09 to 2.06 mg/L at 0.7 meter sites.

Based on precipitation N loading during the 1978 baseline period corresponding to the 1979 effluent discharge period, the bog achieved a 96% retention of nitrite-nitrate N, a 99% retention of ammonia N, but a 46% increase in total Kjeldahl N. As previously noted, the bog discharge contained primarily organic N, while the precipitation was 73% inorganic. Biological conversion of inorganic N to organic N apparently causes a natural net release of organic N. Considering total N input (26.7 kg), a net reduction of 9% (2.5 kg) was achieved. High runoff in August, 1978, also contributed to the organic N release, similar to the total P release.

The effluent N loading to the bog in 1979 was 9.7 kg. Approximately 6% (0.6 kg) was ammonia N, 72% (7.0 kg) was

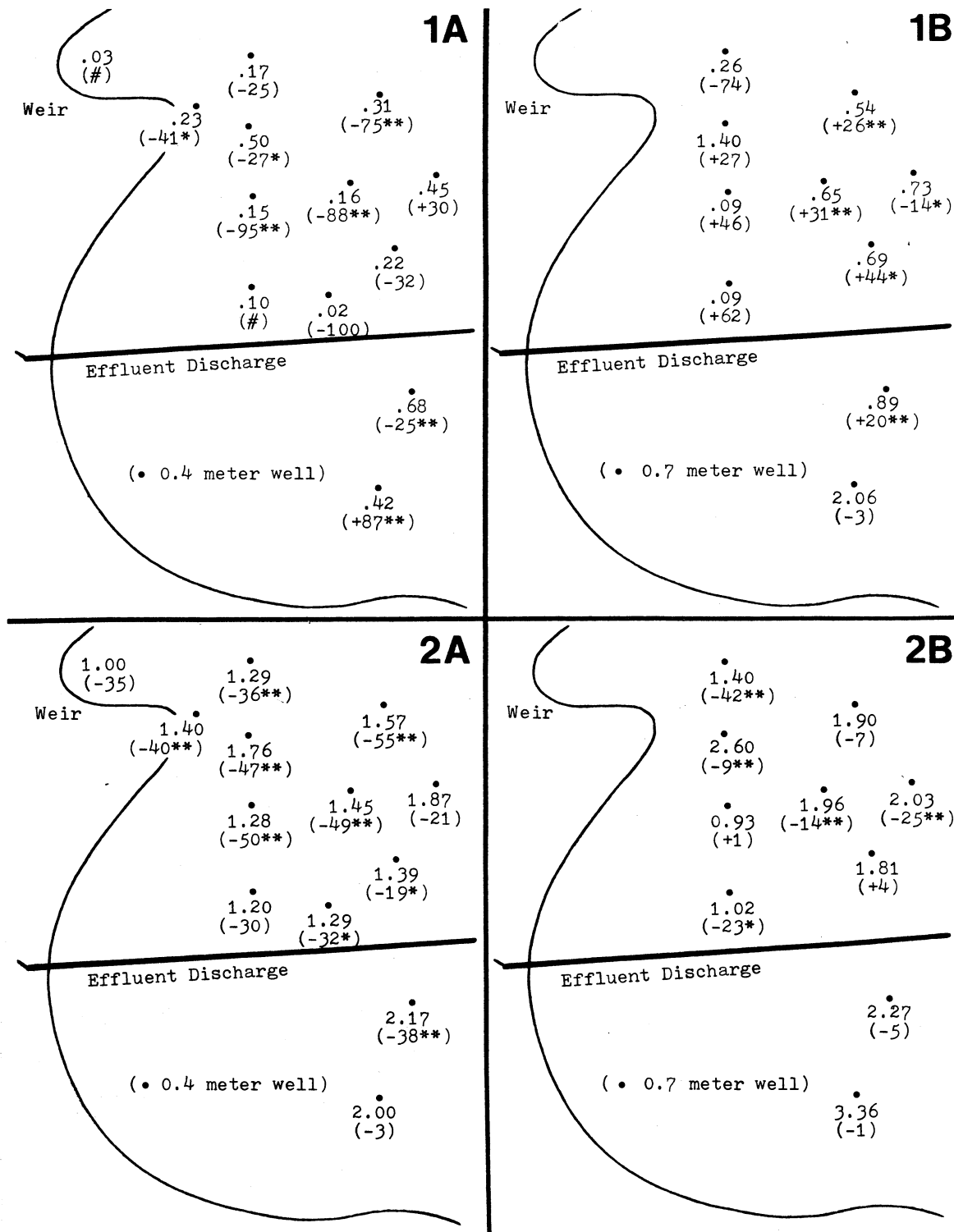


Figure 18. Average baseline ammonia N (1) and Kjeldahl N (2) (mg/L) in the Drummond bog at 0.4 meter sites (A) and 0.7 meter sites (B) and % change ( ) after effluent application based on average values for the last half of the 1979 effluent discharge period and the corresponding 1978 baseline period. (\* % change significant at 0.05 level, \*\* significant at 0.01 level, # insignificant change from a baseline below detection.)

soluble organic N, 22% (2.1 kg) was filterable N, and 0% was nitrite-nitrate N. In addition, precipitation loading added 11.9 kg ammonia N, 9.7 kg nitrite-nitrate N, and 18.3 kg organic N, resulting in a total N input of 49.5 kg. For the discharge period, the bog achieved a 100% retention of nitrite-nitrate N, a 97% retention of ammonia N, and a 53% retention of total Kjeldahl N. Considering all forms, a 62% (30.6 kg) N retention occurred.

It appears that the N added by the effluent was not very significant within the normal N fluxes. Of greater importance with respect to wastewater treatment was the addition of the effluent water (a 27% increase to the water budget) without flushing N from the bog. Total N discharge from the bog in the 1978 and 1979 budgeted periods was 24.2 and 18.9 kg respectively, even though loading in 1979 was considerably higher from precipitation and effluent inputs.

The average effluent ammonia and total Kjeldahl N concentrations were 0.06 and 1.15 mg/L respectively. Based on average bog discharge concentrations for the last half of the 1979 effluent discharge period, the effluent ammonia N concentration was reduced 67% and the Kjeldahl N concentration was reduced 21%. The ammonia decrease actually represented only a drop of 0.04 mg/L.

Effects of the effluent on the bog N chemistry were difficult to identify because of the high natural variability. The only apparent change was a general decrease in soluble Kjeldahl N at 0.4 meter sites (Fig. 17). Analysis of Kjeldahl

N changes on a transect of 0.4 meter sites away from the effluent discharge pipe revealed a pattern of N reduction similar to the total P reduction (Fig. 19). The concentration of soluble Kjeldahl N in the effluent (0.95 mg/L) was in the lower range of the normal bog baseline. The volume of water moving through the bog with that level of Kjeldahl N was sufficient to almost equalize N concentrations to that level across the bog. Significant decreases in the bog background were associated with sites with higher natural levels. No significant removal of Kjeldahl N below what could be explained by filtration of particulate organic N was indicated.

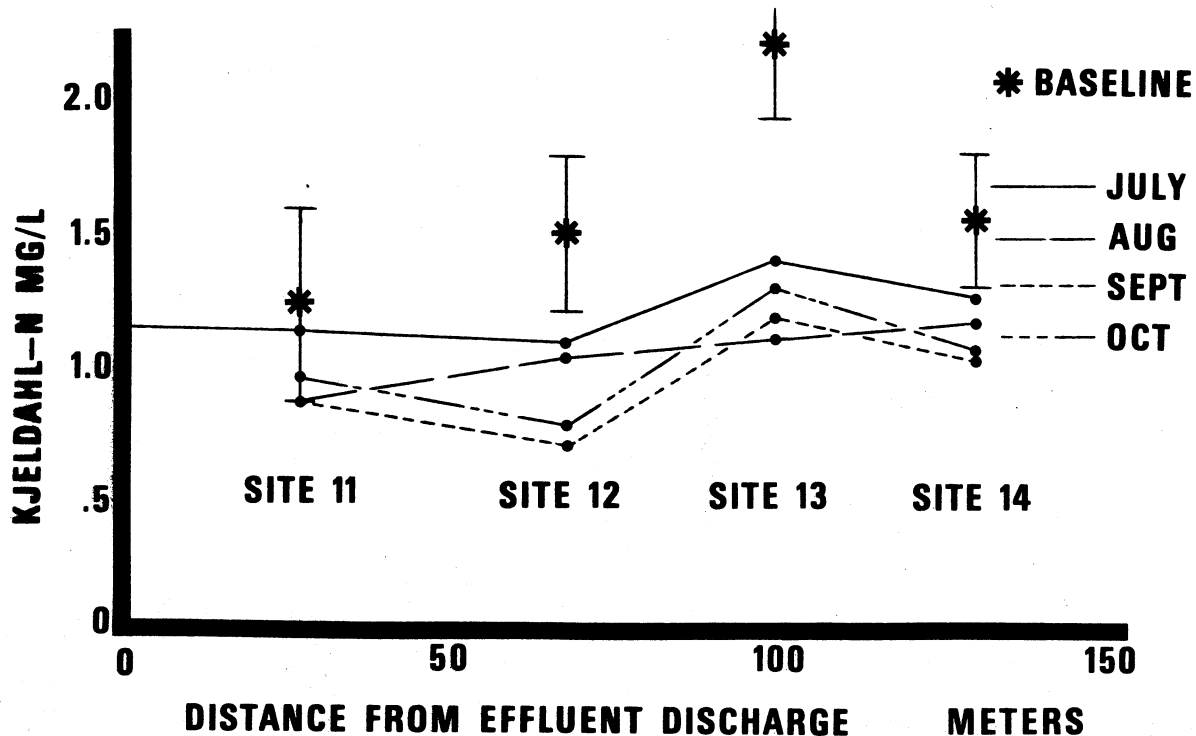


Figure 19. Kjeldahl N on a transect of 0.4 meter sites across the Drummond bog from July through October during the 1979 effluent discharge period and the corresponding 1978 baseline period. Bracketed baseline plots are  $\pm 1$  std. dev.

Kjeldahl N decreased significantly at most 0.4 meter sites and at five 0.7 meter sites (Fig. 18). Decreases in soluble organic N were primarily responsible because ammonia was often a small component of the Kjeldahl N at 0.4 meter sites. Ammonia N changes were less consistent, sometimes increasing at sites where Kjeldahl N decreased,

The average effluent ammonia concentration (0.06 mg/L) was less than the bog baseline at most sites, and therefore the decrease noted at most 0.4 meter sites could be expected. A significant ammonia increase at the 0.4 meter 21 site, previously identified as receiving little effluent impact, indicated that natural variability from year to year could be significant. Four of the five significant ammonia changes at 0.7 meter sites were increases although baseline values at those sites were much higher than the effluent ammonia. This could imply an indirect effluent impact, such as enforced anaerobic conditions from the consistently high water table.

No significant N changes were noted for the 2.3 meter wells in the treatment bog, the bog discharge, the sites below the treatment bog, the 0.4 meter control sites, and the regional groundwater (Table 10). Ammonia N increased significantly at the 2.3 meter control site, again pointing to the high natural variability.

Nitrates were below detection limits in the effluent and at all sampling sites during the effluent application.

## Metals

The fate of heavy metals in peatlands is not clearly known at present. Metals could adsorb to humus or could be mobilized by chelation with soluble organic acids. Research on the ultimate fate of heavy metals in natural wetlands is needed before wetland treatment is used where industrial wastewater is included. The Drummond system treats only domestic sewage.

Metal determinations were made on 5 effluent discharges between July 17 and August 21, 1979. The bog discharge and samples from the 3 sampling depths at sites 11 and 14 were also analyzed for metals before and after effluent application.

Many of the heavy metals (Cd, Cr, Ni, Pb, and Zn) were below detection limits in the effluent (Table 11). Only Ca, Mg, Na, and K were significantly higher in the effluent, and increases in these cations were noted at the bog sites after effluent application. The only change that appeared strongly related to the effluent was a Na increase at the 0.4 meter 11 site closest to the effluent discharge. The relatively high effluent Na concentration and the mobility of Na in the bog (Damman 1978) were responsible for the increase. The Na concentration at the 0.4 meter 14 site increased only 0.21 mg/L during the effluent discharge period, indicating removal or dilution to within baseline at that distance.

The increases for the other cations were relatively small and could be accounted for by natural variation. Also,

Table 11. Average metal concentrations (mg/L) in the lagoon effluent and the Drummond bog before and after effluent application.

Metal	Effluent	Bog	
		Spring 1979	Fall 1979
Al	0.17	0.57	0.60
Ca	20.0	1.17	2.01
Cd	<0.005	<0.005	<0.005
Cr	<0.005	<0.05	<0.005
Cu	0.01	0.06	<0.01
Fe	0.35	0.50	1.06
K	3.14	0.68	0.82
Mg	8.84	0.42	0.73
Mn	0.04	0.01	0.05
Na	20.1	0.95	2.49
Ni	<0.1	<0.1	<0.1
Pb	<0.1	<0.1	<0.1
Zn	<0.01	0.71	0.44

the baseline samples were collected in May and June when concentrations of soluble materials were often lowest from snowmelt.

#### Dissolved Oxygen

The lack of dissolved oxygen in the saturated peat soil was assumed in the previous discussions concerning biological

activity and nutrient dynamics. Forty DO samples were collected from the treatment bog, the bog discharge, and the control bog during the baseline period to quantify normal DO levels and to detect possible changes after effluent application.

Dissolved oxygen was very low in the treatment bog and the control bog. The overall average for the treatment bog was 0.08 mg/L, with 78% of the samples having zero measureable DO. Most non-zero values occurred at the 0.4 meter sites sampled October 15, 1978. A 0.43 inch rainfall occurred on the same date and oxygen may have moved into the peat soil with the precipitation infiltration. The average of 2 weir pond samples was 0.8 mg/L, indicating a greater potential for oxygen diffusion. Based on 18 samples collected August 11, 1979, the DO did not change after effluent application.

Dissolved oxygen dynamics in Weso Lake reflected the seasonal cycles of stratification and mixing. At the time of the fall overturn, around November 1st, DO was relatively high at all depths (Fig. 20). The DO at mid and bottom sites then appeared to consistently drop through winter and summer, until little or no DO was found from July to the fall overturn. The surface water generally retained at least 5 mg/L.

The 1979 effluent discharge period coincided with the summer stratification period. Although the DO depletion in 1979 was more severe than in 1978, there was no indication that the effluent was a factor according to the other monitored parameters.

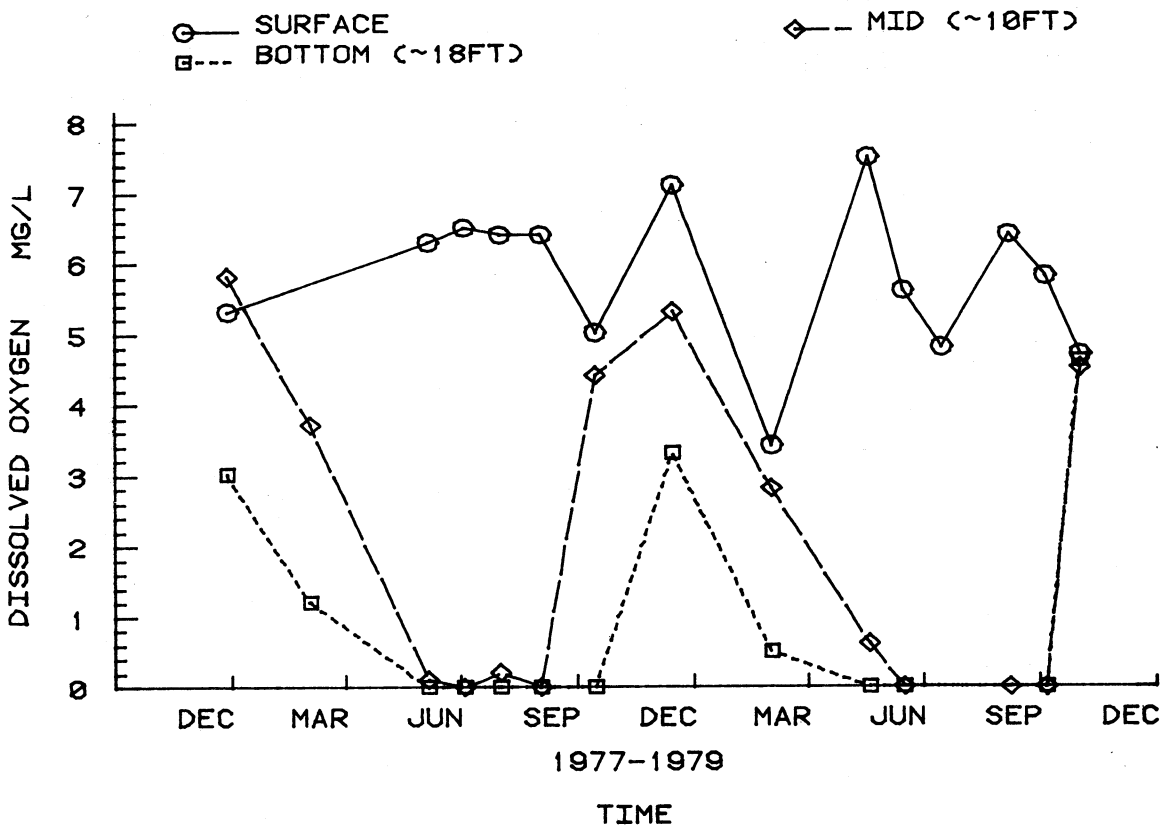


Figure 20. Seasonal dissolved oxygen trends at three depths in Weso Lake.

### Other Parameters

Limited bacteria, alkalinity, hardness, and suspended solids data was collected, primarily for the effluent and the bog discharge. The average effluent and bog discharge baseline values were presented in Table 1.

Fecal coliforms were low in the bog and the effluent, and no significant change in the normal bog discharge of fecal coliforms was noted after effluent application.

The pH of the bog discharge was consistently below the end point of the alkalinity titration on all sampling dates

before and after effluent application, indicating 100% removal of the effluent alkalinity which was 73 mg/L as  $\text{CaCO}_3$ .

Although the effluent hardness (93 mg/L as  $\text{CaCO}_3$  total hardness and 59 mg/L as  $\text{CaCO}_3$  Ca hardness) was considerably higher than the characteristic low hardness of the bog discharge (9 and 7 mg/L as  $\text{CaCO}_3$  respectively), little change was noted after effluent application. The effluent total and Ca hardness concentrations were reduced 83% and 87% respectively by passage through the bog.

The effluent suspended solids (20.6 mg/L) was also considerably higher than the normal bog discharge (1.7 mg/L). Again, no significant effluent impact on the bog was observed. A 95% reduction in concentration of effluent suspended solids was noted for the 1979 effluent discharge period.

#### Peat Core Nutrient Uptake Studies

Measuring the phosphorus removal potential of the peat component was the primary goal of the peat core leaching studies. In addition, total nitrogen and calcium removal and pH and conductivity changes were noted for one set of peat cores. Three leaching runs were made as described in the methods section. Some chemical characteristics of the eluants are given in Table 12.

Table 12. Chemical characteristics of the eluants used in the peat core nutrient uptake studies.

Eluant	pH	Cond. (umhos)	Ca (mg/L)	Ortho-P (mg/L)	Total-P (mg/L)	Total-N (mg/L)
Junction City Effluent	--	--	34	--	1.0	--
Stevens Point Effluent - 1st cycle of run #3	7.51	600	41	3.4	3.5	16.7
Stevens Point Effluent - 2nd cycle of run #3	7.66	800	42	4.5	4.7	15.6
Water-desorption cycle of run #1	--	--	--	--	.015	--
Water-desorption cycle of run #3	6.83	19	2.2	.005	.028	.13

#### Phosphorus Removal

Source of peat and rate of leaching did not significantly change P removal in runs #1 and #2. The composite % removal for the 6 cores in runs #1 and #2 dropped quickly until about 8 bed volumes, then leveled off to approximately 20% when the leaching was arbitrarily stopped at 21 bed volumes (Fig. 21). This indicated a limited potential for producing high quality effluent, above 80% removal, although the continued P removal at 20% implied a significant potential for long-term P uptake. Because approximately 96% of the P applied to the cores was in a soluble form, by standard definition, the continued removal indicated considerable

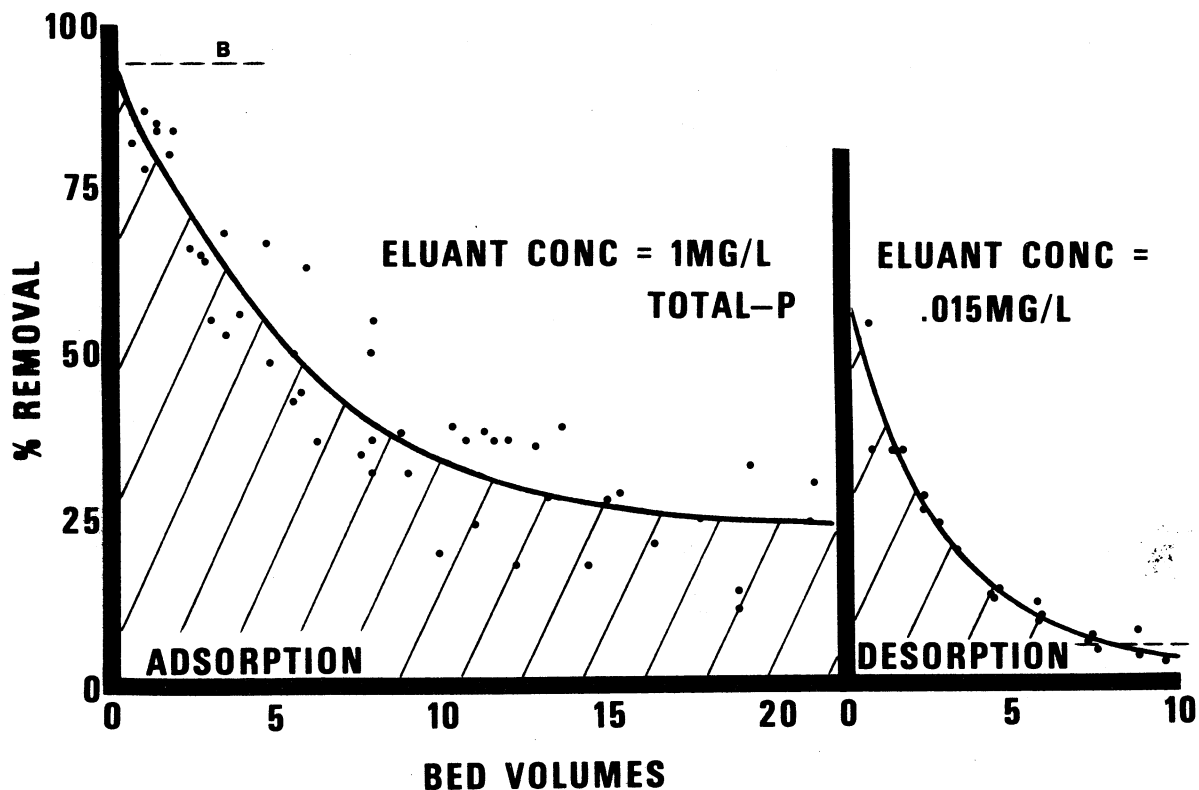


Figure 21. % P removal in peat cores from the Drummond bog. Desorption curve based on % of initial eluant concentration in leachate. Dashed line "B" indicates baseline condition.

adsorption and/or filtration capacity by the peat. The area under the curve represented the P removed, which averaged  $0.060 \pm .010$  mg P removed per gram oven dry weight peat for the 6 cores. Phosphorus adsorption tests on the core apparatus alone indicated insignificant influence on the reported P removal.

When the 3 cores in run #1 were eluted with water, analogous to a flushing event in the bog, such as spring runoff, approximately 13% of the P removed from the effluent was leached from the cores after 8 bed volumes when the normal baseline P concentration was reached.

The effluent P concentrations were considerably higher for run #3, but the same type of adsorption curve was obtained (Fig. 22). During the initial leaching period, the % removal dropped slightly more quickly than for runs #1 and #2, but leveled off at over 30% removal.

The exact removal mechanism was not known. The quick decline in % removal could have been due to saturation of the most active adsorption sites, while the leveling off could reflect a filtration process that would not decrease in efficiency. Approximately 97% of the P applied to the cores

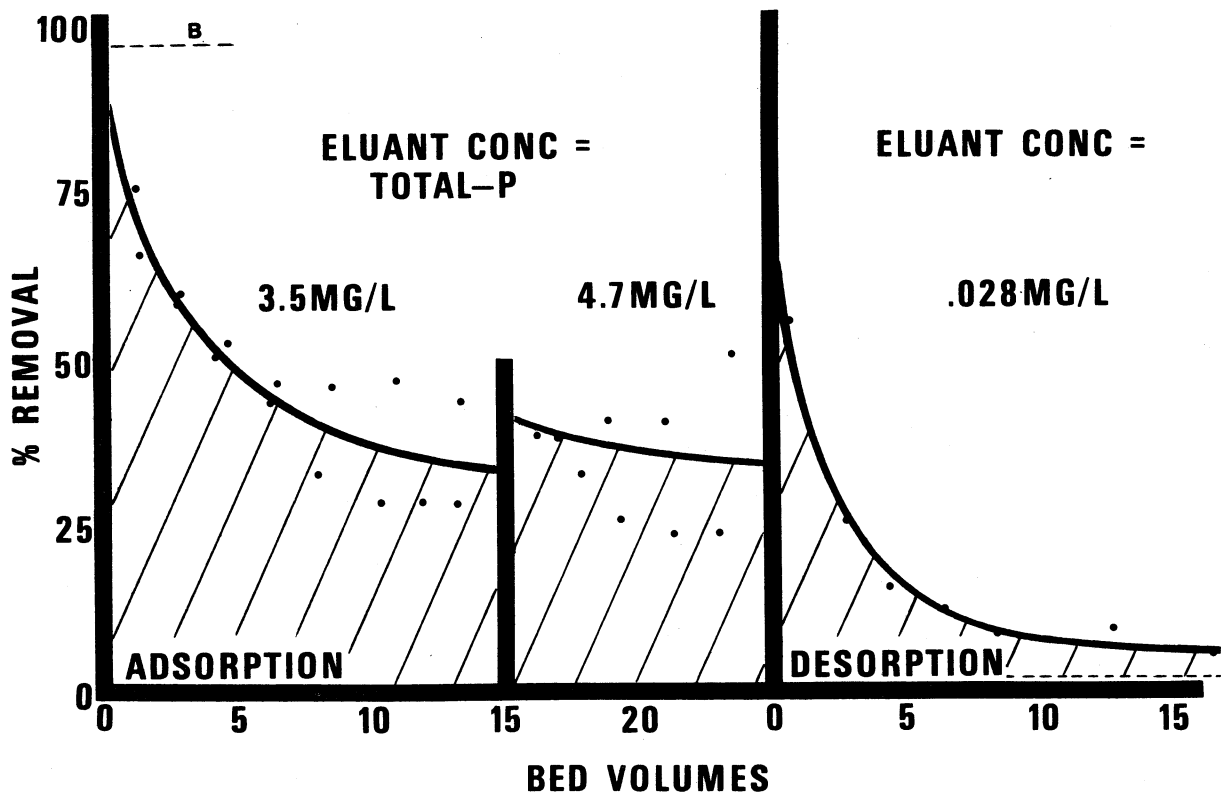


Figure 22. % P removal in peat cores from the Drummond bog. Desorption curve based on % of initial eluant concentration in leachate. Dashed line "B" indicates baseline condition.

was in a soluble reactive form, which would indicate an adsorption process as the primary removal mechanism. The continued P removal, within the extent of the experiment, may then reflect enhanced P removal by the effluent itself. For example, adsorption of effluent cations to the peat exchange sites could be increasing the potential P adsorption sites.

The % P removal in the second leaching cycle for run #3 did not change significantly from the first leaching cycle. Apparently the removal mechanism was not greatly influenced by aeration during the drained rest period. For example, if considerable iron were present, oxidation to the ferric state might increase P removal.

The total P adsorption for run #3 was 0.263 mg P/gram O.D.W. peat. This was considerably higher than the amount removed in runs #1 and #2, although the actual amounts are arbitrary based on the volume of effluent leached. Higher residual P in solution with higher eluant P concentrations would cause adsorption equilibria to shift towards the solid phase.

In run #3, desorption when leached with water was approximately 26%. Leachate P concentrations were significantly higher than the normal baseline when leaching was arbitrarily stopped after 15 bed volumes.

Based on the amounts leached, as shown in Figure 22, the average net P retention for run #3 was 0.191 mg P/gram O.D.W. peat. Extrapolated to the natural bog, this represented approximately 40 kg P removed per acre-foot of surface peat

soil. The rate of P removal had dropped to approximately 35% after the 40 kg P were removed.

If 80% P removal was required for tertiary treatment, then 3.7 kg P could be removed per acre-foot of peat, based on an effluent concentration of 3.5 mg/L. Phosphorus concentrations in the Drummond primary lagoon averaged 4.7 mg/L during the 1979-1980 winter. Assuming approximately 6.5 acres of the Drummond bog receives effluent and the effluent mixes to a depth of 0.5 meter, then 80% P removal could theoretically be obtained for 25 years at the Drummond site, based on 1979 effluent P loading, or for only 1.5 years, based on P loading assuming a P concentration of 3.5 mg/L and a discharge volume of 2 million gallons (7570 m<sup>3</sup>).

Of course, this is a simplistic view which considered only preliminary analysis of the peat component of the complex wetland system. Biological uptake was not considered, nor was the mobilization rate by decomposition. For example, one core not included in the previous analysis experienced a flush of P in the leachate much greater than the eluant concentration after the core was aerated, indicating that a change in the decomposition rate could mobilize considerable retained P.

#### Nitrogen Removal

Nitrogen removal was also measured in run #3. Unlike P removal, N removal essentially dropped to zero by 15 bed volumes (Fig. 23). In the first leaching cycle, ammonia N

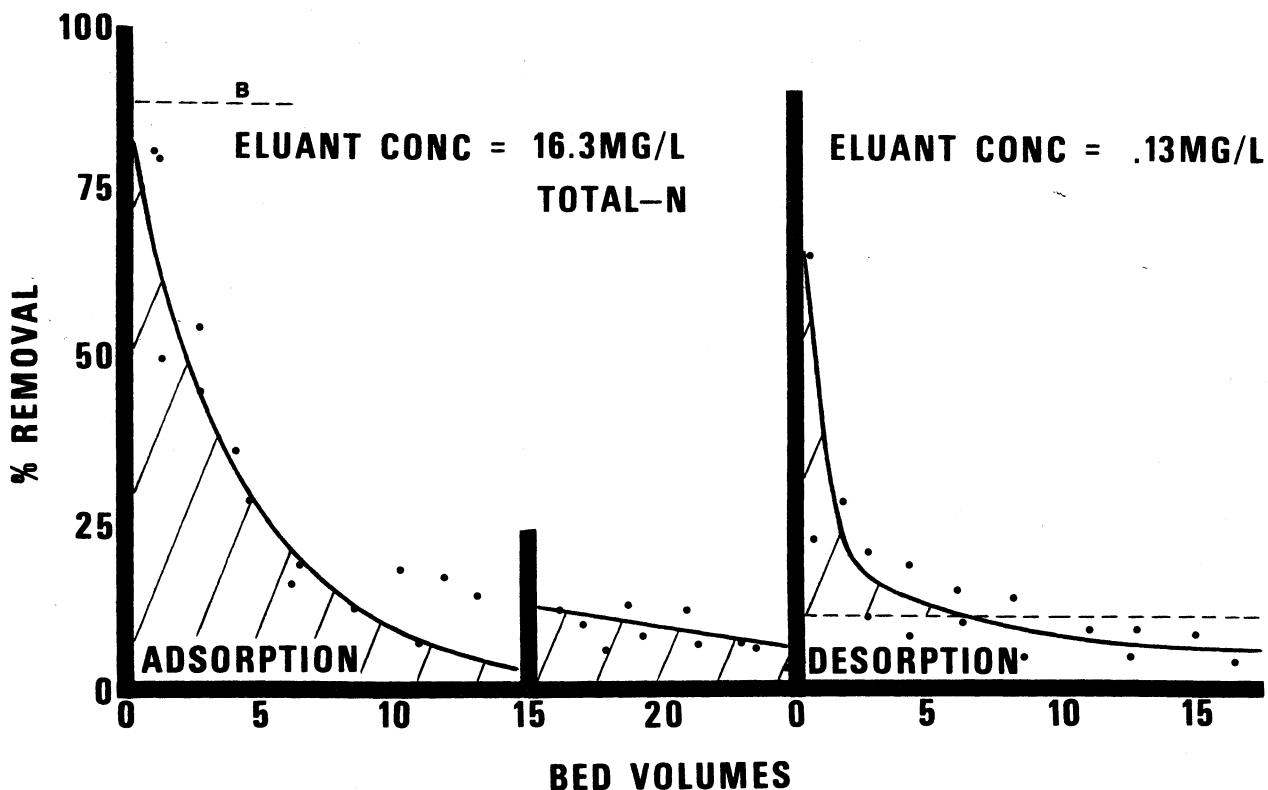


Figure 23. % N removal in peat cores from the Drummond bog. Desorption curve based on % of initial eluant concentration in leachate. Dashed line "B" indicates baseline condition.

averaged 58% of the N applied to the core. Ammonia removal dropped to zero or below after approximately 10 bed volumes, possibly because of saturation of exchange sites it was capable of competing for. Thirty percent of the applied nitrogen was in the nitrite-nitrate form and 12% was characterized as organic. Removal of these forms was slightly better than the overall N removal, offsetting net releases of ammonia after 10 bed volumes. This indicated active N transformation even at the low temperature of the test. Another core not included in the composite analysis experienced a consistent 40-50% N removal rate with almost 100% nitrate

removal, indicating biological activity.

Nitrogen removal was not enhanced by the dry cycle. In the second leaching cycle, organic N was 51% of the applied N, and therefore the slight increase in overall N removal probably reflected entrapment of particulates or large organic molecules.

Approximately 0.45 mg N was removed per gram O.D.W. peat, and only 17% of the retained N was mobilized by leaching with water until the normal baseline concentration was reached at approximately 6 bed volumes. Composition of the leachate during desorption averaged 8% nitrite-nitrate, 31% ammonia, and 61% organic N. Compared to the proportional composition of the effluent, this indicated relatively strong retention of nitrite-nitrate and ammonia N.

#### Calcium Removal

The % Ca removal in run #3 followed a different trend than P or N. Removal started at only 40%, increased to 80% at 8 bed volumes, and then decreased uniformly (Fig. 24). The initial low Ca retention could reflect saturation of the exchange sites by hydrogen ions. As previously noted, the CEC of 6 peat samples averaged 191.3 me/100 g O.D.W. peat, with 93% due to exchange acidity. Initial effluent flushing raised the pH slightly, reducing the hydrogen ion competition and opening some exchange sites.

