

DRILLING WASTE LANDSPREADING FIELD TRIAL

A JOINT RESEARCH PROJECT  
OF  
ALBERTA RESEARCH COUNCIL  
ESSO RESOURCES CANADA LIMITED

Report prepared by

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EXECUTIVE SUMMARY

Drilling associated with the oil and gas industry generates wastes that must be disposed of in an environmentally safe manner. In 1988 a joint research program was developed and implemented by the Alberta Research Council and ESSO Resources Canada Limited to identify the impact of different loading rates of KCl, NaCl, and freshwater gel drilling wastes landspread on Luvisolic soils currently occurring in the Cold Lake area.

During 1989 five site visits were made to complete various tasks. Climate monitoring equipment was installed during the period May 15 to 17 and tissue from the brome grass was collected on June 19. The plots were harvested on June 26 and 27 and, again, on August 14 and 15 at which time soil sampling was also completed.

Observations, relative to the brome grass growth on the various plot treatments, were made throughout the growing season. Germination appeared to be affected by the application of the KCl and NaCl waste materials, particularly the KCl 5 and NaCl 10 treatments. For each of the waste treatment types the yield, obtained for the lower waste application rates, exceeded the yields obtained in the respective control treatments, and the maximum application rate resulted in the lowest yield.

The soil and soil/waste samples obtained were analysed for a number of parameters, including pH,  $\text{CaCO}_3$  equivalent, soluble ions in saturated paste extracts, and total elemental content.

Following waste application, only treatments FW 4, FW 5, and NaCl 10 might present a slight limitation to plant growth as a result of pH level. The  $\text{CaCO}_3$  equivalent values indicated that none of the treatments would be limiting to plant growth as a result of  $\text{CaCO}_3$  levels.

The saturated paste extract data illustrated the changes that occurred in the soils as a result of waste application and the changes that occurred between the 1988 and 1989 sampling events. The mean EC values for all plots and all depths prior to waste

application, were well below 1.0 dS/m suggesting that there was no limitation to plant growth on the basis of EC (Alberta Soils Advisory Committee 1977). Data from the 1989 sampling program that slight limitations to plant growth might occur in the KCl 4 and KCl 5 and NaCl 8 treatments and that moderate limitations might occur in the NaCl 10 treatment as a result of EC level.

The mean SAR values for all plots and all depths, prior to waste application, were below 1.0, suggesting that on the basis of SAR levels, the soils presented no limitation to plant growth. The 1989 data indicated that there were no limitations to plant growth on the basis of SAR for all treatments, except a slight limitation associated with the NaCl 8 and NaCl 9 treatments and a severe limitation for the NaCl 10 treatment. The data, relative to Cl content in the field plots in 1989, indicated that a significant amount was leached downward between the fall of 1987 and 1988.

Elemental content levels increased or decreased slightly as a result of waste addition. Mean values, for the various elements determined, were within the range of values normally found in soils, except for Ca which was slightly below the minimum levels noted.

The effect of the addition of drilling wastes on the elemental enrichment of the brome grass was demonstrated by the enrichment ratio (ER). The tissue from the treated plots exhibited elevated levels of chloride, sodium, and, to a lesser extent, copper, in comparison with the tissue from the control plots. The concentration of potassium in the tissue from the treated plots changed very little relative to the control plots, and magnesium uptake declined with increased waste application rate and, in particular, with the NaCl waste.

The application of the different wastes at various rates had both positive and negative impacts on the soils and the plants grown thereon.

ACKNOWLEDGEMENTS

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1.        INTRODUCTION

Drilling associated with the oil industry generates wastes that must be disposed of in an environmentally safe manner. Drilling in the Cold Lake area generates a number of different types of wastes dominated by freshwater gel wastes and potassium chloride (KCl) and sodium chloride (NaCl) types to a lesser extent. Landspreading is one of the disposal options available and loading rate guidelines have been established by the Energy Resources Conservation Board (ERCB 1975).

The Alberta Research Council is currently conducting research into sampling and characterization strategies to characterize major drilling waste types on a province wide basis. Greenhouse work is being conducted to assess the impact of these wastes on soils and plants. Field studies designed to validate and calibrate the greenhouse results would be very helpful from an operations standpoint to define maximum or tolerable loading on the basis of waste type.

As a result a joint program was developed by the Alberta Research Council and ESSO Resources Canada Limited and undertaken in the Cold Lake area in 1988. This report describes the results of the research conducted in 1989.

2.        OBJECTIVE

The objective of the experiment is to identify the impact of different loading rates of KCl, NaCl, and freshwater gel drilling wastes landspread on Luvisolic soils commonly occurring in the Cold Lake area. Emphasis will be placed on determining maximum tolerable loading rates. The project is expected to continue for a minimum of three years to generate meaningful data for the development of recommendations.

### 3. MATERIALS AND METHODS

This section describes the procedures used in collecting tissue samples, determining yield and sampling the soils and waste/soil mixtures associated with the plots established in 1988 (Macyk et al. 1989). A description of the climate monitoring equipment installed is also provided.

Figures 1 to 4 illustrate the location of the study area as well as the experimental design and key to plot layout for the purposes of sample collection and data reporting.

#### 3.1 PLOT MAINTENANCE

Five site visits were made during the year to complete various tasks. While on site, weed control particularly in the border areas between plots was undertaken. The individual plot treatment corner stakes were replaced with a larger and more sturdy variety and plot identifiers were attached to aid plot identification. During harvest operations additional rock and root picking was undertaken.

Fertilizer was applied on June 27, 1989 at a rate of 130 kg/ha of 16-20-0 following the harvest for yield determination.

#### 3.2 PLANT TISSUE COLLECTION

Tissue from the brome grass was collected on June 19, 1989. Approximately 15 percent of the crop was headed at the time of sampling. It appeared that a higher proportion of the crop was headed in the plots with the higher waste application rates as compared to the lower rate and control plots.

Plant material was collected from several locations within each plot and the samples were transported to the laboratory in paper bags and dried at 70°C for 24 hours prior to grinding and analysis.



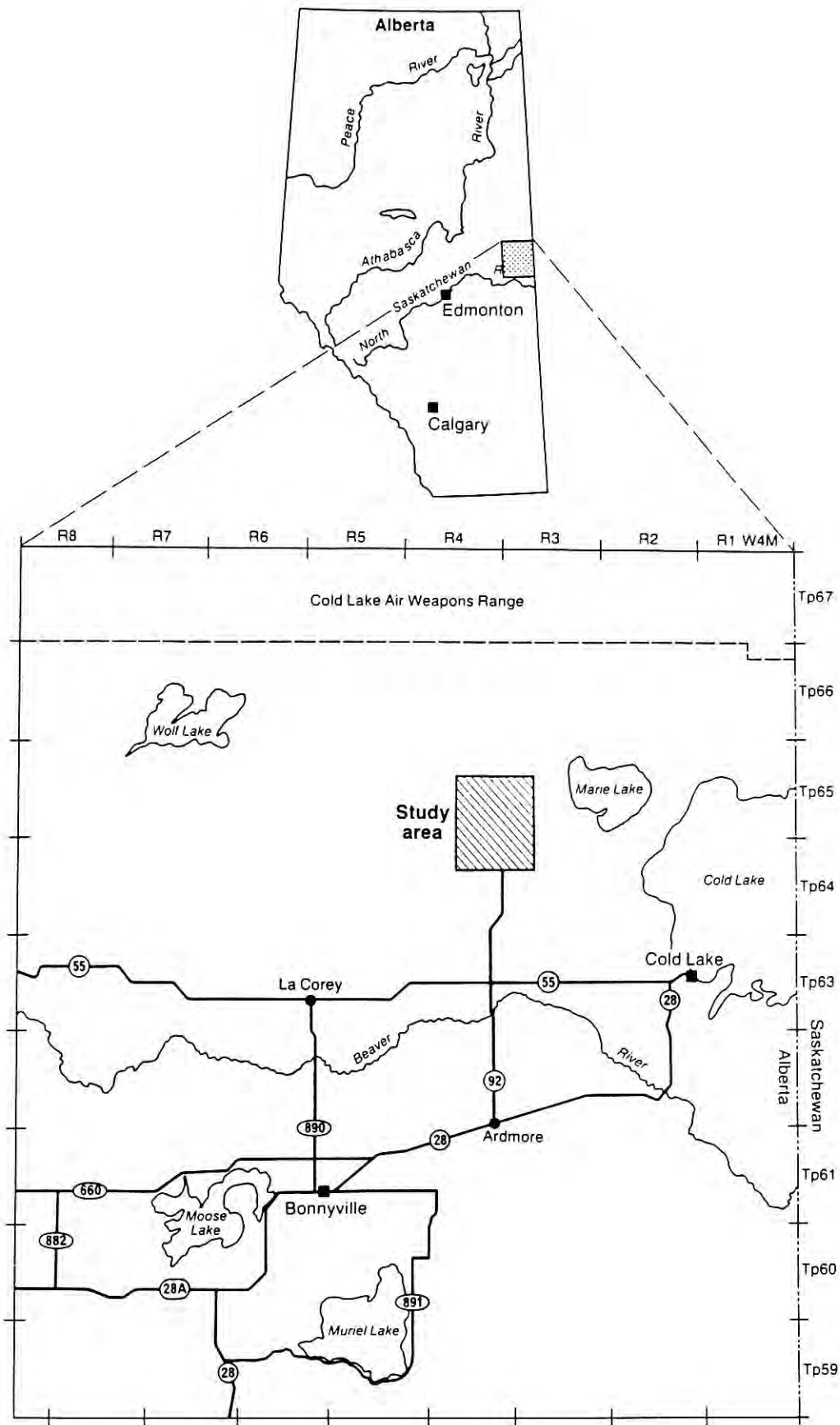
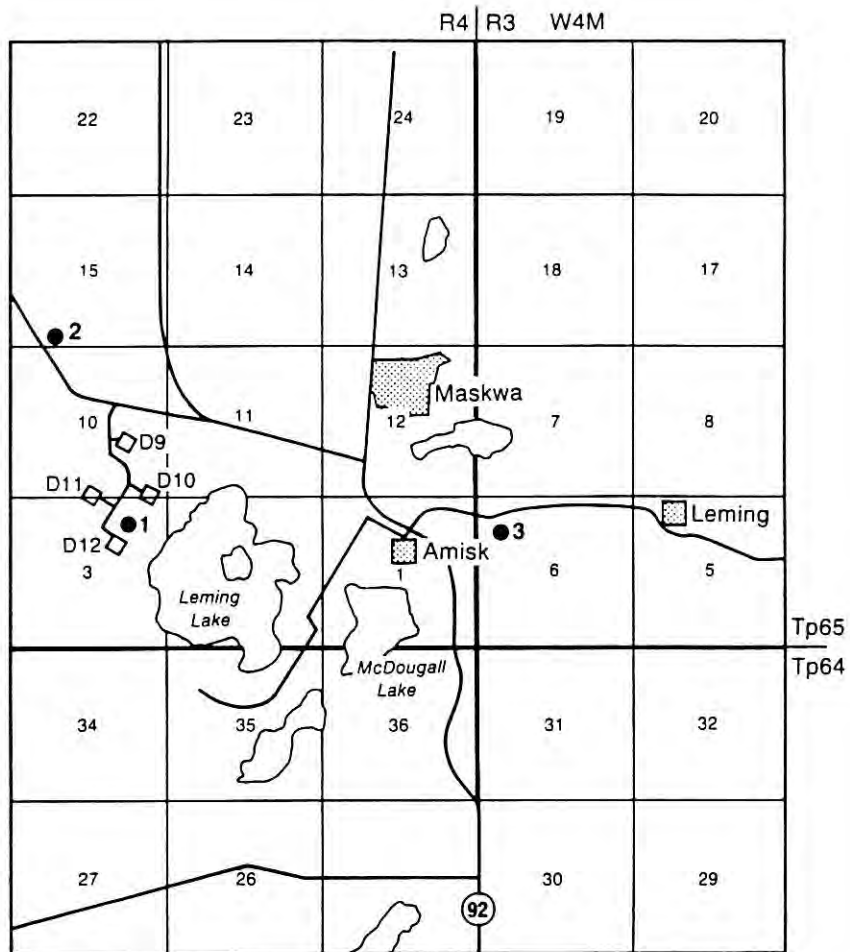


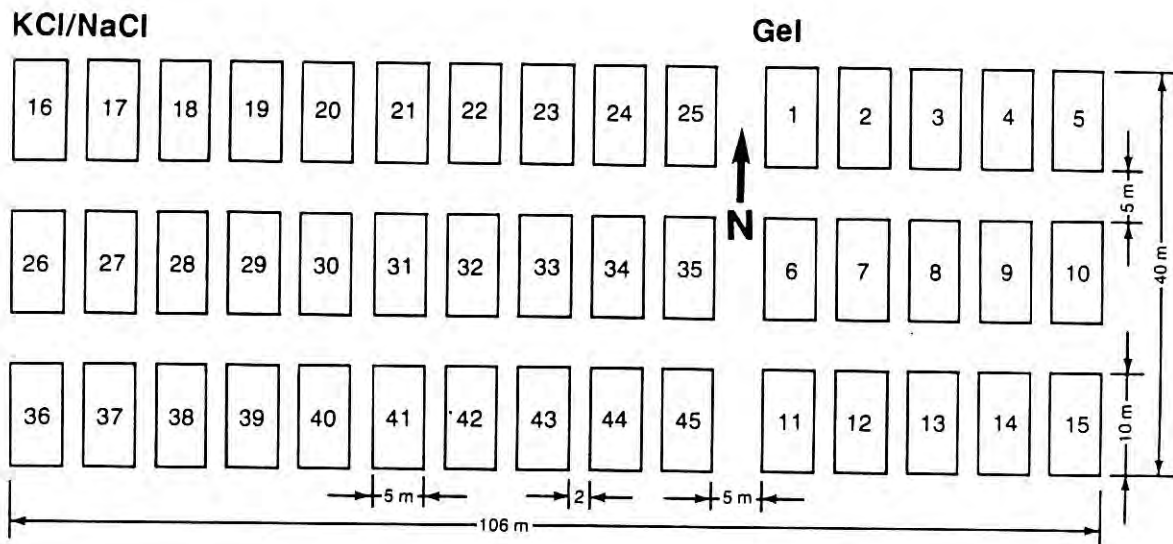
Figure 1. Location of drilling waste landspreading study area.



**Figure 2.** Location of plot area and waste source sites.

- 1 - Plot location
- 2 - NaCl sump site
- 3 - Freshwater gel sump site





**Figure 4.** Key to plot layout for sample collection and data reporting.

### 3.3. YIELD DETERMINATION

The plots were harvested on June 26 and 27, 1989. A second harvest was completed August 14 and 15 to ensure the plots are relatively residue free in the spring of 1990.

The harvesting was done by use of a lawn mower so that all plant material from each plot could be removed (Plate 1). Harvesting the entire plot removed any bias from randomly selecting smaller unit areas within each plot and the use of a mower set at a given height ensured, to the greatest extent possible, uniformity in harvest.

All material from each plot was weighed to determine the fresh weight (Plate 2). A subsample of this fresh material was weighed and transported to the laboratory for drying so that a dry weight could be determined for each plot.

### 3.4 SOIL SAMPLING

Soil sampling was completed August 14 and 15, 1989. Samples from the 0 to 15 cm depth interval were taken from each plot. In some plots a composite sample of five locations was obtained and in selected plots five individual samples were collected to assess degree of variability of the chemical parameters. Sampling of the 15 to 30 cm, 30 to 45 cm, 45 to 60 cm, and 60 to 90 cm depth intervals was also completed in several plots. Details regarding sample distribution are provided in Table 1.

### 3.5 CLIMATE MONITORING EQUIPMENT INSTALLATION

Climate monitoring equipment was installed at the experimental site during the period May 15 to 17, 1989. Two Model 824 Easylogger units (Omnidata International Inc.) which are 12-channel portable data recorders were installed to measure air and soil temperature, precipitation, wind speed and direction, solar radiation, relative humidity and soil moisture (Plate 3). Rainfall intensity is measured by the use of a tipping bucket rain gauge and total amounts by use of a Taylor Clear-Vu rain gauge (Taylor Instrument, Sybron Corporation).





Plate 1. Harvesting by use of a lawn mower.



Plate 2. Fresh weight of harvested material was determined immediately in the field.

