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COLD REGIONS RESEARCH AND ENGINEERING LAB HANOVER NH F/G 13/2
FIVE-YEAR PERFORMANCE OF CRREL LAND TREATMENT TEST CELLS, WATER--ETC(U)
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CRREL-SR-78-26

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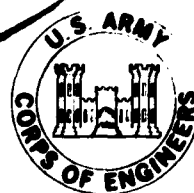
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Special Report 78-26

November 1978

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FIVE-YEAR PERFORMANCE OF CRREL LAND TREATMENT TEST CELLS

WATER QUALITY PLANT YIELDS AND NUTRIENT UPTAKE

T.F. Jenkins, Jr., A.J. Palazzo, P.W. Schumacher, D.B. Keller, J.M. Graham,
S.T. Quarry, H.E. Hare, J.J. Bayer, Jr. and E.S. Foley

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DEPARTMENT OF THE ARMY
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HANOVER, NEW HAMPSHIRE

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Special Report 78-26	2. GOVT ACCESSION NO. AD-A086172	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FIVE-YEAR PERFORMANCE OF CRREL LAND TREATMENT TEST CELLS, Water Quality Plant Yields and Nutrient Uptake		5. TYPE OF REPORT & PERIOD COVERED
7. AUTHOR(s) T.F. Jenkins, Jr., A.J. Palazzo, P.W. Schumacher, D.B. Keller, J.M. Graham, S.T. Quarry, H.E. Hare, J.J. Bayer, Jr. and E.S. Foley		6. PERFORMING ORG. REPORT NUMBER
8. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Cold Regions Research and Engineering Laboratory Hanover, New Hampshire 03755		9. CONTRACT OR GRANT NUMBER(s) Special rept. Jun 73- May 78
11. CONTROLLING OFFICE NAME AND ADDRESS Directorate of Civil Works Office, Chief of Engineers Washington, D.C. 20314		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS CWIS 31297
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 12 27		12. REPORT DATE November 1978
		13. NUMBER OF PAGES 27
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited. 14 CRREL-SR-78-26		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES 10 Thomas F. Jenkins Jr. Antonio J. Palazzo Patricia W. Schumacher Donald B. Keller John M. Graham		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Disposal Effluents Test facilities Waste water Water treatment 037100 SW		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The performance of the six land treatment cells is summarized over a five-year period from June 1973 through May 1978. The data presented include quality and volume of wastewater applied and percolate resulting from application of primary and secondary wastewater by spray irrigation. Mass loadings and removals are presented as well as crop production and nutrient uptake. Nutrient balance sheets are shown which demonstrate the percentage of nitrogen and phosphorus that is attributed to crop uptake and leachate over this period.		

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PREFACE

This study was conducted as a part of the U.S. Army Corps of Engineers Civil Works Research and Investigations Project under Work Unit CWIS 31297, "Optimization of Management Techniques for Wastewater Renovation."

This report was prepared by Thomas F. Jenkins, Jr., Research Chemist, Earth Sciences Branch; Antonio J. Palazzo, Research Agronomist, ESB; Patricia W. Schumacher, Physical Science Technician, ESB; Donald B. Keller, Civil Engineering Technician, Geotechnical Research Branch; John M. Graham, Biological Technician, ESB; Steven T. Quarry, Physical Science Technician, ESB; Helen E. Hare, Physical Science Aide, ESB; John J. Bayer, Jr., Civil Engineering Technician, Civil Engineering Research Branch; and Ellen S. Foley, Physical Science Aide, ESB.

The results presented in this data report represent a very large effort by not only the authors but a large number of other individuals at CRREL. The authors would like to acknowledge Sherwood Reed, Dr. Paul Murrmann, Warren Rickard and Timothy Buzzell for initial design of the CRREL Land Treatment Facility, including the outdoor prototypes known as the test cells; Dr. Harlan McKim for his technical and administrative support in the role of Program Manager; Daniel Leggett for method development in the water chemistry laboratory; Roy Bates for maintaining climatic surveillance; Dr. I.K. Iskandar and Major John Bouzoun for useful technical discussions; Robert Sletten and C. James Martel for supervision of the pretreatment facility; Pat Ricard for outstanding technical support as chief technician in the water quality laboratory for the first three years of the effort; a large number of part-time students to include Lee Henrickson, Lee Jones, Janice Lee, Steve Zebrowski, Katy Weeks, Karen Roy, Martin Leamon and Dennis Albach who performed in an outstanding manner as analysts in the water quality laboratory; and Lydia Bos, Holt Audrey and Wayne Hannel for careful data handling in the storage/retrieval system.

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Construction of the CRREL slow infiltration test cells was completed in early 1973. Details of their construction have been reported by Iskandar et al. (1976). As of 31 May 1978, the test cells had been in operation for five years. Over this period, primary and secondary wastewater were applied to test cells 2-5 at various loading rates (Table 1). Test cells 1 and 6 received 5 cm/wk (2 in./wk) of secondary wastewater over the entire five-year period. The first year of the project may be considered a preliminary experiment to test procedures and analytical methods. A detailed research report examining the second application year has been published (Iskandar et al. 1976). Data reports documenting the performance of the system in the third and fourth years (Ricard et al. 1976, Schumacher et al. 1977) are also available. A comprehensive report presenting water quality and vegetative yield and nutrient uptake has not been published. This report is an attempt to present the pertinent information to enable assessment of system performance over this five-year period.

A unique feature of the CRREL test cells is the ability to monitor the water volumes applied to and percolating through the soil (from June 1974-May 1978)*. This, combined with large numbers of analyses on samples composited over relatively short periods, allows accurate mass balances to be calculated for nutrients such as nitrogen and phosphorus. Other studies that attempt this calculation are faced with making assumptions for volumes of water to attribute to sample analyses.

Due to variability in both the weather and in the specific study being conducted, the period of the year in which wastewater was applied varied considerably (Table 2). Therefore, the amount of water applied yearly to the cells also varied (Table 3).

The results of water quality analyses for samples obtained over each 1-year period are presented in Tables 4a-f. The concentrations given in these tables are volume-weighted averages** with the number of analyses for each parameter given in parentheses. The values given for percolate analysis for pH, conductivity, K⁺, Na⁺, Ca⁺⁺ and Mg⁺⁺ were collected at 46 cm (18 in.) with suction lysimeters. Results from percolate analysis were not useful for these parameters due to interaction with the concrete bottoms in the test cells. Results given for pH on both applicant and percolate are median values rather than means due to the fact that pH is given in log units. The methods used for these analyses have been presented elsewhere (Iskandar et al. 1976).

* Percolate volume from June 1973-May 1974 was not measured.