After 25 bed volumes, a total of 4.5 mg Ca was removed per gram O.D.W. peat. Ca was not detected above the baseline

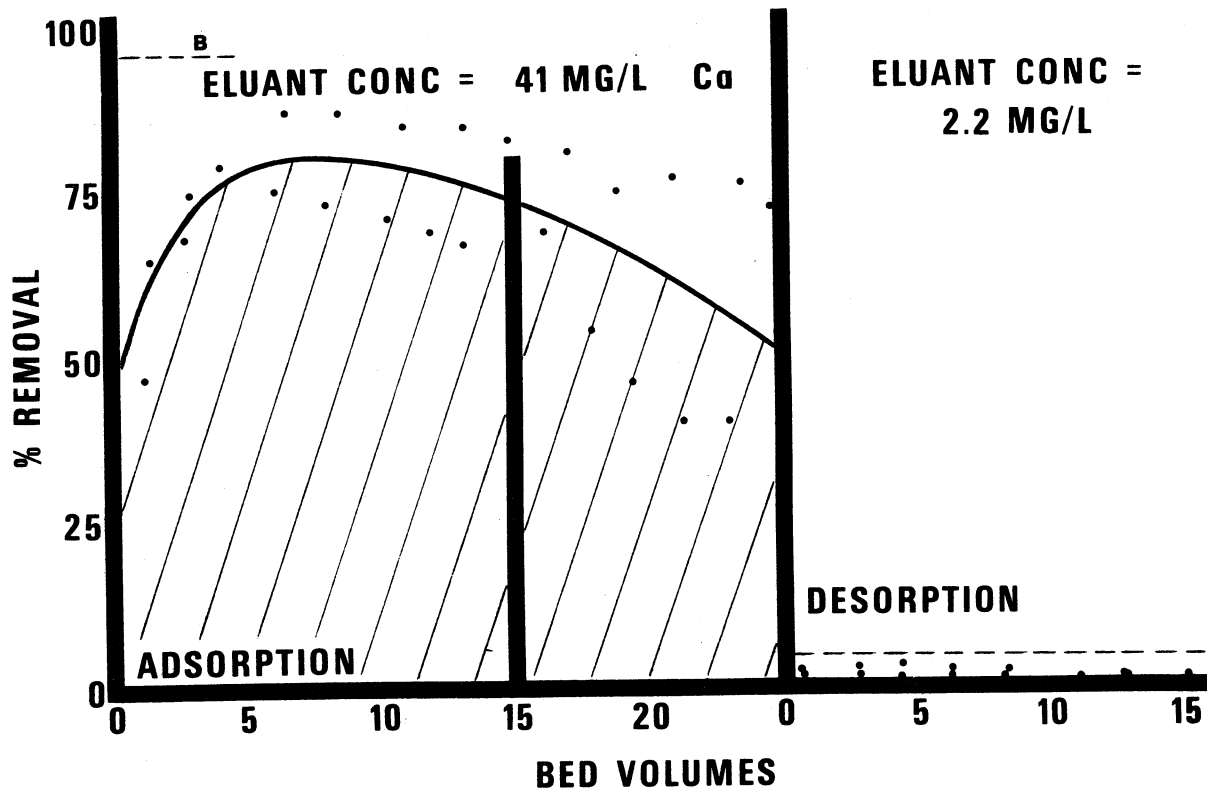


Figure 24. % Ca removal in peat cores from the Drummond bog. Desorption curve based on % of initial eluant concentration in leachate. Dashed line "B" indicates baseline condition.

concentration in the leachate during the water leaching cycle. Apparently adsorbed Ca was strongly complexed by organic chelators.

#### pH and Conductivity Changes

Changes in conductivity of the applied effluent also suggested the retention of certain ionic species. Conductivity in the leachate for run #3 quickly increased to approximately 67% of the effluent value, then remained relatively constant. Mobile ions such as chloride and sodium quickly

passed through the core, while multivalent cations, such as the divalent hardness cations, were more strongly adsorbed.

The pH of the leachate rose to near effluent levels after 25 bed volumes but did not change consistently with the amount of effluent and was variable between the individual cores. The high exchange acidity of the peat represented considerable buffering capacity to maintain relatively low pH. Wastewater alkalinity loading to the cores averaged 116 me while the total exchange acidity of the cores averaged 467 me (262.3 g peat with an exchange acidity of 178 me/100 g). Similarly, only 0.04 acre-foot of peat would be required to remove the total 1979 effluent alkalinity loading to the Drummond bog, assuming a simple alkalinity-acidity neutralization. These calculations are intended only to indicate the magnitude of the acidic buffering capacity of the bog; more research is required before reliable conclusions can be made.

## CONCLUSIONS AND RECOMMENDATIONS

1. Small northern communities, such as Drummond, have an urgent need for alternate methods of tertiary wastewater treatment that are feasible and cost-effective for low-flow systems. Receiving waters are often of high or potentially high quality that can be severely compromised by inadequately treated wastewater. The long-term evaluation of the Drummond demonstration project will be helpful for determining the potential of peatland treatment systems to help fill the tertiary need and for establishing selection and management criteria.

2. Sphagnum peat bogs are complex systems with highly variable water chemistry relating to peat type and degree of decomposition, hydrogeologic regime, moisture conditions, climate, and the activity of plant and microbial communities. Significant differences in water chemistry over time, spatially, and with depth in the peat were noted.

3. A review of the literature indicated a strong potential for wetland treatment systems. Preliminary water quality results for the first 4.5 months of operation at the Drummond site also indicated a good treatment potential. Percent retention of nutrients from precipitation (1978) and precipitation plus effluent (1979) are listed below for the period from June through October:

	<u>% Phosphorus &amp; Nitrogen Retention</u> 1978 <u>(Background)</u>	<u>1979</u> <u>(Eff. Discharged)</u>	<u>% Of 1979</u> <u>Loading Due</u> <u>To Effluent</u>
Total P	-32%(release)	78%	38%
Ortho P	30%	88%	18%
Kjeldahl N	-46%(release)	53%	24%
Ammonia N	99%	97%	5%
NO <sub>2</sub> -NO <sub>3</sub> N	96%	100%	0%

Greater retention was found during the 1979 effluent discharge period than during the undisturbed 1978 baseline period.

The most significant changes in the bog after effluent application were increases in chlorides and conductivity and decreases in total P, Kjeldahl N, and especially COD. Most effluent movement and impact was in the upper 0.5 meter of peat.

4. Phosphorus, nitrogen, and calcium uptake studies using peat cores indicated considerable long-term removal potential by the peat component. Based on specific experimental conditions, net removals of 0.191 and 0.37 mg/gram oven dry weight peat were found for P and N respectively. Extrapolated to the natural peatland, this represents approximately 40 kg P and 75 kg N removed per acre-foot of surface peat soil. Interactions with other wetland components and seasonal and long-term changes could increase or decrease the measured removal rates.

5. Caution should be exercised when applying this type of treatment to other sites. Further water quality testing under continued effluent discharges and nutrient budgeting for the entire year, especially the spring runoff period,

are needed. Long-term impacts on flora and fauna need to be studied. Wetlands are a valuable resource and indiscriminate wastewater discharges into "convenient" wetlands cannot be justified, but the potential of this type of treatment should not be ignored either.

6. Ideally, long-term treatment efficiency of peatlands under various operational schemes and peatland condition should be known for design criteria. Many of these conditions can be simulated in peat core leaching experiments in a controlled environment chamber. Additional experiments should be designed to expand the results presented in this report.

## LITERATURE CITED

- Avnimelech, Y. 1971. Nitrate transformation in peat. *Soil Science*, 111:113-118.
- Bartlett, M.S., L.C. Brown, N.B. Hanes, and N.H. Nickerson. 1979. Denitrification in freshwater wetland soil. *J. Environ. Qual.*, 8:460-464.
- Bay, R.R. 1967. Groundwater and Vegetation in two peat bogs in northern Minnesota. *Ecology*, 48:308-310.
- Bay, R.R. 1969. Runoff from small peatland watersheds. *J. of Hydrology*, 9:90-102.
- Bell, P.R. 1959. The ability of Sphagnum to absorb cations preferentially from dilute solutions resembling natural waters. *J. of Ecology*, 47:351-355.
- Bentley, E.M. 1969. The Effect of Marshes on Water Quality. Ph.D. Thesis. University of Wisconsin-Madison. 197pp.
- Bevis, F.B., and R.H. Kadlec. 1979. Effect of long-term discharge of wastewater on a northern Michigan wetland. In: Conference Abstracts, Wetland Utilization for Management of Community Wastewater. University of Michigan-Ann Arbor.
- Black, W.A.P., W.J. Cornhill, and F.N. Woodward. 1955. A preliminary investigation on the chemical composition of sphagnum moss and peat. *J. Appl. Chem.*, 5:484-492.
- Boelter, D.H. 1964. Water storage characteristics of several peats in situ. *Soil Sci. Soc. Amer. Proc.*, 28:433-435.
- Boelter, D.H. 1965. Hydraulic conductivity of peats. *Soil Science*, 100:227-231.
- Boelter, D.H. 1969. Physical properties of peats as related to degree of decomposition. *Soil Sci. Soc. Amer. Proc.*, 33:606-609.
- Boelter, D.H., and E.S. Verry. 1977. Peatland and Water in the Northern Lake States. US Forest Service, General Technical Report NC-31. North Central Forest Experiment Station. 22pp.
- Bouldin, D.R., R.L. Johnson, C. Burda, and C.W. Kao. 1974. Losses of inorganic nitrogen from aquatic systems. *J. Environ. Qual.*, 3:107-114.
- Bowers, F. 1979. Personal Communication. Department of Biology, University of Wisconsin-Stevens Point.

- Boyt, F.L., S.E. Bayley, and J. Zoltek, Jr. 1977. Removal of nutrients from treated municipal wastewater by wetland vegetation. *Journal WPCF*, 49:789-799.
- Bradley, D.B., and D.H. Sieling. 1953. Effect of organic anions and sugars on phosphate precipitation by iron and aluminum as influenced by pH. *Soil Science*, 76: 175-179.
- Bremner, J.M. 1965. Total nitrogen. pp. 1149-1178. In: C.A. Black (ed.). *Methods of Soil Analysis Part 2*. American Society of Agronomy, Inc., Madison, Wis.
- Burge, W.D., and F.E. Broadbent. 1961. Fixation of ammonia by organic soils. *Soil Sci. Soc. Amer. Proc.*, 25:199-204.
- Canadian Pulp and Paper Association, Technical Section. 1974. Colour of pulp mill effluents. Canadian Pulp and Paper Association. 3pp.
- Chaney, R.L., and P.T. Hundemann. 1979. Use of peat moss columns to remove cadmium from wastewaters. *Journal WPCF*, 51:17-21.
- Chapman, H.D. 1965. Cation-exchange capacity. pp. 891-901. In: C.A. Black (ed.). *Methods of Soil Analysis Part 2*. American Society of Agronomy, Inc., Madison, Wis.
- Clymo, R.S. 1964. The origin of acidity in Sphagnum bogs. *The Bryologist*, 67:427-431.
- Clymo, R.S. 1966. Control of cation concentrations, and in particular of pH, in Sphagnum dominated communities. pp. 273-284. In: H.L. Golterman and R.S. Clymo (eds.). *Chemical Environment in the Aquatic Habitat*. N.V. Noord-Hallandsche Uitgevers Maatschappij.
- Cole, G.A. 1975. *Textbook of Limnology*. The C.V. Mosby Company, Saint Louis, MO. 283 pp.
- Coupal, B., and J. Lalancette. 1976. The treatment of wastewaters with peat moss. *Water Research*, 10:1071-1076.
- Damman, A.W.H. 1978. Distribution and movement of elements in ombrotrophic peat bogs. *Oikos*, 30:480-495.
- Deb, D.L., and N.P. Datta. 1967. Effect of associating anions on phosphorus retention in soil. *Plant and Soil*, 26:303-316 and 26:432-444.
- Doughty, J.L. 1930. The fixation of phosphate by a peat soil. *Soil Science*, 29:23-35.

- Engler, R.M., and W.H. Patrick, Jr. 1974. Nitrate removal from floodwater overlying flooded soils and sediments. *J. Environ. Qual.*, 3:409-413.
- Farnham, R.S., and J.L. Brown. 1972. Advanced wastewater treatment using organic and inorganic materials, Part I. Use of peat and peat-sand filtration media. In: Fourth Int. Peat Congr. Proc., Ontaniemi, Finland, 4:271-286.
- Fetter, C.W., Jr., W.E. Sloey, and F.L. Spangler. 1976. Potential replacement of septic tank drain fields by artificial marsh wastewater treatment systems. *Ground Water*, 14:396-401.
- Fetter, C.W., Jr., W.E. Sloey, and F.L. Spangler. 1978. Use of a natural marsh for wastewater polishing. *Journal WPCF*, 50:290-307.
- Fritz, W.R., and S.C. Helle. 1979. Cypress Wetlands for Tertiary Treatment. Boyle Engineering Corporation, Orlando, Florida. 7pp.
- Gore, A.J.P., and S.E. Allen. 1956. Measurement of exchangeable and total cation content for  $H^+$ ,  $Na^+$ ,  $K^+$ ,  $Mg^{++}$ ,  $Ca^{++}$  and iron, in high level blanket peat. *Oikos*, 7: 48-55.
- Gorham, E. 1956. The ionic composition of some bog and fen waters in the English lake district. *J. of Ecology*, 44:142-152.
- Gorham, E. 1957. The development of peat lands. *The Quarterly Review of Biology*, 32:145-166.
- Gosselink, J.G., and R.E. Turner. 1978. The role of hydrology in freshwater wetland ecosystems. pp. 63-78. In: R.E. Good, D.F. Whigham, and R.L. Simpson (eds.). *Freshwater Wetlands: Ecological Processes and Management Potential*. Academic Press, New York, N.Y.
- Hartland-Rowe, R., and P.B. Wright. 1975. Effects of sewage effluent on a swampland stream. *Verh. Internat. Verein. Limnol.*, 19:1575-1583.
- Hermann, A., J. Zoltek, S. Bayley, and T. Dolan. 1979. Nutrient budget in a fluctuating freshwater marsh system in Florida. In: *Conference Abstracts, Wetland Utilization for Management of Community Wastewater*. University of Michigan-Ann Arbor.
- Hickok, E.A. 1978. Wetlands and organic soils for the control of urban storm water. pp. 153-158. In: *Lake Restoration, Proceedings of a National Conference*. EPA publication 440/5-79-001.

- Hortenstine, C.C., and R.B. Forbes. 1972. Concentrations of nitrogen, phosphorus, potassium, and total soluble salts in soil solution samples from fertilized and unfertilized histosols. *J. Environ. Qual.*, 1:446-449.
- Isaac, R.A., and J.D. Kerber. 1971. Atomic absorption and flame photometry: Techniques and uses in soil, plant, and water analysis. pp. 18-28. In: L.M. Walsh (ed.). *Instrumental Methods for Analysis of Soils and Plant Tissue*. Soil Sci. Soc. Amer., Inc., Madison, Wis.
- Kadlec, J.A. 1976. Dissolved nutrients in a peatland near Houghton Lake, Michigan. pp. 25-50. In: D.L. Tilton, R.H. Kadlec, and C.J. Richardson (eds.). *Freshwater Wetlands and Sewage Effluent Disposal*. University of Michigan-Ann Arbor.
- Kadlec, R.H. 1979. Performance of the Bellaire, Michigan wetland treatment facility and Performance of the Houghton Lake, Michigan wetland treatment system. In: *Conference Abstracts, Wetland Utilization for Management of Community Wastewater*. University of Michigan-Ann Arbor.
- Kaila, A. 1956. Phosphorus in virgin peat soils. *Maataloustieteellinen Aikakauskirja*, 28:142-167.
- Kaila, A. 1959. Retention of phosphate by peat samples. *Maataloustieteellinen Aikakauskirja*, 31:215-225.
- Kappel, W. 1979. Drummond water budget. Paper presented at the annual meeting of Drummond research groups, April 30, Stevens Point, Wis.
- Keeney, D.R. 1973. The nitrogen cycle in sediment-water systems. *J. Environ. Qual.*, 2:15-29.
- Khalid, R.A., W.H. Patrick, Jr., and R.D. Delaune. 1977. Phosphorus sorption characteristics of flooded soils. *Soil Sci. Soc. Amer. J.*, 41:305-310.
- Lalancette, J.M., and B. Coupal. 1972. Recovery of mercury from polluted water through peat treatment. In: *Fourth Int. Peat Congr. Proc.*, Ontaniemi, Finland, 4:213-217.
- Lance, J.C., and F.D. Whisler. 1972. Nitrogen balance in soil columns intermittently flooded with secondary sewage effluent. *J. Environ. Qual.*, 1:180-186.
- Larsen, J.E., G.F. Warren, and R. Langston. 1959. Effect of iron, aluminum and humic acid on phosphorus fixation by organic soils. *Soil Sci. Soc. Amer. Proc.*, 23:438-440.

- Larsen, J.E., R. Langston, and G.F. Warren. 1958. Studies on the leaching of applied labeled phosphorus in organic soils. *Soil Sci. Soc. Amer. Proc.*, 22:558-560.
- Lucas, R.E., and J.F. Davis. 1961. Relationship between pH values of organic soils and availabilities of 12 plant nutrients. *Soil Science*, 92:177-182.
- Mechenich, D.J. 1979. Soluble heavy metal complexing agents in an organic soil-water system. Unpublished report. University of Wisconsin, Stevens Point.
- Mortimer, C.H. 1941. The exchange of dissolved substances between mud and water in lakes. *J. of Ecology*, 29:280-329 and 30:147-201.
- Nicholls, K.H., and H.R. MacCrimmon. 1974. Nutrients in subsurface and runoff waters of the Holland Marsh, Ontario. *J. Environ. Qual.*, 3:31-34.
- Nute, J.W., and F. Demgen. 1979. The wetlands wastewater management alternative. In: *Conference Abstracts, Wetland Utilization for Management of Community Wastewater*. University of Michigan-Ann Arbor.
- Pakarinen, P., and K. Tolonen. 1977. Nutrient contents of sphagnum mosses in relation to bog water chemistry in northern Finland. *Lindbergia*, 4:27-33.
- Parrott, H.A., and D.H. Boelter. 1977. The use of peat filter beds for wastewater renovation at forest recreation areas. Paper presented at a Symposium on Municipal Wastewater and Sludge Recycling on Forest Land and Disturbed Land. Philadelphia, Penn.
- Patrick, W.H., Jr., and K.R. Reddy. 1976. Nitrification-denitrification reactions in flooded soils and water bottoms: dependence on oxygen supply and ammonium diffusion. *J. Environ. Qual.*, 5:469-472.
- Patrick, W.H., Jr., and M.E. Tusneem. 1972. Nitrogen loss from flooded soil. *Ecology*, 53:735-737.
- Patrick, W.H., Jr., and R.A. Khalid. 1974. Phosphate release and sorption by soils and sediments: effect of aerobic and anaerobic conditions. *Science*, 186:53-55.
- Patrick, W.H., Jr., R.D. Delaune, R.M. Engler, and S. Gotoh. 1976. Nitrate removal from water at the water-mud interface in wetlands. EPA-600/3-76-042 Ecological Research Series. 80pp.

- Peech, M. 1965. Exchange acidity. pp. 905-913. In: C.A. Black (ed.). Methods of Soil Analysis Part 2. American Society of Agronomy, Inc., Madison, Wis.
- Pereverzev, V.I., and N.S. Alekseyeva. 1965. Adsorption of phosphorus by the bog soils of Murmansk Oblast. Soviet Soil Science, 1317-1320.
- Pratt, P.F. 1965. Potassium. pp. 1022-1030. In: C.A. Black (ed.). Methods of Soil Analysis Part 2. American Society of Agronomy, Inc., Madison, Wis.
- Prentki, R.T., T.D. Gustafson, and M.S. Adams. 1978. Nutrient movements in lakeshore marshes. pp. 169-194. In: R.E. Good, D.F. Whigham, and R.L. Simpson (eds.). Freshwater Wetlands: Ecological Processes and Management Potential. Academic Press, New York, N.Y.
- Puustjarvi, V. 1956. On the cation exchange capacity of peats and on the factors of influence upon its formation. Agriculturae Scandinavia, 6:410-449.
- Puustjarvi, V. 1968. Cation exchange capacity in sphagnum mosses and its effect on nutrient and water absorption. Peat and Plant News, 1:54-58.
- Redfield, A.C. 1975. A piston corer for peat. Limn. and Ocean., 20:1042-1045.
- Ruel, M., S. Chornet, B. Coupal, P. Aitcin, and M. Cossette. 1977. Industrial utilization of peat moss. pp. 221-246. In: N.W. Radforth and C.O. Browner (eds.). Muskeg and the Northern Environment in Canada. U. of Toronto Press, Toronto.
- Ryan, T.A., Jr., B.L. Joiner, and B.F. Ryan. 1976. Minitab Student Handbook. Duxbury Press, Belmont, CA. 341pp.
- Schwintzer, C.R. 1978. Nutrient and water levels in a small Michigan bog with high tree mortality. The Amer. Mid. Nat., 100:441-451.
- Sillanpaa, M. 1972. Distribution of trace elements in peat profiles. In: Fourth Int. Peat Congr. Proc., Ontaniemi, Finland, 5:185-191.
- Silvo, O.E.J. 1972. Some experiments on purification of waste waters from slaughterhouses with sphagnum peat. In: Fourth Int. Peat Congr. Proc., Ontaniemi, Finland, 4:311-318.

- Sinha, M.K. 1971. Organo-metallic phosphates I. Interaction of phosphorus compounds with humic substances. *Plant and Soil*, 35:471-484.
- Small, M.M. 1979. Marsh/Pond sewage treatment plants II. In: Conference Abstracts, Wetland Utilization for Management of Community Wastewater. University of Michigan-Ann Arbor.
- Spangler, F.L., C.W. Fetter, and W.E. Sloey. 1977. Phosphorus accumulation-discharge cycles in marshes. *Water Resources Bull.*, 13:1191-1201.
- Standard Methods for the Examination of Water and Wastewater, 14th Edition. 1976. American Public Health Association, New York. 1193pp.
- Stanlick, H.T. 1976. Treatment of secondary effluent using a peat bed. pp. 257-268. In: D.L. Tilton, R.H. Kadlec, and C.J. Richardson (eds.). *Freshwater Wetlands and Sewage Effluent Disposal*. University of Michigan-Ann Arbor.
- Steward, K.K., and W.H. Ornes. 1975. Assessing a marsh environment for wastewater renovation. *Journal WPCF*, 47:1880-1891.
- Struthers, P.H., and D.H. Sieling. 1950. Effect of organic anions on phosphate precipitation by iron and aluminum as influenced by pH. *Soil Science*, 69:205-213.
- Surakka, S., and A. Kamppi. 1971. Infiltration of wastewater into peat soil. *Suo*, 22:51-58. (Finnish-English summary).
- Swenson, R.M., C.V. Cole, and D.H. Sieling. 1949. Fixation of phosphate by iron and aluminum and replacement by organic and inorganic ions. *Soil Science*, 67:3-22.
- Technicon. 1977. Nitrogen and Phosphorus Method 329-74 W/B revised 1977, and Nitrate and Nitrite Method 158-71 W/A revised 1977.
- Tilton, D.L., and R.H. Kadlec. 1979. The utilization of a fresh-water wetland for nutrient removal from secondarily treated waste water effluent. *J. Environ. Qual.*, 8:328-334.
- Turner, R.E., J.W. Day, Jr., M. Meo, P.M. Payonk, T.B. Ford, and W.G. Smith. 1976. Aspects of land-treated waste application in Louisiana wetlands. pp. 145-168. In: D.L. Tilton, R.H. Kadlec, and C.J. Richardson (eds.). *Freshwater Wetlands and Sewage Effluent Disposal*. University of Michigan-Ann Arbor.

- Tusneem, M.E., and W.H. Patrick, Jr. 1971. Nitrogen Transformations in Waterlogged Soil. Louisiana Agricultural Experiment Station, Bulletin No. 657.
- Verry, E.S. 1975. Streamflow chemistry and nutrient yields from upland-peatland watersheds in Minnesota. *Ecology*, 56:1149-1157.
- Verry, E.S. 1979. Plant nutrient retention in natural bogs and implications for sewage application. In: Conference Abstracts, Wetland Utilization for Management of Community Wastewater. University of Michigan-Ann Arbor.
- Walmsley, M.E. 1977. Physical and chemical properties of peat. pp. 82-129. In: N.W. Radforth and C.O. Browner (eds.). *Muskeg and the Northern Environment in Canada*. University of Toronto Press, Toronto.
- Werblan, D., A. van der Valk, C.B. Davis, and R.J. Smith. 1979. Artificial marshes as a means of treating wastes from a confined swine feeding unit. In: Conference Abstracts, Wetland Utilization for Management of Community Wastewater. University of Michigan-Ann Arbor.
- Whigham, D.R., and R.L. Simpson. 1976. Sewage spray irrigation in a Delaware River freshwater tidal marsh. pp. 119-144. In: D.L. Tilton, R.H. Kadlec, and C.J. Richardson (eds.). *Freshwater Wetlands and Sewage Effluent Disposal*. University of Michigan-Ann Arbor.
- Wondrausch, J. 1969. Phosphorus sorption in mucky-peat soils. *Polish J. of Soil Sci.*, 2:97-106.
- Yonika, D., and D. Lowry. 1979. Feasibility Study of Wetland Disposal of Wastewater Treatment Plant Effluent. Final Report to the Commonwealth of Massachusetts, Water Resources Commission, Division of Water Pollution Control. 134 pp.
- Young, H.L., and E.L. Skinner. 1974. Water Resources of Wisconsin-Lake Superior Basin. Hydrologic Investigations Atlas HA-524. US Geological Survey.