Table 1. Soil samples collected from the individual plots.

| Plot No. | Treatment | Rate | Sample No. | Depth (cm) |
|----------|-----------|------|------------|------------|
| 1        | FWG       | 3    | TME 1      | 0 to 15    |
|          |           |      | TME 2      | 15 to 30   |
| 2        | FWG       | 2    | TME 3      | 0 to 15    |
| 3        | FWG       | 1    | TME 4      | 0 to 15    |
| 4        | FWG       | 5    | TME 5-9    | 0 to 15    |
| 5        | FWG       | 4    | TME 10     | 0 to 15    |
|          |           |      | TME 11     | 15 to 30   |
| 6        | FWG       | 3    | TME 12     | 0 to 15    |
| 7        | FWG       | 4    | TME 13     | 0 to 15    |
|          |           |      | TME 14     | 15 to 30   |
|          |           |      | TME 15     | 30 to 45   |
|          |           |      | TME 16     | 45 to 60   |
| 8        | FWG       | 2    | TME 17     | 0 to 15    |
| 9        | FWG       | 1    | TME 18     | 0 to 15    |
| 10       | FWG       | 5    | TME 19-23  | 0 to 15    |
|          |           |      | TME 24-28  | 15 to 30   |
|          |           |      | TME 29     | 30 to 45   |
|          |           |      | TME 30     | 45 to 60   |
| 11       | FWG       | 3    | TME 31-35  | 0 to 15    |
| 12       | FWG       | 4    | TME 36     | 0 to 15    |
| 13       | FWG       | 1    | TME 37     | 0 to 15    |
|          |           |      | TME 38     | 15 to 30   |
|          |           |      | TME 39     | 30 to 45   |
|          |           |      | TME 40     | 45 to 60   |
| 14       | FWG       | 5    | TME 41     | 0 to 15    |
|          |           |      | TME 42     | 15 to 30   |
|          |           |      | TME 43     | 30 to 45   |
|          |           |      | TME 44     | 45 to 60   |
| 15       | FWG       | 2    | TME 45     | 0 to 15    |

continued . . .

Table 1. Continued.

| Plot No. | Treatment | Rate | Sample No.  | Depth (cm) |
|----------|-----------|------|-------------|------------|
| 16       | KCl       | 4    | TME 46-50   | 0 to 15    |
|          |           |      | TME 51-55   | 15 to 30   |
|          |           |      | TME 56      | 30 to 60   |
|          |           |      | TME 57      | 60 to 90   |
| 17       | KCl       | 1    | TME 58      | 0 to 15    |
| 18       | NaCl      | 7    | TME 59      | 0 to 15    |
| 19       | NaCl      | 9    | TME 60-64   | 0 to 15    |
|          |           |      | TME 65-69   | 15 to 30   |
|          |           |      | TME 70      | 30 to 45   |
|          |           |      | TME 71      | 45 to 60   |
| 20       | NaCl      | 8    | TME 72      | 0 to 15    |
| 21       | KCl       | 3    | TME 73-77   | 0 to 15    |
| 22       | NaCl      | 6    | TME 78      | 0 to 15    |
|          |           |      | TME 79      | 15 to 30   |
|          |           |      | TME 80      | 30 to 45   |
|          |           |      | TME 81      | 45 to 60   |
| 23       | NaCl      | 10   | TME 82-86   | 0 to 15    |
|          |           |      | TME 87-91   | 15 to 30   |
|          |           |      | TME 92      | 30 to 45   |
|          |           |      | TME 93      | 45 to 60   |
| 24       | KCl       | 4    | TME 94      | 0 to 94    |
| 25       | KCl       | 5    | TME 95-99   | 0 to 15    |
|          |           |      | TME 100-104 | 15 to 30   |
|          |           |      | TME 105     | 30 to 45   |
|          |           |      | TME 106     | 45 to 60   |
| 26       | KCl       | 5    | TME 107     | 0 to 15    |
| 27       | NaCl      | 7    | TME 108-112 | 0 to 15    |
|          |           |      | TME 113     | 15 to 30   |
| 28       | NaCl      | 10   | TME 114-118 | 0 to 15    |
|          |           |      | TME 119-123 | 15 to 30   |

continued . . .



Table 1. Continued.

| Plot No. | Treatment | Rate | Sample No.  | Depth (cm) |
|----------|-----------|------|-------------|------------|
| 29       | KCl       | 4    | TME 124     | 0 to 15    |
|          |           |      | TME 125     | 15 to 30   |
|          |           |      | TME 126     | 30 to 45   |
|          |           |      | TME 127     | 45 to 60   |
|          |           |      | TMK 128     | 60 to 90   |
| 30       | KCl       | 3    | TME 129     | 0 to 15    |
| 31       | NaCl      | 9    | TME 130-134 | 0 to 15    |
|          |           |      | TME 135-139 | 15 to 30   |
|          |           |      | TME 140     | 30 to 45   |
|          |           |      | TME 141     | 45 to 60   |
| 32       | NaCl      | 6    | TME 142     | 0 to 15    |
| 33       | KCl       | 2    | TME 143     | 0 to 15    |
| 34       | NaCl      | 7    | TME 144-148 | 0 to 15    |
|          |           |      | TME 149     | 15 to 30   |
| 35       | NaCl      | 8    | TME 150-154 | 0 to 15    |
|          |           |      | TME 155     | 15 to 30   |
| 36       | NaCl      | 9    | TME 156-160 | 0 to 15    |
|          |           |      | TME 161     | 15 to 30   |
| 37       | KCl       |      | TME 162     | 0 to 15    |
| 38       | NaCl      | 30   | TME 163-167 | 0 to 15    |
|          |           |      | TME 168-172 | 15 to 30   |
|          |           |      | TME 173     | 30 to 45   |
|          |           |      | TME 174     | 45 to 60   |
|          |           |      | TMK 175     | 60 to 90   |
| 39       | KCl       | 3    | TME 176     | 0 to 15    |
| 40       | KCl       | 2    | TME 177     | 0 to 15    |
| 41       | NaCl      | 6    | TME 178     | 0 to 15    |
| 42       | KCl       | 1    | TME 179-183 | 0 to 15    |
| 43       | KCl       | 1    | TME 184     | 0 to 15    |

continued . . .

Table 1. Concluded.

| Plot No. | Treatment | Rate | Sample No.  | Depth (cm) |
|----------|-----------|------|-------------|------------|
| 44       | NaCl      | 8    | TME 185-189 | 0 to 15    |
|          |           |      | TME 190-194 | 15 to 30   |
|          |           |      | TME 195     | 30 to 45   |
|          |           |      | TMK 196     | 45 to 60   |
| 45       | KCl       | 2    | TME 197-201 | 0 to 15    |
|          |           |      | TME 202-206 | 15 to 30   |
|          |           |      | TME 207     | 30 to 45   |

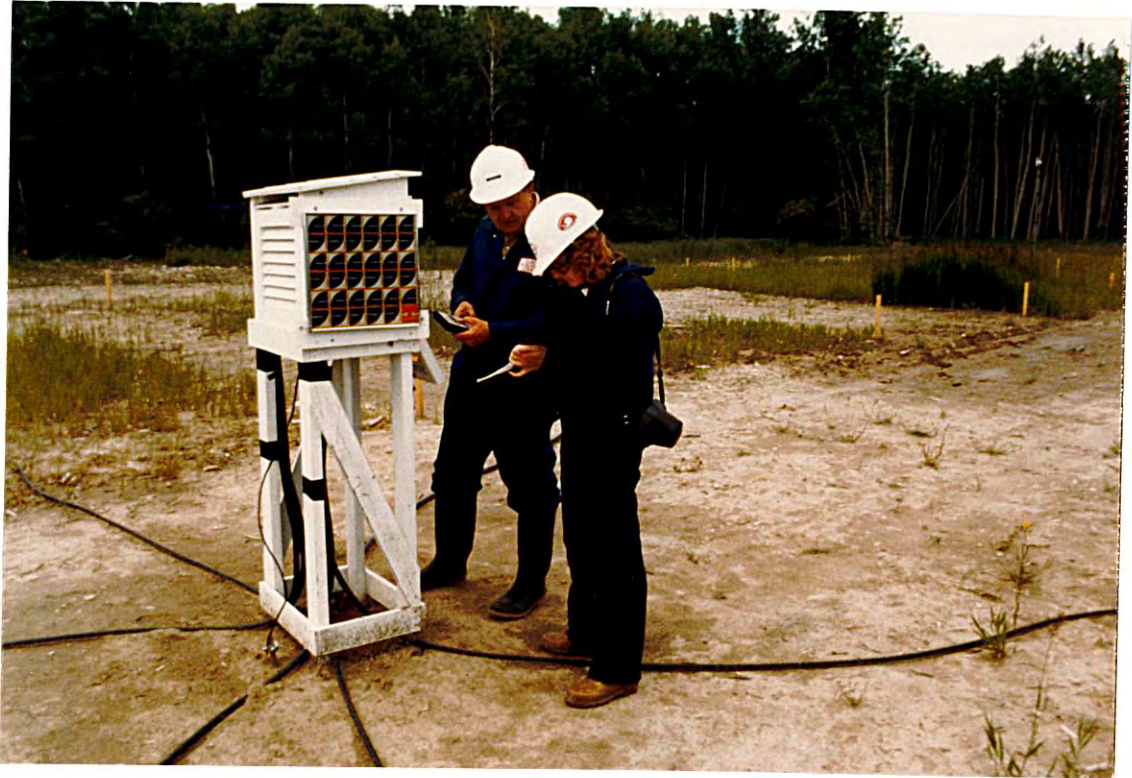


Plate 3. Climate monitoring equipment installed at the experimental site.

Soil moisture was measured by the use of the SM898 Beckman soil moisture block, however, problems were encountered particularly in the plots where high chloride concentrations were present and when the soil material was saturated. Alternative blocks or cells are being investigated in an attempt to install a system that operates consistently.

### 3.6 METHODS OF ANALYSIS

This section describes the methods used for analysis of the soils, soil and waste mixtures, and the tissue collected.

#### 3.6.1 Drilling Waste and Soil Analyses

Soil pH was measured in a paste (Doughty 1941) and in a 2:1 slurry of 0.01 M  $\text{CaCl}_2$  (Peech 1965). Total carbon content was measured with a LECO CR12 carbon analyser (Leco Corporation 1979), and  $\text{CaCO}_3$  equivalent by acid dissolution. Saturated pastes were prepared according to the USDA Soil Salinity Laboratory method (USDA 1954; Rhoades 1982); were extracted and the extracts filtered through a 0.45 mm filter and analysed for pH, electrical conductivity, alkalinity, chloride, and for soluble salts (Na, K, Ca, Al, Cr, Fe, V, Ti, Cd, Cu, Pb, Zn, Mn, Mg, Li, Sr, B, Ba, P, S, Mo, Ni, Se, As, Co, Si) using an ARL model 34000 simultaneous Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES). Cation exchange capacity (CEC) and extractable cations were determined by extraction with a normal (1 M at pH 7.0) ammonium acetate solution (Holmgren et al. 1977), where  $\text{NH}_4$  ions were determined by a Tecator Kjeltac Auto 1030 Analyser distillation and titration unit and the exchangeable ions by the ICP-AES.

DTPA- $\text{NH}_4\text{HCO}_3$  extractable elements (Fe, Cd, Cu, Pb, Zn, Mn, Ca, Mg, Na, K, B, P, Mo, Ni, Se) were determined by the method of Soltanpour and Workman (1981). Total elemental analysis of the samples was done by digestion in a CEM microwave digestion system. The procedure used included ashing the material overnight in a 425°C muffle furnace, digestion in a teflon bomb in the microwave oven with

1.5 mL  $\text{HNO}_3$ , 4.5 mL  $\text{HCl}$ , and 10 mL  $\text{HF}$  for 10 min at 100% power, 20 min at 50% power, and 10 min at 100% power. The digested solutions were transferred and made up with saturated  $\text{H}_3\text{BO}_3$  to 50 mL, and the metal concentrations measured using ICP-AES.

### 3.6.2 Methods of Plant Analysis

The grass samples were digested with a concentrated  $\text{HNO}_3 - \text{HClO}_4$  acid mixture in a teflon bomb heated in a CEM microwave digestion unit and the solution concentration of Al, Fe, Zn, Mn, Ca, Mg, Na, K, Sr, P, Ba, Mo, B, S, Si, and As measured by ICP-AES and Cd and Pb by graphite furnace atomic absorption. Chloride content was determined by the sodium nitrate extraction procedure of Gaines et al. (1984).

#### 4. RESULTS AND DISCUSSION

Data pertinent to the properties of the soils prior to waste application and subsequent to waste application were reported by Macyk et al. (1989a). Data pertinent to the climatic parameters measured, the properties of the soils and soil/waste mixtures, and the elemental composition of the brome grass tissue for the individual plots in 1989 are provided in this section of the report.

##### 4.1 PLOT TREATMENTS

The plot treatments illustrated in Figure 3 represent various application rates of waste based on chloride concentration. Initially, the objective of the experiment was to apply 0(control), 450 kg Cl/ha, 900 kg Cl/ha, 1800 kg Cl/ha, and 3600 kg Cl/ha. It was not possible to achieve anywhere near the suggested rates using the freshwater gel simply because of its low chloride content relative to the other waste types. Levels very close to the target values were achieved with the use of the KCl and NaCl materials. Table 2 provides the chloride levels applied for each of the treatments.

##### 4.2 CLIMATE DATA

Because the climate monitoring station was not installed until mid-May 1989, a complete record for the growing season was not obtained. Furthermore, equipment problems caused mainly by mechanical problems with the moisture sensors resulted in some additional gaps in the data.

All of the data obtained to the end of September relative to air temperature, relative humidity, solar radiation, wind direction, and wind speed are currently available in hard copy file form. Rainfall intensity data are available up to and including October 16. Excerpts of the data are presented in this section of the report.

It is important to note that all data are recorded on a mean value per hour basis. Measurements are made every three minutes and mean values computed and recorded hourly. For example, a value

Table 2. Waste application treatments.

| Treatment        | Chloride Addition (kg Cl/ha) |
|------------------|------------------------------|
| Freshwater gel 1 | 0                            |
| Freshwater gel 2 | 15                           |
| Freshwater gel 3 | 30                           |
| Freshwater gel 4 | 60                           |
| Freshwater gel 5 | 120                          |
| KCl 1            | 0                            |
| KCl 2            | 500                          |
| KCl 3            | 1000                         |
| KCl 4            | 2000                         |
| KCl 5            | 4000                         |
| NaCl 6           | 0                            |
| NaCl 7           | 350                          |
| NaCl 8           | 700                          |
| NaCl 9           | 1400                         |
| NaCl 10          | 2800                         |



recorded at 14:00 hr represents the scans and mean value for the time elapsed between 13:00 and 14:00 hr. Time is always expressed as Mountain Standard Time.

#### 4.2.1 Air Temperature

The more important factors associated with air temperature relate to extremes including minimum and maximum values and their duration. Frost-free period is one parameter that can be obtained from these data. For example, on May 29 the mean air temperature was  $-0.7^{\circ}\text{C}$  from 2:00 to 3:00 a.m.,  $-1.2^{\circ}\text{C}$  from 3:00 to 4:00 a.m., and  $-1.1^{\circ}\text{C}$  from 4:00 to 5:00 a.m. On September 9 mean air temperature was below  $0^{\circ}\text{C}$  from 4:00 to 5:00 a.m. Using these data one calculates a frost-free period of 102 days.

The maximum mean hourly air temperature recorded during the measurement period was  $30.8^{\circ}\text{C}$  on July 20.