**Concentration values for individual samples are weighted relative to the volume the sample represents.

Table 5 presents the mass of nitrogen and phosphorus applied yearly to the test cells. These values vary due to differing volumes of wastewater applied in a given year (Table 3).

During the growing season, the grass on the test cells was harvested two or three times per year. The types of grass species seeded originally and present on the cells has been the subject of another report (Palazzo 1976). The yields of plant material obtained for each harvest as well as the nutrient uptake (obtained from dry weight of material and plant analysis) of nitrogen, phosphorus and potassium are given in Tables 6a-f. These results are based on application of the wastewater on a 25-ft spray circle and do not include the corners of the cells.

Tables 7a-f present balance sheets for the five individual years of test cell operation as well as a five-year total. This includes nutrients applied in the wastewater, nutrients removed in the percolate, and nutrients taken up by the crop*. The difference was obtained and is labeled. The phosphorus not accounted for is thought to have been incorporated in the soil by sorption and precipitation. The nitrogen not accounted for may have been incorporated in the soil as net immobilization or lost from the cells as gaseous products by denitrification or ammonia volatilization.

Over the course of this five-year period, soil amendments have been applied to correct soil pH and nutrient deficiencies (Palazzo and Jenkins, in prep.). Table 8 presents the amounts of the various amendments applied during the study period.

Information on the changes in soil chemistry over this five-year period, including accumulation of phosphorus and trace elements, is the subject of another report (Iskandar et al., in press). Meteorological data collected over this period are also summarized in this document.

*The percolate water volume for the year 1973-74 was assumed to be equal to the amount of wastewater applied.

Table 1. Wastewater Loading Rate for CRREL Test Cells

Application Period	Test Cell					
	Windsor Soil			Charlton Soil		
	1	2	3	4	5	6
1973-1974	2-S* (1d) [†]	4-S (2d)	2-P (2d)	2-P (2d)	4-S (2d)	2-S (1d)
1974-1975	2-S (1d)	6-S (3d)	3-P (3d)	3-P (3d)	3-P (24h)**	2-S (1d)
1975-1976	2-S (1d)	6-S (3d)	3-P (3d)	3-P (3d)	3-P (24h)**	2-S (1d)
1976-1977	2-S (1d)	1-4.8 [†] P (1-4d)	1-4.1P (1-4d)	1-4.4P (1-4d)	1-4.3P (1-4d)	2-S (1d)
1977-1978	2-S (1d)	3-P (1 1/2d)	3-P (1 1/2d)	3-P (1 1/2d)	3-P (1 1/2d)	2-S (1d)

*2-S 2 inches of secondary effluent per week

[†] d is the number of daily (8-hour) applications per week

** 24-hour application over one 24-hour period

[†] weekly applications varied between 1 and 4.8 inches per week

Table 2. Periods of Test Cell Wastewater Application

<u>Year</u>	<u>Test Cell</u>	<u>Application Season</u>
1973-1974	1	13 June '73 - 26 Nov '73, 22 Apr '74 - 31 May '74
	2	9 June '73 - 26 Nov '73, 17 Apr '74 - 31 May '74
	3	13 June '73 - 12 Dec '73, 22 Apr '74 - 31 May '74
	4	13 June '73 - 12 Dec '73, 22 Apr '74 - 31 May '74
	5	11 June '73 - 26 Nov '73, 17 Apr '74 - 31 May '74
	6	13 June '73 - 26 Nov '73, 22 Apr '74 - 31 May '74
1974-1975	1	2 June '74 - 31 May '75,
	2	2 June '74 - 31 May '75,
	3	2 June '74 - 31 May '75,
	4	2 June '74 - 31 May '75,
	5	2 June '74 - 31 May '75,
	6	2 June '74 - 31 May '75,
1975-1976	1	16 June '75 - 25 Jan '76, 26 Apr '76 - 31 May '76
	2	16 June '75 - 4 Jan '76, 17 May '76 - 31 May '76
	3	16 June '75 - 30 Nov '75
	4	16 June '75 - 30 Nov '75
	5	16 June '75 - 30 Nov '75
	6	16 June '75 - 31 May '76
1976-1977	1	1 June '76 - 3 Dec '76, 21 Apr '77 - 31 May '77
	2	8 July '76 - 3 Dec '76, 21 Apr '77 - 31 May '77
	3	8 July '76 - 3 Dec '76, 21 Apr '77 - 31 May '77
	4	8 July '76 - 3 Dec '76, 21 Apr '77 - 31 May '77
	5	8 July '76 - 3 Dec '76, 7 Mar '77 - 31 May '77
	6	1 June '76 - 3 Dec '76, 21 Apr '77 - 31 May '77
1977-1978	1	14 June '77 - 6 Sep '77, 10 Apr '78 - 24 May '78
	2	14 June '77 - 6 Sep '77, 16 May '78 - 23 May '78
	3	14 June '77 - 6 Sep '77, 16 May '78 - 22 May '78
	4	15 June '77 - 7 Sep '77, 16 May '78 - 22 May '78
	5	15 June '77 - 7 Sep '77, 16 May '78 - 23 May '78
	6	14 June '77 - 6 Sep '77, 10 Apr '78 - 24 May '78

Table 3a. Test Cell 1 Water Balance (liters) 1973-1978

	App	Rainfall*	Total App	Perc	Difference
1973-74	48,618	67,153	115,771	-	-
1974-75	107,691	53,092	160,783	106,824	53,959
1975-76	66,529	83,804	150,333	97,744	52,589
1976-77	67,045	71,593	138,638	89,022	49,616
1977-78	48,285	62,528	110,813	81,453	29,360

Table 3b. Test Cell 2 Water Balance (liters) 1973-1978

	App	Rainfall*	Total App	Perc	Difference
1973-74	120,386	67,153	187,539	-	-
1974-75	325,555	53,092	378,647	322,675	55,972
1975-76	156,400	83,804	240,204	184,579	55,625
1976-77	62,953	71,593	134,546	100,333	34,213
1977-78	29,778	62,528	92,306	40,477	51,829

Table 3c. Test Cell 3 Water Balance (liters) 1973-1978

	App	Rainfall*	Total App	Perc	Difference
1973-74	50,935	67,153	118,088	-	-
1974-75	161,994	53,092	215,086	187,528	27,558
1975-76	66,347	83,804	150,151	102,168	47,983
1976-77	61,685	71,593	133,278	95,219	38,059
1977-78	29,470	62,528	91,998	41,042	50,956

*These values supplied by Mr. Roy Bates

Table 3d. Test Cell 4 Water Balance (liters) 1973-1978

	App	Rainfall*	Total App	Perc	Difference
1973-74	50,935	67,153	118,088	-	-
1974-75	156,324	53,092	209,416	179,106	30,310
1975-76	63,974	83,804	147,778	119,296	28,482
1976-77	62,473	71,593	134,066	91,347	42,719
1977-78	33,308	62,528	95,836	45,172	50,664