APPENDIX A

Water quality data for the Drummond treatment bog: the 0.4 meter well at site 01.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHD	ALK MG/L	TCA-HARD AS	CL <---	DO	DOO	DOO5	DOO20	ORTHO MG/L	T-P	NH4	NO23	KJLON --->I	F CCL /100ML	WATER TABLE CM	
77/12/29	77363	****	6.02	65.	****	****	****	6.7	****	147.	3.4	****	0.029	0.036	0.19	0.03	1.02	*****	****
78/ 2/12	78043	****	5.55	58.	****	****	****	1.3	****	123.	4.2	7.4	****	0.015	0.33	<0.02	1.30	*****	****
78/ 3/ 4	78063	****	5.55	64.	****	****	****	1.2	****	135.	4.2	****	0.016	0.080	0.35	<0.02	1.30	*****	****
78/ 3/20	78079	****	5.70	67.	****	****	****	<1.0	****	140.	4.6	****	0.022	0.050	0.25	<0.02	1.53	*****	****
78/ 4/ 2	78092	****	5.97	56.	****	****	****	<1.0	****	154.	2.7	****	0.026	0.046	0.23	<0.02	1.48	0.	****
78/ 4/17	78107	****	6.25	40.	****	****	****	1.2	****	112.	2.2	****	0.027	0.040	0.12	<0.02	2.24	*****	****
78/ 5/ 7	78127	6.0	6.00	47.	****	****	****	<1.0	****	81.	3.2	6.0	0.046	0.080	0.07	<0.02	1.12	*****	****
78/ 5/21	78141	****	7.01	33.	****	****	****	<1.0	****	102.	3.6	****	0.012	0.034	0.06	<0.02	1.20	*****	****
78/ 6/ 6	78157	****	6.41	76.	****	****	****	1.9	****	155.	3.7	****	0.033	0.060	0.14	<0.02	1.72	*****	****
78/ 7/ 4	78185	14.5	6.50	65.	****	****	****	<1.0	****	144.	2.1	****	0.031	0.046	0.05	<0.02	0.64	*****	****
78/ 7/17	78198	****	6.61	33.	****	****	****	<1.0	****	148.	1.8	****	0.066	0.076	<0.02	<0.02	1.52	*****	****
78/ 8/ 2	78214	15.8	6.34	106.	****	****	****	<1.0	****	155.	1.6	****	0.082	0.145	0.35	<0.02	1.92	*****	****
78/ 8/16	78228	****	6.31	116.	****	****	****	1.1	****	160.	2.7	****	0.036	0.095	****	<0.02	1.34	*****	****
78/ 9/ 3	78246	15.5	6.54	92.	****	****	****	<1.0	****	177.	1.5	****	0.047	0.092	0.22	<0.02	1.72	*****	****
78/ 9/18	78261	****	6.39	35.	****	****	****	<1.0	****	144.	1.2	****	0.045	0.070	0.38	<0.02	1.50	*****	****
78/10/15	78288	7.2	6.94	138.	****	****	****	<1.0	****	107.	1.1	2.5	0.030	0.044	0.37	<0.02	1.84	*****	****
78/11/12	78316	****	6.60	90.	****	****	****	1.2	****	131.	1.2	****	0.031	0.034	0.38	<0.02	1.50	*****	****
78/12/16	78350	0.5	6.22	38.	****	****	****	1.1	****	127.	2.8	****	****	0.040	0.53	<0.02	1.64	*****	****
79/ 3/ 3	79062	0.5	6.51	35.	****	****	****	1.1	****	113.	2.4	****	0.005	0.060	0.53	<0.02	1.66	*****	****
79/ 4/ 1	79091	****	6.65	69.	****	****	****	<1.0	****	****	1.4	****	0.002	0.015	0.16	<0.02	0.88	*****	****
79/ 4/21	79111	1.3	5.87	43.	****	****	****	<1.0	****	72.	1.4	****	0.006	0.040	0.16	<0.02	1.12	*****	****
79/ 5/ 7	79127	****	6.09	38.	****	****	****	<1.0	****	76.	4.0	****	0.002	0.030	0.16	<0.02	0.92	*****	****
79/ 5/19	79139	8.3	6.55	61.	****	****	****	<1.0	****	99.	1.4	2.6	0.007	0.028	<0.02	<0.02	0.78	*****	****
79/ 6/ 5	79156	****	6.85	71.	****	****	****	<1.0	****	101.	0.3	****	0.011	0.035	0.10	<0.02	1.20	*****	****
79/ 6/16	79167	14.7	6.12	47.	****	****	****	****	****	118.	****	****	0.020	0.020	0.02	<0.02	0.68	*****	****
79/ 7/ 2	79183	****	****	107.	****	****	****	1.1	****	110.	****	****	****	0.070	****	****	****	*****	****
79/ 7/16	79197	15.5	6.68	104.	****	****	****	5.3	****	95.	****	****	0.016	0.040	0.21	<0.02	1.08	*****	****
79/ 7/30	79211	****	6.93	133.	****	****	****	****	****	93.	0.9	****	0.004	0.020	0.16	<0.02	1.16	*****	****
79/ 8/11	79223	16.1	6.87	130.	****	****	****	16.5	0.0	79.	0.9	****	0.013	0.020	0.08	<0.02	0.96	*****	****
79/ 8/27	79239	****	6.97	125.	****	****	****	18.6	****	79.	0.9	****	0.006	0.020	0.16	<0.02	0.88	*****	****
79/ 9/ 8	79251	13.1	6.94	108.	****	****	****	24.8	****	75.	1.2	****	0.013	0.030	0.14	<0.02	1.00	*****	****
79/ 9/23	79266	****	7.23	178.	****	****	****	21.7	****	85.	0.9	****	0.019	0.040	0.10	<0.02	1.08	*****	****
79/10/ 6	79279	9.8	6.90	181.	****	****	****	18.9	****	74.	1.1	****	****	0.055	0.28	<0.02	1.32	*****	****
79/10/21	79294	****	7.12	140.	****	****	****	18.9	****	101.	1.4	****	0.016	0.030	0.30	<0.02	1.08	*****	****
79/11/ 3	79307	4.5	6.58	136.	****	****	****	20.0	****	71.	1.5	2.9	0.012	0.025	0.22	<0.02	0.84	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.4 meter well at site 11.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND U440	ALK MG/L AS	TACA-HARD AS	CL I<---	DO	CO2	BD05	BD20	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->I /100ML	F COL /100ML	WATER TABLE CM	
77/12/29	77363	****	5.93	136.	****	****	****	2.6	****	199.	16.1	****	0.009	0.060	0.25	0.04	1.36	*****	****
78/ 2/12	78043	****	5.66	68.	****	****	****	1.0	****	149.	10.4	15.0	****	0.085	0.34	<0.02	1.44	*****	****
78/ 3/ 4	78063	****	5.54	71.	****	****	****	<1.0	****	161.	7.6	****	0.018	0.090	0.40	<0.02	1.66	*****	****
78/ 3/20	78079	****	5.67	34.	****	****	****	<1.0	****	167.	6.8	****	0.026	0.035	0.29	<0.02	1.97	*****	****
78/ 4/ 2	78092	****	6.00	67.	****	****	****	<1.0	****	155.	3.0	****	0.019	0.042	0.29	<0.02	1.56	0.	****
78/ 4/17	78107	****	5.64	27.	****	****	****	<1.0	****	96.	2.8	****	0.063	0.080	0.02	<0.02	0.76	*****	****
78/ 5/ 7	78127	9.0	5.70	59.	****	****	****	<1.0	****	117.	6.3	9.8	0.015	0.044	0.01	<0.02	0.98	*****	****
78/ 5/21	78141	****	6.31	68.	****	****	****	<1.0	****	127.	5.0	****	0.013	0.024	<0.02	<0.02	1.18	*****	****
78/ 6/ 6	78157	****	6.06	65.	****	****	****	1.5	****	153.	1.2	****	0.041	0.067	0.05	0.03	1.36	*****	****
78/ 6/20	78171	****	7.22	76.	****	****	****	<1.0	****	146.	1.8	****	0.008	0.044	0.01	<0.02	0.11	*****	****
78/ 7/ 4	78185	10.8	6.36	100.	****	****	****	1.0	0.0	149.	1.7	****	0.037	0.063	0.01	<0.02	0.52	2.	****
78/ 7/17	78198	****	6.38	112.	****	****	****	<1.0	****	171.	1.5	****	0.016	0.064	<0.02	<0.02	1.56	*****	****
78/ 8/ 2	78214	16.8	6.45	143.	****	****	****	<1.0	0.0	175.	1.5	****	0.012	0.023	<0.02	<0.02	0.80	0.	****
78/ 8/16	78228	****	6.32	36.	****	****	****	<1.0	****	174.	3.6	****	0.012	0.062	****	<0.02	1.52	*****	****
78/ 9/ 3	78246	17.0	6.47	130.	****	****	****	<1.0	0.0	217.	4.7	****	0.016	0.066	<0.02	<0.02	1.56	0.	****
78/ 9/18	78261	****	6.21	126.	****	****	****	<1.0	****	160.	4.9	****	0.016	0.035	<0.02	<0.02	1.00	*****	****
78/10/15	78288	7.8	6.48	110.	****	****	****	<1.0	0.2	150.	1.2	3.0	0.020	0.040	<0.02	<0.02	1.60	0.	****
78/11/12	78316	****	6.61	130.	****	****	****	1.0	****	136.	1.2	****	0.014	0.024	<0.02	<0.02	0.92	*****	****
78/12/16	78350	1.4	5.94	31.	****	****	****	<1.0	****	129.	3.0	****	****	0.036	0.05	<0.02	1.04	*****	****
79/ 3/ 3	79052	0.7	6.55	119.	****	****	****	1.0	****	134.	3.3	****	0.012	0.050	0.20	<0.02	1.22	*****	****
79/ 4/ 1	79091	****	6.46	105.	****	****	****	<1.0	****	124.	3.8	****	0.011	0.040	0.03	<0.02	1.12	*****	****
79/ 4/21	79111	3.1	5.83	52.	****	****	****	<1.0	****	75.	2.0	****	0.006	0.040	0.13	<0.02	1.20	*****	****
79/ 5/ 7	79127	****	6.66	101.	****	****	****	<1.0	****	90.	1.4	****	0.008	0.035	0.10	<0.02	0.88	*****	****
79/ 5/19	79139	10.2	6.26	77.	****	****	****	<1.0	****	107.	3.1	4.9	0.019	0.120	0.02	<0.02	1.04	*****	****
79/ 6/ 5	79156	****	6.80	107.	****	****	****	<1.0	****	101.	0.7	****	0.010	0.035	0.03	<0.02	1.12	*****	****
79/ 6/16	79167	15.2	6.09	78.	****	****	****	****	****	123.	****	****	0.017	0.170	<0.02	<0.02	1.04	*****	****
79/ 7/ 2	79183	****	****	159.	****	****	****	4.7	****	89.	****	****	****	0.120	****	****	*****	****	****
79/ 7/16	79197	17.8	6.43	156.	****	****	****	13.4	****	92.	3.0	****	0.008	0.040	0.14	<0.02	1.20	*****	****
79/ 7/30	79211	****	6.27	225.	****	****	****	****	****	97.	0.6	****	0.003	0.030	0.02	<0.02	1.04	*****	****
79/ 8/11	79223	18.1	6.31	170.	****	****	****	24.7	0.0	87.	1.4	****	0.011	0.035	<0.02	<0.02	0.92	*****	****
79/ 8/27	79239	****	6.92	245.	****	****	****	33.0	****	94.	1.2	****	0.014	0.030	0.06	<0.02	0.80	*****	****
79/ 9/ 8	79251	14.2	6.01	190.	****	****	****	35.3	****	93.	1.3	****	0.012	0.040	<0.02	<0.02	0.92	*****	****
79/ 9/23	79266	****	6.35	272.	****	****	****	31.1	****	102.	1.0	****	0.020	0.030	<0.02	<0.02	0.80	*****	****
79/10/ 6	79279	10.5	6.53	235.	****	****	****	30.9	****	97.	1.0	****	****	0.030	0.04	<0.02	0.90	*****	****
79/10/21	79294	****	6.70	165.	****	****	****	30.5	****	95.	1.2	****	0.013	0.020	0.12	<0.02	1.00	*****	****
79/11/ 3	79307	5.3	6.31	178.	****	****	****	27.8	****	77.	1.4	2.7	0.009	0.025	0.02	<0.02	0.76	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.4 meter well at site 12.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHO	ALK MG/L	TRCA-HARD AS	CL I<---	OR	ODD	RODS	SO020	ORT40 MG/L	T-P	NH4	NO23	KULON --->I	F CUL /100ML	WATER TABLE CM	
78/ 2/12	78043	****	5.35	53.	****	****	****	2.0	****	131.	9.8	7.2	****	0.075	0.05	<0.02	2.52	*****	****
78/ 3/ 4	78063	****	4.24	43.	****	****	****	<1.0	****	135.	2.0	****	0.005	0.040	0.02	<0.02	1.04	*****	****
78/ 3/20	78079	****	4.99	47.	****	****	****	<1.0	****	150.	5.4	****	0.011	0.041	0.01	<0.02	1.28	*****	****
78/ 4/ 2	78092	****	5.62	44.	****	****	****	<1.0	****	154.	3.5	****	0.011	0.024	<0.02	<0.02	1.06	0.	****
78/ 4/17	78107	****	6.41	36.	****	****	****	<1.0	****	93.	9.7	****	0.059	0.150	0.25	<0.02	0.66	*****	****
78/ 5/ 7	78127	7.0	5.50	35.	****	****	****	<1.0	****	109.	2.9	5.4	0.026	0.038	0.05	<0.02	0.94	*****	****
78/ 5/21	78141	****	6.45	58.	****	****	****	<1.0	****	112.	6.1	****	0.006	0.034	0.13	<0.02	1.36	*****	****
78/ 6/ 6	78157	****	6.77	110.	****	****	****	1.2	****	127.	1.0	****	0.042	0.072	0.02	<0.02	1.54	*****	****
78/ 6/20	78171	****	7.27	96.	****	****	****	<1.0	****	113.	1.2	****	0.013	0.036	0.02	<0.02	0.96	*****	****
78/ 7/ 4	78185	15.0	6.40	94.	****	****	****	<1.0	****	133.	1.6	****	0.063	0.096	0.18	<0.02	0.76	0.	****
78/ 7/17	78198	****	6.39	96.	****	****	****	<1.0	****	171.	1.7	****	0.056	0.124	0.43	<0.02	2.32	*****	****
78/ 8/ 2	78214	16.1	6.53	141.	****	****	****	<1.0	****	156.	1.9	****	0.025	0.080	0.34	<0.02	1.60	*****	****
78/ 8/16	78228	****	6.63	150.	****	****	****	<1.0	****	138.	2.5	****	0.039	0.069	****	<0.02	1.52	*****	****
78/ 9/ 3	78246	16.7	6.60	129.	****	****	****	<1.0	****	170.	2.4	****	0.037	0.076	0.30	<0.02	1.84	*****	****
78/ 9/18	78261	****	6.59	126.	****	****	****	<1.0	****	147.	1.2	****	0.041	0.060	0.41	<0.02	1.50	*****	****
78/10/15	78288	7.2	6.85	161.	****	****	****	<1.0	0.2	122.	1.0	2.5	0.021	0.046	0.22	<0.02	1.60	0.	****
78/11/12	78316	****	6.54	83.	****	****	****	1.3	****	109.	1.7	****	0.016	0.020	0.13	<0.02	0.96	*****	****
78/12/16	78350	1.8	6.45	101.	****	****	****	1.1	****	107.	2.7	****	****	0.032	0.12	<0.02	0.92	*****	****
79/ 3/ 3	79062	0.3	6.85	132.	****	****	****	1.1	****	103.	2.3	****	0.013	0.050	0.15	<0.02	1.10	*****	****
79/ 4/ 1	79091	****	7.03	200.	****	****	****	<1.0	****	91.	0.7	****	0.011	0.025	0.18	<0.02	0.88	*****	****
79/ 4/21	79111	2.9	6.01	57.	****	****	****	1.4	****	77.	1.6	****	0.014	0.035	0.15	<0.02	0.92	*****	****
79/ 5/ 7	79127	****	6.46	87.	****	****	****	<1.0	****	90.	1.2	****	0.010	0.045	0.08	<0.02	1.04	*****	****
79/ 5/19	79139	9.0	6.54	104.	****	****	****	<1.0	0.0	104.	1.4	2.3	0.019	0.050	0.12	<0.02	0.98	*****	****
79/ 6/ 5	79156	****	6.95	106.	****	****	****	1.0	****	95.	0.8	****	0.015	0.080	0.10	<0.02	1.44	*****	****
79/ 6/16	79167	13.2	6.56	131.	****	****	****	****	****	108.	****	****	0.023	0.030	0.04	<0.02	0.88	*****	****
79/ 7/ 2	79183	****	****	141.	****	****	****	<1.0	****	94.	****	****	****	0.040	****	****	****	*****	****
79/ 7/16	79197	15.9	6.68	153.	****	****	****	1.6	****	107.	1.9	****	0.021	0.050	0.09	<0.02	1.08	*****	****
79/ 7/30	79211	****	7.03	205.	****	****	****	****	****	97.	0.7	****	0.005	0.045	<0.02	<0.02	1.08	*****	****
79/ 8/11	79223	15.6	6.87	150.	****	****	****	5.6	0.0	96.	0.6	****	0.022	0.040	<0.02	<0.02	1.17	*****	****
79/ 8/27	79239	****	6.95	153.	****	****	****	12.1	****	81.	0.7	****	0.013	0.030	<0.02	<0.02	0.90	*****	****
79/ 9/ 8	79251	13.4	6.49	175.	****	****	****	19.0	****	83.	0.9	****	0.022	0.030	<0.02	<0.02	0.76	*****	****
79/ 9/23	79266	****	7.04	220.	****	****	****	16.9	****	83.	0.7	****	0.021	0.030	<0.02	<0.02	0.64	*****	****
79/10/ 6	79279	9.5	6.78	199.	****	****	****	18.1	****	74.	0.7	****	****	0.030	0.04	<0.02	0.84	*****	****
79/10/21	79294	****	6.92	163.	****	****	****	21.9	****	72.	0.7	****	0.008	0.020	<0.02	<0.02	0.68	*****	****
79/11/ 3	79307	4.8	6.52	178.	****	****	****	25.1	****	57.	0.8	1.7	0.013	0.020	0.04	<0.02	0.68	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.4 meter well at site 13.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHO	ALK MG/L	TCA-AS	HARD CA003	CL I<---	DO	ODD	NO05	NO020	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->I	F CGL /100ML	WATER TABLE CM
78/ 3/ 4	78063	****	4.38	63.	****	****	****	1.8	****	208.	****	****	0.148	0.200	1.02	<0.02	2.92	*****	****
78/ 4/ 2	78092	****	5.23	26.	****	****	****	1.9	****	73.	10.4	****	0.056	0.143	0.09	<0.02	0.50	0.	****
78/ 4/17	78107	****	5.70	38.	****	****	****	<1.0	****	102.	6.7	****	0.136	0.270	0.02	<0.02	0.30	*****	****
78/ 5/ 7	78127	****	6.0	5.60	41.	****	****	1.0	****	105.	2.4	4.3	0.015	0.046	0.13	<0.02	1.06	*****	****
78/ 5/21	78141	****	6.10	40.	****	****	****	<1.0	****	117.	1.6	****	0.008	0.034	0.06	<0.02	1.44	*****	****
78/ 6/ 6	78157	****	5.88	42.	****	****	****	1.2	****	136.	3.1	****	0.021	0.052	0.13	0.02	1.48	*****	****
78/ 6/20	78171	****	6.16	39.	****	****	****	<1.0	****	149.	1.7	****	0.046	0.064	0.18	<0.02	1.32	*****	****
78/ 7/ 4	78185	****	13.8	5.77	46.	****	****	1.2	****	150.	1.6	****	0.037	0.063	0.64	<0.02	1.76	0.	****
78/ 7/17	78198	****	6.39	69.	****	****	****	<1.0	****	173.	1.8	****	0.072	0.120	0.39	<0.02	2.28	*****	****
78/ 8/ 2	78214	****	15.1	6.21	94.	****	****	1.0	****	169.	1.6	****	0.057	0.132	0.54	<0.02	2.20	*****	****
78/ 8/16	78228	****	6.15	93.	****	****	****	1.2	****	175.	3.3	****	0.061	0.140	****	<0.02	2.54	*****	****
78/ 9/ 3	78246	****	15.2	6.45	105.	****	****	<1.0	****	182.	1.5	****	0.057	0.128	0.60	<0.02	2.28	*****	****
78/ 9/18	78261	****	6.50	132.	****	****	****	1.0	****	163.	1.4	****	0.073	0.110	0.69	<0.02	2.00	*****	****
78/10/15	78288	****	7.3	6.90	132.	****	****	1.1	0.3	155.	1.5	3.2	0.053	0.083	0.80	<0.02	2.44	0.	****
78/11/12	78316	****	6.16	133.	****	****	****	1.4	****	136.	1.3	****	0.031	0.046	0.68	<0.02	1.82	*****	****
78/12/16	78350	****	1.7	6.12	136.	****	****	1.1	****	138.	3.2	****	****	0.038	0.84	<0.02	2.40	*****	****
79/ 3/ 3	79062	****	0.5	6.52	128.	****	****	<1.0	****	132.	3.9	****	0.031	0.070	1.10	<0.02	2.34	*****	****
79/ 4/ 1	79091	****	6.24	92.	****	****	****	<1.0	****	120.	2.8	****	0.027	0.075	0.94	<0.02	1.92	*****	****
79/ 4/21	79111	****	1.8	5.57	99.	****	****	<1.0	****	109.	2.6	****	0.047	0.065	1.03	<0.02	2.32	*****	****
79/ 5/ 7	79127	****	6.43	56.	****	****	****	<1.0	****	84.	1.3	****	0.008	0.045	0.16	<0.02	0.88	*****	****
79/ 5/19	79139	****	9.8	6.36	51.	****	****	<1.0	0.0	100.	1.2	2.6	0.011	0.035	0.11	<0.02	0.90	*****	****
79/ 6/ 5	79156	****	6.84	78.	****	****	****	1.0	****	105.	1.0	****	0.010	0.040	0.38	<0.02	1.56	*****	****
79/ 6/16	79167	****	11.7	6.41	69.	****	****	****	****	124.	****	****	0.021	0.022	0.22	<0.02	1.00	*****	****
79/ 7/ 2	79183	****	****	111.	****	****	****	<1.0	****	110.	****	****	****	0.050	****	****	*****	****	****
79/ 7/16	79197	****	14.0	6.66	106.	****	****	6.0	****	98.	2.0	****	0.031	0.050	0.43	<0.02	1.36	*****	****
79/ 7/30	79211	****	6.89	135.	****	****	****	****	****	39.	0.9	****	0.011	0.035	0.34	<0.02	1.40	*****	****
79/ 8/11	79223	****	15.6	6.86	120.	****	****	11.3	0.0	85.	1.0	****	0.026	0.040	0.44	<0.02	1.12	*****	****
79/ 8/27	79239	****	6.93	132.	****	****	****	19.4	****	74.	0.8	****	0.018	0.030	0.36	<0.02	1.08	*****	****
79/ 9/ 8	79251	****	12.9	6.93	137.	****	****	28.9	****	75.	0.8	****	0.029	0.040	0.51	<0.02	1.24	*****	****
79/ 9/23	79266	****	7.17	230.	****	****	****	25.0	****	68.	0.7	****	0.013	0.030	0.44	<0.02	1.12	*****	****
79/10/ 6	79279	****	9.8	6.95	194.	****	****	25.3	****	65.	0.6	****	****	0.025	0.56	<0.02	1.30	*****	****
79/10/21	79294	****	6.98	141.	****	****	****	24.3	****	79.	0.7	****	0.012	0.020	0.56	<0.02	1.28	*****	****
79/11/ 3	79307	****	5.0	6.63	109.	****	****	28.9	****	53.	0.9	1.8	0.018	0.020	0.48	<0.02	1.00	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.4 meter well at site 14.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMH0	ALK MG/L	TRCA-HARD AS	CL CAC03	DO I----	DO	DO0	DO05	DO020	DRTH0 MG/L	T-P	NH4	NO23	KJLDN --->I	F COL /100ML	WATER TABLE CM
78/ 3/20	78079	****	4.54	44.	****	****	****	<1.0	****	166.	3.1	****	0.017	0.035	0.15	<0.02	1.59	*****	****
78/ 4/ 2	78092	****	4.65	34.	****	****	****	<1.0	****	127.	1.0	****	0.016	0.050	0.16	<0.02	0.98	0.	****
78/ 4/17	78107	****	4.42	35.	****	****	****	<1.0	****	102.	1.5	****	0.015	0.015	0.02	<0.02	0.50	*****	****
78/ 5/ 7	78127	6.0	5.70	41.	****	****	****	<1.0	****	99.	1.8	3.7	0.032	0.042	0.10	<0.02	1.40	*****	****
78/ 5/21	78141	****	5.16	29.	****	****	****	<1.0	****	126.	1.3	****	0.018	0.054	0.06	<0.02	1.74	*****	****
78/ 6/20	78171	****	5.93	32.	****	****	****	<1.0	****	154.	1.6	****	0.036	0.044	0.05	<0.02	1.20	*****	****
78/ 7/ 4	78185	14.5	6.05	50.	****	****	****	1.0	****	155.	1.7	****	0.025	0.056	0.14	<0.02	0.76	0.	****
78/ 7/17	78198	****	5.85	47.	****	****	****	<1.0	****	185.	1.7	****	0.040	0.068	0.11	<0.02	1.68	*****	****
78/ 8/ 2	78214	15.8	5.63	49.	****	****	****	<1.0	0.0	175.	1.9	****	0.040	0.030	0.21	<0.02	1.60	0.	****
78/ 8/16	78228	****	6.16	73.	****	****	****	<1.0	****	152.	3.5	****	0.032	0.082	****	<0.02	1.92	*****	****
78/ 9/ 3	78246	15.3	6.50	76.	****	****	****	<1.0	0.0	198.	1.7	****	0.023	0.054	0.07	<0.02	1.46	*****	****
78/ 9/18	78261	****	6.39	64.	****	****	****	1.7	****	163.	1.5	****	0.033	0.050	0.14	<0.02	1.40	*****	****
78/10/15	78288	7.2	6.77	36.	****	****	****	<1.0	0.4	162.	1.5	3.1	0.028	0.044	0.26	<0.02	1.74	0.	****
78/11/12	78316	****	6.12	56.	****	****	****	1.3	****	139.	1.4	****	0.020	0.030	0.19	<0.02	1.22	*****	****
78/12/16	78350	1.2	5.92	47.	****	****	****	<1.0	****	136.	2.2	****	****	0.044	0.25	<0.02	1.36	*****	****
79/ 3/ 3	79062	0.9	6.21	68.	****	****	****	<1.0	****	144.	2.6	****	0.014	0.040	0.32	<0.02	1.30	*****	****
79/ 4/ 1	79091	****	6.46	82.	****	****	****	<1.0	****	113.	1.3	****	0.009	0.020	0.22	<0.02	1.04	*****	****
79/ 4/21	79111	1.2	5.70	51.	****	****	****	<1.0	****	95.	1.3	****	0.012	0.035	0.23	<0.02	1.20	*****	****
79/ 5/ 7	79127	****	6.43	51.	****	****	****	<1.0	****	78.	2.3	****	0.009	0.155	0.10	<0.02	0.96	*****	****
79/ 5/19	79139	9.0	6.12	46.	****	****	****	<1.0	****	109.	1.2	2.6	0.011	0.043	0.04	<0.02	0.94	*****	****
79/ 6/ 5	79156	****	6.47	51.	****	****	****	<1.0	****	106.	0.9	****	0.010	0.011	0.43	<0.02	1.04	*****	****
79/ 6/16	79167	13.1	6.05	42.	****	****	****	****	****	134.	****	****	0.029	0.070	0.04	<0.02	1.12	*****	****
79/ 7/ 2	79183	****	****	37.	****	****	****	<1.0	****	136.	****	****	****	0.050	****	****	****	*****	****
79/ 7/16	79197	14.7	6.49	32.	****	****	****	1.0	****	152.	2.4	****	0.038	0.065	0.22	<0.02	1.20	*****	****
79/ 7/30	79211	****	6.61	102.	****	****	****	****	****	157.	1.5	****	0.013	0.035	0.02	<0.02	1.32	*****	****
79/ 8/11	79223	15.1	6.52	36.	****	****	****	1.2	0.0	163.	2.0	****	0.040	0.060	0.06	<0.02	1.32	*****	****
79/ 8/27	79239	****	6.38	79.	****	****	****	3.5	****	132.	1.6	****	0.021	0.050	<0.02	<0.02	1.00	*****	****
79/ 9/ 8	79251	13.1	6.13	32.	****	****	****	7.2	****	127.	1.6	****	0.041	0.050	0.18	<0.02	1.04	*****	****
79/ 9/23	79266	****	6.45	81.	****	****	****	7.2	****	117.	1.7	****	0.022	0.030	0.10	<0.02	1.00	*****	****
79/10/ 6	79279	9.9	6.48	95.	****	****	****	7.6	****	109.	1.6	****	****	0.040	0.14	<0.02	1.10	*****	****
79/10/21	79294	****	6.97	108.	****	****	****	9.0	****	125.	1.3	****	0.007	0.015	0.22	<0.02	1.08	*****	****
79/11/ 3	79307	5.3	6.31	96.	****	****	****	14.0	****	71.	1.3	2.6	0.012	0.025	0.14	<0.02	0.76	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.4 meter well at site 21.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND U/100	ALK MG/L AS	T&C-HARD AS	CL K---	DO	CO <sub>2</sub>	NO <sub>3</sub>	NO <sub>2</sub>	ORTHO MG/L	T-P	NH <sub>4</sub>	PO <sub>4</sub> P	KJLON --->1	F COL /100ML	WATER TABLE CM	
77/11/18	77322	****	5.51	101.	****	****	****	2.2	0.2	****	11.7	****	0.011	0.219	0.22	0.03	2.72	*****	****
77/12/29	77363	****	5.35	119.	****	****	****	3.4	****	181.	3.9	****	0.034	0.090	0.43	0.04	1.36	*****	****
78/ 2/12	78043	****	5.65	104.	****	****	****	6.4	****	145.	5.9	11.0	****	0.100	0.41	<0.02	1.80	*****	****
78/ 3/ 4	78063	0.0	5.34	92.	****	****	****	1.6	****	157.	3.5	****	0.023	0.150	0.39	<0.02	2.04	*****	****
78/ 3/20	78079	****	5.59	94.	****	****	****	1.0	****	154.	3.6	****	0.009	0.041	0.29	<0.02	1.83	*****	****
78/ 4/ 2	78092	****	5.89	73.	****	****	****	1.2	****	188.	2.1	****	0.015	0.042	0.25	<0.02	1.78	0.	****
78/ 4/17	78107	****	6.46	92.	****	****	****	1.4	****	152.	2.2	****	0.017	0.046	0.15	<0.02	2.52	*****	****
78/ 5/ 7	78127	****	5.60	90.	****	****	****	1.6	****	128.	4.8	7.9	0.040	0.064	0.38	<0.02	1.86	*****	****
78/ 5/21	78141	****	7.03	150.	****	****	****	1.0	****	119.	1.0	****	0.006	0.030	0.26	<0.02	1.74	*****	****
78/ 6/ 6	78157	****	6.02	128.	****	****	****	1.2	****	171.	1.2	****	0.024	0.098	0.35	<0.02	2.50	*****	****
78/ 6/20	78171	****	7.13	148.	****	****	****	1.1	****	168.	1.2	****	0.008	0.044	0.33	<0.02	1.80	*****	****
78/ 7/ 4	78195	14.5	6.05	157.	****	****	****	1.1	****	95.	1.4	****	0.012	0.072	0.30	<0.02	1.36	*****	****
78/ 7/17	78198	****	6.50	159.	****	****	****	<1.0	****	189.	0.9	****	0.030	0.084	0.29	<0.02	2.32	*****	****
78/ 8/ 2	78214	15.0	6.22	165.	****	****	****	1.3	****	185.	2.0	****	0.018	0.096	0.44	<0.02	2.44	0.	****
78/ 8/16	78228	****	6.05	137.	****	****	****	1.0	****	199.	4.1	****	0.045	0.105	****	<0.02	2.54	*****	****
78/ 9/ 3	78246	14.5	6.48	207.	****	****	****	<1.0	****	202.	1.4	****	0.021	0.074	0.33	<0.02	2.16	*****	****
78/ 9/18	78261	****	6.63	209.	****	****	****	1.4	****	194.	0.9	****	0.025	0.050	0.32	<0.02	2.04	*****	****
78/10/15	78288	7.9	6.60	204.	****	****	****	2.0	0.0	181.	1.8	3.7	0.039	0.070	0.54	<0.02	2.34	*****	****
78/11/12	78316	****	6.83	225.	****	****	****	1.5	****	156.	0.7	****	0.011	0.030	0.24	<0.02	1.62	*****	****
78/12/16	78350	2.0	6.19	161.	****	****	****	1.3	****	165.	4.6	****	****	0.124	0.57	<0.02	2.16	*****	****
79/ 2/12	79043	****	6.52	275.	****	****	****	1.3	****	164.	1.4	****	0.031	0.052	0.16	<0.02	2.00	*****	****
79/ 3/ 3	79062	1.2	6.29	170.	****	****	****	1.5	****	172.	5.9	****	0.037	0.090	0.71	<0.02	1.98	*****	****
79/ 4/ 1	79091	****	6.38	146.	****	****	****	<1.0	****	161.	4.9	****	0.037	0.115	0.63	<0.02	1.96	*****	****
79/ 4/21	79111	1.3	5.73	95.	****	****	****	<1.0	****	142.	2.0	****	0.046	0.055	0.80	<0.02	1.92	*****	****
79/ 5/ 7	79127	****	6.33	167.	****	****	****	<1.0	****	149.	2.9	****	0.026	0.070	0.48	<0.02	1.80	*****	****
79/ 5/19	79139	7.8	6.02	144.	****	****	****	<1.0	****	165.	2.1	3.9	0.036	0.090	0.66	<0.02	2.04	*****	****
79/ 6/ 5	79156	****	6.57	120.	****	****	****	1.3	****	148.	1.0	****	0.038	0.060	0.78	<0.02	2.20	*****	****
79/ 6/16	79157	12.1	6.05	154.	****	****	****	****	****	187.	****	****	0.058	0.170	0.70	<0.02	2.36	*****	****
79/ 7/ 2	79183	****	****	159.	****	****	****	<1.0	****	162.	****	****	****	0.100	****	****	****	*****	****
79/ 7/16	79197	13.1	6.49	200.	****	****	****	<1.0	****	191.	2.1	****	0.070	0.110	0.87	<0.02	2.40	*****	****
79/ 7/30	79211	****	6.50	196.	****	****	****	****	****	182.	1.2	****	0.028	0.070	0.62	<0.02	2.64	*****	****
79/ 8/11	79223	14.7	6.46	170.	****	****	****	<1.0	****	204.	2.6	****	0.061	0.090	0.72	<0.02	2.44	*****	****
79/ 8/27	79239	****	6.27	110.	****	****	****	1.4	****	176.	1.6	****	0.047	0.090	0.66	<0.02	2.12	*****	****
79/ 9/ 8	79251	12.8	6.23	170.	****	****	****	2.2	****	187.	1.6	****	0.063	0.080	0.76	<0.02	2.16	*****	****
79/ 9/23	79266	****	6.52	177.	****	****	****	2.1	****	183.	1.7	****	0.057	0.080	0.68	<0.02	2.24	*****	****
79/10/ 6	79279	10.1	6.36	174.	****	****	****	2.7	****	156.	1.5	****	****	0.080	0.72	<0.02	2.24	*****	****
79/10/21	79294	****	6.44	155.	****	****	****	3.7	****	202.	1.4	****	0.027	0.040	0.78	<0.02	2.24	*****	****
79/11/ 3	79307	5.3	6.07	165.	****	****	****	5.0	****	137.	1.6	3.0	0.039	0.045	0.68	<0.02	1.72	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.4 meter well at site 22.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND U140	ALK MG/L	T&CA-HARD AS CaCO3	CL I<---	DO	000	3005	80020	ORT40 MG/L	T-P	NH4	NO23	KJLDN --->I	F COL /100ML	WATER TABLE CM		
77/11/18	77322	4.0	4.47	48.	****	****	****	<1.0	0.5	****	7.8	****	0.035	0.395	0.03	0.01	1.92	*****	****	
77/12/29	77363	2.0	5.40	99.	****	****	****	2.9	****	203.	15.5	****	0.108	0.166	0.03	0.03	1.25	*****	****	
78/ 2/12	78043	****	5.06	51.	****	****	****	1.1	****	142.	7.4	13.9	****	0.135	<0.02	<0.02	1.10	*****	****	
78/ 3/ 4	78063	****	5.01	52.	****	****	****	<1.0	****	135.	4.3	****	0.024	0.150	0.01	<0.02	1.02	*****	****	
78/ 3/20	78079	****	5.02	51.	****	****	****	<1.0	****	152.	5.2	****	0.043	0.076	<0.02	<0.02	0.91	*****	****	
78/ 4/ 2	78092	****	5.70	58.	****	****	****	<1.0	****	154.	3.2	****	0.029	0.071	<0.02	<0.02	0.96	0.	****	
78/ 5/ 7	78127	8.0	5.80	61.	****	****	****	1.1	****	109.	5.4	8.3	****	0.013	0.034	<0.02	<0.02	0.82	*****	****
78/ 5/21	78141	****	5.99	77.	****	****	****	<1.0	****	120.	3.8	****	0.009	0.038	0.01	<0.02	1.10	*****	****	
78/ 6/ 6	78157	****	5.84	35.	****	****	****	1.4	****	141.	1.8	****	0.027	0.080	0.02	<0.02	1.68	*****	****	
78/ 6/20	78171	****	6.97	66.	****	****	****	1.1	****	155.	1.9	****	0.020	0.056	<0.02	<0.02	1.08	*****	****	
78/ 7/ 4	78185	11.4	5.94	109.	****	****	****	1.2	0.0	164.	7.1	****	0.040	0.075	<0.02	<0.02	0.68	2.	****	
78/ 7/17	78198	****	6.16	110.	****	****	****	<1.0	****	170.	1.7	****	0.067	0.152	<0.02	<0.02	1.60	*****	****	
78/ 8/ 2	78214	18.0	5.89	112.	****	****	****	1.1	****	191.	2.0	****	0.028	0.132	<0.02	<0.02	1.24	*****	****	
78/ 8/16	78223	****	6.02	121.	****	****	****	1.0	****	139.	2.0	****	0.061	0.129	****	<0.02	1.56	*****	****	
78/ 9/ 3	78246	17.5	6.24	149.	****	****	****	1.0	****	183.	1.9	****	0.076	0.168	<0.02	<0.02	2.04	0.	****	
78/ 9/13	78261	****	6.17	136.	****	****	****	<1.0	****	175.	1.5	****	0.118	0.170	<0.02	<0.02	1.42	*****	****	
78/10/15	78268	8.0	6.19	136.	****	****	****	<1.0	0.0	173.	1.8	3.7	0.143	0.194	<0.02	<0.02	1.40	0.	****	
78/11/12	78316	****	6.85	222.	****	****	****	1.4	****	156.	0.7	****	0.039	0.070	0.05	<0.02	1.02	*****	****	
78/12/16	78350	0.4	5.43	30.	****	****	****	1.0	****	147.	3.0	****	****	0.108	0.01	<0.02	1.12	*****	****	
79/ 3/ 3	79062	0.3	5.96	120.	****	****	****	<1.0	****	157.	4.4	****	0.079	0.140	0.01	<0.02	1.10	*****	****	
79/ 4/ 1	79091	****	6.03	109.	****	****	****	<1.0	****	149.	5.5	****	0.161	0.225	0.02	<0.02	1.08	*****	****	
79/ 4/21	79111	3.1	5.55	53.	****	****	****	<1.0	****	92.	5.5	****	0.135	0.155	0.03	<0.02	2.32	*****	****	
79/ 5/ 7	79127	****	5.99	32.	****	****	****	<1.0	****	120.	3.4	****	0.144	0.205	0.02	<0.02	0.80	*****	****	
79/ 5/19	79139	10.0	5.83	94.	****	****	****	<1.0	****	145.	3.4	5.7	0.114	0.208	<0.02	<0.02	1.10	*****	****	
79/ 6/ 5	79156	****	5.40	46.	****	****	****	1.4	****	164.	1.7	****	0.263	****	0.12	<0.02	2.60	*****	****	
79/ 6/16	79167	13.4	4.96	56.	****	****	****	****	****	173.	****	****	0.188	0.450	<0.02	<0.02	1.56	*****	****	
79/ 7/ 2	79183	****	****	96.	****	****	****	2.2	****	151.	****	****	****	0.240	****	****	*****	*****	****	
79/ 7/16	79197	16.3	5.72	94.	****	****	****	7.2	****	137.	2.2	****	0.159	0.160	<0.02	<0.02	1.16	*****	****	
79/ 7/30	79211	****	5.81	125.	****	****	****	****	****	135.	1.3	****	0.104	0.200	<0.02	<0.02	1.68	*****	****	
79/ 8/11	79223	16.6	5.91	140.	****	****	****	19.0	0.0	114.	1.6	****	0.138	0.170	<0.02	<0.02	0.96	*****	****	
79/ 8/27	79239	****	6.02	160.	****	****	****	28.5	****	104.	1.5	****	0.106	0.140	<0.02	<0.02	0.76	*****	****	
79/ 9/ 8	79251	13.4	5.32	175.	****	****	****	32.0	****	103.	2.7	****	0.131	0.240	<0.02	<0.02	1.16	*****	****	
79/ 9/23	79266	****	6.25	220.	****	****	****	28.5	****	108.	1.5	****	0.092	0.150	<0.02	<0.02	1.04	*****	****	
79/10/ 6	79279	9.9	6.90	210.	****	****	****	28.7	****	90.	1.6	****	****	0.100	<0.02	<0.02	0.98	*****	****	
79/10/21	79294	****	6.33	220.	****	****	****	30.9	****	109.	3.7	****	0.016	0.050	<0.02	<0.02	1.08	*****	****	
79/11/ 3	79307	4.9	5.74	200.	****	****	****	33.3	****	76.	2.1	3.5	0.034	0.060	<0.02	<0.02	0.88	*****	****	