#### 4.2.2 Precipitation

The total amount of precipitation that occurs during the growing season is critical, however, the distribution of rainfall throughout the season is important for effective plant establishment and growth. The tipping bucket rain gauge is useful for assessing the distribution and intensity of rainfall events. A total of 332 mm occurred during the period May 16 to October 16, 1989. More specifically:

|                               |          |
|-------------------------------|----------|
| • May 16 to May 31            | - 51 mm  |
| • June 1 to June 30           | - 78 mm  |
| • July 1 to July 31           | - 44 mm  |
| • August 1 to August 31       | - 101 mm |
| • September 1 to September 30 | - 46 mm  |
| • October 1 to October 16     | - 12 mm  |

The tipping bucket data indicate the intensity of the rainfall events that occurred. Table 3 provides details regarding precipitation at the study site for the month of August which had the highest monthly total for the growing season. It is interesting to

Table 3. RAINFALL - AMOUNT (mm) AND INTENSITY AT THE ESSO FIELD TRIAL SITE IN AUGUST, 1989.

| M     | D     | TIME | RAIN<br>FALL<br>mm | M     | D     | TIME | RAIN<br>FALL<br>mm | M     | D     | TIME | RAIN<br>FALL<br>mm |
|-------|-------|------|--------------------|-------|-------|------|--------------------|-------|-------|------|--------------------|
| 08/02 | 04:07 |      | 1.                 | 08/21 | 22:22 |      | 1.                 | 08/29 | 23:49 |      | 1.                 |
| 08/02 | 06:21 |      | 1.                 | 08/21 | 22:31 |      | 1.                 | 08/29 | 23:57 |      | 1.                 |
| 08/02 | 07:24 |      | 1.                 | 08/21 | 22:43 |      | 1.                 | 08/30 | 00:06 |      | 1.                 |
| 08/02 | 07:25 |      | 1.                 | 08/21 | 22:55 |      | 1.                 | 08/30 | 00:31 |      | 1.                 |
| 08/02 | 07:26 |      | 1.                 | 08/21 | 23:21 |      | 1.                 | 08/31 | 20:22 |      | 1.                 |
| 08/02 | 07:27 |      | 1.                 | 08/21 | 23:51 |      | 1.                 | 08/31 | 20:31 |      | 1.                 |
| 08/02 | 07:28 |      | 1.                 | 08/22 | 00:01 |      | 1.                 | 08/31 | 20:45 |      | 1.                 |
| 08/02 | 07:29 |      | 1.                 | 08/22 | 00:09 |      | 1.                 | 08/31 | 20:57 |      | 1.                 |
| 08/02 | 07:30 |      | 1.                 | 08/22 | 00:16 |      | 1.                 | 08/31 | 21:09 |      | 1.                 |
| 08/02 | 07:31 |      | 1.                 | 08/22 | 00:27 |      | 1.                 | 08/31 | 21:23 |      | 1.                 |
| 08/02 | 07:32 |      | 1.                 | 08/22 | 02:21 |      | 1.                 | 08/31 | 21:35 |      | 1.                 |
| 08/10 | 02:36 |      | 1.                 | 08/22 | 02:47 |      | 1.                 |       |       |      |                    |
| 08/10 | 02:47 |      | 1.                 | 08/23 | 00:14 |      | 1.                 |       |       |      |                    |
| 08/17 | 10:38 |      | 1.                 | 08/23 | 00:15 |      | 1.                 |       |       |      |                    |
| 08/17 | 10:48 |      | 1.                 | 08/23 | 00:16 |      | 1.                 |       |       |      |                    |
| 08/17 | 14:46 |      | 1.                 | 08/23 | 00:17 |      | 1.                 |       |       |      |                    |
| 08/18 | 07:25 |      | 1.                 | 08/23 | 00:19 |      | 1.                 |       |       |      |                    |
| 08/18 | 07:36 |      | 1.                 | 08/23 | 00:23 |      | 1.                 |       |       |      |                    |
| 08/18 | 07:45 |      | 1.                 | 08/23 | 03:33 |      | 1.                 |       |       |      |                    |
| 08/18 | 07:56 |      | 1.                 | 08/23 | 03:48 |      | 1.                 |       |       |      |                    |
| 08/18 | 08:10 |      | 1.                 | 08/23 | 05:00 |      | 1.                 |       |       |      |                    |
| 08/18 | 08:33 |      | 1.                 | 08/23 | 12:22 |      | 1.                 |       |       |      |                    |
| 08/18 | 08:41 |      | 1.                 | 08/23 | 12:52 |      | 1.                 |       |       |      |                    |
| 08/18 | 08:43 |      | 1.                 | 08/23 | 13:19 |      | 1.                 |       |       |      |                    |
| 08/18 | 08:45 |      | 1.                 | 08/23 | 13:47 |      | 1.                 |       |       |      |                    |
| 08/18 | 10:08 |      | 1.                 | 08/23 | 14:17 |      | 1.                 |       |       |      |                    |
| 08/18 | 14:23 |      | 1.                 | 08/23 | 18:51 |      | 1.                 |       |       |      |                    |
| 08/18 | 14:51 |      | 1.                 | 08/23 | 18:54 |      | 1.                 |       |       |      |                    |
| 08/21 | 20:25 |      | 1.                 | 08/23 | 18:57 |      | 1.                 |       |       |      |                    |
| 08/21 | 20:31 |      | 1.                 | 08/23 | 18:59 |      | 1.                 |       |       |      |                    |
| 08/21 | 20:34 |      | 1.                 | 08/23 | 19:04 |      | 1.                 |       |       |      |                    |
| 08/21 | 20:36 |      | 1.                 | 08/23 | 19:07 |      | 1.                 |       |       |      |                    |
| 08/21 | 20:38 |      | 1.                 | 08/23 | 19:14 |      | 1.                 |       |       |      |                    |
| 08/21 | 20:41 |      | 1.                 | 08/23 | 20:01 |      | 1.                 |       |       |      |                    |
| 08/21 | 20:46 |      | 1.                 | 08/25 | 16:41 |      | 1.                 |       |       |      |                    |
| 08/21 | 20:56 |      | 1.                 | 08/27 | 18:45 |      | 1.                 |       |       |      |                    |
| 08/21 | 21:06 |      | 1.                 | 08/27 | 19:01 |      | 1.                 |       |       |      |                    |
| 08/21 | 21:32 |      | 1.                 | 08/28 | 09:34 |      | 1.                 |       |       |      |                    |
| 08/21 | 21:39 |      | 1.                 | 08/28 | 09:42 |      | 1.                 |       |       |      |                    |
| 08/21 | 21:41 |      | 1.                 | 08/28 | 09:47 |      | 1.                 |       |       |      |                    |
| 08/21 | 21:45 |      | 1.                 | 08/28 | 14:38 |      | 1.                 |       |       |      |                    |
| 08/21 | 21:48 |      | 1.                 | 08/29 | 02:43 |      | 1.                 |       |       |      |                    |
| 08/21 | 21:56 |      | 1.                 | 08/29 | 03:10 |      | 1.                 |       |       |      |                    |
| 08/21 | 22:00 |      | 1.                 | 08/29 | 03:43 |      | 1.                 |       |       |      |                    |
| 08/21 | 22:12 |      | 1.                 | 08/29 | 20:41 |      | 1.                 |       |       |      |                    |
|       |       |      |                    | TOTAL |       |      |                    | 101   |       |      |                    |

note that on August 2, 9 mm of rainfall occurred between 7:24 and 7:32 a.m. On August 23, a total of 22 mm of rainfall occurred which accounted for 20% of the total for the month.

#### 4.3 PLOT YIELD

Observations relative to the brome grass growth on the various plot treatments were made throughout the growing season. The freshwater gel treated plots had the best growth overall with the FW 2 and FW 3 treatments having better growth than the FW 1 (control) treatment. The FW 4 and FW 5 treatments had the poorest growth and appeared the most pale green or chlorotic in color. Plates 4 and 5 illustrate the growth achieved in a FW 2 (lowest freshwater gel application rate) and a FW 5 (highest freshwater gel application rate) treatment, respectively.

Germination appeared to be affected by the application of the KCl and NaCl waste materials, particularly the KCl 5 and NaCl 10 treatments. These plots contained far fewer plants than plots with lower application rates, however, the plants present appeared much larger and mature than the plants in the other treatments.

Plates 6 and 7 illustrate the growth achieved in a KCl 2 (lowest KCl application rate) and a KCl 5 (highest KCl application rate) treatment, respectively. Plates 8 and 9 illustrate the growth achieved in a NaCl 7 (lowest NaCl application rate) and a NaCl 10 (highest NaCl application rate) treatment, respectively.

The brome grass was harvested on June 26 and 27, 1989 to obtain yield values for the different treatments. A second harvest was completed in mid-August to keep the plots relatively residue-free in the spring of 1990. Fresh and dry weights were determined for the treatments for both harvest events, however, only the data and interpretation thereof for the first or late June harvest are presented.

The dry weights for the brome grass harvested from each of the plots are presented in Table 4. These data allow for some comparison between the treatments and the replicates within





Plate 4. Grass growth in a FW 2 treatment.

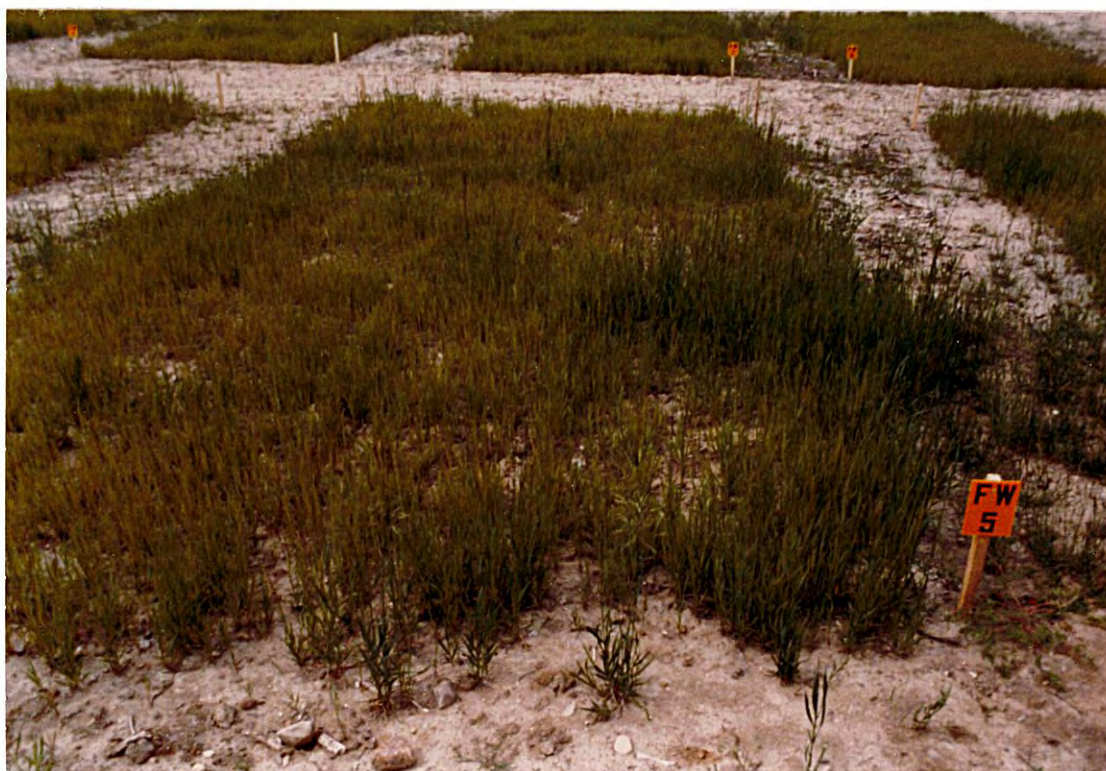


Plate 5. Grass growth in a FW 5 treatment.





Plate 6. Grass growth in a KCl 2 treatment.



Plate 7. Grass growth in a KCl 5 treatment.





Plate 8. Grass growth in a NaCl 7 treatment.



Plate 9. Grass growth in a NaCl 10 treatment.

Table 4. Yield (Dry Weight in g.) for the Esso Field Trial Plots in June, 1989.

| Waste      | Rate | TME<br>(FSN) | Dry Wt.<br>(g) |
|------------|------|--------------|----------------|
| Freshwater | 1    | 3            | 4002           |
| Freshwater | 1    | 9            | 5961           |
| Freshwater | 1    | 13           | 7288           |
| Freshwater | 2    | 2            | 6509           |
| Freshwater | 2    | 8            | 5901           |
| Freshwater | 2    | 15           | 10582          |
| Freshwater | 3    | 1            | 5966           |
| Freshwater | 3    | 6            | 7202           |
| Freshwater | 3    | 11           | 4382           |
| Freshwater | 4    | 5            | 4096           |
| Freshwater | 4    | 7            | 4422           |
| Freshwater | 4    | 12           | 4161           |
| Freshwater | 5    | 4            | 2778           |
| Freshwater | 5    | 10           | 2705           |
| Freshwater | 5    | 14           | 2870           |
| KCl        | 1    | 17           | 2191           |
| KCl        | 1    | 42           | 2222           |
| KCl        | 1    | 43           | 2303           |
| KCl        | 2    | 33           | 3025           |
| KCl        | 2    | 40           | 1875           |
| KCl        | 2    | 45           | 3131           |
| KCl        | 3    | 21           | 2181           |
| KCl        | 3    | 30           | 2179           |
| KCl        | 3    | 39           | 1248           |
| KCl        | 4    | 16           | 1220           |
| KCl        | 4    | 25           | 1938           |
| KCl        | 4    | 29           | 1733           |
| KCl        | 5    | 24           | 1804           |
| KCl        | 5    | 26           | 690            |
| KCl        | 5    | 37           | 1640           |
| NaCl       | 6    | 22           | 3014           |
| NaCl       | 6    | 32           | 3001           |
| NaCl       | 6    | 41           | 2192           |
| NaCl       | 7    | 18           | 2532           |
| NaCl       | 7    | 27           | 3255           |
| NaCl       | 7    | 34           | 2599           |
| NaCl       | 8    | 20           | 1177           |
| NaCl       | 8    | 35           | 5016           |
| NaCl       | 8    | 44           | 2823           |
| NaCl       | 9    | 19           | 3138           |
| NaCl       | 9    | 31           | 1906           |
| NaCl       | 9    | 36           | 1794           |
| NaCl       | 10   | 23           | 2136           |
| NaCl       | 10   | 28           | 556            |
| NaCl       | 10   | 38           | 587            |



treatments. Figure 5 illustrates the mean yields for the different rates of each waste applied and Table 5 provides a comparison of the mean yield values for the treatments within each waste type. There were apparent differences but no significant differences in yield between the treatments for each of the waste types.

For each of the waste treatment types the yield obtained for the lower waste application rates exceeded the yields obtained in the respective control treatments. Rates 2 and 3 for the freshwater gel plots and the NaCl plots exceeded the control yield. The KCl rate 2 treatment exceeded the control yield value. For each of the waste types the maximum application rate resulted in the lowest yield. Similar trends were observed relative to yield of brome grass grown in freshwater gel, KCl, and NaCl waste and soil mixtures in the greenhouse (Macyk et al. 1989b).

#### 4.4 FIELD PLOT SOIL PROPERTIES

A total of 77 soil samples were collected at the 45 plots prior to waste application and 207 samples were collected in mid-September 1988 approximately two months following waste application and incorporation (Macyk et al. 1989). A total of 207 samples were collected in mid-August 1989 (Plate 10). Samples representing the 0 to 15 cm depth were collected at all plots and additional samples representing the 15 to 30 cm, 30 to 45 cm, 45 to 60 cm, and 60 to 90 cm depths were obtained at selected plots. For most plots the surface or 0 to 15 cm depth interval sample represented a composite of five sampling locations. In selected plots a total of five individual samples were collected from the 0 to 15 cm and the 15 to 30 cm depth intervals to assess variability within individual plots.

The samples obtained in 1988 were analysed for several chemical and physical properties, soluble ions in saturated paste extracts, plant available trace elements (DTPA extractable), and total elemental content (Macyk et al. 1989). The samples obtained in 1989 were analysed for some chemical properties as well as soluble

Figure 5. Mean Yield Values (Dry Weight, g) for the Waste Treatments.

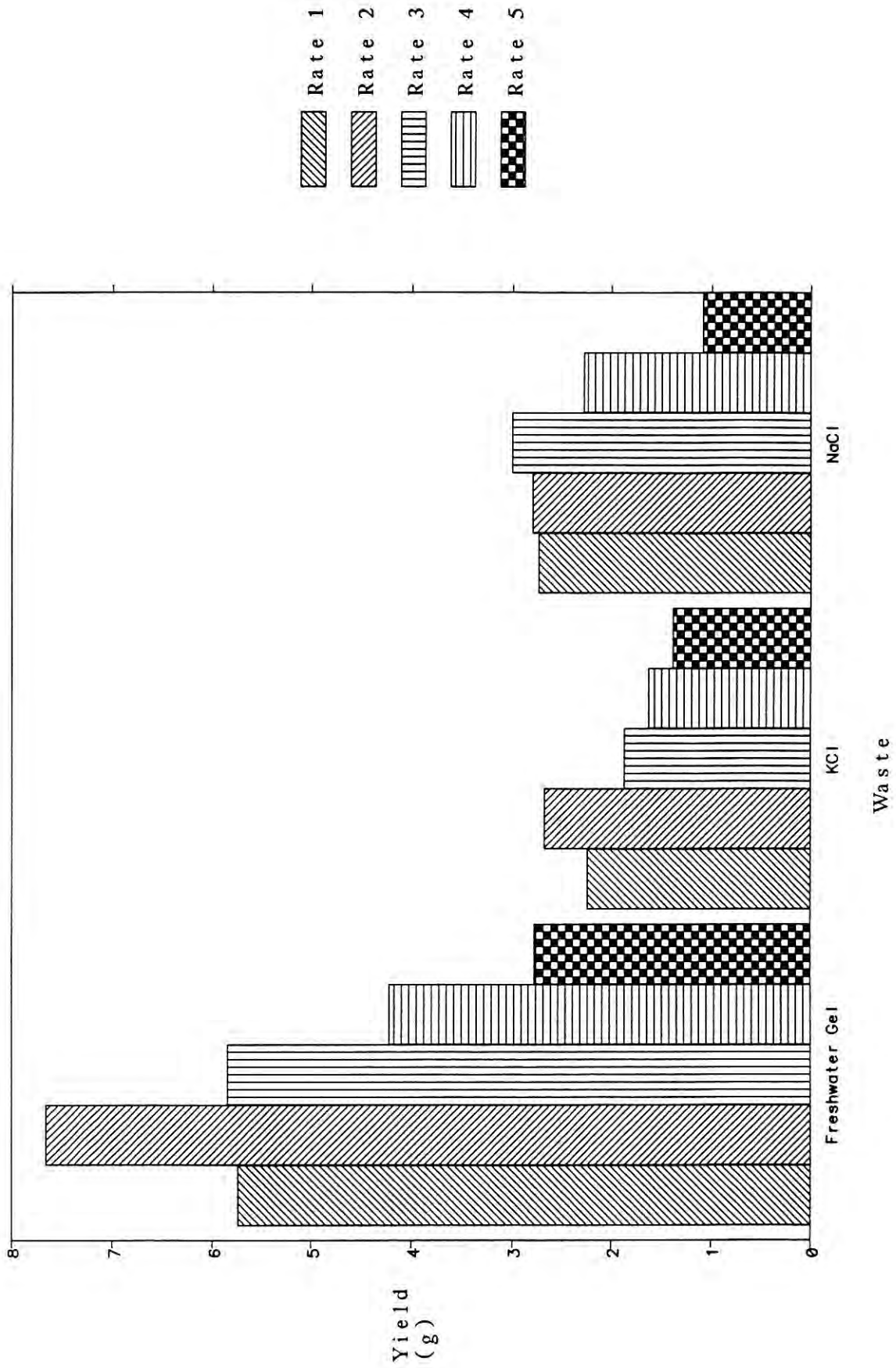


Table 5. Comparison of the Mean Yield Values for the Esso Field Trial Plots.

| Waste      | Rate | N | Yield<br>(g) |
|------------|------|---|--------------|
| Freshwater | 1    | 3 | 5750a        |
| Freshwater | 2    | 3 | 7660a        |
| Freshwater | 3    | 3 | 5850a        |
| Freshwater | 4    | 3 | 4230a        |
| Freshwater | 5    | 3 | 2780a        |
| KCl        | 1    | 3 | 2240a        |
| KCl        | 2    | 3 | 2680a        |
| KCl        | 3    | 3 | 1870a        |
| KCl        | 4    | 3 | 1630a        |
| KCl        | 5    | 3 | 1380a        |
| NaCl       | 6    | 3 | 2740a        |
| NaCl       | 7    | 3 | 2800a        |
| NaCl       | 8    | 3 | 3010a        |
| NaCl       | 9    | 3 | 2280a        |
| NaCl       | 10   | 3 | 1090a        |

\* Treatment means of each waste in any one column not followed by a common letter are significantly different at 0.01 probability by Tukey's Studentized Range (HSD) Test.