Table 3e. Test Cell 5 Water Balance (liters) 1973-1978

	App	Rainfall*	Total App	Perc	Difference
1973-74	101,867	67,153	169,020	-	-
1974-75	149,288	53,092	202,380	163,028	39,352
1975-76	68,596	83,804	152,400	116,866	35,534
1976-77	76,069	71,593	147,662	96,291	51,371
1977-78	31,378	62,528	93,906	39,288	54,618

Table 3f. Test Cell 6 Water Balance (liters) 1973-1978

	App	Rainfall*	Total App	Perc	Difference
1973-74	48,618	67,153	115,771	-	-
1974-75	106,021	53,092	159,113	128,073	31,040
1975-76	87,668	83,804	171,472	129,303	42,169
1976-77	68,230	71,593	139,823	88,076	51,747
1977-78	45,662	62,528	108,190	70,011	38,179

*These values supplied by Mr. Roy Bates.

Table 4a. Yearly Water Quality Analyses for Test Cell 1

	May 73 - May 74		June 74 - May 75		June 75 - May 76		June 76 - May 77		June 77 - May 78	
	App	Perc	App	Perc	App	Perc	App	Perc	App	Perc
NO ₃ ^{-*}	7.5(16) [#]	7.2(28)	2.4(40)	7.9(176)	10.1(35)	4.0(168)	4.2(30)	3.8(100)	7.6(20)	5.0(49)
NH ₄ ⁺	22.8(13)	0.0(19)	20.3(38)	0.1(150)	11.2(34)	0.1(167)	21.5(27)	0.0(94)	24.4(20)	0.0(47)
N(K)***	25.7(20)	0.0(28)	23.4(38)	0.2(150)	12.2(31)	0.4(13)	23.0(30)	0.2(5)	25.3(16)	2.4(18)
F(T)	13.3(20)	<0.2	7.0(36)	<0.2(79)	6.2(23)	-	6.0(29)	-	6.2(16)	-
PO ₄ [≡]	-	-	-	-	-	0.07(41)	-	0.05(36)	4.4(2)	0.02(22)
C(O)	51.4(16)	10.2(26)	42.0(34)	8.5(95)	20.8(22)	7.8(92)	52.5(18)	7.0(33)	39.8(5)	-
K ⁺	10.2(17)	6.8**(23)	7.3(12)	1.8**(5)	13.0(5)	1.0**(7)	13.5(4)	2.4**(3)	11.4(4)	-
NA ⁺	-	-	-	-	40.6(5)	43.8**(5)	49.3(4)	50.8**(3)	43.0(5)	-
CA ⁺⁺	-	-	-	-	6.5(6)	8.5**(8)	18.6(4)	9.7**(3)	7.7(5)	-
Mg ⁺⁺	-	-	-	-	2.6(6)	3.0**(8)	3.7(4)	2.7**(3)	2.4(5)	-
Cl ⁻	55.6(6)	19.4(6)	35.1(37)	21.9(77)	33.1(18)	16.4(79)	37.7(30)	19.1(100)	33.0(19)	23.8(47)
pH	7.6 [@] (11)	7.1 [@] (16)**	7.5 [@] (27)	7.1 [@] (7)**	6.7 [@] (28)	-	7.3 [@] (40)	6.5 [@] (10)**	7.7 [@] (13)	7.5 [@] (6)**
Cond	484(16)	285**(24)	422(29)	330**(8)	339(28)	-	458(31)	345**(4)	498(13)	343(6)**
H ₂ CO ₃	-	-	28(7)	1.0(16)	49(5)	1.8(13)	52(6)	1.7(19)	53(4)	1.7(8)
SS(T)	-	-	101(19)	13.5(28)	31(13)	-	42(11)	0.9(8)	57(6)	1.0(9)
SS(V)	-	-	59(20)	-	24(13)	-	25(10)	0.3(8)	36(6)	0.7(9)
Fecal Col.	-	-	1.9x10 ³ (6)	0(20)	5.4x10 ³ (8)	0(19)	3.4x10 ³ (4)	0(25)	6.5x10 ⁴ (4)	0(8)

@ Median value

* All values given in mg/l except pH (pH units), cond (umhos/cm) and fecal coliform (#/100ml)

** Values refer to samples taken at a depth of 18 inches with suction lysimeters

***Kjeldahl nitrogen

Numbers in parenthesis are the number of analyses

Table 4b. Yearly Water Quality Analyses for Test Cell 2

	May 73 - May 74			June 74 - May 75			June 75 - May 76			June 76 - May 77			June 77 - May 78		
	App	Perc		App	Perc		App	Perc		App	Perc		App	Perc	
NO ^{-*} ₃	10.3(22)	10.8(28)		2.6(123)	13.5(211)		10.9(58)	15.4(174)		0.3(43)	12.5(101)		0.8(12)	9.7(34)	
NH ⁺ ₄	21.6(12)	0.02(19)		21.5(113)	2.9(195)		10.8(59)	0.1(170)		31.3(40)	0.0(97)		28.1(13)	0.1(32)	
N(K)***	24.9(21)	0.1(30)		23.6(110)	2.7(185)		12.2(48)	0.1(14)		30.9(46)	0.0(4)		32.1(12)	0.4(13)	
P(T)	14.3(21)	<0.2(30)		7.0(106)	<0.2(141)		6.1(49)	-		6.6(47)	-		6.3(12)	-	
PO ₄ [≡]	-	-		-	-		-	0.09(46)		-	0.04(35)		-	0.06(17)	
C(O)	53.9(18)	7.5(48)		42.9(93)	8.3(131)		22.7(30)	5.3(93)		69.4(26)	5.7(33)		69.0(1)	-	
K ⁺	18.2(20)	2.7**(23)		8.6(46)	2.7**(11)		10.2(7)	3.7**(9)		13.8(3)	7.6**(5)		-	-	
NA ⁺	-	-		-	-		42.1(6)	41.4**(7)		46.1(3)	36.7**(5)		-	-	
CA ⁺⁺	-	-		-	-		6.5(8)	14.2**(11)		23.9(3)	13.8**(5)		-	-	
Mg ⁺⁺	-	-		-	-		2.1(8)	3.1**(11)		4.9(3)	2.5**(5)		-	-	
Cl ⁻	61.5(7)	23.6(7)		33.0(108)	27.6(142)		27.1(20)	17.5(79)		36.5(38)	35.1(101)		31.0(13)	45.3(34)	
pH	7.50(16)	7.20(17)**		7.50(73)	7.20(16)**		6.70(37)	-		7.20(32)	7.30(8)**		7.60(13)	6.90(9)**	
Cond	500(17)	337**(24)		403(91)	369**(19)		317(39)	-		462(46)	322**(7)		483(13)	449(6)**	
BOD ₅	-	-		35(18)	2.2(5)		53(7)	1.6(23)		44(5)	1.3(19)		46(2)	1.0(7)	
SS(T)	-	-		94(39)	14.9(8)		31(22)	0.2(10)		48(9)	0.89(8)		133(4)	1.0(8)	
SS(V)	-	-		64(40)	0.01(8)		25(20)	0.02(10)		32(8)	0.57(7)		86(4)	0.5(8)	
Fecal Col.	-	-		6.2x10 ³ (26)	0.0(10)		4.4x10 ³ (11)	0.0(38)		4.4x10 ⁴ (5)	0(26)		1.1x10 ⁵ (2)	0(7)	