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.4 meter well at site 23.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMH	ALK MG/L	T&CA-HARD AS	CL	DO	CO2	BO05	BO020	ORT40 MG/L	T-P	NH4	NO23	KJLGN --->I	F CUL /100HL	WATER TABLE CM	
77/12/29	77363	****	6.07	80.	****	****	****	3.0	****	153.	5.7	****	0.020	0.128	0.24	0.04	0.61	*****	****
78/ 3/ 4	78063	0.0	5.88	83.	****	****	****	<1.0	****	134.	4.4	****	0.020	0.090	0.11	<0.02	2.90	*****	****
78/ 3/20	78079	****	6.04	100.	****	****	****	<1.0	****	137.	3.2	****	0.024	0.073	0.10	<0.02	1.25	*****	****
78/ 4/ 2	78092	****	5.81	57.	****	****	****	<1.0	****	144.	2.8	****	0.023	0.076	0.05	<0.02	1.34	0.	****
78/ 4/17	78107	****	6.71	88.	****	****	****	1.0	****	138.	1.6	****	0.009	0.045	0.03	<0.02	1.18	*****	****
78/ 5/ 7	78127	3.0	5.10	36.	****	****	****	<1.0	****	99.	2.6	5.0	0.060	0.030	0.26	<0.02	1.38	*****	****
78/ 5/21	78141	****	6.99	59.	****	****	****	<1.0	****	115.	1.5	****	0.009	0.024	0.07	<0.02	1.30	*****	****
78/ 6/ 6	78157	****	6.43	60.	****	****	****	1.0	****	131.	1.7	****	0.022	0.077	0.04	<0.02	1.70	*****	****
78/ 6/20	78171	****	7.23	82.	****	****	****	<1.0	****	154.	1.7	****	0.014	0.044	0.11	<0.02	1.32	*****	****
78/ 7/ 4	78185	14.7	6.33	72.	****	****	****	1.7	****	164.	2.6	****	0.020	0.144	0.24	<0.02	1.04	*****	****
78/ 7/17	78198	****	6.37	71.	****	****	****	<1.0	****	140.	1.6	****	0.041	0.100	0.22	<0.02	2.00	*****	****
78/ 8/ 2	78214	16.1	6.40	104.	****	****	****	1.0	****	177.	1.8	****	0.014	0.080	0.14	<0.02	1.80	*****	****
78/ 8/16	78228	****	6.45	125.	****	****	****	<1.0	****	185.	2.6	****	0.032	0.085	****	<0.02	1.56	*****	****
78/ 9/ 3	78246	15.8	6.79	142.	****	****	****	<1.0	****	185.	1.3	****	0.028	0.078	0.21	<0.02	1.84	*****	****
78/ 9/18	78261	****	6.75	156.	****	****	****	<1.0	****	181.	1.5	****	0.040	0.070	0.25	<0.02	1.78	*****	****
78/10/15	78288	7.5	6.77	160.	****	****	****	2.6	0.3	147.	1.4	2.8	0.024	0.054	0.27	<0.02	1.92	0.	****
78/11/12	78316	****	6.43	103.	****	****	****	1.4	****	150.	1.5	****	0.025	0.050	0.20	<0.02	1.40	*****	****
78/12/16	78350	1.4	5.98	86.	****	****	****	<1.0	****	141.	2.7	****	****	0.060	0.30	<0.02	1.56	*****	****
79/ 3/ 3	79062	0.3	6.39	117.	****	****	****	<1.0	****	141.	2.0	****	0.018	0.110	0.18	<0.02	1.22	*****	****
79/ 4/ 1	79091	****	5.63	147.	****	****	****	<1.0	****	133.	1.6	****	0.015	0.055	0.22	<0.02	1.32	*****	****
79/ 4/21	79111	1.1	5.83	86.	****	****	****	<1.0	****	137.	2.9	****	0.016	0.045	0.23	<0.02	1.52	*****	****
79/ 5/ 7	79127	****	6.51	58.	****	****	****	<1.0	****	88.	1.5	****	0.007	0.030	0.16	<0.02	1.00	*****	****
79/ 5/19	79139	7.1	6.28	50.	****	****	****	<1.0	0.0	94.	1.2	2.6	0.022	0.030	<0.02	<0.02	0.76	*****	****
79/ 6/ 5	79156	****	6.75	80.	****	****	****	<1.0	****	111.	1.0	****	0.016	0.090	0.04	<0.02	1.04	*****	****
79/ 6/16	79167	10.1	6.42	81.	****	****	****	****	****	134.	****	****	0.020	0.040	<0.02	<0.02	0.90	*****	****
79/ 7/ 2	79183	****	****	92.	****	****	****	6.3	****	101.	****	****	****	0.050	****	****	*****	*****	****
79/ 7/16	79197	13.8	6.76	133.	****	****	****	16.6	****	31.	1.6	****	0.016	0.040	0.06	<0.02	0.72	*****	****
79/ 7/30	79211	****	6.84	174.	****	****	****	****	****	99.	0.9	****	0.004	0.040	0.08	<0.02	1.24	*****	****
79/ 8/11	79223	14.8	6.75	150.	****	****	****	28.0	****	71.	0.8	****	0.006	0.035	<0.02	<0.02	0.72	*****	****
79/ 8/27	79239	****	6.79	150.	****	****	****	39.4	****	64.	0.8	****	0.013	0.040	<0.02	<0.02	0.72	*****	****
79/ 9/ 8	79251	12.4	6.85	204.	****	****	****	40.7	****	64.	0.7	****	0.014	0.040	<0.02	<0.02	0.84	*****	****
79/ 9/23	79266	****	7.08	210.	****	****	****	37.0	****	75.	0.8	****	0.009	0.050	<0.02	<0.02	0.92	*****	****
79/10/ 6	79279	9.7	6.99	198.	****	****	****	35.3	****	65.	0.7	****	****	0.040	<0.02	<0.02	0.88	*****	****
79/10/21	79294	****	6.31	136.	****	****	****	37.6	****	89.	0.6	****	0.005	0.030	0.16	<0.02	1.12	*****	****
79/11/ 3	79307	5.2	6.66	184.	****	****	****	37.7	****	54.	0.7	1.5	0.006	0.030	<0.02	<0.02	0.76	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.4 meter well at site 31.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHD	ALK MG/L	T&CA-HARD AS CaCO3	CL I<---	DO	DOO	BOO5	BOO20	GRTHO MG/L	T-P	NH4	NO23	KJLDN --->I	F COL /100ML	WATER TABLE CM	
78/ 3/20	78079	****	4.31	54.	****	****	****	<1.0	****	209.	1.0	****	0.027	0.069	0.64	<0.02	2.04	*****	****
78/ 4/ 2	78092	****	4.70	43.	****	****	****	<1.0	****	195.	1.7	****	0.063	0.148	0.73	<0.02	2.10	0.	****
78/ 4/17	78107	****	5.15	33.	****	****	****	<1.0	****	94.	1.6	****	0.034	0.070	0.17	<0.02	0.68	*****	****
78/ 5/ 7	78127	6.0	4.60	38.	****	****	****	1.0	****	126.	2.0	5.4	0.115	0.134	0.51	<0.02	2.00	*****	****
78/ 5/21	78141	****	5.71	40.	****	****	****	<1.0	****	142.	1.5	****	0.032	0.086	0.42	<0.02	1.96	*****	****
78/ 6/ 6	78157	****	5.75	50.	****	****	****	1.1	****	159.	2.1	****	0.044	0.088	0.54	<0.02	2.08	*****	****
78/ 6/20	78171	****	6.60	43.	****	****	****	<1.0	****	172.	1.5	****	0.050	0.076	0.47	<0.02	1.88	*****	****
78/ 7/ 4	78185	15.0	5.64	57.	****	****	****	1.1	****	102.	2.1	****	0.067	0.134	0.59	<0.02	1.68	*****	****
78/ 7/17	78198	****	6.06	73.	****	****	****	<1.0	****	203.	1.9	****	0.064	0.156	0.58	<0.02	2.80	*****	****
78/ 8/ 2	78214	15.5	5.33	82.	****	****	****	1.0	****	225.	2.0	****	0.077	0.180	0.69	<0.02	2.92	*****	****
78/ 8/16	78228	****	5.93	92.	****	****	****	1.0	****	213.	3.1	****	0.072	0.140	****	<0.02	2.82	*****	****
78/ 9/ 3	78246	15.7	6.44	122.	****	****	****	<1.0	****	201.	1.8	****	0.061	0.132	0.74	<0.02	1.84	*****	****
78/ 9/18	78261	****	6.13	93.	****	****	****	<1.0	****	199.	1.7	****	0.085	0.130	0.82	<0.02	2.60	*****	****
78/10/15	78288	7.8	6.27	100.	****	****	****	2.2	0.0	181.	2.1	4.2	0.083	0.132	0.85	<0.02	2.76	0.	****
78/11/12	78316	****	5.97	80.	****	****	****	1.1	****	181.	1.7	****	0.055	0.090	0.79	<0.02	2.40	*****	****
78/12/16	78350	1.3	5.77	77.	****	****	****	2.2	****	173.	2.8	****	****	0.136	0.89	<0.02	2.56	*****	****
79/ 2/12	79043	****	6.15	138.	****	****	****	1.8	****	170.	4.4	****	0.021	0.100	0.47	<0.02	2.36	*****	****
79/ 3/ 3	79062	0.7	5.99	88.	****	****	****	1.8	****	181.	3.9	****	0.087	0.160	1.05	<0.02	2.50	*****	****
79/ 4/ 1	79091	****	6.21	97.	****	****	****	<1.0	****	167.	3.3	****	0.086	0.150	0.95	<0.02	2.32	*****	****
79/ 4/21	79111	1.0	5.55	65.	****	****	****	1.0	****	140.	2.4	****	0.063	0.080	0.95	<0.02	2.32	*****	****
79/ 5/ 7	79127	****	5.82	50.	****	****	****	<1.0	****	120.	2.7	****	0.070	0.155	0.66	<0.02	1.56	*****	****
79/ 5/19	79139	8.2	5.47	57.	****	****	****	<1.0	****	132.	1.6	3.4	0.053	0.130	0.62	<0.02	1.74	*****	****
79/ 6/ 5	79156	****	6.34	70.	****	****	****	1.1	****	126.	1.2	****	0.050	0.140	0.83	<0.02	2.04	*****	****
79/ 6/16	79167	11.8	6.02	84.	****	****	****	****	****	157.	****	****	0.067	0.090	0.62	<0.02	1.36	*****	****
79/ 7/ 2	79183	****	****	130.	****	****	****	5.8	****	127.	****	****	****	0.110	****	****	*****	****	
79/ 7/16	79197	14.4	6.53	157.	****	****	****	11.3	****	129.	1.9	****	0.092	0.150	0.71	<0.02	2.48	*****	****
79/ 7/30	79211	****	6.40	140.	****	****	****	****	****	127.	0.9	****	0.030	0.090	0.52	<0.02	1.96	*****	****
79/ 8/11	79223	16.7	6.43	170.	****	****	****	21.5	0.0	103.	1.0	****	0.083	0.130	0.74	<0.02	1.84	*****	****
79/ 8/27	79239	****	6.64	160.	****	****	****	33.8	****	80.	0.8	****	0.062	0.110	0.60	<0.02	1.52	*****	****
79/ 9/ 8	79251	13.2	6.49	237.	****	****	****	35.9	****	82.	0.8	****	0.036	0.080	0.53	<0.02	1.56	*****	****
79/ 9/23	79256	****	6.50	137.	****	****	****	30.1	****	94.	1.1	****	0.063	0.110	0.70	<0.02	1.92	*****	****
79/10/ 6	79279	10.0	6.33	211.	****	****	****	36.8	****	75.	0.8	****	****	0.110	0.54	<0.02	1.60	*****	****
79/10/21	79294	****	6.37	184.	****	****	****	43.5	****	104.	0.9	****	0.045	0.070	0.52	<0.02	1.52	*****	****
79/11/ 3	79307	5.0	6.12	204.	****	****	****	38.1	****	57.	0.6	1.5	0.045	0.070	0.60	<0.02	1.32	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.4 meter well at site 32.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND U4HO	ALK MG/L	TROU-HARD AS CAPG3	CL I<---	DO	ODD	ROD5	ROD20	ORTHO MG/L	T-P	NH4	NO23	KJLON --->I	F COL /100ML	WATER TABLE CM	
77/11/18	77322	4.0	4.61	42.	****	****	****	<1.0	0.7	****	1.5	****	0.019	0.095	0.10	0.02	1.92	*****	****
77/12/29	77363	****	5.25	50.	****	****	****	4.0	****	178.	3.2	****	0.028	0.086	0.08	0.02	0.54	*****	****
78/ 2/12	78043	****	5.43	71.	****	****	****	****	****	161.	4.4	8.6	****	0.125	0.55	<0.02	1.88	*****	****
78/ 3/ 4	78063	0.0	5.46	62.	****	****	****	1.5	****	199.	2.5	****	0.052	0.130	0.47	<0.02	2.30	*****	****
78/ 3/20	78079	****	5.89	44.	****	****	****	1.3	****	198.	2.3	****	0.101	0.167	0.60	<0.02	2.24	*****	****
78/ 4/ 2	78092	****	5.71	61.	****	****	****	1.2	****	166.	3.2	****	0.112	0.231	0.65	<0.02	2.24	0.	****
78/ 4/17	78107	****	6.32	34.	****	****	****	<1.0	****	78.	1.5	****	0.014	0.030	0.01	<0.02	0.42	*****	****
78/ 5/ 7	78127	5.0	5.10	32.	****	****	****	<1.0	****	94.	1.0	2.3	0.013	0.032	0.05	<0.02	0.88	*****	****
78/ 5/21	78141	****	6.12	36.	****	****	****	<1.0	****	121.	1.5	****	0.029	0.045	0.07	<0.02	1.30	*****	****
78/ 6/ 6	78157	****	6.27	53.	****	****	****	1.0	****	143.	2.1	****	0.027	0.055	0.10	<0.02	1.36	*****	****
78/ 6/20	78171	****	5.17	30.	****	****	****	<1.0	****	150.	1.4	****	0.012	0.036	0.09	<0.02	1.12	*****	****
78/ 7/ 4	78135	14.0	5.62	37.	****	****	****	1.0	0.0	170.	2.1	****	0.030	0.030	<0.02	0.02	0.68	0.	****
78/ 7/17	78198	****	6.25	49.	****	****	****	<1.0	****	176.	1.7	****	0.022	0.052	0.09	<0.02	1.44	*****	****
78/ 8/ 2	78214	11.2	6.27	58.	****	****	****	<1.0	****	169.	1.7	****	0.044	0.092	0.26	<0.02	1.76	0.	****
78/ 8/16	78228	****	6.12	54.	****	****	****	<1.0	****	163.	2.1	****	0.021	0.064	****	<0.02	1.52	*****	****
78/ 9/ 3	78246	16.3	6.30	55.	****	****	****	<1.0	0.0	207.	2.0	****	0.030	0.072	<0.02	<0.02	1.64	0.	****
78/ 9/18	78261	****	6.33	56.	****	****	****	1.5	****	183.	1.9	****	0.042	0.085	0.01	<0.02	1.30	*****	****
78/10/15	78288	8.0	6.63	56.	****	****	****	1.1	0.1	127.	1.3	3.2	0.017	0.034	0.05	<0.02	1.32	0.	****
78/11/12	78316	****	6.45	59.	****	****	****	1.4	****	137.	1.5	****	0.022	0.034	0.23	<0.02	1.26	*****	****
78/12/16	78350	1.9	6.20	49.	****	****	****	2.1	****	154.	2.4	****	****	0.136	0.71	<0.02	2.16	*****	****
79/ 3/ 3	79062	0.2	6.48	144.	****	****	****	1.3	****	172.	3.9	****	0.191	0.193	0.89	<0.02	2.60	*****	****
79/ 4/21	79111	0.9	5.58	58.	****	****	****	<1.0	****	76.	1.4	****	0.012	0.030	0.10	<0.02	0.80	*****	****
79/ 5/ 7	79127	****	6.18	45.	****	****	****	<1.0	****	36.	1.3	****	0.008	0.040	0.08	<0.02	0.80	*****	****
79/ 5/19	79139	7.6	6.27	48.	****	****	****	<1.0	0.0	101.	1.2	2.5	0.008	0.038	<0.02	<0.02	0.74	*****	****
79/ 6/ 5	79156	****	6.01	31.	****	****	****	<1.0	****	114.	1.3	****	0.026	0.050	0.06	<0.02	1.04	*****	****
79/ 6/16	79167	10.9	5.11	35.	****	****	****	****	****	131.	****	****	0.025	0.050	0.02	<0.02	0.92	*****	****
79/ 7/ 2	79183	****	****	105.	****	****	****	22.1	****	127.	****	****	****	0.070	****	****	****	*****	****
79/ 7/16	79197	15.3	5.46	128.	****	****	****	30.5	****	74.	1.0	****	0.016	0.070	0.11	<0.02	0.84	*****	****
79/ 7/30	79211	****	5.99	152.	****	****	****	****	****	84.	1.0	****	0.010	0.090	<0.02	<0.02	1.68	*****	****
79/ 8/11	79223	16.0	6.18	155.	****	****	****	35.0	0.0	69.	0.9	****	0.023	0.080	<0.02	<0.02	1.08	*****	****
79/ 8/27	79239	****	6.13	138.	****	****	****	45.6	****	74.	1.0	****	0.040	0.090	0.02	<0.02	1.04	*****	****
79/ 9/ 8	79251	13.0	6.05	167.	****	****	****	46.5	****	77.	1.0	****	0.099	0.160	0.11	<0.02	1.24	*****	****
79/ 9/23	79266	****	6.78	185.	****	****	****	46.5	****	88.	1.2	****	0.071	0.130	0.10	<0.02	1.44	*****	****
79/10/ 6	79279	10.3	6.56	205.	****	****	****	46.8	****	63.	0.7	****	****	0.120	0.12	<0.02	1.36	*****	****
79/10/21	79294	****	6.75	205.	****	****	****	48.8	****	71.	0.5	****	0.026	0.055	0.06	<0.02	1.20	*****	****
79/11/ 3	79307	5.1	6.05	164.	****	****	****	41.3	****	47.	0.5	1.3	0.034	0.060	0.04	<0.02	0.84	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.4 meter well at site 33.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND U440	ALK MG/L	TRCA-HARD AS	CL	DO	CO2	8005	80020	ORTHO MG/L	T-P	NH4	NO23	KJLON --->1	F COL /100ML	WATER TABLE CM
77/12/29	77363	****	5.64	35.	****	****	****	****	173.	5.1	****	0.038	0.124	0.61	0.06	1.05	*****	****
78/ 2/12	78043	****	5.78	101.	****	****	2.1	****	159.	8.8	11.5	****	0.085	0.51	<0.02	1.70	*****	****
78/ 3/ 4	78063	****	5.70	95.	****	****	1.2	****	157.	8.1	****	0.018	0.090	0.22	<0.02	1.74	*****	****
78/ 3/20	78079	****	5.77	94.	****	****	1.1	****	164.	5.9	****	0.027	0.081	0.17	<0.02	1.78	*****	****
78/ 4/ 2	78092	****	5.77	84.	****	****	1.1	****	134.	3.4	****	0.033	0.105	0.20	<0.02	1.78	0.	****
78/ 4/17	78107	****	6.81	99.	****	****	1.4	****	154.	2.5	****	0.033	0.060	0.23	<0.02	1.56	*****	****
78/ 5/21	78141	****	6.68	120.	****	****	<1.0	****	119.	1.0	****	0.020	0.046	0.14	<0.02	1.42	*****	****
78/ 6/ 6	78157	****	6.28	36.	****	****	1.2	****	155.	4.4	****	0.055	0.090	0.45	0.02	2.06	*****	****
78/ 6/20	78171	****	7.20	36.	****	****	1.0	****	168.	1.7	****	0.045	0.076	0.32	<0.02	2.00	*****	****
78/ 7/ 4	78185	12.5	6.38	111.	****	****	2.5	****	153.	4.7	****	0.052	0.060	0.39	<0.02	1.44	*****	****
78/ 7/17	78198	****	6.56	115.	****	****	1.2	****	176.	1.5	****	0.053	0.134	0.39	<0.02	2.52	*****	****
78/ 8/ 2	78214	****	6.41	150.	****	****	1.7	****	191.	2.8	****	0.062	0.140	0.55	<0.02	2.72	*****	****
78/ 8/16	78223	****	6.42	137.	****	****	1.4	****	174.	1.5	****	0.047	0.139	****	<0.02	****	*****	****
78/ 9/ 3	78246	15.2	7.00	138.	****	****	1.2	****	173.	1.4	****	0.026	0.065	0.23	<0.02	1.84	*****	****
78/ 9/18	78261	****	6.98	145.	****	****	1.6	****	153.	1.3	****	0.041	0.095	0.23	<0.02	1.86	*****	****
78/10/15	78288	7.3	6.85	178.	****	****	2.6	1.0	134.	1.2	3.1	0.071	0.124	0.55	<0.02	2.54	0.	****
78/11/12	78316	****	6.16	163.	****	****	1.7	****	150.	1.0	****	0.044	0.080	0.33	<0.02	1.86	*****	****
78/12/16	78350	1.8	6.26	156.	****	****	2.5	****	154.	3.0	****	****	0.132	0.63	<0.02	2.12	*****	****
79/ 2/12	79043	****	6.75	275.	****	****	****	****	144.	0.4	****	0.012	0.040	0.22	<0.02	1.48	*****	****
79/ 3/ 3	79062	0.6	6.63	175.	****	****	<1.0	****	153.	3.5	****	0.039	0.110	0.43	<0.02	1.76	*****	****
79/ 4/ 1	79091	****	6.63	155.	****	****	1.0	****	157.	4.3	****	0.106	0.185	0.80	<0.02	2.12	*****	****
79/ 4/21	79111	0.8	5.77	74.	****	****	1.1	****	149.	2.2	****	0.126	0.130	0.96	<0.02	2.64	*****	****
79/ 5/ 7	79127	****	6.21	55.	****	****	<1.0	****	101.	2.4	****	0.068	0.155	0.46	<0.02	1.96	*****	****
79/ 5/19	79139	7.9	6.36	63.	****	****	<1.0	****	81.	2.0	3.7	0.036	0.105	0.22	<0.02	1.32	*****	****
79/ 6/ 5	79156	****	6.78	33.	****	****	1.1	****	120.	1.1	****	0.036	0.120	1.34	<0.02	1.60	*****	****
79/ 6/16	79157	12.6	6.66	39.	****	****	****	****	145.	****	****	0.048	0.140	0.23	<0.02	1.64	*****	****
79/ 7/ 2	79183	****	****	164.	****	****	<1.0	****	139.	****	****	****	0.110	****	****	****	*****	****
79/ 7/16	79197	15.0	6.68	139.	****	****	3.5	****	143.	1.9	****	0.063	0.160	0.39	<0.02	1.80	*****	****
79/ 7/30	79211	****	6.86	196.	****	****	****	****	129.	0.8	****	0.019	0.190	0.24	<0.02	2.60	*****	****
79/ 8/11	79223	15.3	6.92	130.	****	****	6.4	****	142.	1.1	****	0.062	0.140	0.43	<0.02	1.96	*****	****
79/ 8/27	79239	****	6.98	179.	****	****	16.3	****	119.	1.0	****	0.058	0.120	0.52	<0.02	1.56	*****	****
79/ 9/ 8	79251	13.0	6.68	206.	****	****	16.6	****	113.	1.0	****	0.079	0.130	0.52	<0.02	1.68	*****	****
79/ 9/23	79266	****	7.09	228.	****	****	10.9	****	123.	1.0	****	0.055	0.110	0.46	<0.02	1.92	*****	****
79/10/ 6	79279	9.5	6.87	208.	****	****	10.6	****	123.	0.9	****	****	0.150	0.54	<0.02	2.04	*****	****
79/10/21	79294	****	6.90	205.	****	****	13.4	****	113.	1.2	****	0.040	0.070	0.64	<0.02	1.92	*****	****
79/11/ 3	79307	5.4	6.55	179.	****	****	17.0	****	84.	1.0	2.1	0.055	0.085	0.42	<0.02	1.16	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.4 meter well at site 34.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHO	ALK MG/L	T&CA-MAG AS	HARD CA&M3	CL <---	DO	CO2	BO25	BO20	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->I	F COL /100ML	WATER TABLE CM
77/11/18	77322	4.5	5.58	70.	****	****	****	2.1	****	****	6.8	****	0.021	0.230	0.15	0.02	2.24	*****	****
77/12/29	77363	1.0	6.52	162.	****	****	****	3.9	****	190.	7.9	****	0.058	0.062	0.39	0.04	0.41	*****	****
78/ 2/12	78043	****	5.26	47.	****	****	****	1.0	****	151.	4.9	9.0	****	0.035	0.28	<0.02	2.72	*****	****
78/ 3/ 4	78063	****	5.41	59.	****	****	****	<1.0	****	181.	6.0	****	0.023	0.120	0.36	<0.02	1.70	*****	****
78/ 3/20	78079	****	5.46	31.	****	****	****	<1.0	****	131.	5.0	****	0.043	0.174	0.32	<0.02	1.75	*****	****
78/ 4/ 2	78092	****	5.35	33.	****	****	****	<1.0	****	140.	3.7	****	0.018	0.083	0.14	<0.02	0.96	0.	****
78/ 4/17	78107	****	6.32	36.	****	****	****	<1.0	****	136.	1.6	****	0.054	0.130	0.15	<0.02	1.42	*****	****
78/ 5/ 7	78127	7.0	5.30	33.	****	****	****	<1.0	****	117.	1.9	3.9	0.030	0.050	0.05	<0.02	1.02	*****	****
78/ 5/21	78141	****	6.58	51.	****	****	****	<1.0	****	111.	1.6	****	0.015	0.023	0.01	<0.02	1.16	*****	****
78/ 6/ 6	78157	****	6.15	57.	****	****	****	1.1	****	134.	1.4	****	0.042	0.087	0.21	<0.02	1.58	*****	****
78/ 6/20	78171	****	6.49	54.	****	****	****	<1.0	****	147.	1.7	****	0.050	0.064	0.14	<0.02	1.12	*****	****
78/ 7/ 4	78185	15.5	6.17	67.	****	****	****	1.7	****	159.	2.0	****	0.075	0.103	0.24	<0.02	1.24	*****	****
78/ 7/17	78198	****	6.51	77.	****	****	****	<1.0	****	153.	1.3	****	0.027	0.076	0.08	<0.02	1.64	*****	****
78/ 8/ 2	78214	16.5	6.19	99.	****	****	****	1.2	****	190.	2.0	****	0.074	0.172	0.35	<0.02	2.44	*****	****
78/ 8/16	78228	****	6.40	127.	****	****	****	1.4	****	173.	1.8	****	0.079	0.173	****	<0.02	2.06	*****	****
78/ 9/ 3	78246	16.3	6.35	105.	****	****	****	<1.0	****	195.	1.8	****	0.120	0.210	0.33	<0.02	2.04	*****	****
78/ 9/18	78261	****	6.48	124.	****	****	****	1.6	****	191.	1.9	****	0.161	0.245	0.46	<0.02	*****	*****	****
78/10/15	78288	7.5	6.52	112.	****	****	****	1.7	0.0	154.	1.8	3.8	0.089	0.123	0.49	<0.02	2.16	0.	****
78/11/12	78316	****	6.39	159.	****	****	****	<1.0	****	143.	0.8	****	0.033	0.060	0.35	<0.02	1.56	*****	****
78/12/16	78350	2.0	6.38	124.	****	****	****	2.1	****	158.	2.6	****	****	0.132	0.47	<0.02	1.80	*****	****
79/ 3/ 3	79062	0.7	6.44	143.	****	****	****	1.0	****	163.	4.1	****	0.069	0.130	0.50	<0.02	1.74	*****	****
79/ 4/ 1	79091	****	6.41	113.	****	****	****	<1.0	****	134.	2.6	****	0.107	0.170	0.52	<0.02	1.52	*****	****
79/ 4/21	79111	1.0	5.25	54.	****	****	****	<1.0	****	121.	2.1	****	0.084	0.095	0.60	<0.02	1.48	*****	****
79/ 5/ 7	79127	****	6.44	83.	****	****	****	<1.0	****	110.	1.6	****	0.055	0.115	0.30	<0.02	1.20	*****	****
79/ 5/19	79139	8.7	6.03	67.	****	****	****	<1.0	0.0	120.	1.3	3.1	0.065	0.155	0.26	<0.02	1.36	*****	****
79/ 6/ 5	79156	****	6.73	73.	****	****	****	1.1	****	123.	1.0	****	0.047	0.110	0.54	<0.02	1.52	*****	****
79/ 6/16	79167	11.9	6.17	83.	****	****	****	****	****	137.	****	****	0.057	0.140	0.26	<0.02	1.44	*****	****
79/ 7/ 2	79183	****	****	113.	****	****	****	<1.0	****	133.	****	****	****	0.210	****	****	*****	*****	****
79/ 7/16	79197	14.1	6.54	110.	****	****	****	2.0	****	139.	1.8	****	0.067	0.140	0.17	<0.02	1.12	*****	****
79/ 7/30	79211	****	6.66	150.	****	****	****	****	****	120.	1.2	****	0.020	0.065	0.08	<0.02	1.48	*****	****
79/ 8/11	79223	15.5	6.65	110.	****	****	****	9.2	****	108.	1.2	****	0.032	0.070	0.08	<0.02	0.96	*****	****
79/ 8/27	79239	****	6.94	151.	****	****	****	20.2	****	96.	0.9	****	0.026	0.050	0.02	<0.02	1.12	*****	****
79/ 9/ 8	79251	13.4	6.59	167.	****	****	****	27.6	****	79.	0.9	****	0.037	0.070	0.08	<0.02	0.88	*****	****
79/ 9/23	79266	****	6.94	170.	****	****	****	25.9	****	32.	1.0	****	0.022	0.050	0.10	<0.02	0.88	*****	****
79/10/ 6	79279	9.8	6.81	169.	****	****	****	23.2	****	72.	0.9	****	****	0.060	0.14	<0.02	1.04	*****	****
79/10/21	79294	****	6.93	170.	****	****	****	25.8	****	119.	1.2	****	0.012	0.035	0.16	<0.02	0.96	*****	****
79/11/ 3	79307	5.2	6.55	158.	****	****	****	28.9	****	62.	0.9	2.0	0.012	0.040	0.10	<0.02	0.64	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.6 meter well at site 21.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMH0	ALK MG/L	T&C/AS	HARD CA03	CL I<---	DO	000	0005	00020	0RTH0 MG/L	T-P	NH4	NO23	KJLON --->I	F COL /100ML	WATER TABLE CM
77/10/ 6	77279	****	4.24	93.	****	****	****	2.9	****	****	3.8	****	0.102	0.170	2.23	0.19	8.05	0.	****
77/11/18	77322	****	4.22	59.	****	****	****	1.4	3.3	****	2.5	****	0.023	0.140	0.61	0.02	3.12	*****	****
77/12/29	77363	****	4.35	64.	****	****	****	2.7	****	163.	1.4	****	0.034	0.264	1.60	0.05	2.17	*****	****
78/ 3/20	78079	****	4.61	59.	****	****	****	1.2	****	174.	1.7	****	0.006	0.031	1.00	<0.02	2.80	*****	****
78/ 4/ 2	78092	****	4.27	65.	****	****	****	1.2	****	173.	0.5	****	0.010	0.031	0.94	<0.02	3.00	0.	****
78/ 4/17	78107	****	4.28	63.	****	****	****	<1.0	****	147.	0.9	****	0.021	0.036	1.15	<0.02	1.80	*****	****
78/ 5/ 7	78127	6.0	4.20	68.	****	****	****	1.9	****	148.	1.0	2.4	0.028	0.048	0.92	<0.02	2.46	*****	9.2
78/ 5/21	78141	****	4.21	66.	****	****	****	<1.0	****	133.	0.9	****	0.019	0.062	2.00	<0.02	2.96	*****	****
78/ 6/ 6	78157	****	4.11	67.	****	****	****	1.3	****	156.	1.3	****	0.017	0.026	1.09	0.04	2.76	*****	****
78/ 6/20	78171	****	4.47	57.	****	****	****	1.0	****	156.	0.6	****	0.011	0.044	1.05	<0.02	2.64	*****	****
79/ 7/ 4	78185	11.5	4.20	65.	****	****	****	<1.0	****	145.	1.1	****	0.035	0.060	1.05	<0.02	2.32	*****	6.2
78/ 7/17	78198	****	4.58	59.	****	****	****	<1.0	****	176.	0.8	****	0.011	0.032	1.00	<0.02	2.96	*****	****
78/ 8/ 2	78214	12.5	4.29	56.	****	****	****	<1.0	****	193.	1.1	****	0.040	0.054	0.86	<0.02	3.00	0.	14.2
78/ 8/16	78228	****	4.43	62.	****	****	****	<1.0	****	190.	1.5	****	0.034	0.058	****	<0.02	3.08	*****	****
78/ 9/ 3	78246	14.2	4.23	67.	****	****	****	<1.0	****	127.	1.0	****	0.011	0.034	1.10	<0.02	2.92	*****	5.2
78/ 9/18	78261	****	4.57	62.	****	****	****	1.0	****	208.	1.2	****	0.042	0.065	1.30	<0.02	3.60	*****	****
78/10/15	78288	9.2	4.17	63.	****	****	****	<1.0	****	187.	0.8	2.7	0.017	0.042	1.05	<0.02	3.32	*****	8.2
78/11/12	78316	****	4.67	53.	****	****	****	1.0	****	177.	0.7	****	0.007	0.020	1.23	<0.02	2.96	*****	****
78/12/16	78350	3.0	4.00	59.	****	****	****	1.7	****	163.	1.1	****	0.000	0.044	1.30	<0.02	2.80	*****	16.2
79/ 2/12	79043	****	5.60	100.	****	****	****	1.5	****	194.	1.2	****	0.007	0.032	1.20	<0.02	2.80	*****	****
79/ 3/ 3	79062	2.0	4.36	64.	****	****	****	1.3	****	123.	2.4	****	0.005	0.030	1.35	<0.02	2.80	*****	26.2
79/ 4/ 1	79091	****	4.40	62.	****	****	****	1.1	****	152.	0.8	****	0.003	0.015	1.36	<0.02	2.60	*****	****
79/ 4/21	79111	2.1	4.09	57.	****	****	****	1.0	****	150.	1.2	****	0.005	0.050	1.55	<0.02	2.76	*****	****
79/ 5/ 7	79127	****	4.32	60.	****	****	****	2.0	****	166.	1.0	****	0.005	0.040	1.24	<0.02	2.76	*****	****
79/ 5/19	79139	5.0	4.21	49.	****	****	****	<1.0	****	185.	0.9	2.6	0.007	0.033	1.34	<0.02	****	*****	3.2
79/ 6/ 5	79156	****	4.28	53.	****	****	****	1.5	****	168.	0.5	****	0.011	0.025	1.44	<0.02	2.80	*****	****
79/ 6/16	79167	8.4	4.13	61.	****	****	****	****	****	191.	****	****	0.015	0.030	1.42	<0.02	2.60	*****	3.2
79/ 7/ 2	79183	****	****	60.	****	****	****	<1.0	****	197.	****	****	0.000	0.040	****	****	*****	*****	****
79/ 7/16	79197	10.0	4.15	67.	****	****	****	<1.0	****	198.	0.5	****	0.019	0.030	1.55	<0.02	3.64	*****	4.9
79/ 7/30	79211	****	4.43	63.	****	****	****	****	****	202.	0.7	****	0.014	0.025	1.34	<0.02	3.00	*****	****
79/ 8/11	79223	12.9	4.21	58.	****	****	****	<1.0	****	203.	1.2	****	0.015	0.040	1.36	<0.02	3.60	*****	5.2
79/ 8/27	79239	****	4.44	55.	****	****	****	<1.0	****	211.	1.2	****	0.016	0.040	1.38	<0.02	2.92	*****	****
79/ 9/ 8	79251	11.6	4.21	63.	****	****	****	1.6	****	196.	1.2	****	0.014	0.030	1.32	<0.02	2.84	*****	7.4
79/ 9/23	79266	****	4.49	60.	****	****	****	1.2	****	201.	1.2	****	0.016	0.040	1.34	<0.02	3.00	*****	****
79/10/ 6	79279	10.0	4.18	62.	****	****	****	1.1	****	180.	1.2	****	0.000	0.045	1.36	<0.02	3.02	*****	9.2
79/10/21	79294	****	4.31	55.	****	****	****	1.9	****	219.	0.8	****	0.014	0.025	1.46	<0.02	2.80	*****	****
79/11/ 3	79307	7.0	4.24	65.	****	****	****	2.9	****	170.	0.8	2.6	0.011	0.030	1.20	<0.02	2.40	*****	3.0

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.7 meter well at site 11.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHO	ALK MG/L	TCA-HARD AS	CL CACCB3	DO I----	CO2	BO5	BOD20	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->1	F CGL /100ML	WATER TABLE CM
77/10/ 6	77279	****	4.01	65.	****	****	****	1.6	****	****	1.4	*****	0.016	0.066	0.07	0.24	2.24	0. ****
77/10/15	77248	****	3.99	70.	****	****	****	1.4	****	****	4.7	*****	0.012	0.012	0.10	0.40	4.91	0. ****
77/11/18	77322	****	3.89	59.	****	****	****	<1.0	1.9	****	3.5	*****	0.015	0.063	0.15	0.01	0.64	***** ****
77/12/29	77363	****	3.99	45.	****	****	****	<1.0	****	143.	1.6	*****	0.006	0.080	0.07	0.02	0.85	***** ****
78/ 2/12	78043	****	4.02	46.	****	****	****	1.5	****	107.	0.7	2.7	*****	0.030	<0.02	<0.02	1.02	***** ****
78/ 3/ 4	78063	****	4.01	43.	****	****	****	<1.0	****	117.	0.6	****	0.014	0.020	0.05	<0.02	1.32	***** 19.5
78/ 3/20	78079	****	4.06	45.	****	****	****	<1.0	****	131.	0.4	****	0.008	0.019	0.03	<0.02	0.83	***** ****
78/ 4/ 2	78092	****	4.61	28.	****	****	****	<1.0	0.0	117.	0.8	****	0.001	0.030	0.14	<0.02	0.80	0. 8.5
78/ 5/ 7	78127	8.0	4.05	43.	****	****	****	<1.0	0.2	116.	0.9	1.8	0.011	0.030	0.05	<0.02	1.10	***** 13.5
78/ 5/21	78141	****	4.19	39.	****	****	****	<1.0	****	87.	1.5	****	0.001	0.006	0.08	<0.02	1.30	***** ****
78/ 6/ 6	78157	****	4.18	39.	****	****	****	<1.0	****	133.	1.2	****	0.017	0.042	0.07	<0.02	1.40	***** 9.5
78/ 6/20	78171	****	4.33	32.	****	****	****	<1.0	****	129.	0.8	****	0.010	0.024	0.03	<0.02	0.92	***** ****
78/ 7/ 4	78185	9.5	4.03	43.	****	****	****	<1.0	0.0	134.	1.4	****	0.025	0.030	0.04	<0.02	0.44	7. 10.5
78/ 7/17	78198	****	4.25	40.	****	****	****	<1.0	****	130.	1.1	****	0.010	0.016	0.10	<0.02	1.04	***** ****
78/ 8/ 2	78214	9.8	4.24	42.	****	****	****	<1.0	0.0	135.	1.1	****	0.006	0.024	0.03	<0.02	0.80	0. 18.5
78/ 8/16	78228	****	4.03	48.	****	****	****	<1.0	****	138.	1.4	****	0.015	0.043	****	<0.02	1.28	***** ****
78/ 9/ 3	78246	12.8	4.14	45.	****	****	****	<1.0	0.0	162.	0.9	****	0.008	0.030	0.02	<0.02	1.22	7. 8.5
78/ 9/18	78251	****	4.10	44.	****	****	****	<1.0	****	137.	1.2	****	0.010	0.030	0.09	<0.02	1.04	***** ****
78/10/15	78288	8.8	4.12	44.	****	****	****	<1.0	****	104.	0.8	2.5	0.009	0.024	0.10	<0.02	1.28	0. 12.5
78/11/12	78316	****	4.08	45.	****	****	****	<1.0	****	126.	0.6	****	0.004	0.010	0.09	<0.02	0.96	***** ****
78/12/16	78350	5.3	3.79	41.	****	****	****	<1.0	****	114.	1.4	****	****	0.024	0.10	<0.02	1.00	***** 18.5
79/ 3/ 3	79062	3.9	4.21	40.	****	****	****	<1.0	****	135.	1.3	****	0.002	0.030	0.13	<0.02	0.98	***** 20.5
79/ 4/ 1	79091	****	4.12	41.	****	****	****	<1.0	****	105.	1.1	****	0.002	0.015	0.20	<0.02	0.88	***** ****
79/ 4/21	79111	5.6	4.06	38.	****	****	****	<1.0	****	110.	0.9	****	0.003	0.030	0.12	<0.02	1.16	***** -4.5
79/ 5/ 7	79127	****	4.24	33.	****	****	****	<1.0	****	101.	1.5	****	0.002	0.090	0.16	<0.02	1.00	***** ****
79/ 5/19	79139	7.0	4.13	36.	****	****	****	<1.0	****	105.	0.7	2.5	0.008	0.023	0.08	<0.02	0.86	***** 8.5
79/ 6/ 5	79156	****	4.15	30.	****	****	****	1.2	****	105.	0.6	****	0.006	0.020	0.23	<0.02	1.00	***** ****
79/ 6/16	79167	8.7	4.03	40.	****	****	****	****	****	113.	****	****	0.014	0.020	0.08	<0.02	0.86	***** 6.5
79/ 7/ 2	79183	****	****	45.	****	****	****	<1.0	****	101.	****	****	****	0.060	****	****	****	****
79/ 7/16	79197	6.3	3.97	53.	****	****	****	3.3	****	93.	1.9	****	0.013	0.030	0.03	<0.02	0.72	***** 7.0
79/ 7/30	79211	****	4.73	54.	****	****	****	****	****	94.	0.9	****	0.003	0.015	<0.02	<0.02	0.92	***** ****
79/ 8/11	79223	10.7	3.89	58.	****	****	****	5.8	0.0	97.	1.2	****	0.003	0.020	<0.02	<0.02	1.04	***** 8.1
79/ 8/27	79239	****	3.93	71.	****	****	****	14.5	****	86.	1.1	****	0.009	0.020	0.06	<0.02	0.64	***** ****
79/ 9/ 8	79251	10.9	4.06	65.	****	****	****	15.1	****	98.	1.0	****	0.008	0.020	0.24	<0.02	0.76	***** 11.1
79/ 9/23	79266	****	4.05	48.	****	****	****	10.8	****	94.	1.3	****	0.006	0.020	0.12	<0.02	0.92	***** ****
79/10/ 6	79279	10.3	3.93	82.	****	****	****	10.9	****	94.	0.9	****	****	0.025	0.08	<0.02	0.88	***** 13.1
79/10/21	79294	****	4.05	73.	****	****	****	13.1	****	113.	1.0	****	0.004	0.015	0.20	<0.02	1.04	***** ****
79/11/ 3	79307	7.9	3.93	96.	****	****	****	18.5	****	77.	1.3	3.3	0.003	0.020	0.04	<0.02	0.80	***** 7.0