Plate 10. Soil sampling was completed in all plots.

ions in saturated paste extracts and total elemental content to assess the extent of change in salt concentration (EC and chloride levels) and elemental levels at the various depths in the different treatments.

#### 4.4.1 Chemical Properties

Data for chemical properties including pH and  $\text{CaCO}_3$  equivalent are presented in Appendix I. Table 6 provides mean values for  $\text{pH}(\text{CaCl}_2)$  and  $\text{CaCO}_3$  equivalent for the individual depths within the various treatments.

The Alberta Soils Advisory Committee (1977) suggests that no limitations to plant growth occur at pH levels in the surface soil of 6.5 to 7.5, and that slight limitations occur at levels of 5.5 to 6.4 and 7.6 to 8.4. The mean pH values in the 0 to 15 cm depth interval of the freshwater gel plots ranged from 6.5 to 7.0 prior to waste application which indicates that these soils exhibited no limitation to plant growth. Following waste application, the FW 4 and FW 5 treatments had pH values that could result in slight limitations to plant growth. The difference of 0.1 pH units between 1988 and 1989 was minor.

The mean pH values in the 0 to 15 cm depth interval of the KCl plots ranged from 6.7 to 7.2 prior to waste application and 7.2 to 7.4 following waste application. These values indicate that the KCl waste additions did not result in pH values that could be considered limiting to plant growth.

The mean pH values in the 0 to 15 cm depth interval of the NaCl plots ranged from 6.6 to 7.0 prior to waste application and 6.9 to 7.6 following waste application. These values indicate that the NaCl waste additions did not result in pH values that could be considered limiting to plant growth except for the NaCl 10 treatment which had a mean pH of 7.6 in the fall 1988 and 7.4 in the fall of 1989.

The Alberta Soils Advisory Committee (1987) suggests that a  $\text{CaCO}_3$  equivalent value of less than 2% is rated as good in terms of



Table 6. pH (CaCl2) and CaCO3 Equivalent (%) for the Various Treatments.

| Waste      | Rate | Depth<br>(cm) | pH  |      | CaCO3 |      |      |      |
|------------|------|---------------|-----|------|-------|------|------|------|
|            |      |               | Pre | Post | Pre   | Post |      |      |
| Freshwater | 1    | 0-15          | 6.5 | 7.0  | 7.1   | 0.44 | 0.39 | 0.72 |
| Freshwater | 1    | 15-30         | -   | -    | 7.3   | -    | -    | 2.31 |
| Freshwater | 1    | 30-45         | -   | -    | 7.6   | -    | -    | 4.30 |
| Freshwater | 1    | 45-60         | -   | -    | 7.6   | -    | -    | 4.50 |
| Freshwater | 2    | 0-15          | 6.6 | 7.3  | 7.3   | 1.40 | 1.24 | 1.29 |
| Freshwater | 2    | 15-30         | -   | 7.3  | -     | -    | 0.40 | -    |
| Freshwater | 3    | 0-15          | 6.7 | 7.4  | 7.3   | 0.62 | 0.82 | 0.94 |
| Freshwater | 3    | 15-30         | 5.0 | 5.8  | 6.9   | -    | 0.02 | 0.26 |
| Freshwater | 4    | 0-15          | 6.9 | 7.7  | 7.6   | 0.49 | 0.97 | 1.07 |
| Freshwater | 4    | 15-30         | 7.5 | 7.0  | 7.5   | 5.89 | 0.92 | 1.57 |
| Freshwater | 4    | 30-45         | 7.7 | 7.8  | 7.8   | 4.81 | 5.69 | 6.84 |
| Freshwater | 4    | 45-60         | 7.7 | 7.8  | 7.9   | 4.81 | -    | 4.50 |
| Freshwater | 5    | 0-15          | 7.0 | 8.0  | 7.9   | 0.88 | 1.69 | 1.90 |
| Freshwater | 5    | 15-30         | 7.5 | 7.5  | 7.4   | 4.38 | 1.94 | 1.63 |
| Freshwater | 5    | 30-45         | 7.5 | 7.5  | 7.6   | 4.86 | 3.45 | 2.77 |
| Freshwater | 5    | 45-60         | 7.5 | 7.5  | 7.7   | 4.86 | 3.45 | 4.33 |
| KCl        | 1    | 0-15          | 7.2 | 7.3  | 7.4   | 1.73 | 1.25 | 2.02 |
| KCl        | 1    | 15-30         | -   | -    | -     | -    | -    | -    |
| KCl        | 1    | 30-45         | -   | -    | -     | -    | -    | -    |
| KCl        | 2    | 0-15          | 7.0 | 7.3  | 7.3   | 0.97 | 0.80 | 0.84 |
| KCl        | 2    | 15-30         | -   | -    | 6.4   | -    | -    | 0.85 |
| KCl        | 2    | 30-45         | -   | -    | 5.8   | -    | -    | -    |
| KCl        | 3    | 0-15          | 6.7 | 7.2  | 7.3   | 0.66 | 0.47 | 0.87 |
| KCl        | 4    | 0-15          | 6.8 | 7.4  | 7.4   | 0.19 | 1.09 | 0.64 |
| KCl        | 4    | 15-30         | 6.5 | 7.4  | 6.3   | 1.64 | 1.36 | 0.49 |
| KCl        | 4    | 30-45         | 7.1 | 6.9  | 6.1   | 0.46 | 0.71 | 1.86 |
| KCl        | 4    | 45-60         | 7.1 | 6.9  | 5.9   | 0.46 | 0.35 | 3.41 |
| KCl        | 4    | 60-90         | 6.5 | 5.9  | 5.4   | 0.73 | -    | -    |
| KCl        | 5    | 0-15          | 6.7 | 7.4  | 7.4   | 0.53 | 0.83 | 1.20 |
| KCl        | 5    | 15-30         | 6.3 | 6.0  | -     | 0.22 | -    | -    |
| KCl        | 5    | 30-45         | 5.2 | 4.9  | -     | -    | -    | -    |
| KCl        | 5    | 45-60         | 5.2 | -    | -     | -    | -    | -    |
| KCl        | 5    | 60-90         | 5.4 | -    | -     | 0.04 | -    | -    |

Pre = Sampled prior to waste application; Post = Sampled September 1988, 1989 = Sampled August 1989.

Table 6 (Concluded). pH (CaCl<sub>2</sub>) and CaCO<sub>3</sub> Equivalent (%) for the Various Treatments.

| Waste | Rate | Depth<br>(cm) | pH  |      | 1989 |      | CaCO <sub>3</sub> |      |
|-------|------|---------------|-----|------|------|------|-------------------|------|
|       |      |               | Pre | Post | Pre  | Post | Pre               | Post |
| NaCl  | 6    | 0-15          | 6.9 | 6.9  | 7.1  | 2.04 | 0.57              | 1.10 |
| NaCl  | 6    | 15-30         | -   | -    | 7.3  | -    | -                 | 2.49 |
| NaCl  | 6    | 30-45         | -   | -    | 7.9  | -    | -                 | 4.77 |
| NaCl  | 6    | 30-45         | -   | -    | 7.9  | -    | -                 | 4.69 |
| NaCl  | 7    | 0-15          | 6.7 | 7.2  | 7.1  | 1.00 | 0.84              | 0.76 |
| NaCl  | 7    | 15-30         | -   | -    | 7.2  | -    | -                 | 2.61 |
| NaCl  | 8    | 0-15          | 7.0 | 7.2  | 7.2  | 0.39 | 0.48              | 0.62 |
| NaCl  | 8    | 15-30         | 7.2 | 7.5  | 7.0  | 2.47 | 3.24              | 0.87 |
| NaCl  | 8    | 30-45         | 7.6 | 7.5  | 7.5  | 5.52 | 4.53              | 1.67 |
| NaCl  | 8    | 45-60         | 7.6 | 7.5  | 7.8  | 5.52 | 4.53              | 5.08 |
| NaCl  | 8    | 60-90         | 7.7 | -    | -    | 5.24 | -                 | -    |
| NaCl  | 9    | 0-15          | 7.0 | 7.3  | 7.4  | 0.78 | 0.69              | 0.74 |
| NaCl  | 9    | 15-30         | 6.4 | 6.2  | 6.9  | 0.11 | 0.21              | 1.19 |
| NaCl  | 9    | 30-45         | 6.2 | 6.2  | 6.2  | 0.16 | 0.16              | 0.68 |
| NaCl  | 9    | 45-60         | 6.2 | 6.1  | 6.3  | 0.16 | 0.08              | 2.18 |
| NaCl  | 9    | 60-90         | 6.9 | 6.9  | -    | 0.16 | 0.08              | -    |
| NaCl  | 10   | 0-15          | 6.6 | 7.6  | 7.4  | 0.37 | 1.27              | 1.00 |
| NaCl  | 10   | 15-30         | 6.6 | 7.1  | 6.9  | 0.36 | 0.64              | 0.85 |
| NaCl  | 10   | 30-45         | 6.6 | 6.6  | 7.1  | 4.28 | 3.78              | 5.29 |
| NaCl  | 10   | 45-60         | 6.6 | 6.6  | 7.2  | 4.28 | 4.73              | 2.55 |
| NaCl  | 10   | 60-90         | 5.5 | 5.4  | 6.3  | -    | -                 | -    |

Pre = Sampled prior to waste application; Post = Sampled  
September 1988; 1989 = Sampled August 1989.

Table 7. Mean Values for EC, CI and SAR for the Various Treatments.

| Waste      | Rate  | Depth<br>(cm) | EC   |      | CI   |      | SAR    |       |     |     |     |
|------------|-------|---------------|------|------|------|------|--------|-------|-----|-----|-----|
|            |       |               | Pre  | Post | Pre  | Post | Pre    | Post  |     |     |     |
| Freshwater | 1     | 0-15          | 0.62 | 0.76 | 1.06 | 20.3 | 25.1   | 12.2  | 0.3 | 0.5 | 0.3 |
|            | 2     | 0-15          | 0.51 | 0.91 | 1.17 | 18.7 | 22.3   | 19.8  | 0.3 | 1.9 | 1.2 |
|            | 2     | 15-30         | -    | 0.53 | -    | -    | 11.7   | -     | -   | 0.7 | -   |
|            | 3     | 0-15          | 0.59 | 1.14 | 1.37 | 17.8 | 33.0   | 22.4  | 0.3 | 2.6 | 1.2 |
|            | 3     | 15-30         | 0.25 | 0.36 | 0.93 | 15.9 | 15.8   | 19.3  | 0.4 | 0.7 | 0.8 |
|            | 3     | 30-45         | 0.31 | -    | -    | 15.5 | -      | -     | 0.4 | -   | -   |
|            | 3     | 45-60         | 0.31 | -    | -    | 15.5 | -      | -     | 0.4 | -   | -   |
|            | 4     | 0-15          | 0.59 | 1.10 | 1.11 | 18.2 | 36.3   | 16.0  | 0.3 | 2.0 | 1.4 |
|            | 4     | 15-30         | 0.45 | 0.58 | 0.49 | 8.8  | 15.9   | 7.9   | 0.6 | 0.6 | 1.1 |
|            | 4     | 30-45         | 0.36 | 0.35 | 0.39 | 11.3 | 11.6   | 6.9   | 0.7 | 0.7 | 0.6 |
|            | 4     | 45-60         | 0.36 | 0.35 | 0.39 | 11.3 | 11.6   | 6.9   | 0.7 | 0.7 | 0.7 |
|            | 5     | 0-15          | 0.58 | 1.39 | 1.44 | 16.3 | 40.0   | 32.1  | 0.3 | 3.5 | 2.4 |
| KCI        | 5     | 15-30         | 0.31 | 0.80 | 0.73 | 9.6  | 37.9   | 13.5  | 0.4 | 1.7 | 1.3 |
|            | 5     | 30-45         | 0.26 | 0.32 | 0.54 | 8.9  | 15.8   | 11.0  | 0.4 | 0.6 | 0.9 |
|            | 5     | 45-60         | 0.26 | 0.32 | 0.46 | 8.9  | 15.8   | 9.9   | 0.4 | 0.6 | 0.4 |
|            | 1     | 0-15          | 0.51 | 0.86 | 0.72 | 19.1 | 22.7   | 13.1  | 0.3 | 0.5 | 0.3 |
|            | 2     | 0-15          | 0.54 | 1.20 | 1.09 | 20.6 | 396.0  | 118.8 | 0.3 | 0.8 | 0.7 |
|            | 2     | 15-30         | -    | -    | 0.88 | -    | -      | 157.6 | -   | -   | 0.5 |
|            | 2     | 30-45         | -    | -    | 0.25 | -    | -      | 51.4  | -   | -   | 0.4 |
|            | 3     | 0-15          | 0.52 | 2.60 | 2.02 | 20.3 | 740.0  | 403.0 | 0.3 | 2.0 | 1.5 |
|            | 4     | 0-15          | 0.61 | 2.87 | 2.75 | 22.7 | 1070.0 | 863.0 | 0.3 | 1.8 | 1.6 |
|            | 4     | 15-30         | 0.31 | 0.47 | 1.09 | 11.5 | 69.1   | 386.0 | 0.4 | 0.4 | 0.9 |
|            | 4     | 30-45         | 0.41 | 0.80 | 0.72 | 7.9  | 281.1  | 221.0 | 0.3 | 0.5 | 0.5 |
|            | 4     | 45-60         | 0.41 | 0.54 | 0.72 | 7.9  | 52.5   | 43.2  | 0.3 | 0.3 | 0.5 |
| 4          | 60-90 | 0.23          | 0.13 | 0.09 | 6.0  | 17.9 | 10.2   | 0.5   | 0.6 | 1.1 |     |
|            | 5     | 0-15          | 0.47 | 3.54 | 1.59 | 18.2 | 3135.0 | 353.0 | 0.3 | 1.9 | 1.1 |
|            | 5     | 15-30         | 0.55 | 2.51 | -    | 17.6 | 889.0  | -     | 0.3 | 0.8 | -   |
|            | 5     | 30-45         | 0.19 | 1.65 | -    | 6.7  | 555.0  | -     | 0.5 | 0.6 | -   |
|            | 5     | 45-60         | 0.19 | -    | -    | -    | -      | -     | 0.5 | -   | -   |
|            | 5     | 60-90         | 0.10 | -    | -    | -    | -      | -     | 0.5 | -   | -   |

Table 7. Mean Values for EC, Cl and SAR for the Various Treatments.

| Waste Rate | Depth (cm) | EC   |      | Cl   |      | SAR    |        |
|------------|------------|------|------|------|------|--------|--------|
|            |            | Pre  | Post | Pre  | Post | Pre    | Post   |
| NaCl       | 6 0-15     | 0.53 | 0.70 | 0.89 | 25.9 | 35.6   | 37.2   |
|            | 6 15-30    | -    | -    | 0.76 | -    | 18.2   | -      |
|            | 6 30-45    | -    | -    | 0.24 | -    | 8.2    | -      |
|            | 6 45-60    | -    | -    | 0.23 | -    | 7.0    | -      |
|            | 7 0-15     | 0.57 | 1.95 | 1.20 | 22.2 | 480.0  | 151.0  |
|            | 7 15-30    | -    | -    | 0.58 | -    | 75.0   | -      |
|            | 8 0-15     | 0.61 | 1.38 | 1.80 | 20.8 | 870.0  | 331.0  |
|            | 8 15-30    | 0.55 | 0.49 | 2.01 | 13.1 | 85.1   | 496.5  |
|            | 8 30-45    | 0.34 | 0.28 | 0.43 | 9.1  | 90.3   | 51.0   |
|            | 8 45-60    | 0.34 | 0.27 | 0.33 | 9.1  | 9.7    | 41.1   |
|            | 8 60-90    | 0.36 | -    | -    | 6.9  | -      | -      |
|            | 9 0-15     | 0.60 | 3.01 | 1.80 | 23.4 | 876.0  | 325.0  |
|            | 9 15-30    | 0.39 | -    | -    | 19.2 | 168.0  | 307.0  |
|            | 9 30-45    | 0.21 | -    | -    | 12.8 | 114.2  | 135.4  |
|            | 9 45-60    | 0.21 | -    | -    | 12.8 | 188.2  | 116.5  |
|            | 9 60-90    | 0.16 | -    | -    | 16.4 | 144.1  | -      |
|            | 10 0-15    | 0.51 | 7.27 | 5.36 | 24.4 | 3352.0 | 1728.0 |
|            | 10 15-30   | 0.46 | 0.96 | -    | 14.6 | 206.1  | 539.0  |
|            | 10 30-45   | 0.25 | 0.31 | -    | 7.5  | 42.6   | 306.0  |
|            | 10 45-60   | 0.25 | 0.22 | -    | 7.5  | 25.4   | 192.0  |
|            | 10 60-90   | 0.12 | 0.11 | -    | 8.2  | 20.2   | 454.0  |
|            |            |      |      |      |      |        |        |
|            |            |      |      |      |      |        |        |
|            |            |      |      |      |      |        |        |

Pre = Sampled prior to waste application; Post = Sampled September 1988,  
1989 = Sampled August 1989.

indicated that on the basis of EC soils presented no limitation to plant growth. Following the application of waste materials the soil EC values increased at all locations. In the freshwater gel plots the maximum EC values were in the 1.39 to 1.44 dS/m range. These values suggest that the EC levels of the plot soils would present no limitation to plant growth. Changes in EC levels for the FW 5 treatment are illustrated in Figure 6.