@Median value

* All values given in mg/l except pH (pH units), cond (umhos/cm) and fecal coliform (#/100 ml)

** Values refer to samples taken at a depth of 18 inches with suction lysimeters.

***Kjeldahl nitrogen

Numbers in parenthesis are the number of analyses.

Table 42. Yearly Water Quality Analyses for Test Cell 3

	May 74 - May 74		June 74 - May 75		June 75 - May 76		June 76 - May 77		June 77 - May 78	
	App	Perc	App	Perc	App	Perc	App	Perc	App	Perc
NO_3^-	1.3(13) [#]	9.0(27)	0.8(126)	7.0(206)	0.3(50)	9.9(155)	0.1(43)	11.5(101)	0.8(12)	9.6(34)
NH_4^+	27.4(15)	0.1(17)	22.9(117)	1.8(191)	22.3(51)	0.1(152)	30.9(41)	9.0(97)	26.1(13)	9.0(32)
$\text{H}(\text{K})^{***}$	33.0(19)	0.1(25)	26.7(115)	1.6(180)	24.5(41)	0.5(13)	31.6(47)	0.1(4)	32.1(12)	0.1(13)
$\text{H}(\text{T})$	13.6(19)	<0.2(24)	7.2(113)	<0.2(136)	6.1(41)	-	6.5(48)	-	6.4(12)	-
PO_4^{3-}	-	-	-	-	-	0.06(40)	-	0.04(35)	-	0.06(17)
$\text{C}(\text{O})$	58.3(16)	5.9(24)	54.1(97)	7.8(133)	40.4(22)	6.8(73)	63.5(26)	5.5(33)	69.0(1)	-
K^+	6.4(19)	2.5** (20)	7.5(44)	1.1** (9)	12.9(8)	1.4** (1)	13.8(3)	7.1** (5)	-	-
Na^+	-	-	-	-	38.0(8)	-	46.1(3)	39.5** (5)	-	-
Ca^{++}	-	-	-	-	5.4(9)	24.6** (2)	23.9(3)	14.0** (5)	-	-
Mg^{++}	-	-	-	-	2.5(9)	1.2** (2)	4.9(3)	2.5** (5)	-	-
Cl^-	57.8(6)	17.7(6)	37.5(109)	27.0(137)	29.0(18)	30.7(72)	36.4(43)	39.0(101)	31.1(13)	46.8(34)
pH	7.50(11)	7.10 (16)**	7.40(75)	7.20 (18)**	6.90(31)	-	7.30(50)	7.10 (10)**	7.60(13)	6.50 (9)**
Cond	509(18)	270** (23)	393(91)	339** (17)	357(35)	-	458(47)	308** (7)	484(13)	412(8)**
BOD_5	-	-	92(20)	1.7(4)	111(9)	1.6(20)	110(6)	2.1(18)	44(2)	1.0(7)
$\text{SS}(\text{T})$	-	-	124(42)	0.3(6)	48(19)	0.4(11)	71(10)	1.1(7)	129(4)	1.1(8)
$\text{SS}(\text{V})$	-	-	106(43)	0.3(6)	32(19)	0.2(11)	43(9)	0.33(7)	85(4)	0.6(8)
Fecal Col.	-	-	2.3x10 ⁵ (24)	0(8)	2.1x10 ⁵ (8)	1(33)	3.2x10 ⁵ (5)	0(25)	1.0x10 ⁵ (2)	0(7)

* Median value

* All values given in mg/l except pH (ph units), cond (umhos/cm.) and fecal coliform (#/100 ml)

** Values refer to samples taken at a depth of 18 inches with suction lysimeters.

***Kjeldahl nitrogen

Numbers in parenthesis are the number of analyses.

Table 4d. Yearly Water Quality Analyses for Test cell 4

	May 73 - May 74		June 74 - May 75		June 75 - May 76		June 76 - May 77		June 77 - May 78	
	App	Perc	App	Perc	App	Perc	App	Perc	App	Perc
NO ₃ ^{-*}	2.2(18) [†]	7.9(26)	0.8(89)	11.0(212)	0.3(49)	8.4(154)	0.2(45)	9.3(95)	0.4(15)	10.1(34)
NH ₄ ⁺	27.8(15)	0.01(17)	23.0(87)	0.1(194)	22.0(50)	0.1(153)	30.7(43)	0.0(93)	27.3(15)	0.0(32)
N(K)***	33.0(19)	0.0(24)	27.8(81)	0.1(183)	24.1(40)	0.2(14)	31.7(47)	0.1(4)	30.9(16)	0.3(13)
P(T)	13.7(18)	<0.2(24)	7.5(79)	<0.2(140)	6.0(40)	-	6.4(48)	-	6.1(16)	-
PO ₄ [≡]	-	-	-	-	-	0.09(41)	-	0.04(33)	-	0.06(17)
C(O)	58.3(16)	11.9(22)	55.8(75)	10.1(126)	40.8(21)	7.8(73)	66.4(28)	9.3(33)	70.0(1)	-
K ⁺	6.4(19)	2.8**(23)	7.6(22)	4.9**(10)	12.5(8)	2.9**(12)	14.1(4)	4.5**(5)	-	-
Na ⁺	-	-	-	-	37.0(8)	36.8**(11)	46.3(4)	34.3**(5)	-	-
Ca ⁺⁺	-	-	-	-	5.3(9)	13.2**(13)	18.4(4)	14.9**(5)	-	-
Mg ⁺⁺	-	-	-	-	2.4(9)	1.5**(13)	4.2(4)	2.3**(5)	-	-
Cl ⁻	57.8(6)	15.3(6)	36.3(75)	25.6(142)	28.7(18)	72.9(64)	36.8(45)	58.5(96)	31.0(16)	45.1(34)
pH	7.50(11)	7.10(15)**	7.40(51)	7.20(20)**	7.00(30)	-	7.30(44)	6.90(8)**	7.70(9)	6.40(13)**
Cond	509(18)	252**(22)	397(63)	341**(19)	357(34)	-	460(49)	312**(7)	473(9)	440(13)**
BOD ₅	-	-	83(18)	1.5(5)	107(9)	1.5(22)	87(7)	1.6(18)	-	0.5(7)
SS(T)	-	-	102(31)	0.7(8)	46(18)	0.6(11)	65(9)	1.0(7)	146(1)	1.4(6)
SS(V)	-	-	74(32)	0.2(8)	32(19)	0.2(11)	48(8)	0.7(7)	121(1)	1.0(6)
Fecal Col.	-	-	2.9x10 ⁵ (18)	0(9)	2.0x10 ⁵ (9)	1(31)	2.1x10 ⁵ (5)	0(23)	3.6x10 ³ (1)	0(7)