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.7 meter well at site 12.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHO	ALK MG/L	TCA-HARD AS CaCO3	CL <---	DO	CO2	BOO5	BOO20	ORTHO MG/L	T-P	NH4	NO23	KJLON --->	F COL /100ML	WATER TABLE CM	
77/10/ 6	77279	****	4.30	46.	****	****	****	<1.0	****	****	3.9	****	0.040	0.080	0.07	0.18	2.34	0. ****	
77/10/15	77298	****	4.14	52.	****	****	****	<1.0	****	****	4.1	****	0.004	0.042	0.39	0.50	2.77	0. ****	
77/11/18	77322	6.5	3.86	47.	****	****	****	1.0	****	****	1.2	****	0.005	0.073	0.07	<0.02	1.28	*****	
77/12/29	77363	5.0	3.87	44.	****	****	****	6.6	****	79.	0.9	****	0.000	0.048	0.03	0.01	0.95	*****	
78/ 2/12	78043	****	4.16	32.	****	****	****	<1.0	****	67.	0.5	2.1	****	0.140	0.01	<0.02	3.36	*****	
78/ 3/ 4	78063	****	4.09	35.	****	****	****	1.4	****	89.	0.6	****	0.010	0.020	0.02	<0.02	0.48	*****	
78/ 3/20	78079	****	4.22	33.	****	****	****	<1.0	****	94.	0.5	****	0.011	0.032	0.04	<0.02	0.69	*****	
78/ 4/ 2	78092	****	4.30	34.	****	****	****	<1.0	****	103.	0.7	****	0.005	0.041	0.05	<0.02	0.72	0. 8.2	
78/ 4/17	78107	****	4.24	31.	****	****	****	<1.0	****	85.	0.6	****	0.007	0.060	0.03	<0.02	0.76	*****	
78/ 5/ 7	78127	8.5	4.01	37.	****	****	****	1.3	1.2	99.	0.8	1.4	****	0.009	0.016	0.05	<0.02	0.70	*****
78/ 5/21	78141	****	4.31	32.	****	****	****	<1.0	****	117.	1.2	****	0.032	0.043	0.07	<0.02	1.00	*****	
78/ 6/ 6	78157	****	4.59	28.	****	****	****	<1.0	****	97.	0.8	****	0.015	0.037	0.06	<0.02	0.94	*****	
78/ 6/20	78171	****	4.30	29.	****	****	****	<1.0	****	93.	0.8	****	0.005	0.020	0.05	<0.02	0.78	*****	
78/ 7/ 4	78185	8.5	4.16	36.	****	****	****	<1.0	****	95.	1.2	****	0.009	0.016	0.07	<0.02	0.24	2. 8.2	
78/ 7/17	78198	****	4.43	31.	****	****	****	<1.0	****	103.	1.0	****	0.008	0.012	0.09	<0.02	0.76	*****	
78/ 8/ 2	78214	9.3	4.26	35.	****	****	****	<1.0	****	101.	1.0	****	0.012	0.012	0.11	<0.02	0.64	*****	
78/ 8/16	78228	****	4.42	36.	****	****	****	<1.0	****	104.	1.1	****	0.036	0.041	****	<0.02	1.04	*****	
78/ 9/ 3	78246	12.9	4.17	37.	****	****	****	<1.0	****	125.	0.5	****	0.007	0.020	0.06	<0.02	0.78	0. 5.2	
78/ 9/18	78261	****	4.24	35.	****	****	****	<1.0	****	103.	0.8	****	0.007	0.020	0.11	<0.02	0.96	*****	
78/10/15	78288	8.8	4.77	28.	****	****	****	<1.0	****	101.	0.5	1.5	****	0.005	0.024	0.11	<0.02	1.36	0. 10.2
78/11/12	78316	****	4.84	25.	****	****	****	<1.0	****	99.	0.5	****	0.005	0.010	0.09	<0.02	0.88	*****	
78/12/16	78350	4.5	3.94	34.	****	****	****	<1.0	****	91.	1.3	****	****	0.028	0.15	<0.02	0.92	*****	
79/ 3/ 3	79062	3.0	4.40	32.	****	****	****	<1.0	****	89.	1.1	****	0.003	0.020	0.09	<0.02	0.80	*****	
79/ 4/ 1	79091	****	4.87	33.	****	****	****	<1.0	****	87.	0.9	****	0.001	0.010	0.12	<0.02	0.92	*****	
79/ 4/21	79111	5.3	4.03	37.	****	****	****	<1.0	****	93.	0.8	****	0.004	0.015	0.20	<0.02	0.80	*****	
79/ 5/ 7	79127	****	4.41	35.	****	****	****	<1.0	****	90.	1.0	****	0.005	0.050	0.16	<0.02	0.88	*****	
79/ 5/19	79139	6.4	4.11	35.	****	****	****	<1.0	****	89.	0.7	2.0	****	0.005	0.015	0.11	<0.02	0.86	*****
79/ 6/ 5	79156	****	4.50	26.	****	****	****	1.0	****	84.	0.9	****	0.004	0.020	0.28	<0.02	0.92	*****	
79/ 6/16	79167	7.5	4.11	36.	****	****	****	****	****	95.	****	****	0.010	0.020	0.15	<0.02	0.82	*****	
79/ 7/ 2	79183	****	****	35.	****	****	****	<1.0	****	104.	****	****	****	0.060	****	****	****	****	
79/ 7/16	79197	8.2	4.05	43.	****	****	****	<1.0	****	95.	1.9	****	0.010	0.020	0.23	<0.02	0.50	*****	
79/ 7/30	79211	****	5.37	35.	****	****	****	****	****	96.	0.7	****	0.000	0.010	0.10	<0.02	0.88	*****	
79/ 8/11	79223	10.6	4.04	38.	****	****	****	<1.0	0.0	96.	0.9	****	0.002	0.010	0.08	<0.02	0.92	*****	
79/ 8/27	79239	****	4.09	35.	****	****	****	<1.0	****	99.	0.9	****	0.002	0.010	0.22	<0.02	0.80	*****	
79/ 9/ 8	79251	10.4	4.10	40.	****	****	****	<1.0	****	97.	0.7	****	0.005	0.020	0.10	<0.02	0.92	*****	
79/ 9/23	79266	****	4.56	35.	****	****	****	1.0	****	98.	0.8	****	0.004	0.020	0.12	<0.02	1.00	*****	
79/10/ 6	79279	9.5	4.05	41.	****	****	****	<1.0	****	102.	0.8	****	****	0.020	0.12	<0.02	1.08	*****	
79/10/21	79294	****	4.73	31.	****	****	****	1.4	****	136.	0.8	****	0.007	0.015	0.14	<0.02	1.04	*****	
79/11/ 3	79307	7.5	4.07	45.	****	****	****	<1.0	****	93.	1.0	2.5	****	0.003	0.015	0.14	<0.02	0.88	*****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.7 meter well at site 13.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMH0	ALK MS/L	TCA-HARD AS CA003	CL I<---	DO	OT0	BO05	BO020	ORTHO MG/L	T-P	NH4	NO23	KJLON --->I	F COL /100ML	WATER TABLE CM
77/10/ 6	77279	****	4.02	34.	****	****	****	<1.0	****	****	1.7	****	0.034	0.100	4.02	0.70	10.01	0. ****
77/10/15	77288	****	3.92	30.	****	****	****	<1.0	****	****	2.2	****	0.022	0.132	2.40	0.50	2.52	0. ****
77/12/29	77363	4.0	3.93	62.	****	****	****	<1.0	****	127.	0.9	****	0.000	0.048	2.25	0.05	*****	***** ****
78/ 2/12	78043	****	3.93	63.	****	****	****	1.0	****	107.	0.4	2.0	****	0.070	1.50	<0.02	1.78	***** ****
78/ 3/ 4	78063	****	3.92	62.	****	****	****	<1.0	****	109.	0.4	****	0.008	0.040	1.70	<0.02	2.48	***** ****
78/ 3/20	78079	****	4.05	62.	****	****	****	<1.0	****	125.	0.3	****	0.007	0.025	1.70	<0.02	2.56	***** ****
78/ 4/ 2	78092	****	4.14	56.	****	****	****	<1.0	****	141.	0.7	****	0.002	0.066	1.51	<0.02	2.90	0. ****
78/ 4/17	78107	****	4.22	52.	****	****	****	<1.0	****	118.	0.5	****	0.012	0.056	1.04	<0.02	1.84	***** ****
78/ 5/ 7	78127	8.0	4.03	57.	****	****	****	1.0	1.9	124.	0.9	1.9	0.011	0.030	1.10	<0.02	2.86	***** ****
78/ 5/21	78141	****	4.22	51.	****	****	****	<1.0	****	135.	1.0	****	0.004	0.049	1.25	<0.02	2.90	***** ****
78/ 6/ 6	78157	****	4.26	54.	****	****	****	<1.0	****	127.	0.8	****	0.021	0.035	1.62	<0.02	2.54	***** ****
78/ 6/20	78171	****	4.29	46.	****	****	****	<1.0	****	139.	0.8	****	0.017	0.028	1.05	<0.02	2.50	***** ****
78/ 7/ 4	78185	8.5	4.11	55.	****	****	****	<1.0	****	141.	0.9	****	0.005	0.024	1.30	0.04	2.12	63. ****
78/ 7/17	78198	****	4.42	45.	****	****	****	<1.0	****	148.	0.9	****	0.011	0.023	1.40	<0.02	2.76	***** ****
78/ 8/ 2	78214	9.5	4.19	54.	****	****	****	<1.0	****	144.	1.0	****	0.006	0.020	1.04	<0.02	3.04	***** ****
78/ 8/16	78228	****	4.44	47.	****	****	****	<1.0	****	187.	1.0	****	0.014	0.034	****	<0.02	2.82	***** ****
78/ 9/ 3	78246	11.2	4.09	58.	****	****	****	<1.0	****	164.	0.5	****	0.010	0.024	1.40	<0.02	2.84	0. ****
78/ 9/18	78261	****	4.42	48.	****	****	****	<1.0	****	142.	0.7	****	0.014	0.030	1.60	<0.02	2.92	***** ****
78/10/15	78253	8.0	4.26	43.	****	****	****	<1.0	****	144.	0.4	1.9	0.012	0.030	0.85	<0.02	3.04	0. ****
78/12/16	78350	5.0	3.77	52.	****	****	****	<1.0	****	137.	1.6	****	****	0.032	1.40	<0.02	2.68	***** ****
79/ 3/ 3	79062	3.0	4.26	44.	****	****	****	<1.0	****	151.	1.5	****	0.005	0.020	1.30	<0.02	2.52	***** ****
79/ 4/ 1	79091	****	4.43	44.	****	****	****	<1.0	****	124.	0.8	****	0.004	0.015	1.42	<0.02	2.48	***** ****
79/ 4/21	79111	5.2	4.04	43.	****	****	****	<1.0	****	139.	0.6	****	0.005	0.025	1.45	<0.02	2.52	***** ****
79/ 5/ 7	79127	****	4.17	53.	****	****	****	<1.0	****	129.	0.8	****	0.002	0.045	1.32	<0.02	2.48	***** ****
79/ 5/19	79139	6.2	4.08	44.	****	****	****	<1.0	****	139.	0.7	2.2	0.013	0.038	1.48	<0.02	*****	***** ****
79/ 6/ 5	79156	****	4.18	35.	****	****	****	1.0	****	133.	0.7	****	0.011	0.075	1.52	<0.02	2.64	***** ****
79/ 6/16	79167	7.0	4.03	51.	****	****	****	****	****	149.	****	****	0.010	0.010	1.50	<0.02	2.48	***** ****
79/ 7/ 2	79183	****	****	47.	****	****	****	<1.0	****	135.	****	****	****	0.040	****	****	*****	***** ****
79/ 7/16	79197	7.2	3.99	57.	****	****	****	<1.0	****	152.	1.6	****	0.015	0.030	1.65	<0.02	2.76	***** ****
79/ 7/30	79211	****	4.96	46.	****	****	****	****	****	139.	0.6	****	0.003	0.020	1.29	<0.02	2.60	***** ****
79/ 8/11	79223	8.7	4.04	49.	****	****	****	<1.0	0.2	152.	0.8	****	0.006	0.020	1.52	<0.02	2.72	***** ****
79/ 8/27	79239	****	4.25	45.	****	****	****	1.2	****	152.	0.8	****	0.017	0.030	1.48	<0.02	2.50	***** ****
79/ 9/ 8	79251	9.0	4.10	51.	****	****	****	<1.0	****	150.	0.8	****	0.007	0.020	1.52	<0.02	2.60	***** ****
79/ 9/23	79266	****	4.57	49.	****	****	****	1.9	****	151.	0.8	****	0.018	0.020	1.40	<0.02	2.76	***** ****
79/10/ 6	79279	8.6	4.04	53.	****	****	****	<1.0	****	140.	0.7	****	0.005	0.020	1.60	<0.02	2.62	***** ****
79/10/21	79294	****	4.39	42.	****	****	****	1.8	****	153.	1.2	****	0.006	0.020	1.80	<0.02	2.92	***** ****
79/11/ 3	79307	7.6	4.07	56.	****	****	****	1.2	****	137.	1.1	2.7	0.011	0.020	1.54	<0.02	2.44	***** ****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.7 meter well at site 14.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMH0	ALK MG/L	TACAS HARD AS	CL <---	OR	ODD	BOO5	BOO20	ORTHO MS/L	T-P	NH4	NO23	KJLON --->1	F COL /100ML	WATER TABLE CM
77/10/ 6	77279	****	3.86	77.	****	****	****	1.7	****	****	7.2	****	0.063	0.148	0.21	0.35	17.18	0. ****
77/10/15	77288	****	3.83	64.	****	****	****	2.1	****	****	3.2	****	0.049	0.110	1.20	0.60	8.69	0. ****
77/11/18	77322	6.5	3.75	72.	****	****	****	1.1	2.0	****	5.4	****	0.016	0.148	0.05	0.01	2.00	*****
77/12/29	77363	3.5	3.78	54.	****	****	****	1.0	****	170.	1.9	****	0.052	0.122	0.20	0.03	0.27	*****
78/ 2/12	78043	****	3.91	49.	****	****	****	1.1	****	133.	0.9	3.5	****	0.090	0.26	<0.02	1.28	*****
78/ 3/ 4	78063	****	3.90	53.	****	****	****	1.1	****	134.	1.3	****	0.015	0.060	0.21	<0.02	1.44	*****
78/ 3/20	78079	****	4.03	52.	****	****	****	<1.0	****	151.	0.4	****	0.008	0.028	0.14	<0.02	1.30	*****
78/ 4/ 2	78092	****	4.28	43.	****	****	****	<1.0	****	158.	0.9	****	0.013	0.058	0.18	<0.02	1.50	0. 1.5
78/ 4/17	78107	****	4.11	42.	****	****	****	<1.0	****	106.	0.8	****	****	0.040	0.10	<0.02	0.62	*****
78/ 5/ 7	78127	7.0	4.00	44.	****	****	****	<1.0	****	132.	1.1	2.1	0.120	0.128	0.22	<0.02	1.46	*****
78/ 5/21	78141	****	4.01	50.	****	****	****	<1.0	****	135.	1.2	****	0.071	0.122	0.26	<0.02	1.82	*****
78/ 6/ 6	78157	****	3.93	51.	****	****	****	<1.0	****	146.	1.2	****	0.074	0.100	0.40	0.03	1.70	*****
78/ 6/20	78171	****	3.97	68.	****	****	****	<1.0	****	155.	1.0	****	0.070	0.084	0.22	<0.02	1.48	*****
78/ 7/ 4	78185	8.8	4.59	36.	****	****	****	2.1	0.0	89.	2.2	****	0.066	0.096	0.32	<0.02	1.20	0. 5.5
78/ 7/17	78198	****	4.42	41.	****	****	****	<1.0	****	176.	1.2	****	0.078	0.092	0.23	<0.02	1.72	*****
78/ 8/ 2	78214	9.0	4.06	55.	****	****	****	<1.0	0.0	173.	1.7	****	0.073	0.112	0.40	<0.02	2.08	1. 11.5
78/ 8/16	78228	****	3.97	102.	****	****	****	<1.0	****	174.	1.8	****	0.041	0.128	****	<0.02	2.40	*****
78/ 9/ 3	78246	13.7	3.95	52.	****	****	****	<1.0	0.0	205.	****	****	0.017	0.050	0.35	<0.02	1.54	0. 3.5
78/ 9/18	78261	****	4.02	51.	****	****	****	<1.0	****	175.	1.1	****	0.016	0.045	0.21	<0.02	1.44	*****
78/10/15	78288	8.4	3.92	55.	****	****	****	1.0	****	160.	1.0	3.5	0.015	0.042	0.18	<0.02	1.60	0. 10.5
78/11/12	78316	****	4.14	40.	****	****	****	<1.0	****	147.	0.8	****	0.016	0.020	0.18	<0.02	1.26	*****
78/12/16	78350	4.8	3.77	47.	****	****	****	1.1	****	126.	1.6	****	****	0.025	0.36	<0.02	1.52	*****
79/ 3/ 3	79062	3.1	4.10	48.	****	****	****	<1.0	****	128.	1.2	****	0.005	0.070	0.34	<0.02	1.68	*****
79/ 4/ 1	79091	****	4.30	47.	****	****	****	1.2	****	79.	1.7	****	0.008	0.025	0.14	<0.02	1.24	*****
79/ 4/21	79111	4.8	3.98	51.	****	****	****	<1.0	****	96.	0.8	****	0.008	0.045	0.39	<0.02	1.56	*****
79/ 5/ 7	79127	****	4.29	41.	****	****	****	<1.0	****	94.	0.9	****	0.005	0.025	0.32	<0.02	0.84	*****
79/ 5/19	79139	6.2	4.05	43.	****	****	****	<1.0	0.0	104.	0.9	2.8	0.010	0.028	0.08	<0.02	0.96	*****
79/ 6/ 5	79156	****	4.26	30.	****	****	****	1.3	****	122.	0.7	****	0.023	0.090	0.84	<0.02	1.20	*****
79/ 6/16	79167	7.2	3.96	46.	****	****	****	****	****	139.	****	****	0.025	0.060	0.10	<0.02	1.16	*****
79/ 7/ 2	79183	****	****	54.	****	****	****	<1.0	****	139.	****	****	****	0.040	****	****	*****	****
79/ 7/16	79197	8.8	3.88	59.	****	****	****	1.1	****	149.	1.6	****	0.036	0.050	0.09	<0.02	1.16	*****
79/ 7/30	79211	****	4.31	48.	****	****	****	****	****	156.	1.2	****	0.016	0.030	<0.02	<0.02	1.28	*****
79/ 8/11	79223	11.0	3.87	59.	****	****	****	1.0	0.0	152.	1.7	****	0.016	0.030	<0.02	<0.02	1.28	*****
79/ 8/27	79239	****	3.87	60.	****	****	****	3.6	****	144.	1.4	****	0.016	0.030	<0.02	<0.02	0.96	*****
79/ 9/ 8	79251	9.7	3.92	54.	****	****	****	6.7	****	133.	1.1	****	0.012	0.020	<0.02	<0.02	1.04	*****
79/ 9/23	79266	****	4.12	62.	****	****	****	5.8	****	125.	1.2	****	0.009	0.050	0.02	<0.02	1.04	*****
79/10/ 6	79279	9.2	3.82	72.	****	****	****	6.6	****	91.	1.4	****	****	0.030	0.06	<0.02	1.04	*****
79/10/21	79294	****	3.98	64.	****	****	****	8.5	****	94.	1.0	****	0.003	0.020	0.14	<0.02	0.98	*****
79/11/ 3	79307	7.4	3.77	100.	****	****	****	13.5	****	70.	1.6	3.7	0.004	0.020	0.10	<0.02	0.88	*****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.7 meter well (A) and 1.7 meter well (B) at site 21.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMH0	ALK MG/L	TRCA-HARD AS	CL CAC03	CL <---	DO	ORP	BO05	BO020	ORTHO MG/L	T-P	NH4	NO23	KJLON --->1 /100ML	F COL	WATER TABLE CM
<b>A</b>																			
79/ 2/12	79043	****	4.90	53.	****	****	****	1.1	****	159.	0.7	****	0.006	0.032	****	<0.02	****	*****	****
79/ 4/ 1	79091	****	4.85	54.	****	****	****	<1.0	****	154.	1.5	****	0.004	0.020	1.98	<0.02	3.32	*****	****
79/ 4/21	79111	5.0	4.32	52.	****	****	****	1.0	****	167.	1.4	****	0.006	0.025	2.15	<0.02	3.40	*****	****
79/ 5/19	79139	6.9	4.52	50.	****	****	****	<1.0	****	159.	1.2	2.7	0.002	0.025	2.06	<0.02	****	*****	****
79/ 6/16	79167	7.7	4.37	52.	****	****	****	****	****	171.	****	****	0.017	0.050	2.04	<0.02	3.18	*****	****
79/ 7/ 2	79183	****	****	56.	****	****	****	<1.0	****	175.	****	****	****	0.050	****	****	*****	*****	****
79/ 7/16	79197	7.5	4.33	59.	****	****	****	<1.0	****	159.	1.6	****	0.015	0.030	2.20	<0.02	3.72	*****	****
79/ 7/30	79211	****	5.96	59.	****	****	****	****	****	175.	1.1	****	0.006	0.025	1.76	<0.02	3.48	*****	****
79/ 8/11	79223	9.0	4.36	50.	****	****	****	<1.0	****	166.	1.0	****	0.006	0.020	1.92	<0.02	3.28	*****	****
79/ 8/27	79239	****	5.21	48.	****	****	****	1.0	****	205.	1.3	****	0.019	0.030	1.84	<0.02	3.28	*****	****
79/ 9/ 8	79251	8.0	4.44	51.	****	****	****	1.3	****	169.	1.0	****	0.011	0.020	1.86	<0.02	3.20	*****	****
79/ 9/23	79266	****	4.94	50.	****	****	****	1.0	****	166.	1.3	****	0.010	0.030	1.94	<0.02	3.36	*****	****
79/10/ 6	79279	8.0	4.38	56.	****	****	****	1.0	****	166.	0.9	****	****	0.035	2.10	<0.02	3.30	*****	****
79/10/21	79294	****	4.57	47.	****	****	****	1.0	****	181.	0.9	****	0.007	0.025	2.30	<0.02	3.48	*****	****
79/11/ 3	79307	6.3	4.35	54.	****	****	****	1.2	****	159.	0.9	2.9	0.009	0.045	1.93	<0.02	3.08	*****	****
<b>B</b>																			
77/10/ 6	77279	****	6.38	****	****	****	****	****	****	****	1.1	****	0.010	0.042	6.30	0.32	6.50	0.	****
77/10/15	77288	****	****	35.	****	****	****	2.0	****	****	7.0	****	0.002	0.030	1.30	0.30	4.28	0.	****
78/ 4/ 2	78092	****	5.55	68.	****	****	****	1.0	****	179.	5.2	****	0.032	0.081	2.50	<0.02	4.00	0.	****
78/ 4/17	78107	****	6.02	59.	****	****	****	1.0	****	135.	2.0	****	0.008	0.160	1.25	<0.02	3.00	*****	****
78/ 5/ 7	78127	5.0	5.10	65.	****	****	****	1.6	****	147.	4.3	7.5	0.043	0.073	1.90	<0.02	3.80	*****	****
78/ 5/21	78141	****	5.60	58.	****	****	****	<1.0	****	129.	1.6	****	0.022	0.022	1.81	<0.02	3.70	*****	****
78/ 6/20	78171	****	5.91	70.	****	****	****	1.0	****	146.	1.2	****	0.013	0.040	1.55	<0.02	3.36	*****	****
78/ 8/16	78228	****	6.89	34.	****	****	****	1.1	****	171.	2.1	****	0.011	0.056	****	****	3.56	*****	****
78/ 9/18	78251	****	5.79	100.	****	****	****	1.5	****	140.	0.9	****	0.010	0.050	1.80	<0.02	3.88	*****	****
78/11/12	78316	****	5.94	107.	****	****	****	1.3	****	147.	1.0	****	0.012	0.020	1.65	<0.02	3.28	*****	****
78/12/16	78350	4.3	5.73	78.	****	****	****	1.7	****	133.	4.3	****	****	0.036	2.15	<0.02	3.52	*****	****
79/ 5/ 7	79127	****	5.96	61.	****	****	****	1.0	****	163.	2.0	****	0.006	0.035	1.72	<0.02	3.08	*****	****
79/ 6/ 5	79156	****	5.49	47.	****	****	****	1.5	****	169.	0.9	****	0.011	0.050	1.94	<0.02	3.16	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.7 meter well at site 23.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND U4HG	ALK MG/L AS	T&CA-HARD AS	CL I----	DO	CO2	BO3F	BOO2O	GRHO MG/L	T-P	NH4	NO23	KJLON --->I /100ML	F COL /100ML	WATER TABLE CM
77/10/ 6	77279	****	4.00	73.	****	****	****	1.0	****	****	3.2	****	0.040	0.102	1.02	0.21	2.14	0. ****
77/10/15	77248	****	3.33	73.	****	****	****	1.0	****	****	****	****	0.001	0.076	0.70	0.50	1.00	0. ****
77/12/29	77363	****	4.10	46.	****	****	****	1.2	****	138.	7.6	****	0.096	0.156	1.00	0.05	1.39	*****
78/ 2/12	78043	****	4.08	44.	****	****	****	<1.0	****	116.	5.7	9.8	****	0.060	0.99	<0.02	1.54	*****
78/ 3/ 4	78063	0.5	4.01	48.	****	****	****	<1.0	****	134.	3.3	****	0.048	0.080	0.85	<0.02	2.08	*****
78/ 3/20	78079	****	4.03	54.	****	****	****	<1.0	****	157.	1.4	****	0.026	0.073	0.68	<0.02	2.32	*****
78/ 4/ 2	78092	****	4.14	50.	****	****	****	<1.0	****	170.	0.8	****	0.003	0.053	0.40	<0.02	2.10	0. 10.0
78/ 4/17	78107	****	4.12	49.	****	****	****	<1.0	****	130.	0.6	****	0.017	0.017	0.47	<0.02	1.20	*****
78/ 5/ 7	78127	6.0	3.90	70.	****	****	****	1.3	****	124.	0.7	2.0	0.007	0.046	0.50	<0.02	1.90	*****
78/ 5/21	78141	****	4.05	50.	****	****	****	<1.0	****	127.	0.9	****	0.029	0.058	0.56	<0.02	2.18	*****
78/ 6/ 6	78157	****	4.07	48.	****	****	****	1.0	****	148.	1.1	****	0.018	0.048	0.48	0.02	2.04	*****
78/ 6/20	78171	****	4.29	40.	****	****	****	<1.0	****	152.	0.3	****	0.007	0.040	0.54	<0.02	1.84	*****
78/ 7/ 4	78185	10.8	4.01	56.	****	****	****	<1.0	****	159.	1.3	****	0.004	0.044	0.51	<0.02	1.76	*****
78/ 7/17	78198	****	4.25	46.	****	****	****	<1.0	****	170.	0.8	****	0.015	0.032	0.55	<0.02	2.00	*****
78/ 8/ 2	78214	13.0	4.05	58.	****	****	****	<1.0	****	154.	1.2	****	0.010	0.036	0.59	<0.02	2.12	*****
78/ 8/16	78228	****	4.37	44.	****	****	****	<1.0	****	171.	1.0	****	0.006	0.056	****	<0.02	2.32	*****
78/ 9/ 3	78246	13.5	4.03	57.	****	****	****	<1.0	0.0	193.	0.9	****	0.008	0.036	0.60	<0.02	2.08	*****
78/ 9/18	78261	****	4.41	43.	****	****	****	<1.0	****	185.	0.7	****	0.009	0.040	0.63	<0.02	2.04	*****
78/10/15	78288	9.3	4.03	51.	****	****	****	<1.0	****	171.	0.5	2.0	0.010	0.028	0.70	<0.02	2.52	0. 10.0
78/11/12	78316	****	4.51	37.	****	****	****	<1.0	****	159.	0.7	****	0.007	0.020	0.64	<0.02	2.08	*****
78/12/16	78350	3.7	3.79	48.	****	****	****	<1.0	****	148.	1.5	****	0.005	0.032	0.83	<0.02	2.20	*****
79/ 2/12	79043	****	4.37	66.	****	****	****	<1.0	****	154.	1.3	****	0.005	0.028	0.57	<0.02	1.96	*****
79/ 3/ 3	79062	1.8	4.12	49.	****	****	****	<1.0	****	146.	1.5	****	0.011	0.050	0.92	<0.02	2.18	*****
79/ 4/ 1	79091	****	4.07	51.	****	****	****	<1.0	****	144.	0.9	****	0.005	0.015	0.72	<0.02	2.04	*****
79/ 4/21	79111	1.7	3.91	55.	****	****	****	<1.0	****	152.	1.0	****	0.012	0.050	0.66	<0.02	1.96	*****
79/ 5/ 7	79127	****	4.28	47.	****	****	****	<1.0	****	145.	0.9	****	0.010	0.060	0.68	<0.02	1.76	*****
79/ 5/19	79139	5.9	3.92	54.	****	****	****	<1.0	****	145.	0.7	2.6	0.018	0.060	0.64	<0.02	1.78	*****
79/ 6/ 5	79156	****	4.34	34.	****	****	****	1.1	****	271.	0.7	****	0.013	0.040	0.54	<0.02	1.64	*****
79/ 6/16	79167	6.0	3.89	55.	****	****	****	****	****	165.	****	****	0.020	0.030	0.80	<0.02	1.90	*****
79/ 7/ 2	79183	****	****	57.	****	****	****	<1.0	****	162.	****	****	0.000	0.040	****	****	****	****
79/ 7/16	79197	10.8	3.90	63.	****	****	****	1.1	****	161.	1.2	****	0.019	0.040	0.94	<0.02	2.24	*****
79/ 7/30	79211	****	4.39	54.	****	****	****	****	****	147.	0.8	****	0.006	0.020	0.62	<0.02	1.72	*****
79/ 8/11	79223	13.4	3.92	59.	****	****	****	1.3	****	149.	1.1	****	0.016	0.020	0.74	<0.02	2.16	*****
79/ 8/27	79239	****	4.15	52.	****	****	****	4.0	****	130.	1.0	****	0.015	0.030	0.74	<0.02	1.84	*****
79/ 9/ 8	79251	12.0	3.96	51.	****	****	****	5.0	****	140.	0.8	****	0.021	0.040	0.79	<0.02	1.96	*****
79/ 9/23	79266	****	4.06	67.	****	****	****	4.5	****	131.	1.1	****	0.010	0.020	0.80	<0.02	1.92	*****
79/10/ 6	79279	10.2	3.90	69.	****	****	****	4.7	****	127.	0.8	****	0.000	0.030	0.90	<0.02	1.92	*****
79/10/21	79294	****	****	60.	****	****	****	10.4	****	120.	1.2	****	0.005	0.020	0.90	<0.02	1.96	*****
79/11/ 3	79307	6.9	3.99	80.	****	****	****	9.9	****	89.	0.9	2.5	0.004	0.030	0.84	<0.02	1.68	*****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.7 meter well at site 31.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHO	ALK MG/L	T&CA-HARD AS CA003	CL I<---	DO	CO2	SO25	SO220	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->I	F COL /100ML	WATER TABLE CM
77/10/ 6	77279	****	3.91	56.	****	****	****	1.4	****	****	3.8	*****	0.046	0.084	1.08	0.38	3.64	0. ****
77/10/15	77288	****	3.76	52.	****	****	****	1.1	****	****	7.0	*****	0.012	0.066	0.80	0.30	3.65	0. ****
78/ 3/ 4	78063	0.0	3.95	56.	****	****	****	<1.0	****	154.	0.9	*****	0.029	0.440	0.75	<0.02	3.60	***** 22.5
78/ 3/20	78079	****	4.04	56.	****	****	****	<1.0	****	161.	1.0	*****	0.018	0.034	0.79	<0.02	2.24	***** ****
78/ 4/ 2	78092	****	4.04	55.	****	****	****	<1.0	****	192.	0.9	*****	0.002	0.060	0.78	<0.02	2.72	0. 17.5
78/ 4/17	78107	****	4.05	54.	****	****	****	<1.0	****	154.	0.6	*****	0.011	0.018	0.67	<0.02	1.40	***** ****
78/ 5/ 7	78127	6.0	3.90	57.	****	****	****	1.0	****	147.	1.0	2.2	0.011	0.034	0.77	<0.02	2.16	***** 14.5
78/ 5/21	78141	****	4.11	50.	****	****	****	<1.0	****	137.	1.1	*****	0.040	0.076	0.91	<0.02	2.60	***** ****
78/ 6/ 6	78157	****	4.08	51.	****	****	****	<1.0	****	154.	1.3	*****	0.015	0.040	1.03	<0.02	2.26	***** 13.5
78/ 6/20	78171	****	4.03	50.	****	****	****	<1.0	****	151.	0.7	*****	0.026	0.028	0.88	<0.02	2.08	***** ****
78/ 7/ 4	78185	12.2	4.12	50.	****	****	****	<1.0	****	153.	1.0	*****	0.005	0.028	0.93	<0.02	1.52	***** 14.5
78/ 7/17	78198	****	4.49	43.	****	****	****	<1.0	****	165.	1.0	*****	0.014	0.020	0.76	<0.02	2.32	***** ****
78/ 8/ 2	78214	13.7	4.22	50.	****	****	****	<1.0	****	160.	1.5	*****	0.007	0.024	0.87	<0.02	2.16	***** 19.5
78/ 8/16	78228	****	4.26	47.	****	****	****	<1.0	****	159.	1.1	*****	0.007	0.038	****	<0.02	2.54	***** ****
78/ 9/ 3	78246	14.0	4.11	52.	****	****	****	<1.0	****	180.	0.9	*****	0.003	0.024	0.98	<0.02	2.24	***** 12.5
78/ 9/18	78261	****	4.32	47.	****	****	****	<1.0	****	176.	0.7	*****	0.018	0.035	0.95	<0.02	2.52	***** ****
78/10/15	78288	9.2	4.09	52.	****	****	****	<1.0	****	133.	0.7	2.4	0.005	0.026	0.94	<0.02	2.60	0. 14.5
78/11/12	78316	****	4.38	42.	****	****	****	<1.0	****	162.	0.9	*****	0.009	0.020	0.88	<0.02	2.22	***** ****
78/12/16	78350	3.5	3.91	47.	****	****	****	<1.0	****	145.	1.2	*****	*****	0.036	1.00	<0.02	2.40	***** 20.5
79/ 2/12	79043	****	4.93	60.	****	****	****	1.0	****	156.	1.9	*****	0.004	0.024	0.66	<0.02	1.84	***** ****
79/ 3/ 3	79062	1.5	4.30	53.	****	****	****	<1.0	****	151.	2.8	*****	0.011	0.040	1.05	<0.02	2.30	***** 26.5
79/ 4/ 1	79091	****	4.14	53.	****	****	****	<1.0	****	145.	1.2	*****	0.004	0.020	0.96	<0.02	2.20	***** ****
79/ 4/21	79111	1.9	3.98	54.	****	****	****	<1.0	****	165.	1.5	*****	0.006	0.020	1.00	<0.02	2.12	***** 3.5
79/ 5/ 7	79127	****	4.26	52.	****	****	****	<1.0	****	163.	1.3	*****	0.009	0.050	0.94	<0.02	2.00	***** ****
79/ 5/19	79139	5.8	4.08	51.	****	****	****	<1.0	****	158.	1.4	3.2	0.003	0.050	1.08	<0.02	2.24	***** 12.0
79/ 6/ 5	79156	****	4.24	40.	****	****	****	1.2	****	153.	0.6	*****	0.011	0.050	0.88	<0.02	2.08	***** ****
79/ 6/16	79167	10.0	4.04	53.	****	****	****	****	****	166.	****	*****	0.021	0.022	1.12	<0.02	2.06	***** 10.5
79/ 7/ 2	79183	****	****	52.	****	****	****	<1.0	****	151.	****	*****	*****	0.040	****	*****	*****	*****
79/ 7/16	79197	12.1	4.05	53.	****	****	****	<1.0	****	159.	1.5	*****	0.023	0.050	1.20	<0.02	2.48	***** 10.4
79/ 7/30	79211	****	5.31	56.	****	****	****	****	****	146.	1.0	*****	0.011	0.050	0.90	<0.02	2.12	***** ****
79/ 8/11	79223	14.3	4.11	47.	****	****	****	<1.0	0.0	159.	1.5	*****	0.016	0.020	1.04	<0.02	2.48	***** 11.6
79/ 8/27	79239	****	4.14	49.	****	****	****	<1.0	****	148.	1.6	*****	0.015	0.030	1.04	<0.02	2.16	***** ****
79/ 9/ 8	79251	12.9	4.16	50.	****	****	****	<1.0	****	158.	1.4	*****	0.017	0.040	1.15	<0.02	2.16	***** 13.7
79/ 9/23	79266	****	4.50	51.	****	****	****	1.9	****	150.	1.4	*****	0.009	0.040	1.04	<0.02	2.32	***** ****
79/10/ 6	79279	10.8	4.13	54.	****	****	****	<1.0	****	164.	1.2	*****	*****	0.040	1.16	<0.02	2.32	***** 15.1
79/10/21	79294	****	4.41	52.	****	****	****	3.6	****	157.	2.0	*****	0.008	0.020	1.24	<0.02	2.36	***** ****
79/11/ 3	79307	6.8	4.32	50.	****	****	****	<1.0	****	144.	1.5	3.5	0.007	0.050	1.04	<0.02	2.24	***** 10.8