Changes in EC levels in the KCl plots were greater than those in the freshwater gel plots and are illustrated for KCl 4 plots in Figure 7. For all treatments the EC values in the 0 to 15 cm depth interval decreased from the fall of 1988 to August 1989. Concomitant with this was increases in EC levels in the depth intervals below the surface 15 cm. This indicates the degree of leaching that occurred. On the basis of the soil quality criteria described above, treatments 3, 4, and 5 would have had slight limitations to plant growth on the basis of EC for the 0 to 15 cm depth in the fall of 1988 with a reduction in limitation by the fall of 1989.

In the NaCl plots the mean EC values were somewhat higher than in the freshwater gel and KCl plots. The trends regarding the changes that occurred with time are similar to the freshwater gel and KCl treatments. The highest application rate of NaCl waste resulted in EC levels that imply a moderate limitation to plant growth. The mean EC value for the NaCl 10 treatment was 7.27 dS/m in the fall of 1988 and decreased to 5.36 dS/m by the fall of 1989.

4.4.2.2 Sodium adsorption ratio (SAR) values. The Alberta Soils Advisory Committee (1977) presented the following criteria for SAR levels in soil:

|                     | <u>SAR Value</u> |
|---------------------|------------------|
| No limitation       | <4               |
| Slight limitation   | 4 to 8           |
| Moderate limitation | 8 to 12          |
| Severe limitation   | >12              |



Figure 6. Change in Mean EC Values for the Freshwater Gel Rate 5 Plots.

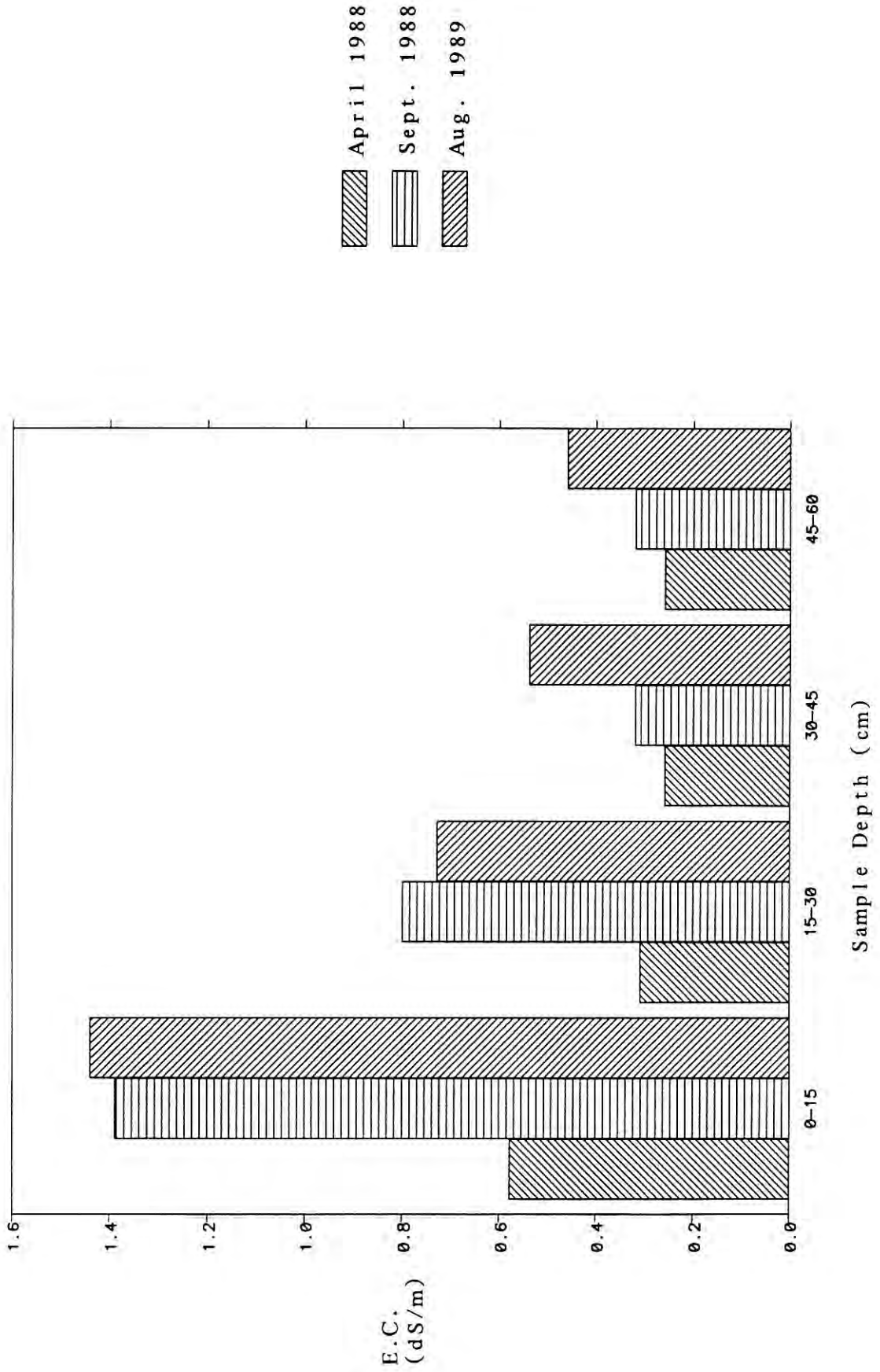


Figure 7. Change in Mean EC Values for the KCl Rate 4 Plots.

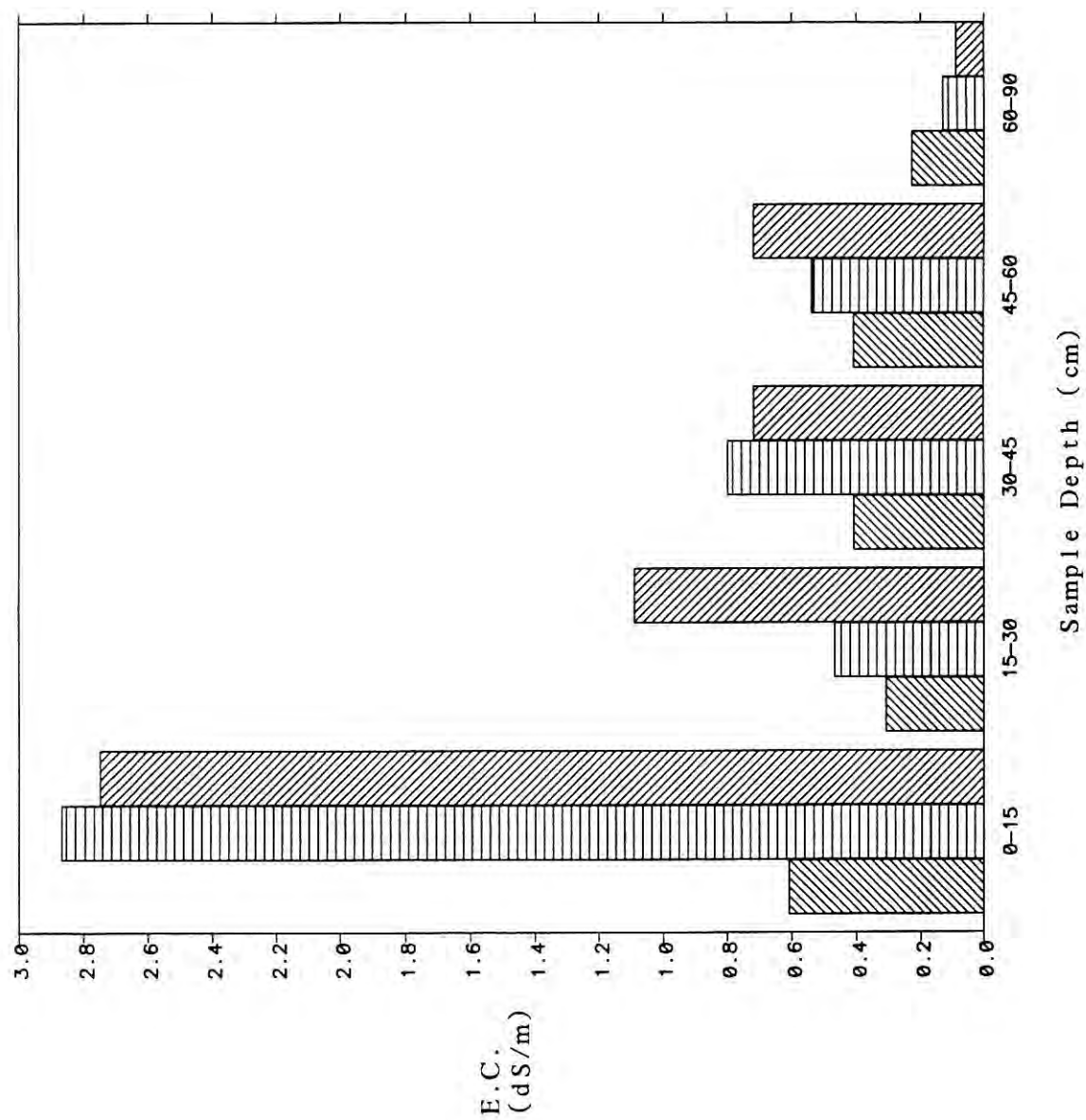


Figure 8. Change in Sodium Adsorption Ratio (SAR) Mean Values for the Freshwater Gel Rate 5 Plots.

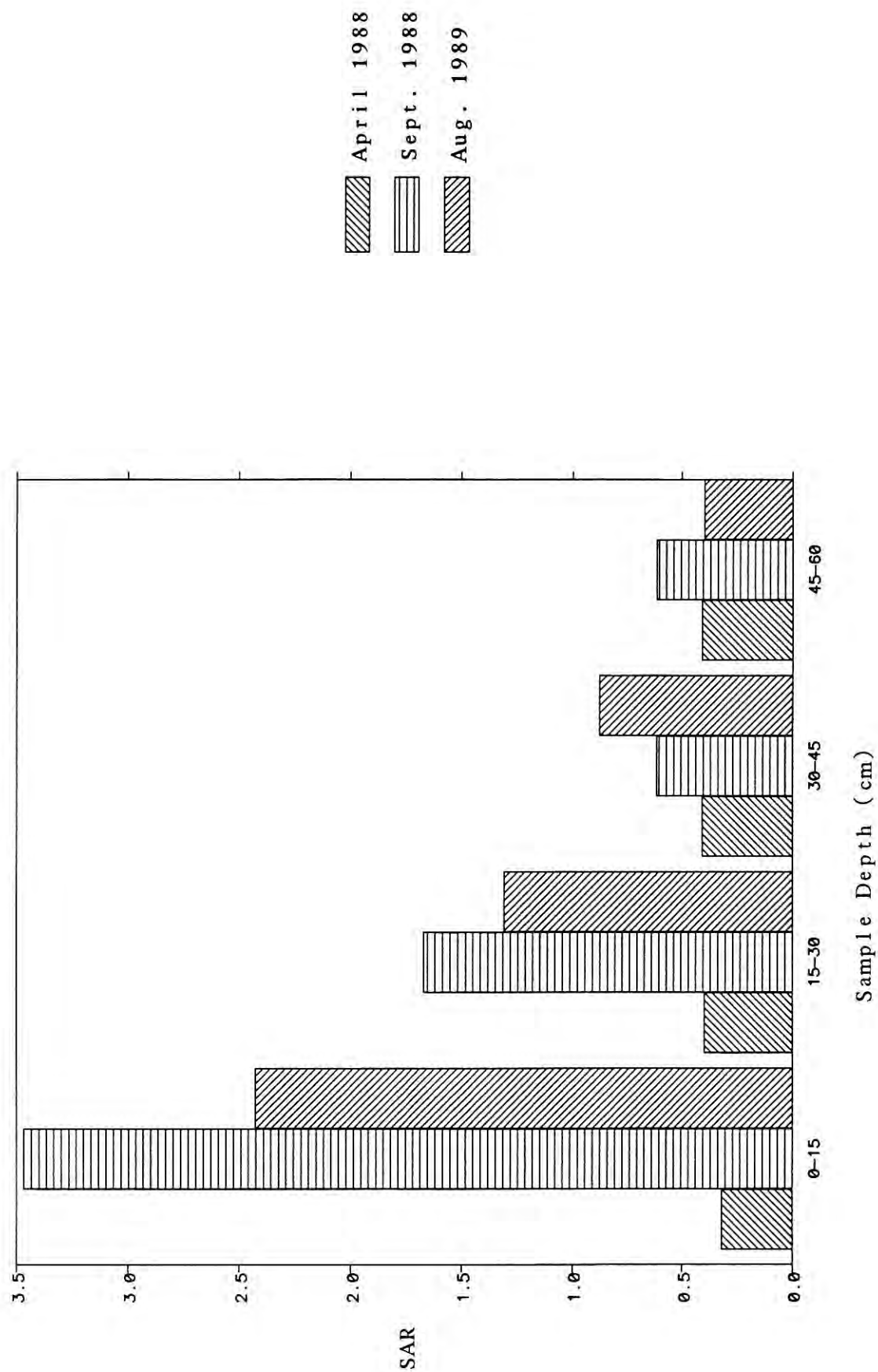
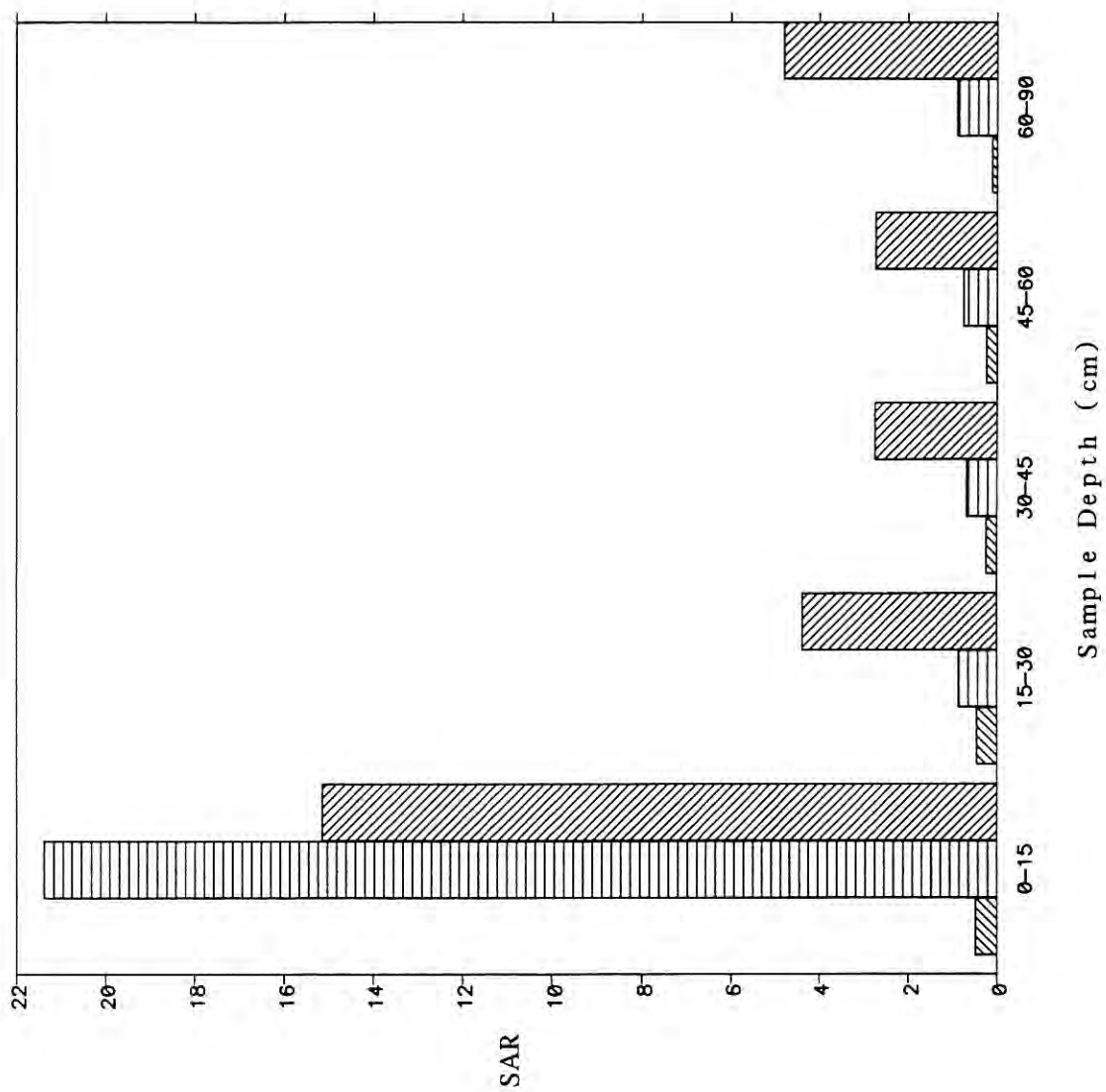


Figure 9. Change in Sodium Adsorption Ratio (SAR) Mean Values for the NaCl Rate 10 Plots.