② Median value

* All values given in mg/l except pH (pH units), cond (umhos/cm.) and fecal coliform (#/100 ml)

** Values refer to samples taken at a depth of 18 inches with suction lysimeters.

***Kjeldahl nitrogen

† Numbers in parenthesis are the number of analyses.

Table 4e. Yearly Water Quality Analyses for Test Cell 5

	May 73 - May 74		June 74		June 75 - May 75		June 76		June 76 - May 77		June 77 - May 78	
	App	Perc	App	Perc	App	Perc	App	Perc	App	Perc	App	Perc
NO ₃ ^{-*}	4.9(17)	9.3(23) [†]	1.5(54)	11.9(175)	0.2(25)	5.8(151)	0.1(47)	9.0(98)	0.4(15)	12.2(33)		
NH ₄ ⁺	20.9(10)	0.0(17)	21.5(53)	0.0(154)	20.8(26)	0.0(150)	31.5(44)	0.0(92)	27.3(15)	0.0(31)		
N(K) ^{***}	22.1(19)	0.0(26)	25.3(51)	0.1(152)	23.9(24)	0.0(14)	31.9(49)	0.4(4)	31.0(16)	0.1(13)		
P(T)	10.9(19)	<0.2(26)	7.2(51)	<0.2(79)	6.5(24)	-	6.3(50)	-	6.0(16)	-		
PO ₄ [≡]	-	-	-	-	-	0.06(43)	-	0.05(34)	-	0.07(17)		
C(O)	50.9(15)	9.2(20)	54.6(47)	9.7(96)	42.9(13)	8.4(71)	67.9(31)	11.7(32)	70.0(1)	-		
K ⁺	13.4(16)	3.7**(19)	7.5(13)	1.6**(6)	13.4(7)	3.2**(11)	14.4(5)	4.7**(5)	-	-		
Na ⁺	-	-	-	-	38.1(7)	39.1**(8)	46.3(5)	41.2**(5)	-	-		
Ca ⁺⁺	-	-	-	-	5.5(7)	14.0**(12)	17.8(5)	21.6**(5)	-	-		
Mg ⁺⁺	-	-	-	-	2.5(7)	1.4**(12)	4.1(5)	3.4**(5)	-	-		
Cl ⁻	62.0(6)	20.4(6)	34.5(46)	24.8(54)	28.7(12)	23.8(64)	36.6(47)	38.8(98)	31.0(17)	47.7(33)		
pH	7.6@ (13)	7.1@ (15)**	7.4@ (34)	7.1@ (6)**	6.9@ (19)	-	7.3@ (60)	6.4@ (10)**	7.7@ (9)	6.4** (12)		
Cond	476(18)	295**(23)	391(37)	348**(11)	408(20)	-	463(51)	398**(7)	470(10)	383(12)**		
BOD ₅	-	-	85(10)	0.9(21)	85(4)	1.4(21)	89(6)	1.3(19)	-	0.6(7)		
SS(T)	-	-	57(20)	2.6(26)	47(14)	0.4(11)	70(9)	0.8(8)	146(1)	0.9(6)		
SS(V)	-	-	40(21)	1.2(28)	28(14)	0.2(11)	49(8)	0.5(8)	121(1)	0.8(6)		
Fecal Col.	-	-	2.6x10 ⁵ (11)	4.2x10 ² (28)	2.7x10 ⁵ (6)	0.1(31)	2.6x10 ⁵ (5)	0 (24)	3.6x10 ³ (1)	0(7)		

@ Median value

* All values given in mg/l except pH (pH units), cond ($\mu\text{mhos/cm.}$) and fecal coliform (#/100 ml)

** Values refer to samples taken at a depth of 18 inches with suction lysimeters.

***Kjeldahl nitrogen

Numbers in parenthesis are the number of analyses.

Table 4f. Yearly Water Quality Analyses for Test Cell 6

	May 73 - May 74		June 74 - May 75		June 75 - May 76		June 76 - May 77		June 77 - May 78	
	App	Perc	App	Perc	App	Perc	App	Perc	App	Perc
NO ₃ ^{-*}	5.7(17) [‡]	5.8(27)	2.3(40)	9.0(180)	8.9(45)	5.5(166)	4.2(30)	5.3(99)	7.3(20)	3.5(48)
NH ₄ ⁺	22.8(13)	0.1(18)	20.5(38)	0.0(154)	11.4(43)	0.0(162)	20.9(27)	0.1(95)	24.6(20)	0.0(47)
N(K)***	25.7(20)	0.0(26)	23.5(38)	0.1 (155)	12.5(37)	0.2(11)	22.5(30)	0.1(4)	25.5(16)	2.8(18)
P(T)	13.3(20)	<0.2(27)	7.0(36)	<0.2(81)	5.8(37)	-	6.0(29)	-	6.2(16)	-
PO ₄ [≡]	-	-	-	-	-	0.05(40)	-	0.04(36)	4.4(2)	0.02(22)
C(O)	51.4(16)	10.5(24)	42.6(34)	10.3(101)	19.9(27)	7.4(95)	51.5(18)	8.2(32)	40.5(5)	-
K ⁺	10.2(17)	2.0**(22)	7.2(12)	2.8**(5)	12.5(5)	1.6**(12)	13.2(4)	0.9**(5)	11.4(5)	1.6(4)**
NA ⁺	-	-	-	-	38.2(5)	40.5**(11)	49.0(4)	33.5**(5)	42.7(5)	47.5(4)**
CA ⁺⁺	-	-	-	-	6.6(6)	14.2**(13)	19.1(4)	11.2**(5)	7.8(5)	17.7(4)**
Mg ⁺⁺	-	-	-	-	2.6(6)	1.1**(13)	3.7(4)	1.9**(5)	2.4(5)	2.2(4)**
Cl ⁻	55.6(6)	19.3(6)	35.4(37)	25.2(79)	32.2(28)	23.5(49)	37.5(30)	17.8(98)	33.1(19)	36.1(47)
pH	7.6@ (11)	7.3@ (15)**	7.5@ (27)	7.1@ (8)**	6.7@ (35)	-	7.3@ (46)	7.0@ (8)**	7.7@ (13)	6.3@ (11)**
Cond	484(16)	256(21)**	426(29)	363(9)**	342(33)	-	458(31)	300(7)**	499(13)	439(11)**
BOD ₅	-	-	28(7)	0.6(17)	30(10)	1.2(14)	52(6)	1.2(19)	52(4)	0.6(8)
SS(T)	-	-	96(19)	0.8(26)	32(19)	-	42(11)	1.0(8)	57(6)	0.7(9)
SS(V)	-	-	64(20)	0.3(28)	22(19)	-	25(10)	0.2(7)	36(6)	0.5(8)
Fecal Col.	-	-	6.1x10 ³ (6)	1 (22)	4.3x10 ³ (11)	0(19)	3.3x10 ³ (4)	0(25)	6.3x10 ⁴ (4)	0(8)