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.7 meter well at site 32.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHQ	ALK MG/L	TRCA-HARD AS CALCS	CL <---	DO	OD	BD05	BD020	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->I	F COL /100ML	WATER TABLE CM
77/10/ 6	77279	****	4.04	75.	****	****	****	7.2	****	****	2.5	****	0.056	0.066	1.92	0.74	2.56	0. ****
77/10/15	77283	****	3.77	72.	****	****	****	1.9	****	****	4.3	****	0.034	0.083	1.00	0.50	1.64	0. ****
77/12/29	77353	3.0	5.03	44.	****	****	****	<1.0	****	124.	1.6	****	0.002	0.030	1.00	0.05	****	****
78/ 2/12	78043	****	3.91	53.	****	****	****	<1.0	****	120.	1.1	4.5	****	0.040	0.79	<0.02	1.48	****
78/ 3/ 4	78063	0.2	3.97	56.	****	****	****	<1.0	****	113.	0.8	****	0.004	0.190	0.55	<0.02	2.12	****
78/ 3/20	78079	****	3.89	68.	****	****	****	<1.0	****	133.	0.4	****	0.004	0.033	0.16	<0.02	1.57	****
78/ 4/ 2	78092	****	4.06	53.	****	****	****	<1.0	****	152.	0.6	****	0.004	0.059	0.37	<0.02	1.70	0. ****
78/ 4/17	78107	****	3.99	61.	****	****	****	<1.0	****	132.	0.7	****	0.013	****	0.35	<0.02	1.04	****
78/ 5/ 7	78127	6.0	3.80	62.	****	****	****	1.0	****	123.	0.9	2.0	0.007	0.026	0.37	<0.02	1.54	****
78/ 5/21	78141	****	4.03	54.	****	****	****	<1.0	****	125.	0.9	****	0.029	0.043	0.64	<0.02	1.83	****
78/ 6/ 6	78157	****	4.05	54.	****	****	****	<1.0	****	144.	0.4	****	0.014	0.050	0.53	<0.02	1.72	****
78/ 6/20	78171	****	3.92	55.	****	****	****	<1.0	****	144.	0.7	****	0.016	0.016	0.59	<0.02	1.58	****
78/ 7/ 4	78185	10.5	4.10	50.	****	****	****	<1.0	0.0	144.	1.0	****	0.017	0.023	0.46	<0.02	1.24	42. ****
78/ 7/17	78193	****	4.13	49.	****	****	****	<1.0	****	152.	0.9	****	0.007	0.016	0.54	<0.02	1.84	****
78/ 8/ 2	78214	12.5	4.11	54.	****	****	****	<1.0	****	154.	1.0	****	0.006	0.020	0.66	<0.02	2.04	25. ****
78/ 8/16	78223	****	4.04	52.	****	****	****	<1.0	****	154.	1.0	****	0.009	0.039	****	<0.02	2.16	****
78/ 9/ 3	78246	13.3	3.93	57.	****	****	****	<1.0	****	154.	0.5	****	0.003	0.020	0.61	<0.02	1.38	0. ****
78/ 9/13	78261	****	4.09	57.	****	****	****	<1.0	****	175.	0.7	****	0.003	0.025	0.63	<0.02	1.82	****
78/10/15	78283	9.0	3.98	52.	****	****	****	<1.0	****	125.	0.7	2.0	0.005	0.026	1.00	<0.02	2.72	0. ****
78/11/12	78316	****	4.37	40.	****	****	****	<1.0	****	151.	0.8	****	0.007	0.020	0.93	<0.02	2.32	****
78/12/16	78350	3.7	3.87	45.	****	****	****	<1.0	****	135.	1.2	****	****	0.023	1.10	<0.02	2.28	****
79/ 2/12	79043	****	4.53	47.	****	****	****	<1.0	****	145.	0.6	****	0.005	0.024	0.69	<0.02	1.06	****
79/ 3/ 3	79062	1.8	4.12	47.	****	****	****	<1.0	****	143.	1.4	****	0.017	0.040	1.03	<0.02	2.18	****
79/ 4/ 1	79091	****	3.95	53.	****	****	****	<1.0	****	141.	0.9	****	0.004	0.010	0.82	<0.02	2.04	****
79/ 4/21	79111	2.5	3.91	53.	****	****	****	<1.0	****	149.	0.9	****	0.003	0.010	0.76	<0.02	1.76	****
79/ 5/ 7	79127	****	4.26	48.	****	****	****	<1.0	****	146.	1.0	****	0.002	0.035	0.82	<0.02	1.76	****
79/ 5/19	79139	6.9	3.97	53.	****	****	****	<1.0	****	139.	0.9	2.6	0.004	0.035	0.86	<0.02	1.94	****
79/ 6/ 5	79156	****	4.05	41.	****	****	****	1.3	****	137.	0.6	****	0.012	0.030	0.96	<0.02	2.12	****
79/ 6/16	79167	8.1	3.94	53.	****	****	****	****	****	147.	****	****	0.020	0.022	0.96	<0.02	1.80	****
79/ 7/ 2	79183	****	****	54.	****	****	****	2.7	****	132.	****	****	****	0.030	****	****	****	****
79/ 7/16	79197	11.1	3.91	61.	****	****	****	<1.0	****	150.	1.1	****	0.021	0.030	1.04	<0.02	2.28	****
79/ 7/30	79211	****	4.32	57.	****	****	****	****	****	140.	0.8	****	0.006	0.015	0.90	<0.02	2.08	****
79/ 8/11	79223	13.8	3.95	54.	****	****	****	<1.0	0.0	155.	1.1	****	0.012	0.030	0.86	<0.02	2.24	****
79/ 8/27	79239	****	4.06	50.	****	****	****	1.8	****	155.	1.1	****	0.025	0.040	1.12	<0.02	2.16	****
79/ 9/ 8	79251	12.6	4.00	46.	****	****	****	2.3	****	133.	0.8	****	0.022	0.030	0.93	<0.02	1.96	****
79/ 9/23	79266	****	4.15	54.	****	****	****	1.7	****	143.	1.3	****	0.009	0.040	1.16	<0.02	2.24	****
79/10/ 6	79279	10.5	3.99	59.	****	****	****	2.3	****	120.	0.9	****	****	0.040	1.04	<0.02	2.06	****
79/10/21	79294	****	4.42	47.	****	****	****	3.7	****	136.	0.5	****	0.024	0.030	1.42	<0.02	2.44	****
79/11/ 3	79307	6.8	4.04	64.	****	****	****	4.2	****	111.	0.9	2.5	0.004	0.050	0.92	<0.02	2.12	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.7 meter well at site 33.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHQ	ALK MG/L AS CaCO3	T&A-HARD AS CaCO3	CL I----	DO	ORP	BOD5	BOD20	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->1	F COL /100ML	WATER TABLE CM
77/10/ 6	77279	****	3.95	75.	****	****	****	<1.0	****	****	2.0	****	0.013	0.026	2.31	0.38	2.34	0. ****
77/10/15	77288	****	4.46	55.	****	****	****	1.2	****	****	7.8	****	0.013	0.048	2.00	0.80	5.54	0. ****
77/11/18	77322	6.5	4.24	54.	****	****	****	<1.0	1.6	****	0.8	****	0.005	0.014	1.02	0.01	2.56	*****
78/ 2/12	78043	****	3.95	54.	****	****	****	1.0	****	137.	1.1	3.6	****	0.070	0.84	<0.02	1.84	*****
78/ 3/ 4	78063	1.8	3.97	54.	****	****	****	6.6	****	134.	0.8	****	****	0.110	0.91	<0.02	2.54	*****
78/ 3/20	78079	****	4.03	56.	****	****	****	<1.0	****	137.	0.9	****	0.006	0.034	0.85	<0.02	2.04	*****
78/ 4/ 2	78092	****	3.98	65.	****	****	****	<1.0	****	150.	0.8	****	0.008	0.047	0.70	<0.02	2.10	0. 7.5
78/ 4/17	78107	****	4.21	55.	****	****	****	<1.0	****	126.	1.6	****	0.012	0.012	0.61	<0.02	1.18	*****
78/ 5/ 7	78127	7.0	3.90	65.	****	****	****	1.0	****	127.	1.1	2.3	0.013	0.032	0.64	<0.02	1.96	*****
78/ 6/ 6	78157	****	4.16	52.	****	****	****	<1.0	****	134.	1.0	****	0.017	0.070	0.77	<0.02	2.00	*****
78/ 6/20	78171	****	3.99	56.	****	****	****	<1.0	****	143.	0.9	****	0.023	0.024	0.69	<0.02	1.80	*****
78/ 7/ 4	78185	8.7	4.00	58.	****	****	****	<1.0	****	144.	1.5	****	0.004	0.052	0.70	<0.02	1.56	*****
78/ 7/17	78198	****	4.31	46.	****	****	****	<1.0	****	150.	1.0	****	0.012	0.024	0.66	0.04	2.28	*****
78/ 8/ 2	78214	9.8	4.08	53.	****	****	****	<1.0	****	136.	1.3	****	0.012	0.024	0.65	<0.02	2.24	*****
78/ 8/16	78228	****	4.15	50.	****	****	****	<1.0	****	155.	1.1	****	0.012	0.056	****	<0.02	*****	*****
78/ 9/ 3	78246	10.5	3.98	63.	****	****	****	<1.0	****	157.	0.9	****	0.013	0.026	0.74	<0.02	2.02	*****
78/ 9/18	78261	****	4.12	51.	****	****	****	<1.0	****	185.	0.9	****	0.017	0.040	0.79	<0.02	2.28	*****
78/10/15	78288	8.3	4.00	56.	****	****	****	<1.0	****	133.	0.9	2.9	0.008	0.040	0.78	<0.02	2.72	0. 9.5
78/11/12	78316	****	4.49	39.	****	****	****	<1.0	****	159.	2.2	****	0.011	0.030	0.72	<0.02	2.50	*****
78/12/16	78350	5.0	3.66	49.	****	****	****	<1.0	****	145.	1.5	****	****	0.032	0.84	<0.02	2.16	*****
79/ 3/ 3	79062	3.0	4.12	50.	****	****	****	<1.0	****	140.	1.3	****	0.005	0.030	0.96	<0.02	2.18	*****
79/ 4/ 1	79091	****	3.99	57.	****	****	****	<1.0	****	133.	1.2	****	0.002	0.010	0.78	<0.02	1.96	*****
79/ 4/21	79111	3.1	3.66	60.	****	****	****	<1.0	****	139.	1.1	****	0.004	0.060	0.66	<0.02	2.48	*****
79/ 5/ 7	79127	****	4.16	50.	****	****	****	<1.0	****	126.	2.2	****	0.006	0.045	0.64	<0.02	1.44	*****
79/ 5/19	79139	5.6	3.94	56.	****	****	****	<1.0	****	****	1.0	3.0	0.004	0.030	0.58	<0.02	1.58	*****
79/ 6/ 5	79156	****	4.10	41.	****	****	****	1.3	****	129.	0.8	****	0.013	0.035	0.60	<0.02	1.84	*****
79/ 6/16	79167	6.3	3.95	52.	****	****	****	****	****	147.	****	****	0.017	0.030	0.60	<0.02	1.54	*****
79/ 7/ 2	79183	****	****	40.	****	****	****	<1.0	****	167.	****	****	****	0.030	****	****	*****	****
79/ 7/16	79197	7.9	3.87	56.	****	****	****	1.3	****	147.	1.3	****	0.018	0.020	0.70	<0.02	1.96	*****
79/ 7/30	79211	****	4.07	61.	****	****	****	****	****	154.	1.2	****	0.011	0.015	0.64	<0.02	1.80	*****
79/ 8/11	79223	11.0	3.65	30.	****	****	****	5.1	****	123.	1.2	****	0.006	0.020	0.54	<0.02	2.08	*****
79/ 8/27	79239	****	4.04	63.	****	****	****	7.1	****	124.	1.2	****	0.007	0.030	0.58	<0.02	1.64	*****
79/ 9/ 8	79251	9.7	3.90	74.	****	****	****	12.5	****	128.	0.9	****	0.020	0.050	0.72	<0.02	1.96	*****
79/ 9/23	79266	****	4.11	71.	****	****	****	7.6	****	126.	1.3	****	0.008	0.030	0.60	<0.02	1.84	*****
79/10/ 6	79279	9.5	3.81	80.	****	****	****	8.0	****	127.	1.0	****	****	0.035	0.68	<0.02	1.80	*****
79/10/21	79294	****	4.40	70.	****	****	****	13.7	****	114.	1.3	****	0.009	0.030	0.66	<0.02	1.80	*****
79/11/ 3	79307	7.0	3.81	110.	****	****	****	15.5	****	88.	1.2	3.3	0.003	0.030	0.56	<0.02	1.56	*****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 0.7 meter well at site 34.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND U/MH	ALK MG/L	TOTAL-HARD AS CaCO3	CL I<---	DO	ORP	SD05	SD020	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->I	F CUL /100ML	WATER TABLE CM
77/10/ 6	77279	****	4.10	52.	****	****	****	<1.0	****	****	2.9	****	0.002	0.098	0.88	0.24	2.73	0. ****
77/10/15	77288	****	4.53	54.	****	****	****	<1.0	****	****	3.2	****	0.001	0.090	1.10	0.20	3.02	0. ****
78/ 6/20	78171	****	4.27	44.	****	****	****	<1.0	****	165.	1.4	****	0.017	0.068	0.45	<0.02	1.96	*****
78/ 7/ 4	78185	9.3	4.04	51.	****	****	****	<1.0	****	165.	1.4	****	0.003	0.044	0.42	<0.02	1.44	*****
78/ 7/17	78193	****	4.96	38.	****	****	****	<1.0	****	189.	1.2	****	0.007	0.028	0.32	<0.02	2.44	*****
78/ 8/ 2	78214	10.8	4.07	53.	****	****	****	<1.0	****	173.	1.1	****	0.027	0.036	0.37	<0.02	2.24	*****
78/ 8/16	78228	****	3.96	53.	****	****	****	<1.0	****	172.	2.5	****	0.005	0.041	****	<0.02	2.20	*****
78/ 9/ 3	78246	10.8	4.01	59.	****	****	****	<1.0	****	150.	1.0	****	0.006	0.026	0.41	<0.02	1.74	*****
78/ 9/18	78261	****	4.50	42.	****	****	****	<1.0	****	191.	0.8	****	0.030	0.050	0.41	<0.02	1.86	*****
78/10/15	78288	8.0	3.95	55.	****	****	****	<1.0	****	142.	1.0	2.7	0.004	0.034	0.46	<0.02	2.00	*****
78/12/16	78350	5.0	3.63	52.	****	****	****	<1.0	****	161.	1.3	****	****	0.032	1.62	<0.02	1.86	*****
79/ 3/ 3	79062	3.5	4.03	51.	****	****	****	<1.0	****	151.	1.3	****	0.003	0.030	0.52	<0.02	1.72	*****
79/ 4/ 1	79091	****	4.07	52.	****	****	****	<1.0	****	144.	1.0	****	0.001	0.020	0.54	<0.02	1.76	*****
79/ 4/21	79111	5.1	3.84	53.	****	****	****	<1.0	****	164.	1.0	****	0.004	0.030	0.55	<0.02	1.88	*****
79/ 5/ 7	79127	****	4.02	55.	****	****	****	1.0	****	161.	1.1	****	0.001	0.040	0.62	<0.02	1.56	*****
79/ 5/19	79139	6.0	3.97	54.	****	****	****	<1.0	****	162.	0.8	2.6	0.003	0.035	0.50	<0.02	1.72	*****
79/ 6/ 5	79156	****	4.25	40.	****	****	****	<1.0	****	154.	0.8	****	0.011	0.040	0.42	<0.02	2.04	*****
79/ 6/16	79167	7.0	3.84	61.	****	****	****	****	****	175.	****	****	0.016	0.030	0.54	<0.02	1.56	*****
79/ 7/ 2	79183	****	****	44.	****	****	****	<1.0	****	162.	****	****	****	0.040	****	****	*****	
79/ 7/16	79197	7.6	3.81	71.	****	****	****	<1.0	****	165.	1.0	****	0.008	0.040	0.63	<0.02	1.92	*****
79/ 7/30	79211	****	4.34	50.	****	****	****	****	****	161.	0.8	****	0.005	0.030	0.44	<0.02	2.12	*****
79/ 8/11	79223	9.7	3.88	51.	****	****	****	<1.0	****	166.	1.1	****	0.006	0.020	0.50	<0.02	2.20	*****
79/ 8/27	79239	****	3.92	55.	****	****	****	<1.0	****	165.	1.1	****	0.015	0.030	0.46	<0.02	1.84	*****
79/ 9/ 8	79251	9.4	3.90	42.	****	****	****	<1.0	****	165.	0.8	****	0.010	0.040	0.52	<0.02	1.84	*****
79/ 9/23	79266	****	4.12	57.	****	****	****	1.6	****	161.	1.1	****	0.005	0.030	0.50	<0.02	1.80	*****
79/10/ 6	79279	9.2	3.85	65.	****	****	****	<1.0	****	163.	1.0	****	****	0.035	0.56	<0.02	2.00	*****
79/10/21	79294	****	4.09	50.	****	****	****	1.4	****	161.	0.7	****	0.005	0.025	0.58	<0.02	1.84	*****
79/11/ 3	79307	7.6	3.89	69.	****	****	****	<1.0	****	153.	1.2	3.4	0.004	0.035	0.50	<0.02	1.84	*****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 2.3 meter well at site 11.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMH0	ALK MG/L	TACA-HARD AS	CL CAS03	DO I<---	CO0	BO05	BO020	GRTH0 MG/L	T-P	NH4	NO23	KJLON --->I	F COL /100ML	WATER TABLE CM
77/10/ 6	77279	****	4.71	43.	****	****	****	1.3	****	****	3.0	****	0.080	0.158	3.74	0.35	3.80	0. ****
77/12/29	77363	****	5.08	47.	****	****	****	1.4	****	392.	1.3	****	0.006	0.058	2.00	0.04	****	****
78/ 2/12	78043	****	5.28	32.	****	****	****	<1.0	****	72.	1.3	3.4	****	0.035	1.10	<0.02	1.74	****
78/ 3/ 4	78063	****	5.20	36.	****	****	****	1.7	****	94.	0.8	****	0.001	0.040	1.75	<0.02	2.44	****
78/ 4/ 2	78092	****	5.38	35.	****	****	****	<1.0	0.1	120.	0.4	****	0.009	0.057	1.63	<0.02	2.50	0. ****
78/ 4/17	78107	****	5.47	29.	****	****	****	<1.0	****	86.	2.0	****	0.001	0.028	1.15	<0.02	1.34	****
78/ 5/ 7	78127	9.0	5.10	34.	****	****	****	1.0	****	97.	0.9	2.2	0.018	0.044	1.05	<0.02	2.32	****
78/ 5/21	78141	****	6.01	37.	****	****	****	<1.0	****	90.	1.8	****	0.010	0.012	1.40	<0.02	2.00	****
78/ 6/ 6	78157	****	4.75	35.	****	****	****	1.1	****	89.	0.6	****	0.019	0.038	1.84	<0.02	2.42	****
78/ 6/20	78171	****	4.91	28.	****	****	****	<1.0	****	90.	1.2	****	0.002	0.020	0.75	<0.02	1.90	****
78/ 7/ 4	78185	10.2	4.96	27.	****	****	****	<1.0	0.3	87.	1.3	****	0.034	0.044	1.20	<0.02	1.68	****
78/ 7/17	78198	****	5.99	43.	****	****	****	1.6	****	103.	1.0	****	0.023	0.024	0.95	<0.02	2.16	****
78/ 8/ 2	78214	12.5	5.27	30.	****	****	****	2.3	****	88.	2.1	****	0.014	0.020	1.00	<0.02	2.24	****
78/ 8/16	78228	****	5.46	40.	****	****	****	****	****	106.	1.1	****	0.006	0.014	****	<0.02	1.88	****
78/ 9/ 3	78246	****	5.02	28.	****	****	****	<1.0	****	154.	0.6	****	0.013	0.013	1.30	<0.02	2.16	0. ****
78/ 9/18	78261	****	5.38	44.	****	****	****	<1.0	****	111.	0.8	****	0.007	0.020	1.30	<0.02	****	****
78/10/15	78283	****	5.19	29.	****	****	****	****	****	88.	****	****	0.004	0.028	1.40	<0.02	2.32	0. ****
78/11/12	78316	****	5.75	58.	****	****	****	1.4	****	112.	0.9	****	0.014	0.020	0.54	<0.02	1.48	****
78/12/16	78350	5.8	5.42	42.	****	****	****	<1.0	****	85.	1.0	****	****	0.024	1.35	<0.02	2.16	****
79/ 1/21	79111	6.4	5.09	32.	****	****	****	<1.0	****	77.	0.8	****	0.005	0.020	1.65	<0.02	2.24	****
79/ 5/ 7	79127	****	5.90	51.	****	****	****	<1.0	****	90.	2.1	****	0.002	0.035	1.14	<0.02	1.84	****
79/ 5/19	79139	8.0	4.87	31.	****	****	****	<1.0	****	91.	1.5	4.0	0.002	0.020	1.70	<0.02	****	****
79/ 6/ 5	79156	****	5.17	38.	****	****	****	1.0	****	84.	0.6	****	0.006	0.007	1.58	<0.02	2.28	****
79/ 6/16	79167	8.0	4.87	34.	****	****	****	****	****	89.	****	****	0.010	0.010	1.72	<0.02	2.04	****
79/ 7/ 2	79183	****	****	45.	****	****	****	-1.1	****	83.	****	****	****	0.030	****	****	****	****
79/ 7/16	79197	8.2	5.06	23.	****	****	****	<1.0	****	90.	1.2	****	0.008	0.010	0.90	<0.02	2.32	****
79/ 7/30	79211	****	4.91	34.	****	****	****	****	****	103.	0.7	****	0.006	0.010	1.12	<0.02	1.76	****
79/ 8/11	79223	10.2	4.99	26.	****	****	****	<1.0	0.0	84.	1.5	****	0.008	0.010	1.50	<0.02	2.56	****
79/ 8/27	79239	****	5.84	54.	****	****	****	****	****	90.	1.0	****	0.016	0.020	1.26	<0.02	1.88	****
79/ 9/ 8	79251	9.1	4.98	30.	****	****	****	<1.0	****	83.	0.9	****	0.008	0.030	1.54	<0.02	2.08	****
79/ 9/23	79266	****	5.44	47.	****	****	****	****	****	87.	0.9	****	0.009	0.020	1.54	<0.02	2.20	****
79/10/ 6	79279	7.3	5.04	32.	****	****	****	<1.0	****	65.	1.0	****	****	0.025	1.54	<0.02	2.16	****
79/10/21	79294	****	5.66	52.	****	****	****	****	****	92.	0.9	****	0.003	0.020	1.62	<0.02	2.28	****
79/11/ 3	79307	6.0	5.07	68.	****	****	****	<1.0	****	80.	1.8	3.6	0.006	0.025	1.58	<0.02	2.12	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 2.3 meter well at site 14.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UNHO	ALK MG/L	TCA-CHLORIDE AS CARBONATES	CL I<---	DO	CO <sub>2</sub>	BO <sub>5</sub>	BO <sub>20</sub>	QRTHO MG/L	T-P	NH <sub>4</sub>	NO <sub>3</sub>	KJLDN --->I	F COL /100ML	WATER TABLE CM	
77/10/ 6	77279	****	4.61	54.	****	****	****	1.4	****	****	4.4	****	0.050	0.116	5.00	0.32	5.46	0. ****	
77/11/18	77322	6.0	4.71	50.	****	****	****	3.1	****	****	****	****	0.026	0.210	2.90	0.02	4.00	*****	
77/12/29	77363	5.0	4.48	51.	****	****	****	5.2	****	127.	1.7	****	0.006	0.124	2.65	0.04	****	*****	
78/ 2/12	78043	****	4.75	42.	****	****	****	1.1	****	135.	1.4	2.1	****	0.025	2.25	<0.02	1.98	*****	
78/ 3/ 4	78063	****	4.50	42.	****	****	****	1.0	****	116.	1.1	****	0.016	0.060	2.40	<0.02	3.66	*****	
78/ 3/20	78079	****	4.68	45.	****	****	****	1.5	****	130.	1.3	****	0.004	0.034	1.85	<0.02	2.68	*****	
78/ 4/ 2	78092	****	4.96	42.	****	****	****	1.0	****	137.	1.0	****	0.015	0.051	2.25	<0.02	3.24	0. ****	
78/ 4/17	78107	****	4.96	38.	****	****	****	<1.0	****	114.	1.1	****	0.002	0.100	1.90	<0.02	2.48	*****	
78/ 5/ 7	78127	8.0	4.70	44.	****	****	****	1.2	****	117.	1.1	2.3	****	0.026	****	1.90	<0.02	3.42	*****
78/ 5/21	78141	****	4.91	39.	****	****	****	<1.0	****	107.	1.1	****	0.024	0.047	0.97	<0.02	3.40	*****	
78/ 6/ 6	78157	****	4.75	43.	****	****	****	1.2	****	117.	1.5	****	0.023	0.035	1.12	<0.02	3.18	*****	
78/ 6/20	78171	****	4.64	37.	****	****	****	<1.0	****	123.	0.9	****	0.008	0.016	1.50	<0.02	2.64	*****	
78/ 7/ 4	78185	8.1	4.76	40.	****	****	****	1.0	0.0	126.	1.7	****	0.031	0.040	1.80	<0.02	2.72	0. ****	
78/ 7/17	78198	****	4.65	40.	****	****	****	<1.0	****	122.	1.4	****	0.031	0.032	1.42	<0.02	3.12	*****	
78/ 8/ 2	78214	9.3	4.92	48.	****	****	****	1.1	0.0	123.	2.3	****	0.031	0.032	2.20	<0.02	3.64	1. ****	
78/ 8/16	78228	****	4.82	45.	****	****	****	<1.0	****	120.	0.9	****	0.004	0.027	****	<0.02	3.16	*****	
78/ 9/ 3	78246	11.1	4.77	43.	****	****	****	<1.0	****	152.	1.1	****	0.017	0.020	1.80	<0.02	3.16	0. ****	
78/ 9/18	78261	****	4.60	45.	****	****	****	<1.0	****	141.	1.1	****	0.015	0.030	2.05	<0.02	3.20	*****	
78/10/15	78288	8.0	4.85	42.	****	****	****	<1.0	****	126.	1.3	3.1	****	0.030	0.049	2.25	<0.02	3.56	0. ****
78/11/12	78316	****	4.77	36.	****	****	****	****	****	115.	1.0	****	0.014	0.040	1.12	<0.02	3.12	*****	
78/12/16	78350	3.5	4.92	42.	****	****	****	<1.0	****	113.	1.3	****	****	0.044	2.20	<0.02	3.40	*****	
79/ 3/ 3	79062	4.5	5.14	52.	****	****	****	1.0	****	121.	2.3	****	0.024	0.060	2.00	<0.02	2.30	*****	
79/ 4/ 1	79091	****	4.99	47.	****	****	****	1.0	****	114.	0.9	****	0.015	0.030	2.18	<0.02	3.20	*****	
79/ 4/21	79111	5.4	4.63	40.	****	****	****	<1.0	****	108.	1.1	****	0.015	0.030	2.40	<0.02	3.28	*****	
79/ 5/ 7	79127	****	4.77	46.	****	****	****	<1.0	****	117.	2.0	****	0.013	0.040	2.03	<0.02	2.88	*****	
79/ 5/19	79139	6.6	4.64	45.	****	****	****	<1.0	****	122.	1.1	2.3	****	0.014	0.043	2.20	<0.02	****	*****
79/ 6/ 5	79156	****	4.42	34.	****	****	****	1.4	****	115.	0.7	****	0.005	0.010	2.14	<0.02	3.00	*****	
79/ 6/16	79167	7.2	4.77	49.	****	****	****	****	****	126.	****	****	0.041	0.043	****	<0.02	2.88	*****	
79/ 7/ 2	79183	****	****	45.	****	****	****	<1.0	****	113.	****	****	****	0.040	****	****	****	*****	
79/ 7/16	79197	7.7	4.73	47.	****	****	****	1.1	****	121.	1.3	****	0.043	0.060	0.85	<0.02	3.66	*****	
79/ 7/30	79211	****	4.54	45.	****	****	****	****	****	124.	1.0	****	0.007	0.010	1.78	<0.02	2.80	*****	
79/ 8/11	79223	8.7	4.77	41.	****	****	****	<1.0	0.0	113.	2.3	****	0.043	0.050	2.30	<0.02	3.28	*****	
79/ 8/27	79239	****	4.73	41.	****	****	****	<1.0	****	139.	1.2	****	0.048	0.050	2.40	<0.02	3.16	*****	
79/ 9/ 8	79251	8.9	4.69	45.	****	****	****	1.2	****	111.	1.3	****	0.039	0.040	2.34	<0.02	3.20	*****	
79/ 9/23	79266	****	4.67	40.	****	****	****	1.1	****	119.	1.7	****	0.014	0.020	2.20	<0.02	3.08	*****	
79/10/ 6	79279	8.6	4.64	47.	****	****	****	<1.0	****	106.	1.4	****	****	0.055	2.60	<0.02	3.36	*****	
79/10/21	79294	****	4.84	43.	****	****	****	<1.0	****	124.	4.2	****	0.025	0.025	2.90	<0.02	3.40	*****	
79/11/ 3	79307	7.5	4.64	49.	****	****	****	1.7	****	106.	1.5	3.5	****	0.050	1.15	<0.02	3.28	*****	

APPENDIX A continued

Water quality data for the Drummond treatment bog: the 2.3 meter well at site 32.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMH0	ALK MG/L	TRCA-HARD AS	CL CAC03	CL I<---	DO	CO0	B005	B0020	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->I	F COL /100ML	WATER TABLE CM
77/12/29	77363	****	4.54	60.	****	****	****	2.6	****	222.	1.2	****	0.065	0.076	2.75	0.05	****	*****	****
78/ 6/20	78171	****	4.93	37.	****	****	****	<1.0	****	140.	0.3	****	0.015	0.044	1.60	<0.02	2.86	*****	****
78/ 7/ 4	78185	8.7	4.20	37.	****	****	****	<1.0	0.0	141.	1.5	****	0.037	0.064	1.30	<0.02	2.96	1.	****
79/ 2/12	79043	****	4.99	45.	****	****	****	<1.0	****	141.	1.0	****	0.007	0.036	1.10	<0.02	3.20	*****	****

APPENDIX A continued

Water quality data for the Drummond treatment bog: the bog discharge at weir site 60.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHQ	ALK MG/L	T&CA-HARD AS	CL CAPSS	TL I<---	DO	CO3	BR05	BOD20	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->I	F COL /100ML	TSS MG/L
77/10/ 6	77279	****	4.13	50.	****	****	****	1.6	****	****	1.4	****	0.018	0.022	0.24	0.24	1.68	0.	****
77/10/15	77298	6.0	3.80	54.	****	****	****	<1.0	4.2	****	0.4	****	0.018	0.040	0.30	0.40	0.50	0.	****
77/11/18	77322	2.5	4.01	47.	****	****	****	<1.0	2.6	****	0.7	****	0.036	0.152	0.17	0.02	2.00	*****	****
77/12/29	77363	****	3.90	48.	****	****	****	1.1	****	140.	1.0	****	0.028	0.036	0.09	0.06	0.75	*****	****
78/ 4/ 2	78092	****	4.14	56.	****	****	****	1.6	****	102.	0.7	****	0.021	0.043	0.09	<0.02	0.64	0.	****
78/ 5/ 7	78127	****	4.40	38.	****	****	****	<1.0	****	92.	0.7	1.4	0.038	0.038	0.03	0.02	0.76	*****	****
78/ 6/ 6	78157	****	4.09	37.	****	****	****	<1.0	****	117.	1.3	****	0.021	0.042	0.06	<0.02	1.14	*****	****
78/ 7/ 4	78185	18.6	4.19	41.	****	****	****	<1.0	****	133.	1.3	****	0.011	0.044	0.01	<0.02	0.56	4.	****
78/ 7/17	78198	****	4.25	42.	****	****	****	<1.0	****	140.	1.4	****	0.011	0.036	0.01	<0.02	1.20	*****	****
78/ 8/ 2	78214	24.7	4.41	37.	****	****	****	<1.0	****	136.	1.9	****	0.025	0.052	<0.02	<0.02	2.00	*****	10.5
78/ 8/16	78228	****	4.13	51.	****	****	****	****	****	137.	1.8	****	0.013	0.104	****	0.08	1.36	*****	****
78/ 9/ 3	78246	22.8	4.14	48.	0.	****	****	<1.0	0.0	153.	1.2	****	0.025	0.040	<0.02	<0.02	1.28	0.	1.0
78/10/15	78298	6.5	4.09	46.	****	****	10.	<1.0	1.5	134.	1.1	2.9	0.020	0.039	0.01	<0.02	1.40	0.	0.0
78/11/12	78316	****	4.14	38.	****	****	****	<1.0	****	126.	1.2	****	0.019	0.030	0.01	<0.02	0.92	*****	0.8
78/12/16	78350	0.1	3.87	41.	****	****	****	<1.0	****	119.	1.4	****	****	0.048	0.04	<0.02	0.92	*****	0.5
79/ 4/21	79111	1.6	4.03	38.	0.	12.	6.	<1.0	****	52.	0.8	****	0.005	0.010	0.13	<0.02	0.52	0.	****
79/ 5/ 7	79127	****	4.15	42.	0.	5.	****	<1.0	****	75.	1.2	****	0.002	0.025	<0.02	<0.02	0.60	*****	1.5
79/ 5/19	79139	15.1	4.15	37.	0.	9.	6.	<1.0	****	91.	0.6	1.9	0.004	0.010	<0.02	<0.02	0.88	0.	0.5
79/ 6/ 5	79156	****	4.01	29.	0.	9.	6.	1.2	****	93.	1.1	****	0.019	0.055	<0.02	<0.02	1.20	*****	0.0
79/ 6/16	79167	16.8	4.07	39.	0.	10.	6.	****	****	101.	****	****	0.021	0.060	0.02	<0.02	0.88	1.	0.5
79/ 7/ 2	79183	****	****	45.	****	13.	8.	<1.0	****	117.	****	****	****	0.050	****	****	****	****	****
79/ 7/16	79197	18.4	3.93	60.	0.	14.	6.	4.2	****	107.	1.0	****	0.022	0.050	0.05	<0.02	1.04	1.	0.8
79/ 7/30	79211	****	4.02	30.	0.	12.	3.	****	****	110.	1.8	****	0.007	0.045	0.02	<0.02	1.32	*****	1.0
79/ 3/11	79223	24.0	4.15	64.	0.	15.	9.	6.9	****	98.	2.3	****	0.012	0.040	<0.02	<0.02	0.88	*****	0.9
79/ 8/27	79239	****	3.94	75.	0.	12.	3.	20.0	****	86.	1.2	****	0.011	0.030	<0.02	<0.02	0.68	*****	1.0
79/ 9/ 8	79251	13.8	4.09	71.	0.	16.	9.	25.0	****	99.	1.9	****	0.018	0.045	<0.02	<0.02	1.12	1.	1.5
79/ 9/23	79266	****	4.20	39.	0.	16.	8.	13.3	****	87.	1.7	****	0.005	0.030	0.04	<0.02	0.96	*****	1.3
79/10/ 6	79279	9.6	4.07	83.	0.	17.	8.	13.5	****	39.	1.7	****	****	0.055	0.02	<0.02	0.90	0.	1.5
79/10/21	79294	****	4.11	32.	0.	15.	7.	21.5	****	80.	1.7	****	0.004	0.020	<0.02	<0.02	0.96	*****	1.3
79/11/ 3	79307	3.8	3.92	98.	0.	17.	7.	15.2	****	71.	1.0	3.0	0.011	0.020	0.04	<0.02	0.84	0.	0.2

APPENDIX A continued

Water quality data for the Drummond treatment bog: the lagg at site 67 (A) and site 68 (B).