Maas (1986) indicates that the chloride concentration in the plots will have no negative impact on plant growth.

The KCl treatments had considerably higher Cl additions than the freshwater gel treatments. The rapid leaching of the Cl following waste application is illustrated in Figure 10. Using the value of 1000 ppm Cl as the level in soil that begins to impact plant growth, suggests that some limitation was possible for treatment KCl 4 and definitely a problem for treatment KCl 5 in the fall of 1988. The mean Cl values for the 0 to 15 cm depth decreased in 1989.

The trends associated with Cl levels in the KCl waste treated plots were repeated in the NaCl waste treated plots. The rapid leaching of Cl is illustrated in Figure 11.

#### 4.4.3 Total Elemental Analysis Data

Data for the total elemental analyses are presented in Appendix III. These data can be used to assess the potential for heavy metal and other trace element contamination. Table 8 provides mean values for selected elements in the soils and soil/waste mixtures for 1989. Elemental content levels increased or decreased slightly as a result of waste addition. Values for the total elemental content of the various treatments were compared to the values for total elemental content of soils presented in Table 9 (Lindsay 1979). All mean values for the various elements shown in Table 8 were within the range of values normally found in soils, except for Ca which was slightly below the minimum levels indicated.

#### 4.5 TISSUE ANALYSIS DATA

The total elemental content data for the brome grass tissue collected in 1988 and 1989 are presented in Tables 10 and 11, respectively. The 1988 data represents an incomplete set, simply because the vegetation cover in all plots was not adequate to provide a sample. This was particularly the case for the KCl and NaCl waste amended plots.



Figure 10. Change in Mean Chloride Values for the KCl Rate 4 Plots.

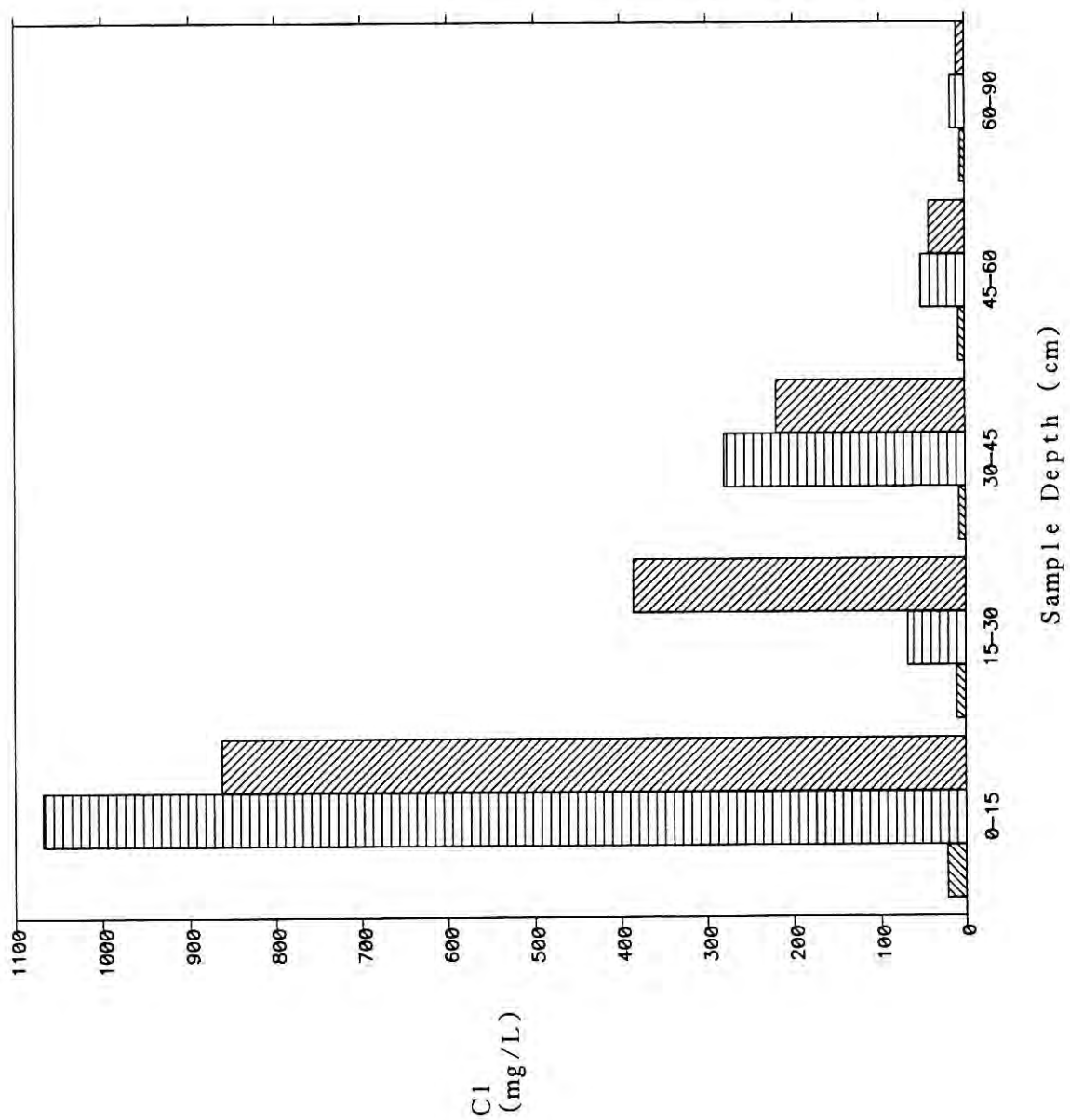


Figure 11. Change in Mean Chloride Values for the NaCl Rate 10 Plots.

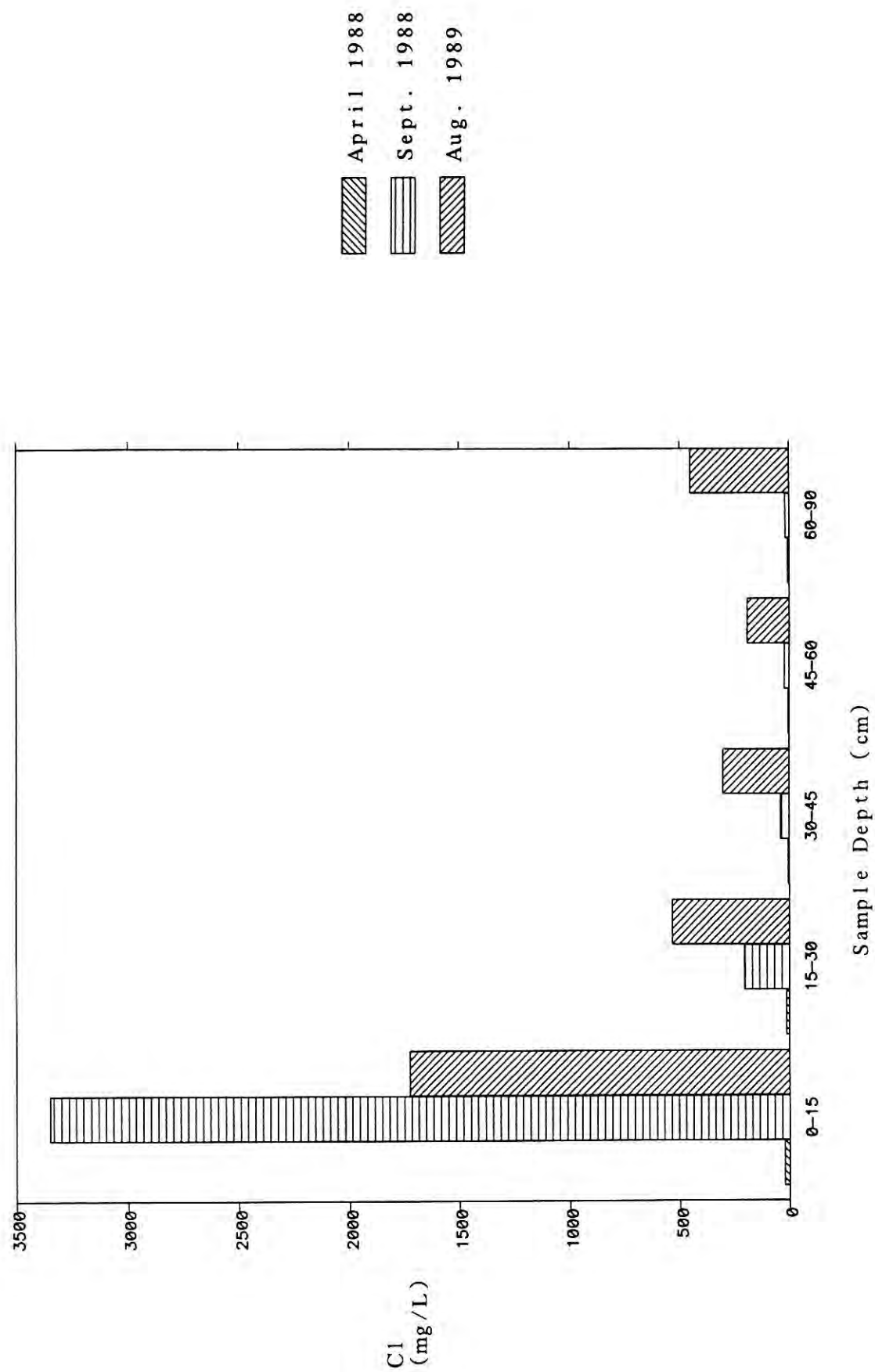


Table 8. Mean Values for Selected Elements for Soil and Soil/Waste Samples Obtained August, 1989.

| Waste      | Rate | Depth<br>(cm) | (mg/g) |      |      |      |      | (ug/g) |       |      |      |      |
|------------|------|---------------|--------|------|------|------|------|--------|-------|------|------|------|
|            |      |               | Mn     | Na   | Ca   | Mg   | K    | Ba     | Cu    | Zn   | Ni   | Cr   |
| Freshwater | 1    | 0-15          | 0.349  | 6.64 | 4.04 | 2.03 | 11.1 | 1.89   | 12.50 | 33.4 | 17.1 | 49.5 |
| Freshwater | 2    | 0-15          | 0.349  | 7.37 | 3.93 | 2.28 | 12.0 | 1.20   | 6.44  | 37.0 | 15.5 | 57.8 |
| Freshwater | 3    | 0-15          | 0.393  | 8.35 | 4.64 | 2.48 | 13.0 | 1.62   | 12.00 | 54.7 | 19.8 | 58.2 |
| Freshwater | 4    | 0-15          | 0.330  | 6.87 | 3.90 | 2.42 | 11.3 | 1.36   | 11.90 | 32.0 | 20.1 | 48.6 |
| Freshwater | 5    | 0-15          | 0.352  | 7.15 | 4.33 | 2.57 | 11.7 | 0.94   | 8.30  | 46.0 | 16.5 | 53.9 |
| KCl        | 1    | 0-15          | 0.366  | 6.42 | 4.53 | 2.78 | 11.3 | 1.80   | 6.25  | 58.3 | 16.5 | 45.0 |
| KCl        | 2    | 0-15          | 0.332  | 6.60 | 4.90 | 2.79 | 11.1 | 3.81   | 11.60 | 54.0 | 22.6 | 45.9 |
| KCl        | 3    | 0-15          | 0.388  | 6.87 | 4.27 | 2.50 | 11.6 | 2.47   | 11.70 | 58.9 | 21.3 | 47.6 |
| KCl        | 4    | 0-15          | 0.362  | 7.11 | 4.13 | 2.49 | 12.2 | 2.23   | 15.70 | 53.7 | 26.3 | 48.4 |
| KCl        | 5    | 0-15          | 0.381  | 6.94 | 4.70 | 2.72 | 11.9 | 2.90   | 15.10 | 51.5 | 28.0 | 52.6 |
| NaCl       | 6    | 0-15          | 0.354  | 6.53 | 3.84 | 2.14 | 11.0 | 2.40   | 14.00 | 58.3 | 25.0 | 46.6 |
| NaCl       | 7    | 0-15          | 0.371  | 6.58 | 3.89 | 2.25 | 10.9 | 2.14   | 19.00 | 50.4 | 29.4 | 45.2 |
| NaCl       | 8    | 0-15          | 0.370  | 6.34 | 3.66 | 1.86 | 10.1 | 2.33   | 8.31  | 47.4 | 17.5 | 40.9 |
| NaCl       | 9    | 0-15          | 0.401  | 6.89 | 4.37 | 2.36 | 11.1 | 3.01   | 13.60 | 45.2 | 27.6 | 46.2 |
| NaCl       | 10   | 0-15          | 0.405  | 7.26 | 4.50 | 2.50 | 10.8 | 2.71   | 17.60 | 50.0 | 27.6 | 47.5 |

Table 9. Elemental constituents of soils.

| Element      | Mean   | Maximum | Minimum | Element                   | Mean   | Maximum | Minimum |
|--------------|--------|---------|---------|---------------------------|--------|---------|---------|
| C<br>(%)     | 2.00   |         |         | Li<br>( $\mu\text{g/g}$ ) | 20.00  | 200.0   | 5.000   |
| Ca<br>(mg/g) | 13.70  | 500.0   | 7.000   | Cr<br>( $\mu\text{g/g}$ ) | 100.00 | 1000.0  | 1.000   |
| Mg<br>(mg/g) | 5.00   | 6.0     | 0.600   | Cu<br>( $\mu\text{g/g}$ ) | 30.00  | 100.0   | 2.000   |
| Ti<br>(mg/g) | 4.00   | 10.0    | 1.000   | Hg<br>( $\mu\text{g/g}$ ) | 0.03   | 0.3     | 0.010   |
| Na<br>(mg/g) | 6.30   | 7.5     | 0.750   | Ni<br>( $\mu\text{g/g}$ ) | 40.00  | 500.0   | 5.000   |
| S<br>(mg/g)  | 0.70   | 10.0    | 0.030   | Pb<br>( $\mu\text{g/g}$ ) | 10.00  | 200.0   | 2.000   |
| P<br>(mg/g)  | 0.60   | 5.0     | 0.200   | Co<br>( $\mu\text{g/g}$ ) | 8.00   | 40.0    | 1.000   |
| Sr<br>(mg/g) | 0.20   | 1.0     | 0.050   | Mo<br>( $\mu\text{g/g}$ ) | 2.00   | 5.0     | 0.200   |
| Al<br>(mg/g) | 71.00  | 300.0   | 10.000  | Cd<br>( $\mu\text{g/g}$ ) | 0.06   | 0.7     | 0.010   |
| Si<br>(mg/g) | 320.00 | 350.0   | 230.000 | Se<br>( $\mu\text{g/g}$ ) | 0.30   | 2.0     | 0.100   |
| B<br>(mg/g)  | 0.01   | 0.1     | 0.002   | Ag<br>( $\mu\text{g/g}$ ) | 0.05   | 5.0     | 0.010   |
| Ba<br>(mg/g) | 0.43   | 3.0     | 0.100   | Zn<br>( $\mu\text{g/g}$ ) | 50.00  | 300.0   | 10.000  |
| Fe<br>(mg/g) | 38.00  | 550.0   | 7.000   | V<br>( $\mu\text{g/g}$ )  | 100.0  | 500.0   | 20.000  |
| K<br>(mg/g)  | 8.30   | 30.0    | 0.400   | As<br>( $\mu\text{g/g}$ ) | 5.00   | 50.0    | 1.000   |
| Mn<br>(mg/g) | 0.60   | 3.0     | 0.020   | Zr<br>( $\mu\text{g/g}$ ) | 300.0  | 2000.0  | 60.0    |

From Lindsay (1979).