@ Median value

* All values given in mg/l except pH (pH units), cond (µmhos/cm.) and fecal coliform (#/100 ml)

** Values refer to samples taken at a depth of 18 inches with suction lysimeters.

***Kjeldahl nitrogen

‡ Numbers in parenthesis are the number of analyses.

Table 5. Amounts of Nitrogen and Phosphorus Applied to Test Cells
(kg/ha)

<u>Year</u>	<u>Test Cell</u>	<u>Total Nitrogen</u>	<u>Total Phosphorus</u>
1973-1974	1	353	142
	2	928	377
	3	393	152
	4	393	153
	5	602	243
	6	334	142
1974-1975	1	673	163
	2	2055	499
	3	1072	255
	4	1003	257
	5	956	235
	6	628	168
1975-1976	1	324	91
	2	784	207
	3	361	88
	4	343	84
	5	358	96
	6	411	112
1976-1977	1	399	89
	2	430	89
	3	429	87
	4	436	87
	5	533	106
	6	398	90
1977-1978	1	348	66
	2	232	45
	3	233	45
	4	251	48
	5	231	44
	6	328	62

Table 6a. Test Cell Harvest Data for Cell 1

<u>Year</u>	<u>Date</u>	<u>Yield mt/ha*</u>	<u>N uptake kg/ha</u>	<u>P uptake kg/ha</u>	<u>K uptake kg/ha</u>
73-74	July 1973	1.62	44.4	4.7	37.3
	mid-Sept 1973	1.53	57.8	6.0	45.9
	3 June 1974	3.22	120.8	12.6	96.9
	TOTAL	6.37	223.0	23.3	180.1
74-75	20 July 1974	3.03	89.7	9.4	77.3
	18 Sept 1974	3.38	98.0	11.8	83.2
	10 June 1975	5.86	159.4	8.8	127.8
	TOTAL	12.27	347.1	30.0	288.3
75-76	23 July 1975	3.8	88.1	11.1	76.2
	23 Sept 1975	1.6	58.5	6.0	33.6
	8 June 1976	4.2	96.6	10.9	74.3
	TOTAL	9.6	243.2	28.0	184.1
76-77	4 Aug 1976	3.1	86.8	8.7	57.7
	15 Sept 1976	0.9	30.6	3.9	22.4
	1 June 1977	4.1	99.9	16.8	154.5
	TOTAL	8.1	217.3	29.4	234.6
77-78	18 July 1977	4.9	177.9	20.9	166.7
	31 Oct 1977	2.5	71.8	9.8	74.5
	13 June 1978	4.2	109.1	16.5	167.5
	TOTAL	11.6	358.8	47.2	408.7

* Metric tons per hectare

Table 6b. Test Cell Harvest Data for Cell 2

<u>Year</u>	<u>Date</u>	<u>Yield mt/ha</u>	<u>N uptake kg/ha</u>	<u>P uptake kg/ha</u>	<u>K uptake kg/ha</u>
73-74	July 1973	1.8	50.0	4.8	40.5
	mid-Sept 1973	2.3	109.	9.5	84.0
	3 June 1974	3.9	149.0	15.6	120.9
	TOTAL	8.0	308.0	29.9	245.4
74-75	20 July 1974	4.0	127.8	10.9	104.8
	18 Sept 1974	5.1	173.0	17.7	124.5
	10 June 1975	6.8	244.5	12.3	172.1
	TOTAL	15.9	545.3	40.9	401.4
75-76	23 July 1975	4.6	157.8	17.2	115.5
	23 Sept 1975	2.9	69.8	8.7	52.3
	TOTAL	7.5	227.6	25.9	167.8
76-77	15 Sept 1976	2.5	87.5	11.8	85.5
	1 June 1977	3.9	88.9	16.8	186.0
	TOTAL	6.4	176.4	38.6	271.5
77-78	18 July 1977	4.6	113.3	18.7	143.5
	31 Oct 1977	3.6	93.2	15.3	108.5
	TOTAL	8.2	206.5	34.0	252.0

Table 6c. Test Cell Harvest Data for Cell 3

<u>Year</u>	<u>Date</u>	<u>Yield mt/ha</u>	<u>N uptake kg/ha</u>	<u>P uptake kg/ha</u>	<u>K uptake kg/ha</u>
73-74	July 1973	1.3	31.2	3.6	29.2
	mid Sept 1973	2.3	44.3	5.0	41.4
	3 June 1974	2.8	105.2	10.3	81.2
	TOTAL	6.4	180.5	18.9	151.8
74-75	20 July 1974	3.2	120.7	9.8	70.5
	18 Sept 1974	4.5	135.0	12.7	92.4
	10 June 1975	4.9	163.9	8.9	124.3
	TOTAL	12.6	419.6	31.4	287.2
75-76	23 July 1975	3.8	109.0	12.0	81.2
	23 Sept 1975	2.0	53.0	7.5	40.6
	TOTAL	5.8	162.0	19.5	121.8
76-77	15 Sept 1976	3.0	99.0	6.9	62.7
	1 June 1977	4.4	113.9	16.5	212.3
	TOTAL	7.4	212.9	23.4	275.0
77-78	18 July 1977	5.2	139.4	22.0	199.6
	31 Oct 1977	3.6	68.7	14.0	122.1
	TOTAL	8.8	208.1	36.0	321.7