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHO	ALK MG/L	T&CA-HARD AS	CL CAC03	CL I<---	DO	ODD	9935	80020	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->I	F COL /100ML	TSS MG/L
<b>A</b>																			
79/ 5/19	79139	****	4.37	27.	****	****	****	<1.0	****	95.	0.7	2.1	0.004	0.025	<0.02	<0.02	0.74	*****	****
79/ 6/16	79167	16.2	4.32	30.	****	****	****	****	****	107.	****	****	0.019	0.030	0.04	<0.02	0.88	*****	****
79/ 7/ 2	79183	****	****	61.	****	****	****	1.4	****	****	****	****	****	****	****	****	****	****	****
79/ 7/16	79197	16.8	4.40	34.	****	****	****	<1.0	****	113.	1.2	****	0.023	0.050	0.05	<0.02	1.20	*****	****
79/ 7/30	79211	****	4.92	47.	****	****	****	****	****	176.	10.4	****	0.109	0.205	<0.02	<0.02	1.56	*****	****
79/ 8/11	79223	18.5	4.56	39.	****	****	****	<1.0	****	124.	1.8	****	0.026	0.030	<0.02	<0.02	1.56	*****	****
79/ 8/27	79239	****	4.46	32.	****	****	****	<1.0	****	119.	1.7	****	0.033	0.040	<0.02	<0.02	1.08	*****	****
79/ 9/ 8	79251	11.1	4.43	35.	****	****	****	<1.0	****	121.	1.6	****	0.030	0.040	<0.02	<0.02	1.24	*****	****
79/ 9/23	79266	****	4.81	37.	****	****	****	1.8	****	140.	5.0	****	0.033	0.070	0.04	<0.02	1.48	*****	****
79/10/ 6	79279	9.2	4.23	43.	****	****	****	1.5	****	122.	2.2	****	****	0.085	0.04	<0.02	1.38	*****	****
79/10/21	79294	****	4.51	36.	****	****	****	1.9	****	137.	2.8	****	0.043	0.065	<0.02	<0.02	1.28	*****	****
79/11/ 3	79307	2.4	4.39	45.	****	****	****	2.3	****	96.	1.3	3.9	0.015	0.035	<0.02	<0.02	0.96	*****	****
<b>B</b>																			
78/ 8/ 2	78214	17.1	4.47	43.	****	****	****	<1.0	****	157.	1.7	****	0.111	0.344	0.33	<0.02	3.92	*****	****
78/ 9/ 3	78246	18.0	4.43	39.	****	****	****	<1.0	****	110.	1.0	****	0.045	0.082	0.07	<0.02	1.76	*****	****
78/10/15	78288	5.0	4.31	46.	****	****	****	3.9	****	134.	5.7	12.2	0.092	0.132	0.05	<0.02	1.56	23.	****
79/ 4/21	79111	6.8	4.35	32.	0.	10.	6.	<1.0	****	54.	1.2	****	0.007	0.050	0.03	<0.02	1.00	*****	****
79/ 5/19	79139	****	4.44	29.	****	****	****	<1.0	****	89.	0.7	2.3	0.008	0.050	<0.02	<0.02	0.90	*****	****
79/ 6/16	79167	17.0	4.30	32.	****	****	****	****	****	118.	****	****	0.026	0.040	0.02	<0.02	1.10	*****	****
79/ 7/ 2	79183	****	****	95.	****	****	****	3.3	****	****	****	****	****	****	****	****	****	****	****
79/ 7/16	79197	16.4	4.28	46.	****	****	****	2.7	****	117.	0.9	****	0.061	0.080	0.10	<0.02	1.28	*****	****
79/ 7/30	79211	****	4.79	49.	****	****	****	****	****	107.	1.1	****	0.120	0.125	0.06	<0.02	1.24	*****	****
79/ 8/11	79223	16.0	4.15	95.	****	****	****	16.4	****	64.	1.2	****	0.016	0.030	0.02	<0.02	1.44	*****	****
79/ 8/27	79239	****	4.70	38.	****	****	****	4.7	****	96.	1.5	****	0.050	0.080	0.04	<0.02	1.16	*****	****
79/ 9/ 8	79251	11.6	4.56	50.	****	****	****	8.7	****	105.	1.4	****	0.092	0.110	0.02	<0.02	0.96	*****	****
79/ 9/23	79266	****	5.69	60.	****	****	****	23.4	****	154.	10.3	****	0.394	0.520	0.04	<0.02	2.40	*****	****
79/10/ 6	79279	9.0	4.70	65.	****	****	****	12.0	****	106.	4.0	****	****	0.160	0.04	<0.02	1.64	*****	****
79/10/21	79294	****	4.77	52.	****	****	****	9.7	****	113.	2.2	****	0.093	0.110	0.02	<0.02	1.40	*****	****
79/11/ 3	79307	2.2	4.73	49.	****	****	****	4.9	****	92.	1.5	4.5	0.116	0.130	<0.02	<0.02	1.08	*****	****

APPENDIX B

Water quality data for the control bog: the 0.4 meter well at site 41.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMG	ALK MG/L	TRCA-HARD AS	CL CAC03	DO	000	005	0020	ORHO MG/L	T-P	NH4	NO23	KJLON --->1	F COL /100ML	WATER TABLE CM	
77/11/18	77322	4.0	5.22	68.	****	****	****	1.3	2.0	****	9.6	****	0.040	0.492	<0.02	0.03	3.92	*****	****
77/12/29	77363	****	5.48	38.	****	****	****	2.3	****	140.	10.6	****	0.014	0.116	0.10	0.04	1.02	*****	****
78/ 2/12	78043	****	5.80	105.	****	****	****	2.1	****	133.	11.1	23.5	****	0.115	0.05	<0.02	1.42	*****	****
78/ 3/ 4	78063	0.0	5.49	32.	****	****	****	<1.0	****	147.	3.3	****	0.016	0.130	0.12	<0.02	1.86	*****	****
78/ 3/20	78079	****	5.36	32.	****	****	****	<1.0	****	149.	3.7	****	0.013	0.035	0.07	<0.02	1.64	*****	****
78/ 4/ 2	78092	****	5.19	94.	****	****	****	2.4	****	243.	11.1	****	0.021	0.072	0.18	<0.02	1.74	0.	****
78/ 4/17	78107	****	5.61	115.	****	****	****	1.4	****	204.	****	****	0.052	0.130	0.11	<0.02	1.50	*****	****
78/ 5/ 7	78127	7.0	4.90	78.	****	****	****	****	****	139.	27.5	45.5	0.002	0.075	0.03	<0.02	1.30	*****	****
78/ 5/21	78141	****	5.71	36.	****	****	****	<1.0	****	134.	2.9	****	0.020	0.028	0.01	<0.02	1.10	*****	****
78/ 6/ 6	78157	****	6.12	115.	****	****	****	1.4	****	156.	4.1	****	0.023	0.070	0.12	0.06	1.54	*****	****
78/ 6/20	78171	****	7.18	74.	****	****	****	<1.0	****	149.	5.1	****	0.006	0.040	0.05	<0.02	0.10	*****	****
78/ 7/ 4	78185	14.5	6.20	142.	****	****	****	1.0	****	179.	6.9	****	0.014	0.076	<0.02	<0.02	0.92	*****	****
78/ 7/17	78198	****	6.32	123.	****	****	****	<1.0	****	157.	2.5	****	0.026	0.080	<0.02	<0.02	1.40	*****	****
78/ 8/ 2	78214	16.3	5.93	94.	****	****	****	1.1	****	164.	2.5	****	0.011	0.072	0.02	<0.02	1.32	*****	****
78/ 8/16	78228	****	5.76	114.	****	****	****	1.2	****	137.	2.9	****	0.015	0.055	****	<0.02	1.56	*****	****
78/ 9/ 3	78246	16.7	6.43	134.	****	****	****	<1.0	****	131.	0.6	****	0.009	0.062	0.03	<0.02	1.32	*****	****
78/ 9/18	78261	****	6.25	106.	****	****	****	<1.0	****	115.	0.7	****	0.011	0.030	0.04	<0.02	0.96	*****	****
78/10/15	78288	8.9	6.49	142.	****	****	****	2.3	****	139.	0.7	2.4	0.014	0.050	0.03	<0.02	1.52	*****	****
78/11/12	78316	****	6.85	160.	****	****	****	1.6	****	107.	0.7	****	0.007	0.020	<0.02	<0.02	0.74	*****	****
78/12/16	78350	1.0	5.76	53.	****	****	****	1.5	****	116.	2.3	****	****	0.028	0.03	<0.02	1.00	*****	****
79/ 3/ 3	79062	0.8	6.17	120.	****	****	****	<1.0	****	164.	4.0	****	0.010	0.070	0.12	<0.02	1.26	*****	****
79/ 4/21	79111	2.7	5.62	65.	****	****	****	<1.0	****	97.	3.5	****	0.009	0.095	0.14	<0.02	2.36	*****	****
79/ 5/ 7	79127	****	5.97	39.	****	****	****	<1.0	****	97.	4.5	****	0.013	0.095	0.02	<0.02	1.60	*****	****
79/ 5/19	79139	10.0	6.06	75.	****	****	****	<1.0	****	94.	5.5	11.6	0.015	0.068	0.06	<0.02	0.82	*****	****
79/ 6/ 5	79156	****	6.42	78.	****	****	****	1.6	****	95.	3.1	****	0.012	0.070	0.12	<0.02	1.52	*****	****
79/ 6/16	79167	12.0	5.73	58.	****	****	****	****	****	87.	****	****	0.021	0.050	0.10	<0.02	0.94	*****	****
79/ 7/ 2	79183	****	****	105.	****	****	****	<1.0	****	91.	****	****	****	0.060	****	****	****	*****	****
79/ 7/16	79197	12.9	6.23	45.	****	****	****	1.0	****	90.	3.5	****	0.027	0.070	0.29	<0.02	1.24	*****	****
79/ 7/30	79211	****	6.47	75.	****	****	****	****	****	96.	1.0	****	0.005	0.065	0.04	<0.02	1.72	*****	****
79/ 8/11	79223	15.0	6.33	79.	****	****	****	<1.0	****	94.	1.2	****	0.022	0.065	0.02	<0.02	0.96	*****	****
79/ 8/27	79239	****	6.09	65.	****	****	****	1.0	****	107.	1.4	****	0.016	0.060	<0.02	<0.02	0.96	*****	****
79/ 9/ 8	79251	12.6	6.08	71.	****	****	****	1.4	****	111.	2.6	****	0.020	0.070	0.12	<0.02	1.24	*****	****
79/ 9/23	79266	****	6.54	144.	****	****	****	<1.0	****	108.	1.1	****	0.008	0.060	0.04	<0.02	1.16	*****	****
79/10/ 6	79279	10.5	6.31	136.	****	****	****	<1.0	****	143.	1.9	****	****	0.060	0.26	<0.02	1.34	*****	****
79/10/21	79294	****	6.51	65.	****	****	****	<1.0	****	144.	1.2	****	0.014	0.040	0.10	<0.02	1.04	*****	****
79/11/ 3	79307	6.0	6.06	30.	****	****	****	1.2	****	87.	1.5	2.9	0.009	0.040	0.14	<0.02	0.72	*****	****

APPENDIX B continued

Water quality data for the control bog: the 0.4 meter well at site 42.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHO	ALK MG/L	TCA-HARD AS	CL I<---	OR	CO	SO4	NO2O	ORTHO MG/L	T-P	NH4	NO3	KJLDN --->I	F CUL /100ML	WATER TABLE CM	
77/11/18	77322	****	4.85	73.	****	****	****	1.0	****	****	****	0.023	0.299	0.07	0.02	2.48	*****	****	
77/12/29	77363	****	5.54	108.	****	****	****	2.5	****	190.	14.1	****	0.078	0.138	0.15	0.04	0.51	*****	****
78/ 2/12	78043	****	5.43	98.	****	****	****	1.2	****	159.	9.0	****	****	0.100	0.10	<0.02	1.40	*****	****
78/ 3/ 4	78063	0.0	5.90	170.	****	****	****	1.6	****	196.	6.4	****	0.022	0.090	0.11	<0.02	1.64	*****	****
78/ 3/20	78079	****	5.47	102.	****	****	****	<1.0	****	167.	11.4	****	0.017	0.104	0.07	<0.02	2.12	*****	****
78/ 4/ 2	78092	****	5.32	77.	****	****	****	<1.0	****	195.	10.4	****	0.012	0.058	0.16	<0.02	1.60	0.	****
78/ 4/17	78107	****	5.93	77.	****	****	****	1.1	****	176.	****	****	0.040	0.075	0.12	<0.02	2.06	*****	****
78/ 5/ 7	78127	6.5	5.20	78.	****	****	****	****	****	145.	9.9	****	0.015	0.064	0.07	<0.02	1.46	*****	****
78/ 5/21	78141	****	6.24	138.	****	****	****	<1.0	****	168.	2.1	****	0.005	0.046	0.04	<0.02	1.64	*****	****
78/ 6/ 6	78157	****	5.69	122.	****	****	****	<1.0	****	171.	1.0	****	0.023	0.092	0.09	<0.02	1.84	*****	****
78/ 6/20	78171	****	7.22	139.	****	****	****	<1.0	****	151.	0.9	****	0.018	0.084	0.04	<0.02	0.10	*****	****
78/ 7/ 4	78185	14.0	5.93	84.	****	****	****	<1.0	****	144.	4.0	****	0.005	0.056	0.08	<0.02	0.48	0.	****
78/ 7/17	78198	****	6.38	155.	****	****	****	<1.0	****	173.	4.3	****	0.035	0.108	<0.02	<0.02	1.72	*****	****
78/ 8/ 2	78214	15.5	6.11	141.	****	****	****	<1.0	****	170.	7.6	****	0.028	0.120	0.08	<0.02	1.48	0.	****
78/ 8/16	78228	****	6.20	117.	****	****	****	1.0	****	155.	2.8	****	0.022	0.100	****	<0.02	1.76	*****	****
78/ 9/ 3	78246	15.5	6.63	223.	****	****	****	<1.0	****	177.	2.1	****	0.017	0.076	0.01	<0.02	1.48	*****	****
78/ 9/18	78261	****	6.43	204.	****	****	****	<1.0	****	162.	0.7	****	0.022	0.060	0.09	<0.02	1.28	*****	****
78/10/15	78288	8.7	6.63	217.	****	****	****	1.1	0.0	205.	2.1	3.9	0.026	0.052	0.12	<0.02	1.52	0.	****
78/11/12	78316	****	6.46	220.	****	****	****	1.1	****	139.	1.8	****	0.007	0.030	0.19	<0.02	1.26	*****	****
78/12/16	78350	1.7	6.45	137.	****	****	****	1.5	****	136.	2.8	****	****	0.060	0.06	<0.02	1.24	*****	****
79/ 3/ 3	79062	1.0	7.15	300.	****	****	****	1.0	****	135.	0.5	****	0.013	0.070	0.08	<0.02	1.10	*****	****
79/ 4/ 1	79091	****	6.76	143.	****	****	****	1.0	****	179.	8.2	****	0.015	0.085	0.18	<0.02	1.32	*****	****
79/ 4/21	79111	2.2	6.02	138.	****	****	****	1.4	****	196.	4.8	****	0.024	0.100	0.15	<0.02	2.52	*****	****
79/ 5/ 7	79127	****	6.75	253.	****	****	****	1.1	****	193.	2.2	****	0.016	0.100	0.02	<0.02	1.40	*****	****
79/ 5/19	79139	7.0	5.97	148.	****	****	****	<1.0	****	173.	3.2	****	0.019	0.118	0.02	<0.02	1.28	*****	****
79/ 6/ 5	79156	****	6.72	200.	****	****	****	1.5	****	153.	4.0	****	0.024	0.085	0.14	<0.02	1.44	*****	****
79/ 6/16	79167	10.0	5.96	135.	****	****	****	****	****	157.	****	****	0.028	0.070	0.08	<0.02	1.24	*****	****
79/ 7/ 2	79183	****	****	****	****	****	****	<1.0	****	129.	****	****	****	0.070	****	****	*****	*****	****
79/ 7/16	79197	13.7	6.31	169.	****	****	****	<1.0	****	149.	3.4	****	0.026	0.090	0.15	<0.02	1.32	*****	****
79/ 7/30	79211	****	6.63	205.	****	****	****	****	****	127.	0.7	****	0.007	0.060	<0.02	<0.02	1.52	*****	****
79/ 8/11	79223	14.0	6.63	240.	****	****	****	<1.0	0.0	154.	1.4	****	0.024	0.060	0.04	<0.02	1.04	*****	****
79/ 8/27	79239	****	6.58	170.	****	****	****	<1.0	****	162.	2.3	****	0.014	0.050	0.04	<0.02	1.04	*****	****
79/ 9/ 8	79251	12.6	6.18	144.	****	****	****	<1.0	****	151.	2.8	****	0.017	0.060	<0.02	<0.02	1.08	*****	****
79/ 9/23	79266	****	7.06	390.	****	****	****	<1.0	****	163.	1.3	****	0.015	0.040	0.04	<0.02	1.48	*****	****
79/10/ 6	79279	10.6	6.19	151.	****	****	****	<1.0	****	139.	1.6	****	****	0.040	0.04	<0.02	1.24	*****	****
79/10/21	79294	****	7.07	258.	****	****	****	<1.0	****	198.	1.3	****	0.014	0.035	0.04	<0.02	1.16	*****	****
79/11/ 3	79307	5.9	6.37	190.	****	****	****	<1.0	****	120.	1.0	3.4	0.012	0.035	0.10	<0.02	0.88	*****	****

APPENDIX B continued

Water quality data for the control bog: the 2.3 meter well at site 42.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMH0	ALK MG/L	TRCA-HARD AS	CL CAC03	DO I<---	COO	BO05	BO020	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->I	F COL /100ML	WATER TABLE CM
77/11/18	77322	****	****	****	****	****	****	0.3	****	****	****	****	****	****	****	****	****	****
77/12/29	77363	****	4.28	44.	****	****	<1.0	****	133.	1.9	****	0.056	0.138	1.85	0.05	****	****	****
78/ 2/12	78043	****	4.23	42.	****	****	<1.0	****	103.	1.1	7.1	****	0.165	1.80	<0.02	2.60	****	****
78/ 3/ 4	78053	4.0	4.21	42.	****	****	1.2	****	134.	0.9	****	0.073	0.160	1.90	<0.02	3.10	****	****
78/ 3/20	78079	****	4.35	42.	****	****	<1.0	****	184.	0.7	****	0.112	0.209	1.40	<0.02	2.84	****	****
78/ 4/ 2	78092	****	4.52	39.	****	****	<1.0	****	169.	0.8	****	0.111	0.200	2.00	<0.02	3.36	0.	****
78/ 4/17	78107	****	4.54	35.	****	****	<1.0	****	126.	0.8	****	0.074	0.085	1.55	<0.02	1.90	****	****
78/ 5/ 7	78127	6.5	4.20	44.	****	****	1.0	****	125.	0.9	1.3	0.093	0.116	1.25	<0.02	3.04	****	****
78/ 5/21	78141	****	4.68	34.	****	****	<1.0	****	122.	1.3	****	0.073	0.084	0.90	<0.02	2.70	****	****
78/ 6/ 6	78157	****	4.50	38.	****	****	1.1	****	136.	3.6	****	0.053	0.064	1.45	<0.02	2.60	****	****
78/ 6/20	78171	****	4.40	32.	****	****	<1.0	****	124.	1.2	****	0.064	0.064	1.25	<0.02	2.20	****	****
78/ 7/ 4	78185	7.0	4.33	38.	****	****	<1.0	****	132.	2.3	****	0.069	0.116	0.55	0.02	2.48	****	****
78/ 7/17	78193	****	4.61	36.	****	****	<1.0	****	129.	1.1	****	0.063	0.072	1.20	<0.02	2.48	****	****
78/ 8/ 2	78214	8.0	4.37	42.	****	****	<1.0	****	130.	1.5	****	0.043	0.092	1.60	0.02	2.68	****	****
78/ 8/16	78228	****	4.31	42.	****	****	<1.0	****	141.	2.1	****	0.046	0.125	****	0.02	2.86	****	****
78/ 9/ 3	78246	9.3	4.40	39.	****	****	<1.0	****	154.	0.6	****	0.049	0.070	1.30	<0.02	2.32	****	****
78/ 9/18	78261	****	4.87	45.	****	****	<1.0	****	143.	0.6	****	0.045	0.060	1.30	<0.02	3.00	****	****
78/10/15	78288	8.1	4.33	39.	****	****	<1.0	****	102.	1.1	7.1	0.059	0.034	1.20	<0.02	3.12	0.	****
78/11/12	78316	****	4.93	39.	****	****	<1.0	****	142.	1.4	****	0.073	0.108	1.05	<0.02	2.76	****	****
78/12/16	78350	4.8	4.46	40.	****	****	<1.0	****	135.	1.7	****	****	0.124	0.44	<0.02	2.76	****	****
79/ 3/ 3	79062	4.5	4.48	50.	****	****	<1.0	****	140.	1.6	****	0.090	0.150	1.55	<0.02	2.88	****	****
79/ 4/ 1	79091	****	4.38	45.	****	****	<1.0	****	147.	0.9	****	0.087	0.130	1.78	<0.02	2.84	****	****
79/ 4/21	79111	5.3	4.28	38.	****	****	<1.0	****	136.	1.0	****	0.081	0.150	2.15	<0.02	2.92	****	****
79/ 5/ 7	79127	****	4.47	44.	****	****	<1.0	****	134.	1.3	****	0.039	0.100	1.66	<0.02	2.32	****	****
79/ 5/19	79139	7.0	4.24	44.	****	****	<1.0	****	136.	0.9	3.1	0.052	0.145	1.81	<0.02	****	****	****
79/ 6/ 5	79156	****	4.32	34.	****	****	1.2	****	119.	0.9	****	0.030	0.040	1.33	<0.02	2.12	****	****
79/ 6/16	79167	6.4	4.21	38.	****	****	****	****	136.	****	****	0.065	0.130	1.62	<0.02	2.70	****	****
79/ 7/ 2	79183	****	****	40.	****	****	<1.0	****	124.	****	****	****	0.050	****	****	****	****	****
79/ 7/16	79197	7.1	4.28	48.	****	****	<1.0	****	130.	1.3	****	0.069	0.120	1.95	<0.02	2.96	****	****
79/ 7/30	79211	****	4.95	30.	****	****	****	****	124.	0.7	****	0.064	0.085	1.44	<0.02	2.36	****	****
79/ 8/11	79223	7.3	4.38	37.	****	****	<1.0	0.0	127.	1.1	****	0.107	0.150	1.72	<0.02	3.20	****	****
79/ 8/27	79239	****	4.42	35.	****	****	<1.0	****	123.	1.2	****	0.081	0.100	1.55	<0.02	2.32	****	****
79/ 9/ 8	79251	7.0	4.33	27.	****	****	<1.0	****	140.	0.9	****	0.107	0.150	1.76	<0.02	2.68	****	****
79/ 9/23	79266	****	5.35	53.	****	****	<1.0	****	135.	1.6	****	0.064	0.080	1.48	<0.02	2.20	****	****
79/10/ 6	79279	7.6	4.27	44.	****	****	<1.0	****	132.	0.9	****	****	0.160	1.90	<0.02	2.86	****	****
79/10/21	79294	****	4.76	36.	****	****	<1.0	****	146.	1.0	****	0.094	0.105	2.04	<0.02	2.80	****	****
79/11/ 3	79307	7.0	4.29	45.	****	****	<1.0	****	126.	1.1	3.3	0.114	0.150	1.80	<0.02	2.60	****	****

APPENDIX C

Water quality data for the lower bog: the 0.4 meter well at site 51 (A) and site 52 (B).

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHO	ALK MG/L	TROA-HARD AS	CL CAC33	CL I<---	DO	CO2	BO35	BO220	ORTHO MG/L	T-P	NH4	NO23	KJLON --->I	F COL /100ML	WATER TABLE CM
<b>A</b>																			
77/11/18	77322	3.5	5.53	33.	****	****	****	1.6	1.0	****	1.9	****	0.021	0.420	0.04	0.01	1.44	*****	****
77/12/29	77363	****	5.84	58.	****	****	****	2.9	****	84.	3.0	****	0.040	0.044	0.03	0.01	0.64	*****	****
78/ 3/ 4	78063	****	5.79	43.	****	****	****	1.8	****	69.	0.6	****	0.017	0.060	0.01	<0.02	0.64	*****	****
78/ 3/20	78079	****	5.82	51.	****	****	****	2.0	****	74.	0.8	****	0.009	0.024	0.03	<0.02	0.64	*****	****
78/ 5/ 7	78127	9.0	5.70	33.	****	****	****	1.1	****	69.	2.4	3.9	0.023	0.034	0.01	<0.02	0.80	*****	****
78/ 6/ 6	78157	****	5.62	33.	****	****	****	1.1	****	100.	3.2	****	0.056	0.037	0.11	<0.02	1.40	*****	****
78/ 7/ 4	78185	15.5	6.35	70.	****	****	****	<1.0	****	96.	2.6	****	0.024	0.044	<0.02	<0.02	0.32	0.	****
78/ 8/ 2	78214	15.2	6.30	70.	****	****	****	1.1	****	109.	2.4	****	0.026	0.068	0.36	<0.02	0.96	0.	****
78/ 9/ 3	78246	14.5	6.53	100.	****	****	****	<1.0	****	124.	2.3	****	0.062	0.086	<0.02	<0.02	1.08	*****	****
78/10/15	78238	8.1	6.30	59.	****	****	****	1.1	****	67.	1.8	3.5	0.049	0.062	0.06	<0.02	1.20	*****	****
78/11/12	78316	****	6.02	47.	****	****	****	1.7	****	38.	1.0	****	0.030	0.040	0.03	<0.02	0.86	*****	****
78/12/16	78350	1.3	6.52	42.	****	****	****	2.1	****	83.	5.4	****	****	0.064	0.06	<0.02	1.00	*****	****
79/ 4/ 1	79091	****	6.85	30.	****	****	****	<1.0	****	55.	1.6	****	0.012	0.030	<0.02	<0.02	0.56	*****	****
79/ 4/21	79111	1.3	5.61	32.	****	****	****	<1.0	****	57.	1.1	****	0.015	****	<0.02	0.05	****	*****	****
79/ 5/ 7	79127	****	5.83	35.	****	****	****	<1.0	****	55.	1.0	****	0.010	0.045	0.10	<0.02	0.56	*****	****
79/ 5/19	79139	10.3	5.66	40.	****	****	****	<1.0	****	76.	1.0	2.0	0.028	0.035	0.02	<0.02	0.82	*****	****
79/ 6/ 5	79156	****	5.72	25.	****	****	****	<1.0	****	41.	0.6	****	0.009	0.030	0.14	<0.02	0.96	*****	****
79/ 6/16	79167	15.0	5.75	47.	****	****	****	****	****	102.	****	****	0.067	0.100	0.06	<0.02	1.02	*****	****
79/ 7/ 2	79183	****	****	45.	****	****	****	<1.0	****	103.	****	****	****	0.190	****	****	****	*****	****
79/ 7/16	79197	16.1	5.81	50.	****	****	****	1.0	****	105.	****	****	0.075	0.110	0.20	<0.02	1.20	*****	****
79/ 7/30	79211	****	6.42	66.	****	****	****	****	****	82.	0.9	****	0.039	0.070	<0.02	<0.02	1.16	*****	****
79/ 8/11	79223	15.5	6.26	72.	****	****	****	5.2	****	82.	3.8	****	0.057	0.075	0.06	<0.02	0.84	*****	****
79/ 8/27	79239	****	6.02	62.	****	****	****	8.5	****	31.	1.8	****	0.049	0.070	0.08	<0.02	0.88	*****	****
79/ 9/ 8	79251	12.3	5.93	65.	****	****	****	12.0	****	66.	1.7	****	0.061	0.130	0.23	<0.02	1.00	*****	****
79/ 9/23	79266	****	6.15	74.	****	****	****	11.2	****	69.	1.0	****	0.042	0.050	0.16	<0.02	0.84	*****	****
79/10/ 6	79279	10.6	6.25	103.	****	****	****	12.5	****	76.	2.6	****	****	0.065	0.16	<0.02	0.96	*****	****
79/10/21	79294	****	6.41	79.	****	****	****	12.3	****	72.	0.9	****	0.049	0.060	0.08	<0.02	1.08	*****	****
79/11/ 3	79307	5.0	6.15	95.	****	****	****	12.4	****	44.	1.5	2.7	0.049	0.060	0.16	<0.02	0.72	*****	****
<b>B</b>																			
79/ 7/ 4	78185	15.8	6.60	72.	****	****	****	1.8	****	44.	1.3	****	0.014	0.042	0.02	<0.02	0.20	*****	****
79/ 9/ 8	79251	13.1	7.15	161.	****	****	****	<1.0	****	24.	0.3	****	0.011	0.030	<0.02	<0.02	0.64	*****	****
79/10/ 6	79279	9.5	6.60	124.	****	****	****	<1.0	****	33.	0.1	****	****	0.050	0.02	<0.02	0.88	*****	****

APPENDIX D

Water quality data for the regional groundwater: site 81.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMH0	ALK MG/L	T&CA-HARD AS	CL CAC03	DO IC---	CO2	BO05	BO020	ORTHO MG/L	T-P	NH4	NO23	KJLON --->1	F COL /100ML	WATER TABLE CM	
77/12/29	77363	****	7.23	275.	116.	132.	94.	****	****	7.	1.1	****	0.012	0.026	****	****	0.51	*****	****
78/ 2/12	78043	****	7.73	251.	123.	116.	80.	19.7	****	4.	0.5	1.7	****	0.105	0.06	<0.02	****	*****	****
78/ 3/ 4	78063	****	8.28	243.	118.	118.	77.	28.2	****	8.	0.0	****	0.004	****	0.07	<0.02	0.20	*****	****
78/ 4/ 2	78092	****	8.66	196.	91.	94.	51.	13.3	****	9.	1.4	****	0.002	0.031	0.04	0.06	0.20	0.	****
78/ 5/ 7	78127	****	9.10	150.	****	****	****	11.2	****	17.	0.3	2.8	0.002	0.003	0.02	<0.02	0.12	*****	****
78/ 6/ 6	78157	****	9.47	132.	****	****	****	12.8	****	12.	****	****	0.008	0.017	0.06	0.02	0.34	*****	****
78/ 7/ 4	78185	****	9.47	110.	54.	****	****	5.2	****	12.	2.7	****	0.006	0.020	<0.02	<0.02	0.00	*****	****
78/ 8/ 2	78214	9.3	9.64	112.	54.	51.	19.	5.5	****	2.	2.4	****	0.003	0.008	0.03	<0.02	0.00	*****	****
78/ 9/ 3	78246	9.3	9.58	117.	48.	46.	14.	7.8	****	1.	2.2	****	0.013	0.013	0.01	<0.02	0.22	*****	****
78/10/15	78288	****	8.46	103.	46.	44.	14.	11.6	****	0.	0.5	1.6	0.001	0.008	0.02	<0.02	0.36	*****	****
78/11/12	78316	****	9.43	108.	46.	****	****	6.4	****	9.	0.7	****	0.005	0.005	0.03	<0.02	0.22	*****	****
78/12/16	78350	****	8.66	123.	****	50.	28.	14.4	****	1.	1.2	****	0.003	0.016	0.13	<0.02	0.36	*****	****
79/ 3/ 3	79062	****	9.46	126.	44.	44.	****	5.6	****	6.	1.4	****	0.010	0.012	0.07	<0.02	0.28	*****	****
79/ 4/ 1	79091	****	9.25	117.	50.	38.	14.	7.1	****	8.	1.4	****	0.001	0.005	0.14	<0.02	0.52	*****	****
79/ 4/21	79111	****	9.37	101.	44.	40.	12.	4.8	****	7.	1.3	****	****	****	0.13	<0.02	0.28	*****	****
79/ 5/ 7	79127	****	8.83	110.	48.	36.	14.	5.0	****	11.	1.4	****	0.000	0.015	0.14	<0.02	0.20	*****	****
79/ 5/19	79139	****	9.33	103.	50.	39.	12.	4.8	****	9.	1.0	3.0	0.007	0.015	0.06	<0.02	0.40	*****	****
79/ 6/ 5	79156	****	8.80	93.	50.	44.	14.	5.5	****	3.	0.8	****	0.010	0.015	0.22	<0.02	0.32	*****	****
79/ 7/ 2	79183	****	****	127.	****	44.	17.	5.8	****	10.	****	****	****	****	****	****	****	*****	****
79/ 7/16	79197	****	8.80	133.	55.	44.	13.	7.4	****	6.	1.2	****	0.008	0.030	0.19	<0.02	0.36	*****	****
79/ 8/11	79223	****	9.26	110.	57.	48.	13.	4.5	****	0.	1.6	****	0.003	0.020	0.03	<0.02	0.80	*****	****
79/ 9/ 8	79251	****	9.42	98.	58.	47.	17.	5.3	****	0.	1.5	****	0.005	0.020	0.03	<0.02	0.32	*****	****
79/10/ 6	79279	****	9.48	120.	56.	46.	15.	4.7	****	2.	1.1	****	****	0.035	0.16	<0.02	0.52	*****	****
79/11/ 3	79307	****	9.37	128.	54.	52.	17.	4.3	****	5.	1.6	3.5	0.006	0.045	0.06	<0.02	0.40	*****	****