Table 10. Total Elemental Analysis Data for the Bromo Grass Tissue Collected in the Field Trial Plots in 1988.

| Waste      | Rate | Plot | FSN<br>(TME) | (mg/g) |      |      |      |      |       | (ug/g) |       |       |      |       |      |
|------------|------|------|--------------|--------|------|------|------|------|-------|--------|-------|-------|------|-------|------|
|            |      |      |              | Ca     | Mg   | K    | P    | S    | Si    | Cl     | Al    | Fe    | Ti   | Cr    | Zn   |
| Freshwater | 1    | 3    | 3            | 6.52   | 2.11 | 29.3 | 2.71 | 1.89 | 0.323 | 3.82   | 61.3  | 87.8  | 1.74 | <0.94 | 22.2 |
| Freshwater | 1    | 9    | 7            | 6.42   | 2.09 | 29.1 | 2.97 | 1.93 | 0.337 | 5.70   | 54.8  | 78.9  | 1.69 | <0.94 | 26.1 |
| Freshwater | 1    | 13   | 13           | 6.67   | 2.09 | 27.8 | 3.05 | 1.90 | 0.356 | 5.75   | 69.4  | 96.4  | 2.68 | <0.94 | 20.1 |
| Freshwater | 2    | 2    | 4            | 6.01   | 1.64 | 28.1 | 2.83 | 1.97 | 0.471 | 9.42   | 51.7  | 76.8  | 1.81 | <0.94 | 24.4 |
| Freshwater | 2    | 8    | 8            | 6.28   | 1.81 | 31.3 | 3.00 | 2.52 | 0.302 | 8.45   | 65.5  | 94.1  | 1.96 | <0.94 | 24.3 |
| Freshwater | 2    | 15   | 11           | 7.24   | 2.09 | 30.5 | 3.04 | 2.75 | 0.379 | 9.54   | 67.8  | 114.5 | 2.54 | <0.94 | 19.3 |
| Freshwater | 3    | 1    | 5            | 6.83   | 1.87 | 29.2 | 2.86 | 2.35 | 0.359 | 10.44  | 76.7  | 103.0 | 2.51 | <0.94 | 24.8 |
| Freshwater | 3    | 6    | 10           | 6.61   | 2.15 | 33.0 | 3.26 | 2.65 | 0.366 | 10.23  | 62.6  | 99.1  | 2.08 | <0.94 | 24.3 |
| Freshwater | 3    | 11   | 15           | 6.55   | 1.84 | 28.4 | 3.13 | 2.25 | 0.408 | 11.11  | 70.4  | 100.7 | 2.39 | <0.94 | 20.7 |
| Freshwater | 4    | 5    | 1            | 7.35   | 1.83 | 31.3 | 2.54 | 2.33 | 0.391 | 11.48  | 75.0  | 95.4  | 2.37 | <0.94 | 18.9 |
| Freshwater | 4    | 7    | 9            | 6.71   | 1.93 | 30.2 | 2.92 | 2.30 | 0.430 | 9.25   | 88.5  | 118.2 | 3.00 | <0.94 | 22.4 |
| Freshwater | 4    | 12   | 14           | 6.89   | 1.83 | 28.2 | 2.77 | 2.08 | 0.473 | 10.88  | 65.5  | 84.4  | 2.00 | <0.94 | 17.7 |
| Freshwater | 5    | 4    | 2            | 6.86   | 1.52 | 28.1 | 2.07 | 2.08 | 0.345 | 10.80  | 76.0  | 100.9 | 2.35 | <0.94 | 17.1 |
| Freshwater | 5    | 10   | 6            | 7.35   | 1.85 | 25.4 | 2.40 | 1.92 | 0.390 | 11.52  | 80.6  | 106.4 | 2.60 | <0.94 | 25.0 |
| Freshwater | 5    | 14   | 12           | 8.37   | 2.03 | 28.3 | 2.63 | 2.26 | 0.500 | 11.04  | 92.8  | 168.4 | 3.25 | <0.94 | 19.0 |
| KCl        | 2    | 45   | 16           | 7.75   | 1.87 | 30.6 | 3.19 | 2.24 | 0.335 | 18.72  | 92.1  | 127.6 | 3.14 | <0.94 | 22.8 |
| KCl        | 2    | 33   | 19           | 7.29   | 2.12 | 29.3 | 2.74 | 1.63 | 0.346 | 7.18   | 95.6  | 122.3 | 3.15 | <0.94 | 20.2 |
| KCl        | 3    | 30   | 22           | 8.85   | 1.87 | 26.8 | 2.56 | 1.70 | 0.391 | 17.85  | 89.1  | 121.7 | 2.95 | <0.94 | 19.7 |
| KCl        | 3    | 21   | 25           | 7.79   | 1.77 | 29.1 | 2.84 | 1.90 | 0.514 | 14.09  | 90.1  | 128.4 | 3.16 | <0.94 | 21.9 |
| NaCl       | 6    | 32   | 20           | 7.39   | 2.16 | 26.8 | 2.66 | 1.66 | 0.300 | 8.28   | 73.4  | 108.1 | 2.64 | <0.94 | 17.6 |
| NaCl       | 6    | 22   | 24           | 6.31   | 1.91 | 28.5 | 2.77 | 1.59 | 0.353 | 7.84   | 64.6  | 91.3  | 2.06 | <0.94 | 20.1 |
| NaCl       | 7    | 27   | 23           | 6.39   | 1.68 | 31.8 | 3.05 | 2.20 | 0.313 | 18.40  | 73.8  | 119.0 | 2.65 | <0.94 | 25.4 |
| NaCl       | 8    | 44   | 17           | 7.85   | 2.01 | 25.9 | 2.80 | 1.92 | 0.417 | 16.41  | 111.2 | 151.4 | 4.45 | <0.94 | 21.8 |
| NaCl       | 8    | 35   | 18           | 7.68   | 1.95 | 28.7 | 3.16 | 1.99 | 0.419 | 19.24  | 74.5  | 110.5 | 2.48 | 1.63  | 27.1 |
| NaCl       | 8    | 20   | 26           | 7.31   | 1.92 | 27.4 | 3.01 | 1.79 | 0.328 | 15.47  | 74.0  | 110.1 | 2.54 | <0.94 | 21.0 |
| NaCl       | 9    | 31   | 21           | 8.38   | 2.02 | 24.9 | 2.80 | 1.86 | 0.295 | 15.68  | 107.3 | 150.6 | 4.27 | <0.94 | 19.3 |
| NaCl       | 9    | 19   | 27           | 7.04   | 1.77 | 27.2 | 3.51 | 2.17 | 0.386 | 18.45  | 71.7  | 107.3 | 2.10 | <0.94 | 23.3 |



Table 10 (Concluded). Total Elemental Analysis Data for the Bromine Grass Tissue Collected in the Field Trial Plots in 1988.

| Waste      | Rate | Plot | FSN<br>(TME) | (ug/g) |       |       |       |      |       |       |       |       |        | As   | Cd    | Pb    |
|------------|------|------|--------------|--------|-------|-------|-------|------|-------|-------|-------|-------|--------|------|-------|-------|
|            |      |      |              | Mn     | Na    | Li    | Sr    | Ba   | Mo    | B     | Ni    | Se    | Co     |      |       |       |
| Freshwater | 1    | 3    | 3            | 64.7   | 15.0  | <1.89 | 10.42 | 14.2 | 2.91  | 5.77  | <1.42 | <14.2 | <0.473 | 25.5 | 0.000 | 0.715 |
| Freshwater | 1    | 9    | 7            | 66.1   | 22.9  | <1.89 | 9.31  | 14.2 | 2.77  | 5.67  | <1.42 | <14.2 | <0.473 | 25.3 | 0.043 | 0.000 |
| Freshwater | 1    | 13   | 13           | 70.4   | 18.4  | <1.89 | 9.22  | 14.0 | 2.59  | 4.99  | <1.42 | <14.2 | <0.473 | 26.2 | 0.000 | 0.282 |
| Freshwater | 2    | 2    | 4            | 76.0   | 62.4  | <1.89 | 13.15 | 13.7 | <2.37 | 10.31 | <1.42 | <14.2 | <0.473 | 24.8 | 0.000 | 0.473 |
| Freshwater | 2    | 8    | 8            | 63.3   | 42.7  | <1.89 | 12.69 | 14.3 | <2.37 | 6.81  | <1.42 | <14.2 | <0.473 | 24.3 | 0.175 | 0.524 |
| Freshwater | 2    | 15   | 11           | 65.7   | 31.5  | <1.89 | 11.22 | 18.1 | <2.37 | 8.73  | <1.42 | <14.2 | <0.473 | 25.6 | 0.000 | 0.000 |
| Freshwater | 3    | 1    | 5            | 95.4   | 55.8  | <1.89 | 15.87 | 15.7 | <2.37 | 12.49 | <1.42 | <14.2 | <0.473 | 25.1 | 0.087 | 0.390 |
| Freshwater | 3    | 6    | 10           | 78.1   | 35.1  | <1.89 | 14.27 | 16.2 | <2.37 | 7.89  | <1.42 | <14.2 | <0.473 | 25.1 | 0.000 | 0.425 |
| Freshwater | 3    | 11   | 15           | 64.3   | 91.6  | <1.89 | 14.32 | 14.3 | <2.37 | 8.98  | <1.42 | <14.2 | <0.473 | 25.2 | 0.000 | 0.510 |
| Freshwater | 4    | 5    | 1            | 61.6   | 46.3  | <1.89 | 13.33 | 15.5 | <2.37 | 10.22 | <1.42 | <14.2 | <0.473 | 25.2 | 0.000 | 0.372 |
| Freshwater | 4    | 7    | 9            | 67.8   | 39.6  | <1.89 | 12.77 | 15.1 | <2.37 | 9.47  | <1.42 | <14.2 | <0.473 | 23.7 | 0.128 | 0.405 |
| Freshwater | 4    | 12   | 14           | 67.3   | 47.3  | <1.89 | 12.91 | 14.4 | <2.37 | 7.04  | <1.42 | <14.2 | <0.473 | 25.7 | 0.041 | 0.611 |
| Freshwater | 5    | 4    | 2            | 63.1   | 56.8  | <1.89 | 15.16 | 15.7 | <2.37 | 11.38 | <1.42 | <14.2 | <0.473 | 25.7 | 0.000 | 0.608 |
| Freshwater | 5    | 10   | 6            | 89.4   | 280.2 | <1.89 | 17.47 | 18.9 | <2.37 | 10.58 | <1.42 | <14.2 | <0.473 | 24.9 | 0.084 | 0.126 |
| Freshwater | 5    | 14   | 12           | 88.4   | 198.8 | <1.89 | 17.84 | 20.4 | <2.37 | 11.61 | <1.42 | <14.2 | <0.473 | 29.0 | 0.000 | 0.445 |
| KCl        | 2    | 45   | 16           | 91.7   | 26.8  | <1.89 | 14.61 | 25.1 | <2.37 | 7.08  | <1.42 | <14.2 | <0.473 | 25.8 | 0.000 | 0.575 |
| KCl        | 2    | 33   | 19           | 74.3   | 29.6  | <1.89 | 10.46 | 16.2 | 2.67  | 6.67  | <1.42 | <14.2 | <0.473 | 25.8 | 0.000 | 0.700 |
| KCl        | 3    | 30   | 22           | 178.4  | 85.6  | <1.89 | 19.08 | 23.3 | <2.37 | 9.69  | <1.42 | <14.2 | <0.473 | 24.7 | 0.042 | 0.000 |
| KCl        | 3    | 21   | 25           | 122.2  | 62.9  | <1.89 | 16.91 | 24.8 | <2.37 | 10.11 | <1.42 | <14.2 | <0.473 | 25.2 | 0.283 | 0.000 |
| NaCl       | 6    | 32   | 20           | 79.5   | 12.5  | <1.89 | 10.15 | 14.8 | <2.37 | 6.06  | <1.42 | <14.2 | <0.473 | 25.3 | 0.273 | 0.000 |
| NaCl       | 6    | 22   | 24           | 73.0   | 18.3  | <1.89 | 10.42 | 15.9 | 2.69  | 8.52  | <1.42 | <14.2 | <0.473 | 25.6 | 0.119 | 0.158 |
| NaCl       | 7    | 27   | 23           | 168.0  | 145.2 | <1.89 | 9.96  | 15.3 | <2.37 | 8.65  | <1.42 | <14.2 | <0.473 | 25.9 | 0.000 | 0.043 |
| NaCl       | 8    | 44   | 17           | 98.3   | 342.7 | <1.89 | 11.96 | 18.6 | <2.37 | 6.93  | <1.42 | <14.2 | <0.473 | 26.6 | 0.041 | 1.031 |
| NaCl       | 8    | 35   | 18           | 104.7  | 192.7 | <1.89 | 14.25 | 21.1 | <2.37 | 7.19  | <1.42 | <14.2 | <0.473 | 26.1 | 0.000 | 0.556 |
| NaCl       | 8    | 20   | 26           | 108.9  | 473.2 | <1.89 | 11.84 | 17.7 | <2.37 | 8.37  | <1.42 | <14.2 | <0.473 | 25.1 | 0.282 | 0.201 |
| NaCl       | 9    | 31   | 21           | 135.3  | 616.0 | <1.89 | 13.79 | 18.2 | <2.37 | 10.56 | <1.42 | <14.2 | <0.473 | 26.2 | 0.129 | 0.000 |
| NaCl       | 9    | 19   | 27           | 130.7  | 277.2 | <1.89 | 12.28 | 16.3 | <2.37 | 9.57  | <1.42 | <14.2 | <0.473 | 25.6 | 0.203 | 0.183 |

Table 11. Total Elemental Analysis Data for the Brome Grass Tissue Collected in the Field Trial Plots in 1989.