Table 6d. Test Cell Harvest Data for Cell 4

<u>Year</u>	<u>Date</u>	<u>Yield mt/ha</u>	<u>N uptake kg/ha</u>	<u>P uptake kg/ha</u>	<u>K uptake kg/ha</u>
73-74	July 1973	2.2	57.6	6.4	52.8
	mid-Sept 1973	2.3	89.7	8.1	69.0
	3 June 1974	2.9	106.5	10.3	81.5
	TOTAL	7.4	253.8	24.8	203.3
74-75	20 July 1974	2.9	92.6	7.4	70.2
	18 Sept 1974	5.8	162.4	17.5	139.1
	10 June 1975	4.9	164.3	8.9	140.6
	TOTAL	13.6	419.3	33.8	349.9
75-76	23 July 1975	3.8	109.0	13.2	92.5
	23 Sept 1975	2.0	67.3	7.1	36.1
	TOTAL	5.8	176.3	20.3	128.6
76-77	15 Sept 1976	2.0	66.0	10.2	59.8
	1 June 1977	3.8	87.8	14.2	179.2
	TOTAL	5.8	153.8	24.4	240.0
77-78	18 July 1977	4.6	84.5	20.1	181.4
	31 Oct 1977	4.4	106.2	15.4	153.8
	TOTAL	9.0	190.7	35.5	335.2

Table 6e. Test Cell Harvest Data for Cell 5

<u>Year</u>	<u>Date</u>	<u>Yield mt/ha</u>	<u>N uptake kg/ha</u>	<u>P uptake kg/ha</u>	<u>K uptake kg/ha</u>
73-74	July 1973	3.0	82.2	8.4	75.0
	mid-Sept 1973	1.8	75.7	6.3	65.2
	3 June 1974	2.9	112.5	11.3	89.3
	TOTAL	7.7	270.4	26.0	229.5
74-75	20 July 1974	4.2	98.8	8.3	78.8
	18 Sept 1974	5.6	166.2	16.1	134.0
	10 June 1975	5.3	126.6	8.5	92.6
	TOTAL	15.1	391.6	32.9	305.4
75-76	23 July 1975	4.2	144.2	14.0	97.5
	23 Sept 1975	2.5	68.6	8.6	54.9
	TOTAL	6.7	212.8	22.6	152.4
76-77	15 Sept 1976	2.1	63.0	8.8	71.6
	1 June 1977	5.9	120.4	19.6	237.8
	TOTAL	8.0	183.4	28.4	309.4
77-78	18 July 1977	5.0	159.7	18.0	119.8
	31 Oct 1977	4.4	105.1	16.6	149.3
	TOTAL	9.4	264.8	34.6	269.1

Table 6f. Test Cell Harvest Data for Cell 6

<u>Year</u>	<u>Date</u>	<u>Yield mt/ha</u>	<u>N uptake kg/ha</u>	<u>P uptake kg/ha</u>	<u>K uptake kg/ha</u>
73-74	July 1973	2.5	67.0	6.6	55.4
	mid-Sept 1973	2.3	78.5	6.3	59.0
	3 June 1974	3.4	121.0	13.1	103.8
	TOTAL	8.2	266.5	26.0	218.2
74-75	20 July 1974	2.9	79.1	6.2	58.4
	18 Sept 1974	4.2	130.8	9.7	78.9
	10 June 1975	3.5	133.4	6.3	100.4
	TOTAL	10.6	343.3	22.2	237.7
75-76	23 July 1975	3.6	97.2	7.9	66.2
	23 Sept 1975	2.1	68.2	6.2	41.7
	8 June 1976	4.7	108.1	13.6	96.8
	TOTAL	10.4	273.5	27.7	204.7
76-77	4 Aug 1976	5.7	108.3	12.5	82.9
	15 Sept 1976	0.7	23.1	2.5	13.9
	1 June 1977	5.2	131.8	23.4	230.4
	TOTAL	11.6	263.2	38.4	327.2
77-78	18 July 1977	4.8	76.2	16.9	136.4
	31 Oct 1977	4.1	100.7	13.5	122.4
	13 June 1978	4.4	126.0	18.4	175.0
	TOTAL	13.3	302.9	48.8	433.8

Table 7a. Nutrient Balance Sheet Test Cell #1

Period	Nitrogen (kg/ha)				Phosphorus (kg/ha)			
	App	Plant Uptake	Perc.	Unacc. for	App	Plant Uptake	Perc.	Unacc. for
1973-74	353	223 63.2%	77 23.0%	53 15.0%	142	23.3 16.4%	<2.1 <1.5%	116.4 82.0%
1974-75	673	347 51.6%	194 28.8%	131 19.5%	163	30.0 18.4%	<4.7 <2.8%	128.3 78.7%
1975-76	324	243 75.0%	94 29.1%	-13 -4%	91	28.0 30.8%	1.4 1.5%	61.6 70.6%
1976-77	399	217 54.5%	78 19.5%	104 26%	89	29.4 33.0%	1.0 1.1%	58.6 65.8%
1977-78	348	359 103%	130 37.4%	-141 -40.5%	66	47.2 71.5%	0.4 0.6%	18.4 27.9%
Total	2097	1389 66.2%	573 27.3%	135 6.4%	551	158 28.7%	<9.6 <1.7%	383 69.6%

Table 7b. Nutrient Balance Sheet Test Cell #2

Period	Nitrogen (kg/ha)				Phosphorus (kg/ha)			
	App	Plant Uptake	Perc.	Unacc. for	App	Plant Uptake	Perc.	Unacc. for
1973-74	928	308 33.2%	287 31.0%	333 35.9%	377	26.9 7.9%	<5.3 <1.4%	342 90.7%
1974-75	2055	545 26.5%	1217 59.1%	283 14.3%	499	40.9 8.2%	<14.1 < 2.8%	444 89.0%
1975-76	784	228 29.1%	627 79.9%	-70.7 -9.0%	207	25.9 12.5%	3.6 1.7%	178 85.7%
1976-77	430	176 40.9%	275 63.9%	-21 -4.9%	89*	38.6 43.4%	0.9 1.0%	49.5 55.6%
1977-78	232	207 89.2%	172 74.3%	-147 -63.4%	45	34.0 75.6%	1.0 2.2%	10.0 22.2%
Total	4429	1464 33.1%	2578 58.2%	387 8.7%	1217	169 13.9%	<24.9 < 2.0%	1023 84.1%

*An additional 41 kg/ha over and above the wastewater phosphorus was added during 1976-77 as solid fertilizer (see Table 8).