APPENDIX D continued

Water quality data for the regional groundwater: site 82.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHG	ALK MG/L	T&CA-HARD AS MG/L	CL	DD	CO2	SO4	SO2&O3	CRTHG MG/L	T-P	NH4	NO23	KJLDN --->1	F COL /100ML	WATER TABLE CM	
78/ 2/12	78043	****	9.14	112.	50.	49.	20.	5.8	****	1.	0.1	1.1	****	0.055	0.05	0.02	****	*****	****
78/ 3/ 4	78063	****	9.55	107.	50.	50.	20.	7.1	****	5.	0.3	****	0.001	0.080	0.04	<0.02	0.26	*****	****
78/ 5/ 7	78127	****	9.80	36.	****	****	****	4.1	****	5.	1.1	3.4	0.000	0.000	0.04	<0.02	0.30	*****	****
78/ 6/ 6	78157	****	9.99	40.	****	****	****	4.1	****	****	2.6	****	0.008	0.037	0.12	0.02	0.36	*****	****
78/ 7/ 4	78185	****	9.95	71.	34.	****	****	3.4	****	11.	2.2	****	0.008	0.012	<0.02	<0.02	0.00	0.	****
78/ 8/ 2	78214	8.1	9.97	56.	34.	28.	14.	2.4	****	7.	2.3	****	0.000	0.004	<0.02	<0.02	0.20	*****	****
78/ 9/ 3	78246	****	9.76	74.	30.	26.	12.	3.3	****	0.	1.5	****	0.002	0.006	0.01	<0.02	0.28	*****	****
78/10/15	78238	****	9.33	98.	46.	46.	22.	6.8	****	0.	0.5	1.3	0.001	0.008	0.05	<0.02	0.39	*****	****
78/11/12	78316	****	9.66	77.	32.	****	****	2.6	****	9.	0.9	****	0.001	0.005	0.01	<0.02	0.26	*****	****
78/12/16	78350	****	9.67	40.	****	32.	16.	3.9	****	6.	1.7	****	0.003	0.016	0.03	<0.02	0.32	*****	****
79/ 3/ 3	79062	****	9.64	100.	32.	32.	****	1.9	****	6.	1.5	****	0.003	0.005	0.01	<0.02	0.30	*****	****
79/ 4/ 1	79091	****	9.53	39.	30.	23.	14.	2.3	****	7.	1.2	****	0.000	0.000	<0.02	<0.02	0.44	*****	****
79/ 4/21	79111	****	9.63	70.	32.	24.	14.	1.6	****	4.	1.1	****	0.001	0.005	0.10	<0.02	0.32	*****	****
79/ 5/ 7	79127	****	9.12	79.	32.	25.	15.	1.6	****	24.	1.1	****	0.001	0.010	0.10	<0.02	0.08	*****	****
79/ 5/19	79139	****	9.71	65.	30.	26.	12.	2.1	****	7.	1.0	3.0	0.001	0.005	<0.02	<0.02	0.38	*****	****
79/ 6/ 5	79156	****	8.90	54.	30.	30.	10.	1.9	****	2.	0.7	****	0.004	0.015	0.02	<0.02	0.36	*****	****
79/ 6/16	79167	****	9.59	71.	30.	24.	8.	****	****	15.	****	****	0.009	0.010	0.04	<0.02	0.40	*****	****
79/ 7/ 2	79183	****	****	74.	****	28.	16.	1.9	****	13.	****	****	****	0.020	****	****	****	*****	****
79/ 7/16	79197	****	8.99	43.	40.	34.	15.	3.3	****	7.	1.0	****	0.008	0.015	0.06	<0.02	0.32	*****	****
79/ 7/30	79211	****	8.43	43.	36.	35.	18.	****	****	6.	1.4	****	0.006	0.010	0.02	<0.02	0.52	*****	****
79/ 8/11	79223	****	9.37	44.	39.	34.	13.	1.8	****	0.	1.2	****	0.009	0.010	0.02	<0.02	0.60	*****	****
79/ 8/27	79239	****	9.35	75.	38.	30.	13.	2.3	****	6.	1.2	****	0.009	0.010	<0.02	<0.02	0.12	*****	****
79/ 9/ 8	79251	****	9.51	43.	39.	36.	16.	2.9	****	2.	0.9	****	0.002	0.005	<0.02	<0.02	0.12	*****	****
79/ 9/23	79266	****	9.01	39.	39.	36.	13.	2.5	****	11.	1.0	****	0.002	0.010	0.04	<0.02	0.22	*****	****
79/10/ 6	79279	****	9.61	89.	39.	36.	16.	2.1	****	2.	0.6	****	****	0.015	0.02	<0.02	0.68	*****	****
79/10/21	79294	****	8.91	72.	39.	36.	16.	1.9	****	8.	1.6	****	0.001	0.005	<0.02	<0.02	0.44	*****	****
79/11/ 3	79307	****	9.67	91.	38.	38.	19.	2.0	****	16.	0.6	1.6	0.004	0.010	0.02	<0.02	0.28	*****	****

APPENDIX E

Water quality data for the precipitation.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHO	ALK MG/L	T&CA-HARD AS MG/L	CL CACO3 I<---	DO	COO	BOO5	BOO20	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->I	F COL /100ML	SO4 MG/L	
78/ 3/ 4	78063	****	5.03	8.	****	****	****	<1.0	****	3.	****	****	0.004	0.040	0.06	0.32	0.36	*****	****
78/ 3/ 4	78063	****	4.73	10.	****	****	****	<1.0	****	3.	****	****	0.002	0.040	0.07	0.34	0.26	*****	****
78/ 5/24	78144	****	5.34	13.	1.	2.	2.	<1.0	****	5.	1.7	****	0.005	0.014	0.14	0.24	0.16	*****	****
78/ 5/28	78143	****	5.47	14.	1.	3.	2.	<1.0	****	11.	1.2	****	0.000	0.032	0.21	0.27	0.42	*****	****
78/ 6/ 8	78159	****	5.92	12.	2.	****	2.	<1.0	****	****	****	****	0.004	0.038	0.10	0.24	0.10	*****	****
78/ 6/13	78154	****	6.23	16.	2.	****	1.	<1.0	****	****	****	****	0.000	0.036	0.22	0.26	0.24	*****	****
78/ 6/16	78167	****	5.99	13.	4.	****	****	<1.0	****	****	****	****	0.000	0.028	0.13	0.22	0.16	*****	****
78/ 7/ 2	78183	****	6.29	17.	4.	****	****	1.1	****	****	****	****	0.000	0.012	0.13	0.36	0.30	*****	****
78/ 7/ 3	78184	****	6.44	20.	4.	****	****	1.0	****	****	****	****	0.000	0.012	0.04	0.20	0.14	*****	****
78/ 7/ 8	78189	****	6.45	13.	0.	****	****	<1.0	****	****	****	****	0.184	0.200	0.24	0.24	1.78	*****	****
78/ 7/13	78194	****	6.53	11.	2.	****	****	<1.0	****	****	****	****	0.010	0.014	0.03	0.28	0.12	*****	****
78/ 7/18	78199	****	6.61	35.	6.	****	****	1.1	****	****	****	****	0.008	0.014	0.77	0.96	1.58	*****	****
78/ 7/22	78203	****	6.53	13.	4.	****	****	<1.0	****	****	****	****	0.005	0.006	0.05	0.36	0.12	*****	****
78/ 7/25	78206	****	6.63	23.	4.	****	****	<1.0	****	****	****	****	0.011	0.032	0.63	0.62	1.04	*****	****
78/ 7/29	78210	****	6.69	27.	6.	****	****	<1.0	****	****	****	****	0.007	0.024	0.44	0.78	0.64	*****	****
78/ 8/ 2	78214	****	6.76	11.	4.	****	****	<1.0	****	****	****	****	0.000	0.030	0.19	0.20	0.30	*****	****
78/ 8/15	78227	****	5.66	20.	2.	****	****	<1.0	****	****	****	****	0.011	0.014	0.43	0.38	0.58	*****	****
78/ 8/16	78228	****	6.44	17.	1.	****	****	<1.0	****	****	****	****	0.003	0.003	0.23	0.30	0.32	*****	****
78/ 8/23	78235	****	5.50	9.	1.	****	****	<1.0	****	****	****	****	0.000	0.004	0.12	0.16	0.16	*****	****
78/ 9/11	78254	****	5.92	17.	2.	****	****	<1.0	****	9.	****	****	0.004	0.014	0.33	0.16	0.52	*****	****
78/ 9/14	78257	****	5.94	11.	2.	****	****	<1.0	****	0.	****	****	0.000	0.008	0.11	0.34	0.18	*****	****
78/ 9/19	78262	****	5.96	19.	2.	****	****	<1.0	****	3.	****	****	0.005	0.012	0.33	0.42	0.52	*****	****
78/10/ 6	78279	****	6.25	14.	2.	****	****	<1.0	****	4.	****	****	0.000	0.012	0.13	0.16	0.22	*****	****
78/10/15	78288	****	6.31	20.	2.	****	****	<1.0	****	1.	****	****	0.003	0.012	0.12	0.38	0.38	*****	****
78/11/23	78327	****	7.26	46.	****	****	****	2.2	****	****	****	****	0.031	0.144	0.16	0.38	0.72	*****	****
78/12/19	78353	****	6.46	18.	2.	****	****	2.8	****	****	****	****	0.012	0.025	0.10	0.40	0.18	*****	0.0

APPENDIX E continued

Water quality data for the precipitation.

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMH0	ALK MG/L	T&C-HARD AS	CL CAC03 I<---	CG	CO0	BO05	BU020	GRTH0 MG/L	T-P	NH4	NO23	KJLDN --->I	F CUL /100ML	SO4 MG/L	
79/ 3/ 3	79062	****	4.56	20.	****	8.	****	<1.0	****	0.	****	****	0.003	0.040	0.11	0.58	0.40	*****	****
79/ 3/ 3	79062	****	4.59	20.	****	8.	****	<1.0	****	0.	****	****	0.003	0.020	0.15	0.56	0.48	*****	****
79/ 3/ 3	79062	****	4.61	23.	****	8.	****	<1.0	****	5.	****	****	0.006	0.020	0.10	0.20	0.46	*****	****
79/ 3/22	79061	****	6.58	42.	6.	****	****	2.7	****	****	****	****	0.016	0.090	0.31	0.60	0.31	*****	8.7
79/ 4/21	79111	****	4.99	8.	4.	2.	0.	1.1	****	1.	****	****	0.004	0.125	0.26	0.20	1.16	*****	0.0
79/ 5/ 5	79125	****	6.17	27.	6.	8.	****	****	****	****	****	****	0.013	0.020	0.52	0.35	0.84	*****	4.5
79/ 5/ 7	79127	****	6.39	28.	4.	6.	4.	****	****	****	****	****	0.014	0.060	1.12	0.65	1.68	*****	4.3
79/ 5/10	79130	****	5.88	26.	2.	****	****	<1.0	****	****	****	****	0.000	0.040	1.01	0.45	1.16	*****	2.5
79/ 5/17	79137	****	6.30	36.	3.	****	****	1.0	****	****	****	****	0.005	0.045	0.42	0.65	1.40	*****	7.9
79/ 5/23	79143	****	6.07	26.	4.	8.	6.	****	****	****	****	****	0.014	0.020	0.98	0.55	1.16	*****	5.0
79/ 5/31	79151	****	6.24	25.	4.	8.	6.	****	****	****	****	****	0.010	0.050	0.62	0.50	1.10	*****	3.6
79/ 6/10	79161	****	5.95	17.	6.	4.	****	****	****	****	****	****	0.196	0.500	0.88	0.10	****	*****	5.9
79/ 6/17	79168	****	6.58	19.	****	****	****	<1.0	****	****	****	****	0.230	0.250	0.36	0.16	1.68	*****	****
79/ 7/ 3	79184	****	6.62	45.	8.	6.	2.	<1.0	****	****	****	****	0.012	0.020	0.36	0.30	0.56	*****	1.0
79/ 7/13	79194	****	6.33	19.	****	****	****	<1.0	****	****	****	****	0.008	0.010	0.68	1.14	0.88	*****	****
79/ 7/24	79205	****	6.10	19.	6.	7.	0.	<1.0	****	****	****	****	0.010	0.010	0.56	0.32	0.60	*****	1.7
79/ 7/26	79207	****	6.38	23.	****	****	****	<1.0	****	****	****	****	0.020	****	0.24	0.26	****	*****	****
79/ 8/13	79225	****	6.53	29.	5.	****	****	1.3	****	****	****	****	0.334	0.360	1.16	0.50	4.56	*****	3.7
79/ 8/23	79235	****	6.18	18.	2.	9.	****	<1.0	****	****	****	****	0.024	0.040	0.26	0.32	0.74	*****	2.0
79/ 8/27	79239	****	6.25	16.	****	****	****	<1.0	****	****	****	****	0.062	0.100	0.30	0.22	0.82	*****	1.0
79/ 9/11	79254	****	6.40	19.	4.	8.	****	<1.0	****	****	****	****	0.002	0.015	0.48	0.38	0.68	*****	1.5
79/10/19	79292	****	6.05	34.	2.	****	****	<1.0	****	****	****	****	0.006	0.040	0.48	0.74	1.40	*****	8.6
79/10/22	79295	****	6.30	18.	2.	****	****	<1.0	****	****	****	****	0.005	0.035	0.24	0.32	0.30	*****	4.0
79/10/25	79298	****	6.31	7.	2.	****	****	<1.0	****	****	****	****	0.005	0.030	0.02	0.04	0.24	*****	0.4

APPENDIX F

Water quality data for the Drummond primary lagoon (A), secondary lagoon (B), and lagoon effluent discharged to the bog (C).

CALENDAR DATE	JULIAN DATE	TEMP C	PH	COND UMHO	ALK MG/L	T&CA-HARD AS MG/L	CL CAC03 I<---	DO	COO	BD05	BO020	GRTHD MG/L	T-P	NH4	NO23	KJLDN --->I	F COL /100ML	TSS MG/L	
<b>A</b>																			
78/ 5/ 7	78127	****	9.80	320.	****	****	****	1.0	****	42.	4.1	****	0.372	0.480	0.88	0.08	3.80	*****	****
78/10/15	78288	****	7.67	495.	128.	138.	106.	114.0	****	45.	2.1	11.6	0.832	0.838	0.70	0.98	6.86	*****	****
79/ 9/ 8	79251	****	7.78	590.	168.	176.	122.	119.0	****	55.	1.7	****	3.090	3.130	4.55	0.06	7.60	*****	****
79/10/ 6	79279	****	7.91	630.	172.	184.	126.	110.0	****	38.	2.5	****	2.500	2.500	4.80	0.52	6.60	*****	****
79/11/ 3	79307	****	7.69	650.	156.	176.	122.	98.0	****	32.	6.9	****	2.130	2.350	3.50	2.30	5.60	*****	****
<b>B</b>																			
79/ 5/19	79139	****	9.99	220.	67.	84.	60.	54.7	****	31.	3.1	****	0.052	0.130	<0.02	<0.02	1.20	*****	****
79/ 6/16	79167	****	7.72	240.	70.	88.	58.	****	****	49.	****	****	0.045	0.300	0.12	<0.02	1.84	0.	****
79/ 7/16	79197	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	20.	****
79/ 9/ 8	79251	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	2.	****
79/10/ 6	79279	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	0.	****
79/11/ 3	79307	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	3.	****
<b>C</b>																			
79/ 6/27	79178	****	8.10	270.	68.	86.	56.	38.4	****	32.	1.7	****	0.072	0.290	0.24	<0.02	1.16	*****	10.0
79/ 7/ 2	79183	****	8.25	230.	71.	88.	58.	39.4	****	27.	1.5	****	0.099	0.250	0.13	<0.02	1.12	*****	13.0
79/ 7/ 9	79190	****	8.37	255.	64.	82.	52.	36.7	****	29.	1.7	****	0.064	0.230	0.06	<0.02	0.88	*****	17.0
79/ 7/17	79198	****	8.28	240.	72.	90.	60.	38.0	****	23.	1.9	****	0.064	0.150	0.04	<0.02	1.11	*****	****
79/ 7/23	79204	****	8.44	250.	72.	92.	58.	39.0	****	33.	4.1	****	0.071	0.210	0.14	<0.02	1.27	*****	****
79/ 8/ 3	79215	****	8.10	270.	80.	100.	65.	38.0	****	27.	2.5	****	0.061	0.150	0.02	<0.02	1.03	*****	****
79/ 8/14	79226	****	8.22	237.	79.	102.	62.	58.5	****	39.	1.7	****	0.063	0.220	0.09	<0.02	1.62	*****	17.3
79/ 8/21	79233	****	8.08	300.	80.	104.	64.	60.8	****	31.	1.8	****	0.068	0.190	0.02	<0.02	1.30	*****	16.0
79/ 9/12	79255	****	8.53	240.	66.	90.	54.	44.7	****	27.	1.4	****	0.018	0.110	0.04	<0.02	1.38	*****	25.3
79/ 9/17	79260	****	8.20	240.	64.	84.	58.	37.2	****	25.	1.2	****	0.015	0.110	0.02	<0.02	1.16	*****	27.3
79/ 9/25	79268	****	8.21	270.	71.	92.	62.	37.7	****	26.	0.7	****	0.024	0.085	0.02	<0.02	1.06	*****	19.3
79/10/ 5	79278	****	8.28	250.	64.	82.	52.	31.9	****	34.	1.2	****	0.021	0.080	0.02	<0.02	****	*****	22.5
79/10/11	79284	****	8.33	360.	84.	108.	70.	63.4	****	26.	3.0	7.8	0.018	0.085	<0.02	<0.02	1.06	*****	23.0
79/10/20	79293	****	8.59	320.	74.	96.	58.	63.4	****	24.	2.0	6.5	0.013	0.135	<0.02	<0.02	1.12	*****	31.5
79/10/24	79297	****	8.55	290.	74.	94.	58.	52.2	****	23.	2.3	7.0	0.011	0.090	<0.02	<0.02	0.94	*****	26.0

APPENDIX G

Water quality data for Weso Lake.

CALENDAR DATE	JULIAN DATE	DEPTH FEET	TEMP C	PH	COND UMHO	ALK MG/L AS	TCA-CASO3	HARD	CL <---	DO	CO2	BOD5	BOD20	GRHO MG/L	T-P	NH4	NO23	KJLDN --->	F CCL /100ML	TSS MG/L
77/11/18	77322	0	2.5	5.54	28.	****	****	****	1.1	5.3	****	1.7	****	0.022	0.086	0.14	0.02	1.63	*****	****
77/12/29	77363	0	****	5.16	38.	****	****	****	4.8	5.3	33.	1.7	****	0.032	0.072	0.08	0.07	0.75	*****	****
77/12/29	77363	10	****	5.63	33.	****	****	****	3.2	5.8	58.	1.0	****	0.058	0.178	0.15	0.07	0.51	*****	****
77/12/29	77363	18	****	5.30	32.	****	****	****	5.2	3.0	75.	1.2	****	0.074	0.128	0.20	0.08	0.61	*****	****
78/ 3/ 4	78063	0	****	5.47	31.	****	****	****	1.0	****	59.	0.4	****	0.024	0.040	0.05	0.08	0.70	*****	****
78/ 3/ 4	78063	10	****	5.47	29.	****	****	****	<1.0	3.7	55.	0.4	****	0.024	0.080	0.01	0.16	0.74	*****	****
78/ 3/ 4	78063	18	****	5.60	32.	****	****	****	<1.0	1.2	59.	0.5	****	0.029	0.100	0.31	0.05	0.98	*****	****
78/ 5/ 7	78127	0	18.0	5.30	25.	****	****	****	1.2	7.7	44.	0.8	1.9	0.032	0.032	0.02	0.01	1.04	*****	****
78/ 6/ 6	78157	0	****	5.54	25.	****	****	****	<1.0	6.3	55.	0.5	****	0.023	0.055	0.05	<0.02	0.88	*****	****
78/ 6/ 6	78157	4	****	****	****	****	****	****	****	1.3	****	****	****	****	****	****	****	****	*****	****
78/ 6/ 6	78157	10	****	5.44	28.	****	****	****	1.1	0.1	49.	0.2	****	0.035	0.105	0.03	<0.02	0.76	*****	****
78/ 6/ 6	78157	18	****	5.80	32.	****	****	****	1.3	0.0	56.	0.3	****	0.071	****	0.49	<0.02	1.36	*****	****
78/ 7/ 4	78185	0	23.9	5.35	21.	****	****	****	<1.0	6.5	52.	1.0	****	0.009	0.036	0.01	<0.02	0.24	3.	****
78/ 7/ 4	78185	2	****	****	****	****	****	****	****	5.4	****	****	****	****	****	****	****	****	*****	****
78/ 7/ 4	78185	4	****	****	****	****	****	****	****	0.1	****	****	****	****	****	****	****	****	*****	****
78/ 7/ 4	78185	10	8.5	5.55	26.	****	****	****	1.0	0.0	50.	1.1	****	0.023	0.048	<0.02	<0.02	0.16	*****	****
78/ 7/ 4	78185	14	****	****	****	****	****	****	****	0.0	****	****	****	****	****	****	****	****	*****	****
78/ 7/ 4	78185	18	6.7	5.88	34.	****	****	****	1.0	0.0	71.	1.1	****	0.092	0.120	0.84	<0.02	1.04	*****	****
78/ 8/ 2	78214	0	24.7	5.98	21.	****	****	****	1.0	6.4	49.	0.8	****	0.006	0.024	0.02	<0.02	0.52	0.	2.0
78/ 8/ 2	78214	4	****	****	****	****	****	****	****	3.2	****	****	****	****	****	****	****	****	*****	****
78/ 8/ 2	78214	10	12.0	5.69	25.	****	****	****	1.1	0.2	49.	0.8	****	0.033	0.036	<0.02	<0.02	0.36	*****	11.5
78/ 8/ 2	78214	14	****	****	****	****	****	****	****	0.0	****	****	****	****	****	****	****	****	*****	****
78/ 8/ 2	78214	18	7.6	5.93	34.	****	****	****	1.0	0.0	57.	1.4	****	0.074	0.074	0.47	<0.02	1.04	*****	31.5
78/ 9/ 3	78246	0	25.3	5.70	23.	4.	****	****	<1.0	6.4	51.	0.9	****	0.008	0.022	0.06	<0.02	0.60	*****	5.5
78/ 9/ 3	78246	6	****	****	****	****	****	****	****	0.1	****	****	****	****	****	****	****	****	*****	****
78/ 9/ 3	78246	8	****	****	****	****	****	****	****	0.1	****	****	****	****	****	****	****	****	*****	****
78/ 9/ 3	78246	10	11.4	5.93	28.	6.	****	****	<1.0	0.0	141.	0.7	****	0.025	0.044	<0.02	<0.02	0.62	*****	21.0
78/ 9/ 3	78246	18	7.8	6.25	34.	10.	****	****	<1.0	0.0	133.	0.8	****	0.093	0.110	0.71	<0.02	1.50	*****	41.5
78/10/15	78288	0	10.4	5.90	27.	****	****	****	2.0	5.0	13.	0.8	1.8	0.007	0.022	0.01	<0.02	0.88	*****	4.0
78/10/15	78288	10	3.3	5.68	27.	2.	****	10.	1.3	4.4	13.	0.5	1.4	0.011	0.028	<0.02	<0.02	1.04	*****	4.0
78/10/15	78288	12	****	****	****	****	****	****	****	0.0	****	****	****	****	****	****	****	****	*****	****
78/10/15	78288	14	****	****	****	****	****	****	****	0.5	****	****	****	****	****	****	****	****	*****	****
78/10/15	78288	18	6.0	6.07	38.	****	****	****	<1.0	0.0	26.	1.4	5.6	0.135	0.172	0.95	<0.02	2.20	*****	29.0
78/11/12	78316	0	0.5	5.56	26.	****	****	****	1.1	****	57.	0.8	****	0.015	0.034	0.13	<0.02	0.80	*****	2.8
78/11/12	78316	10	4.0	5.93	25.	****	****	****	<1.0	****	49.	0.7	****	0.018	0.040	0.13	<0.02	0.84	*****	2.8
78/11/12	78316	18	4.0	5.93	25.	****	****	****	1.0	****	52.	0.7	****	0.018	0.040	0.14	<0.02	0.80	*****	****

APPENDIX G continued

Water quality data for Weso Lake.

CALENDAR DATE	JULIAN DATE	DEPTH FEET	TEMP C	PH	COND UMHQ	ALK MG/L	T&CA-HARD AS	CL CAC03	CL <---	DO	000	8005	80020	ORTHO MG/L	T-P	NH4	NO23	KJLDN --->1	F COL /100ML	TSS MG/L
78/12/16	78350	0	0.5	5.73	32.	****	****	****	<1.0	7.1	54.	1.7	****	****	0.064	0.16	<0.02	1.04	*****	5.3
78/12/16	78350	6	***	****	****	****	****	****	<1.0	5.5	****	****	****	****	****	****	****	****	****	****
78/12/16	78350	10	3.6	5.70	30.	****	****	****	<1.0	5.3	51.	1.6	****	****	0.056	0.17	<0.02	0.96	*****	3.8
78/12/16	78350	14	****	****	****	****	****	****	****	4.7	****	****	****	****	****	****	****	****	****	****
78/12/16	78350	18	3.3	5.65	30.	****	****	****	<1.0	3.3	43.	1.1	****	****	0.068	0.27	<0.02	1.00	*****	2.8
79/ 3/ 3	79062	0	****	5.68	45.	4.	****	****	<1.0	3.4	51.	0.7	****	0.021	0.040	<0.02	<0.02	0.70	*****	5.5
79/ 3/ 3	79062	6	****	****	****	****	****	****	****	3.5	****	****	****	****	****	****	****	****	****	****
79/ 3/ 3	79062	10	****	5.61	43.	4.	****	****	<1.0	2.8	51.	0.7	****	0.025	0.050	<0.02	0.25	0.78	*****	4.5
79/ 3/ 3	79062	12	****	****	****	****	****	****	****	1.5	****	****	****	****	****	****	****	****	****	****
79/ 3/ 3	79062	14	****	****	****	****	****	****	****	1.0	****	****	****	****	****	****	****	****	****	****
79/ 3/ 3	79062	18	****	5.80	45.	6.	****	****	<1.0	0.5	51.	0.7	****	0.031	0.070	0.18	0.28	1.14	*****	16.5
79/ 4/ 1	79091	0	****	5.51	46.	4.	****	****	1.0	****	61.	1.2	****	0.004	0.020	0.06	0.30	1.04	*****	****
79/ 4/ 1	79091	10	****	5.58	34.	6.	****	****	<1.0	****	51.	0.8	****	0.017	0.030	0.02	0.25	0.88	*****	****
79/ 4/ 1	79091	18	****	5.77	33.	8.	****	****	1.0	****	55.	0.7	****	0.016	0.030	0.08	0.15	0.84	*****	****
79/ 5/ 7	79127	0	7.0	5.53	27.	3.	13.	****	<1.0	****	51.	1.2	****	0.003	0.050	0.02	<0.02	0.84	*****	6.5
79/ 5/ 7	79127	10	5.0	5.54	29.	3.	11.	4.	1.3	****	53.	1.4	****	0.008	0.050	0.04	0.05	1.08	*****	7.5
79/ 5/ 7	79127	18	6.0	6.13	34.	6.	15.	9.	<1.0	****	70.	2.4	****	0.017	0.110	0.34	<0.02	1.24	*****	18.8
79/ 5/19	79139	0	17.9	5.55	24.	2.	12.	6.	<1.0	7.5	49.	1.6	3.7	0.003	0.020	<0.02	<0.02	0.72	*****	2.0
79/ 5/19	79139	6	****	****	****	****	****	****	****	4.3	****	****	****	****	****	****	****	****	****	****
79/ 5/19	79139	10	5.8	5.39	27.	4.	12.	7.	<1.0	0.6	83.	0.5	1.7	0.011	0.040	0.05	0.05	0.88	*****	7.0
79/ 5/19	79139	14	****	****	****	****	****	****	****	0.0	****	****	****	****	****	****	****	****	****	****
79/ 5/19	79139	18	5.8	5.81	33.	6.	17.	9.	<1.0	0.0	67.	0.8	3.7	0.040	0.130	0.48	<0.02	1.56	*****	25.5
79/ 6/ 5	79156	0	****	5.51	22.	4.	10.	4.	1.2	****	40.	2.2	****	0.009	0.045	0.16	<0.02	0.94	*****	1.5
79/ 6/ 5	79156	10	****	5.55	21.	6.	12.	4.	1.0	****	46.	1.3	****	0.021	0.065	0.32	<0.02	1.04	*****	10.0
79/ 6/ 5	79156	18	****	5.77	28.	6.	12.	6.	1.0	****	****	****	****	****	0.040	****	0.42	<0.02	*****	****
79/ 6/16	79167	0	25.0	5.44	25.	2.	10.	5.	****	5.6	43.	****	****	0.012	****	0.04	<0.02	0.72	*****	3.0
79/ 6/16	79167	4	****	****	****	****	****	****	****	2.2	****	****	****	****	****	****	****	****	****	****
79/ 6/16	79167	6	****	****	****	****	****	****	****	0.6	****	****	****	****	****	****	****	****	****	****
79/ 6/16	79167	10	9.5	5.28	26.	2.	15.	5.	****	0.0	59.	****	****	0.020	0.050	0.04	<0.02	0.76	*****	4.0
79/ 6/16	79167	18	6.5	5.63	34.	8.	15.	8.	****	0.0	60.	****	****	0.074	0.200	0.58	<0.02	1.56	*****	26.5
79/ 7/ 2	79183	0	****	****	27.	****	13.	7.	<1.0	****	49.	****	****	****	0.030	****	****	****	****	****
79/ 7/ 2	79183	10	****	****	30.	****	14.	9.	<1.0	****	63.	****	****	****	0.040	****	****	****	****	****
79/ 7/ 2	79183	18	****	****	38.	****	17.	10.	<1.0	****	63.	****	****	****	0.130	****	****	****	****	****
79/ 7/16	79197	0	27.5	5.74	27.	3.	10.	4.	<1.0	4.8	52.	1.7	****	0.014	0.050	0.11	<0.02	0.68	*****	3.0
79/ 7/16	79197	2	****	****	****	****	****	****	****	1.9	****	****	****	****	****	****	****	****	****	****
79/ 7/16	79197	4	****	****	****	****	****	****	****	0.0	****	****	****	****	****	****	****	****	****	****
79/ 7/16	79197	6	****	****	****	****	****	****	****	0.0	****	****	****	****	****	****	****	****	****	****
79/ 7/16	79197	8	****	****	****	****	****	****	****	0.0	****	****	****	****	****	****	****	****	****	****
79/ 7/16	79197	10	8.5	5.83	30.	5.	15.	6.	<1.0	****	52.	1.0	****	0.023	0.070	0.49	<0.02	0.68	*****	6.0
79/ 7/16	79197	18	5.3	6.25	37.	12.	18.	10.	<1.0	****	64.	0.7	****	0.155	0.290	0.93	<0.02	1.68	*****	10.0

135

APPENDIX G continued

Water quality data for Weso Lake.

CALENDAR DATE	JULIAN DATE	DEPTH FEET	TEMP C	PH	COND UMHO	ALK MG/L	TRCA-HARD AS	CL CAC03	DO	CO2	BO75	BO020	ORTHO MG/L	T-P	NH4	NO23	KJLON --->1	F COL /100ML	TSS MG/L	
79/ 7/30	79211	0	****	5.02	32.	2.	12.	5.	****	****	43.	2.2	*****	0.005	0.035	0.16	<0.02	0.76	*****	5.0
79/ 7/30	79211	10	****	5.29	35.	4.	14.	3.	****	****	57.	1.2	*****	0.016	0.045	0.06	<0.02	0.52	*****	9.5
79/ 7/30	79211	18	****	6.20	37.	9.	16.	9.	****	****	107.	1.6	*****	0.061	0.205	0.52	<0.02	1.76	*****	18.0
79/ 8/11	79223	0	26.0	5.79	25.	2.	10.	6.	<1.0	****	55.	2.8	*****	0.005	0.050	0.04	<0.02	0.83	*****	5.8
79/ 8/11	79223	10	8.5	5.64	31.	4.	15.	8.	<1.0	****	55.	1.2	*****	0.031	0.070	0.04	<0.02	1.04	*****	14.4
79/ 8/11	79223	18	6.0	5.95	34.	10.	17.	3.	<1.0	****	66.	1.7	*****	0.103	0.180	0.64	<0.02	1.56	*****	23.7
79/ 8/27	79239	0	****	5.78	20.	3.	9.	6.	1.4	****	38.	1.0	*****	0.007	0.020	<0.02	<0.02	0.50	*****	1.5
79/ 8/27	79239	10	****	5.80	25.	5.	13.	6.	<1.0	****	53.	1.0	*****	0.012	0.050	<0.02	<0.02	0.56	*****	7.3
79/ 8/27	79239	18	****	6.08	28.	11.	13.	8.	<1.0	****	51.	1.4	*****	0.103	0.390	0.54	<0.02	1.48	*****	20.0
79/ 9/ 8	79251	0	18.8	5.88	23.	3.	10.	6.	1.6	6.4	49.	1.7	*****	0.015	0.050	<0.02	<0.02	0.68	*****	2.0
79/ 9/ 8	79251	2	****	****	****	****	****	****	****	6.3	****	****	****	****	****	****	****	****	****	****
79/ 9/ 8	79251	4	****	****	****	****	****	****	****	5.4	****	****	****	****	****	****	****	****	****	****
79/ 9/ 8	79251	6	****	****	****	****	****	****	****	0.5	****	****	****	****	****	****	****	****	****	****
79/ 9/ 8	79251	8	****	****	****	****	****	****	****	0.1	****	****	****	****	****	****	****	****	****	****
79/ 9/ 8	79251	10	10.7	5.59	28.	4.	14.	5.	<1.0	0.0	66.	0.8	*****	0.020	0.080	0.12	<0.02	1.06	*****	13.3
79/ 9/ 8	79251	18	6.0	6.00	32.	10.	16.	8.	<1.0	****	56.	1.1	*****	0.133	0.220	0.65	<0.02	1.72	*****	20.0
79/ 9/23	79266	0	****	5.92	24.	3.	10.	5.	1.8	****	39.	1.3	*****	0.002	0.030	0.10	<0.02	0.72	*****	1.3
79/ 9/23	79266	10	****	5.68	28.	5.	14.	6.	1.0	****	49.	1.0	*****	0.004	0.040	0.04	<0.02	0.80	*****	12.0
79/ 9/23	79266	18	****	5.90	34.	10.	15.	3.	1.0	****	67.	1.4	*****	0.093	0.210	0.64	<0.02	2.00	*****	21.0
79/10/ 6	79279	0	12.9	5.87	26.	3.	10.	5.	1.3	5.8	43.	0.9	*****	0.035	0.04	<0.02	<0.02	0.78	*****	2.0
79/10/ 6	79279	4	****	****	****	****	****	****	****	5.6	****	****	****	****	****	****	****	****	****	****
79/10/ 6	79279	6	****	****	****	****	****	****	****	5.4	****	****	****	****	****	****	****	****	****	****
79/10/ 6	79279	8	****	****	****	****	****	****	****	4.9	****	****	****	****	****	****	****	****	****	****
79/10/ 6	79279	10	10.5	5.66	30.	4.	12.	6.	<1.0	0.0	65.	1.0	*****	0.070	0.02	<0.02	<0.02	0.94	*****	13.3
79/10/ 6	79279	14	****	****	****	****	****	****	****	0.0	****	****	****	****	****	****	****	****	****	****
79/10/ 6	79279	18	6.1	6.17	40.	12.	14.	8.	<1.0	****	68.	1.2	*****	0.240	0.92	<0.02	<0.02	1.72	*****	15.0
79/10/21	79294	0	****	5.93	22.	4.	11.	6.	1.7	****	43.	1.2	*****	0.003	0.020	0.02	<0.02	0.58	*****	2.0
79/10/21	79294	10	****	5.82	27.	4.	12.	6.	1.7	****	45.	0.9	*****	0.004	0.015	0.02	<0.02	1.00	*****	2.7
79/10/21	79294	18	****	6.01	39.	14.	16.	8.	1.1	****	74.	1.7	*****	0.153	0.235	1.28	<0.02	2.24	*****	33.0
79/11/ 3	79307	0	5.5	5.81	35.	4.	11.	5.	1.6	4.7	30.	2.3	4.6	0.011	0.065	0.14	<0.02	1.20	*****	5.3
79/11/ 3	79307	6	****	****	****	****	****	****	****	4.6	****	****	****	****	****	****	****	****	****	****
79/11/ 3	79307	10	5.5	5.80	32.	4.	12.	6.	1.5	4.5	38.	1.3	3.1	0.011	0.055	0.08	<0.02	0.84	*****	5.3
79/11/ 3	79307	14	****	****	****	****	****	****	****	4.3	****	****	****	****	****	****	****	****	****	****
79/11/ 3	79307	18	5.4	5.79	34.	5.	13.	6.	1.4	4.6	35.	1.4	3.1	0.012	0.055	0.10	<0.02	0.94	*****	3.7