Table 7c. Nutrient Balance Sheet Test Cell #3

Period	Nitrogen (kg/ha)				Phosphorus (kg/ha)			
	App	Plant Uptake	Perc.	Unacc. for	App	Plant Uptake	Perc.	Unacc. for
1973-74	393	181 46.0%	102 25.8%	110 28.0%	152	18.9 12.4%	<2.2 <1.5%	130.9 86.1%
1974-75	1072	420 39.2%	351 32.7%	301 28.0%	255	31.4 12.3%	<8.2 <3.2%	215.4 84.5%
1975-76	361	162 44.9%	233 64.5%	-34 -9.4%	88	19.6 22.1%	1.2 1.4%	67.2 76.3%
1976-77	429	213 49.7%	242 56.4%	-26 -6.1%	87*	23.4 26.9%	0.8 0.9%	62.8 72.2%
1977-78	233	208 89.3%	175 75.1%	-150 -64.3%	45	36.0 80.0%	1.1 2.5%	7.9 17.6%
Total	2488	1184 47.6%	1103 44.3%	201 8.1%	627	129 20.6%	<13.5% < 2.1%	484.2 77.2%

*An additional 41 kg/ha over and above the wastewater phosphorus was added during 1976-77 as solid fertilizer (see Table 8).

Table 7d. Nutrient Balance Sheet Test Cell #4

Period	Nitrogen (kg/ha)				Phosphorus (kg/ha)			
	App	Plant Uptake	Perc.	Unacc. for	App	Plant Uptake	Perc.	Unacc. for
1973-74	393	254 64.6%	88 22.4%	51 13.0%	153	24.8 16.2%	<2.2 1.4%	126.0 82.4%
1974-75	1003	419 41.8%	449 44.8%	135 13.4%	257	33.8 13.2%	<7.8 <3.0%	215.4 83.8%
1975-76	343	176 51.3%	225 65.6%	-58 -16.9%	84	20.3 24.2%	2.4 2.9%	61.3 77.3%
1976-77	436	154 35.3%	188 43.1%	94 21.6%	87*	24.4 28.0%	0.8 0.9%	61.8 71.0%
1977-78	251	191 76.1%	176 70.1%	-116 -46.2%	48	35.5 74.0%	1.1 2.3%	11.4 23.8%
Total	2426	1194 49.2%	1126 46.4%	106 4.4%	629	139 22.1%	<14.3 < 2.3%	475.7 75.6%

*An additional 81 kg/ha over and above the wastewater phosphorus was added during 1976-77 as solid fertilizer (see Table 8).

Table 7e. Nutrient Balance Sheet Test Cell #5

Period	Nitrogen (kg/ha)				Phosphorus (kg/ha)			
	App	Plant Uptake	Perc.	Unacc. for	App	Plant Uptake	Perc.	Unacc. for
1973-74	602	270 44.8%	207 34.4%	125 20.8%	243	26.0 10.7%	<4.5 1.9%	212.5 87.4%
1974-75	956	392 41.0%	441 46.1%	123 12.9%	235	33.0 14.0%	<7.1 <3.0%	194.8 82.9%
1975-76	358	213 59.4%	159 44.4%	-14 -3.9%	96	22.6 23.5%	1.6 1.7%	71.8 74.8%
1976-77	533	183 34.4%	198 37.1%	152 28.5%	106*	28.4 26.8%	1.1 1.0%	76.5 72.1%
1977-78	231	265 114.7%	188 81.3%	-222 -96.1%	44	34.6 78.6%	1.1 2.6%	8.3 18.9%
Total	2680	1323 49.4%	1193 44.5%	164 6.1%	724	145 20.0%	15.4 <2.1	564 77.9%

*An additional 81 kg/ha over and above the wastewater phosphorus was added during 1976-77 as solid fertilizer (see Table 8).

Table 7f. Nutrient Balance Sheet Test Cell #6

Period	Nitrogen (kg/ha)				Phosphorus (kg/ha)			
	App	Plant Uptake	Perc.	Unacc. for	App	Plant Uptake	Perc.	Unacc. for
1973-74	334	267 79.9%	62 18.5%	5 1.5%	142	26.0 18.3%	<2.1 1.5%	113.9 80.2%
1974-75	628	343 54.6%	254 40.4%	31 4.9%	168	22.2 13.2%	<5.6 <3.3%	140.2 83.5%
1975-76	411	273 66.5%	164 40.0%	-26 -6.3%	112	27.7 24.7%	1.4 1.2%	82.9 74.0%
1976-77	398	263 66.1%	104 26.2%	31 7.8%	90	38.4 42.7%	0.8 0.9%	50.9 56.4%
1977-78	328	303 92.4%	98 29.9%	-73 -22.3%	62	48.8 78.7%	0.3 0.5%	12.9 20.8%
Total	2099	1449 69.0%	682 32.5%	-32 -1.5%	574	163 28.4%	<7.3 <1.3%	404 70.3%

Table 8. Soil Amendments Applied to Test Cells (28' x 28').
(May 1973 through May 1978).

Lime: Lime applied as dolomitic limestone (CaMgCO_3).

Date of Treatment	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6
	kg/ha					
1973	-	-	-	-	-	-
1974	-	-	-	-	-	-
October 1975	504	1,497	1,329	1,497	1,497	1,665
28-29 May 1976 (during reseeding)	-	4,492	3,988	4,492	4,492	-
2 May 1977	2,200	2,200	2,200	2,200	2,200	2,200
1978	-	-	-	-	-	-
TOTAL	2,704	8,189	7,517	8,189	8,189	3,865

Potassium: K applied as potassium chloride fertilizer (KCl).

Date of Treatment	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6
	kg/ha					
28-29 May 1976	-	300	300	300	300	-
2 May 1977	300	300	300	300	300	300
4 May 1978	137					137
TOTAL	437	600	600	600	600	437

Phosphorus: P additions as superphosphate fertilizer (0-20-0).

Date of Treatment	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6
	kg/ha					
9 August 1976	-	41	41	81	81	-

REFERENCES

1. Iskandar, I.K., R.S. Sletten, D.C. Leggett, and T.F. Jenkins. 1976. Wastewater renovation by a prototype slow infiltration land treatment system. CRREL Report 76-19.
2. Iskandar, I.K., R. Bates, F. Page, S. Quarry and J. Ingersol (in press). Changes in soil characteristics and climatology during five years of wastewater application to CRREL prototype test cells. Special Report.
3. Palazzo, A.J. 1976. The effects of wastewater application on the growth and chemical composition of forages. CRREL Report 76-39.
4. Palazzo, A.J. and T.F. Jenkins. Land application of wastewater: Effect on soil and plant potassium. CRREL Special Report (in prep.).
5. Ricard, P.S., D.B. Keller, R.H. Ardrey, and T.F. Jenkins. 1976. Water quality measurements for a prototype land treatment system, June 1975 to May 1976. CRREL Internal Report 499.
6. Schumacher, P.W., D.B. Keller, S.E. Zebrowski, E.S. Foley, S.T. Quarry, and T.F. Jenkins. 1977. Water quality measurements for a prototype land treatment system, June 1976 to May 1977. CRREL Internal Report 507.