| Waste      | Rate | Plot | FSN<br>(TMT) | Ca   | Mg    | K    | P<br>(mg/g) | S     | Si    | Cl   | Al   | Fe    | Ti    | Cr<br>(ug/g) | Cu    | Zn   | Mn    |
|------------|------|------|--------------|------|-------|------|-------------|-------|-------|------|------|-------|-------|--------------|-------|------|-------|
| Freshwater | 1    | 3    | 3            | 2.96 | 1.175 | 18.9 | 1.87        | 0.851 | 0.480 | 3.27 | 16.1 | 870.0 | 0.417 | 3.213        | 3.30  | 14.4 | 78.6  |
| Freshwater | 1    | 9    | 9            | 2.56 | 1.130 | 19.9 | 2.06        | 0.959 | 0.474 | 2.89 | 11.7 | 29.8  | 0.430 | 0.860        | 3.74  | 17.5 | 51.7  |
| Freshwater | 1    | 13   | 13           | 2.72 | 1.133 | 20.4 | 2.02        | 0.952 | 0.477 | 3.61 | 13.9 | 116.6 | 0.430 | 0.861        | 3.61  | 23.5 | 48.5  |
| Freshwater | 2    | 2    | 2            | 2.90 | 1.011 | 21.9 | 2.06        | 1.066 | 0.476 | 4.17 | 13.4 | 97.2  | 0.382 | 0.763        | 3.59  | 19.0 | 80.4  |
| Freshwater | 2    | 8    | 8            | 2.88 | 1.110 | 21.3 | 2.09        | 1.049 | 0.526 | 4.91 | 13.3 | 52.6  | 0.428 | 0.857        | 3.81  | 17.3 | 48.1  |
| Freshwater | 2    | 15   | 15           | 2.66 | 1.047 | 19.3 | 1.83        | 0.924 | 0.374 | 4.68 | 14.7 | 98.0  | 0.408 | 0.817        | 6.49  | 19.4 | 51.4  |
| Freshwater | 3    | 1    | 1            | 2.27 | 0.887 | 22.8 | 1.93        | 0.959 | 0.472 | 4.15 | 10.0 | 54.6  | 0.394 | 0.788        | 2.80  | 13.4 | 113.2 |
| Freshwater | 3    | 6    | 6            | 2.54 | 1.126 | 21.5 | 2.14        | 0.994 | 0.536 | 4.80 | 10.9 | 76.1  | 0.425 | 0.849        | 3.78  | 18.1 | 51.6  |
| Freshwater | 3    | 11   | 11           | 2.79 | 1.049 | 19.5 | 2.03        | 0.949 | 0.558 | 4.17 | 12.7 | 91.3  | 0.445 | 0.891        | 3.47  | 16.7 | 54.6  |
| Freshwater | 4    | 5    | 5            | 3.11 | 0.999 | 17.4 | 1.76        | 0.805 | 0.548 | 4.50 | 20.3 | 43.4  | 0.424 | 0.849        | 5.86  | 13.1 | 63.9  |
| Freshwater | 4    | 7    | 7            | 2.85 | 1.195 | 21.7 | 2.13        | 1.043 | 0.707 | 4.41 | 11.6 | 29.5  | 0.422 | 0.844        | 3.93  | 15.1 | 46.4  |
| Freshwater | 4    | 12   | 12           | 3.14 | 1.134 | 19.7 | 1.92        | 0.934 | 0.611 | 4.37 | 18.2 | 181.7 | 0.424 | 0.849        | 3.31  | 15.4 | 60.7  |
| Freshwater | 5    | 4    | 4            | 3.08 | 1.060 | 18.8 | 1.83        | 0.866 | 0.582 | 4.21 | 19.1 | 39.8  | 0.443 | 0.886        | 3.46  | 13.5 | 73.9  |
| Freshwater | 5    | 10   | 10           | 3.31 | 1.205 | 20.7 | 2.00        | 1.018 | 0.667 | 4.54 | 16.8 | 85.6  | 0.438 | 0.876        | 3.37  | 15.5 | 73.1  |
| Freshwater | 5    | 14   | 14           | 3.04 | 1.115 | 19.5 | 1.90        | 0.877 | 0.615 | 4.92 | 20.4 | 189.1 | 0.432 | 0.864        | 3.74  | 17.2 | 68.5  |
| KCl        | 1    | 17   | 17           | 2.67 | 0.966 | 16.4 | 1.65        | 0.732 | 0.383 | 4.26 | 13.8 | 23.4  | 0.421 | 0.841        | 3.79  | 12.4 | 73.9  |
| KCl        | 1    | 42   | 42           | 2.44 | 1.021 | 16.2 | 1.73        | 0.827 | 0.353 | 4.00 | 13.0 | 37.9  | 0.423 | 0.847        | 3.18  | 11.6 | 58.6  |
| KCl        | 1    | 43   | 43           | 2.79 | 1.041 | 17.7 | 1.82        | 0.929 | 0.372 | 3.20 | 22.5 | 82.3  | 1.003 | 1.003        | 3.18  | 15.4 | 64.6  |
| KCl        | 2    | 33   | 33           | 2.72 | 1.214 | 16.9 | 1.79        | 0.799 | 0.484 | 3.62 | 18.1 | 32.3  | 0.433 | 0.866        | 3.79  | 13.5 | 70.6  |
| KCl        | 2    | 40   | 40           | 2.55 | 0.935 | 13.8 | 1.58        | 0.776 | 0.221 | 4.08 | 17.7 | 35.9  | 0.426 | 0.851        | 2.17  | 10.8 | 48.7  |
| KCl        | 2    | 45   | 45           | 2.42 | 0.997 | 18.9 | 1.97        | 0.865 | 0.302 | 5.14 | 16.0 | 71.1  | 0.407 | 0.814        | 3.58  | 14.5 | 91.1  |
| KCl        | 3    | 21   | 21           | 2.25 | 0.945 | 19.9 | 1.96        | 0.811 | 0.428 | 4.28 | 12.5 | 88.6  | 0.441 | 0.882        | 14.43 | 16.3 | 73.9  |
| KCl        | 3    | 30   | 30           | 3.06 | 1.036 | 19.4 | 1.84        | 0.830 | 0.380 | 4.63 | 19.3 | 44.7  | 0.434 | 0.869        | 9.34  | 13.6 | 101.3 |
| KCl        | 3    | 39   | 39           | 2.82 | 0.847 | 14.0 | 1.62        | 0.787 | 0.242 | 4.38 | 22.3 | 57.8  | 0.510 | 0.850        | 2.42  | 10.7 | 59.1  |
| KCl        | 4    | 16   | 16           | 3.16 | 1.086 | 32.8 | 1.82        | 0.856 | 0.463 | 4.12 | 24.0 | 36.6  | 0.505 | 0.842        | 2.61  | 14.0 | 87.6  |
| KCl        | 4    | 25   | 25           | 2.99 | 0.866 | 20.8 | 2.27        | 1.133 | 0.400 | 6.01 | 20.9 | 300.7 | 0.449 | 0.898        | 13.74 | 20.7 | 124.8 |
| KCl        | 4    | 29   | 29           | 3.07 | 1.033 | 19.6 | 1.89        | 0.875 | 0.391 | 4.74 | 21.9 | 34.1  | 0.435 | 0.870        | 13.32 | 14.8 | 93.3  |
| KCl        | 5    | 24   | 24           | 2.52 | 1.055 | 20.3 | 2.05        | 0.896 | 0.447 | 3.99 | 18.3 | 31.3  | 0.445 | 0.890        | 4.85  | 15.0 | 84.6  |
| KCl        | 5    | 26   | 26           | 2.67 | 0.926 | 19.5 | 2.05        | 0.886 | 0.394 | 4.71 | 22.2 | 37.9  | 0.507 | 0.845        | 4.69  | 12.8 | 69.4  |
| KCl        | 5    | 37   | 37           | 2.81 | 0.907 | 17.3 | 1.73        | 0.779 | 0.365 | 4.33 | 17.8 | 22.2  | 0.426 | 0.851        | 2.43  | 13.1 | 52.5  |
| NaCl       | 6    | 22   | 22           | 3.06 | 1.211 | 19.8 | 2.07        | 0.935 | 0.369 | 4.06 | 16.2 | 26.2  | 0.398 | 0.797        | 4.02  | 15.1 | 63.5  |
| NaCl       | 6    | 32   | 32           | 3.00 | 1.253 | 17.8 | 1.77        | 0.775 | 0.393 | 3.77 | 18.3 | 27.1  | 0.446 | 0.893        | 3.71  | 12.8 | 73.0  |
| NaCl       | 6    | 41   | 41           | 2.82 | 1.097 | 16.2 | 1.77        | 0.808 | 0.341 | 4.57 | 19.4 | 99.5  | 0.451 | 0.903        | 3.11  | 14.0 | 58.9  |
| NaCl       | 7    | 18   | 18           | 2.48 | 1.098 | 16.6 | 1.71        | 0.771 | 0.451 | 4.31 | 15.9 | 57.9  | 0.414 | 0.828        | 11.10 | 12.3 | 70.6  |
| NaCl       | 7    | 27   | 27           | 2.90 | 1.141 | 18.0 | 1.88        | 0.821 | 0.422 | 4.40 | 19.8 | 190.7 | 0.451 | 0.901        | 3.87  | 14.5 | 137.1 |
| NaCl       | 7    | 34   | 34           | 2.64 | 1.139 | 20.1 | 2.03        | 0.901 | 0.389 | 4.93 | 27.1 | 66.4  | 0.730 | 0.858        | 3.39  | 16.2 | 100.7 |
| NaCl       | 8    | 20   | 20           | 2.60 | 1.132 | 17.1 | 1.78        | 0.817 | 0.243 | 4.00 | 17.7 | 51.5  | 0.431 | 0.861        | 13.99 | 46.8 | 78.0  |
| NaCl       | 8    | 35   | 35           | 2.59 | 1.045 | 19.5 | 1.89        | 0.844 | 0.437 | 5.22 | 18.8 | 28.9  | 0.432 | 0.864        | 3.33  | 14.2 | 84.5  |
| NaCl       | 8    | 44   | 44           | 2.57 | 1.061 | 17.0 | 1.73        | 0.810 | 0.241 | 4.56 | 19.4 | 166.0 | 0.459 | 1.545        | 3.63  | 26.9 | 76.3  |
| NaCl       | 9    | 19   | 19           | 0.89 | 0.900 | 15.9 | 1.77        | 0.719 | 0.481 | 4.34 | 11.2 | 237.8 | 0.426 | 0.851        | 8.85  | 18.8 | 81.2  |
| NaCl       | 9    | 31   | 31           | 3.16 | 1.199 | 18.5 | 1.96        | 0.873 | 0.426 | 4.55 | 23.2 | 129.8 | 0.562 | 0.864        | 4.28  | 13.8 | 97.4  |
| NaCl       | 9    | 36   | 36           | 3.00 | 1.202 | 17.7 | 1.95        | 0.907 | 0.385 | 4.46 | 26.3 | 37.4  | 0.709 | 0.886        | 3.81  | 13.5 | 57.2  |
| NaCl       | 10   | 23   | 23           | 2.16 | 0.824 | 20.2 | 2.20        | 0.868 | 0.428 | 5.18 | 15.2 | 109.4 | 0.431 | 0.862        | 4.31  | 15.3 | 83.7  |
| NaCl       | 10   | 28   | 28           | 2.71 | 0.870 | 20.6 | 2.26        | 0.948 | 0.365 | 5.99 | 26.6 | 49.6  | 0.767 | 0.807        | 4.92  | 15.6 | 122.2 |
| NaCl       | 10   | 38   | 38           | 2.25 | 0.853 | 13.7 | 1.84        | 0.771 | 0.274 | 4.58 | 21.8 | 38.8  | 0.597 | 0.854        | 2.60  | 12.9 | 58.7  |

Elements (V, Cd, Pb, Li, Mo, Ni, Se and Co) below the detection limit are excluded from this table.

The effect of the addition of drilling waste on the elemental enrichment of the affected plants can be demonstrated by the enrichment ratio (ER). The ER of a chemical element is calculated by dividing the elemental concentration of the fly ash-affected plant tissue with that of the unaffected plant tissue. The higher ER of a chemical element indicates greater degree of plant tissue enrichment in the affected soils. An enrichment ratio of  $<1$  would be indicative of the reduced plant uptake of that element by plants. The ER for selected elements for 1988 and 1989 are presented in Table 12.

The tissue from the treated plots exhibited elevated levels of chloride, sodium and to a lesser extent copper in comparison with the tissue from the control plots. Boron levels increased two-fold over control levels for the FW 5 treatment in 1988, however, they were down to control levels in 1989. The boron levels reported in Table 10 and 11 are below the intermediate range of 15 to 800 ppm B in grasses reported by Chapman (1966).

Copper levels in the tissue were higher in 1989 than in 1988. Tissue levels of 1.0 to 5.1 ppm and 5.2 to 18.0 ppm copper are considered deficient and normal, respectively. Tissue grown in the control plots had copper levels at about the mid-point of the deficient range. Addition of waste resulted in increased tissue copper values with some of the values occurring in the normal range for grasses.

Sodium levels in the tissue increased with increasing application rate of the different wastes, particularly the NaCl material. Substantial differences in the uptake of Na between 1988 and 1989 were evident from the ER values of 29.0 vs 2.3 for the NaCl 9 treatment, respectively. This is related to the fact that the sodium was leached downward from the zone of waste incorporation and out of the currently established root zone. Normal and excessive levels of sodium in grasses are 300 to 1100 ppm and 3200 to 43700 ppm, respectively. Using these criteria and the data from

Table 12. ER (Enrichment Ratio) Values for Elements in the Brome Grass Tissue for 1988 and 1989.

| Waste      | Rate | B         |           | Ca        |           | Cl        |           | Cr        |           | Cu        |           | K         |           | Mg        |           | Na        |           | P         |           |
|------------|------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|            |      | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 | Post 1989 |
| Freshwater | 1    | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       |
| Freshwater | 2    | 1.6       | 1.0       | 1.0       | 1.0       | 1.8       | 1.4       | 0.9       | 1.1       | 1.3       | 1.0       | 1.1       | 1.0       | 0.9       | 0.9       | 2.4       | 1.0       | 1.0       | 1.0       |
| Freshwater | 3    | 1.8       | 1.0       | 1.0       | 0.9       | 2.1       | 1.3       | 1.0       | 1.1       | 0.9       | 1.1       | 1.1       | 1.1       | 0.9       | 0.9       | 3.2       | 0.9       | 1.1       | 1.0       |
| Freshwater | 4    | 1.6       | 1.1       | 1.1       | 1.1       | 2.1       | 1.4       | 1.0       | 1.0       | 1.2       | 1.0       | 1.0       | 1.0       | 0.9       | 1.0       | 2.4       | 0.9       | 0.9       | 1.0       |
| Freshwater | 5    | 2.0       | 1.0       | 1.2       | 1.1       | 2.2       | 1.4       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 0.9       | 1.0       | 9.5       | 1.3       | 0.8       | 1.0       |
| KCl        | 1    | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       |
| KCl        | 2    | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.1       | 0.9       | 1.0       | 0.9       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.2       | 1.0       | 1.0       |
| KCl        | 3    | 1.4       | 1.0       | 1.1       | 1.0       | 1.2       | 1.2       | 1.0       | 0.8       | 2.6       | 0.9       | 1.1       | 0.9       | 0.9       | 0.9       | 2.6       | 2.0       | 0.6       | 1.1       |
| KCl        | 4    | 1.1       | 1.1       | 1.1       | 1.1       | 1.3       | 1.3       | 1.0       | 1.0       | 2.9       | 1.5       | 1.5       | 1.5       | 1.0       | 1.0       | 1.4       | 1.4       | 1.2       | 1.1       |
| KCl        | 5    | 1.0       | 1.0       | 1.0       | 1.0       | 1.1       | 1.1       | 1.0       | 1.0       | 1.2       | 1.1       | 1.1       | 1.1       | 1.0       | 1.0       | 1.4       | 1.4       | 1.1       | 1.1       |
| NaCl       | 6    | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       |
| NaCl       | 7    | 1.2       | 1.0       | 0.9       | 0.9       | 2.3       | 1.1       | 1.0       | 1.4       | 1.7       | 1.1       | 1.1       | 1.0       | 0.8       | 0.9       | 9.4       | 1.1       | 1.1       | 1.0       |
| NaCl       | 8    | 1.0       | 1.0       | 1.1       | 0.9       | 2.1       | 1.1       | 1.3       | 1.2       | 1.9       | 1.0       | 1.0       | 1.0       | 1.0       | 0.9       | 21.8      | 1.3       | 1.1       | 1.0       |
| NaCl       | 9    | 1.4       | 1.0       | 1.1       | 0.8       | 2.1       | 1.1       | 1.0       | 1.3       | 1.3       | 1.6       | 0.9       | 1.0       | 0.9       | 0.9       | 29.0      | 2.3       | 1.2       | 1.0       |
| NaCl       | 10   | 1.0       | 1.0       | 0.8       | 0.8       | 1.3       | 1.3       | 1.0       | 1.0       | 1.1       | 1.1       | 1.0       | 1.0       | 0.7       | 0.7       | 10.9      | 10.9      | 1.2       | 1.1       |

Post = Sampled September 1988; 1989 = Sampled August 1989.

| Waste      | Rate | S         |           | Zn        |           |
|------------|------|-----------|-----------|-----------|-----------|
|            |      | Post 1989 | Post 1989 | Post 1989 | Post 1989 |
| Freshwater | 1    | 1.0       | 1.0       | 1.0       | 1.0       |
| Freshwater | 2    | 1.3       | 1.1       | 1.0       | 1.0       |
| Freshwater | 3    | 1.3       | 1.1       | 1.0       | 0.9       |
| Freshwater | 4    | 1.2       | 1.0       | 0.9       | 0.8       |
| Freshwater | 5    | 1.1       | 1.0       | 0.9       | 0.8       |
| KCl        | 1    | 1.0       | 1.0       | 1.0       | 1.0       |
| KCl        | 2    | 1.0       | 1.0       | 1.0       | 1.0       |
| KCl        | 3    | 0.9       | 1.0       | 1.0       | 1.0       |
| KCl        | 4    | 1.2       | 1.2       | 1.3       | 1.3       |
| KCl        | 5    | 1.0       | 1.0       | 1.0       | 1.0       |
| NaCl       | 6    | 1.0       | 1.0       | 1.0       | 1.0       |
| NaCl       | 7    | 1.4       | 1.0       | 1.3       | 1.0       |
| NaCl       | 8    | 1.2       | 1.0       | 1.2       | 2.1       |
| NaCl       | 9    | 1.2       | 1.0       | 1.1       | 1.1       |
| NaCl       | 10   | 1.0       | 1.0       | 1.0       | 1.0       |

Tables 9 and 10, it was apparent that the normal levels were not exceeded, and that for many of the treatments were not even achieved.

Chloride values in Table 10 range from 3.82 mg/g (3820 ppm) to 18.45 mg/g (19450 ppm), and in Table 11 range from 2.89 mg/g (2890 ppm) to 6.01 mg/g (6010 ppm). Chapman (1966) reports an intermediate range of 7000 ppm and a high range of 8700 to 15400 ppm for chloride in grasses. Using these values as a guideline suggests that the application of all wastes resulted in high levels of chloride in the tissue in 1988 particularly the tissue from the KCl and NaCl treated plots. It is difficult to assess the impact of chloride levels on plant health and growth, because the only consistent or general symptom of excess chloride is reduced leaf size and slower growth rate. However, for many plants sharply reduced growth occurs without leaf symptoms (Chapman 1966). The chloride levels in the tissue in 1989 were considerably lower than those in 1988 which is shown both in the data in Tables 10 and 11 and the ER values in Table 12. The decrease in tissue chloride levels in 1989 is directly related to the decrease in soil/waste chloride levels, described in Section 4.4.2.3 of this report. All values reported for 1989 were below the intermediate level of 7000 ppm, reported by Chapman (1966).

The concentration of potassium in the tissue did not change at all for all treatments except for the KCl 4 plots, despite the fact that the KCl treated plots received a high concentration of potassium especially at the higher application rates. Magnesium uptake declined with increased waste application rate and in particular with the NaCl waste. It is likely that the levels of other cations were in part responsible for the lowered uptake of magnesium by the brome grass.



## 5. SUMMARY

### 5.1 PLOT YIELD

Observations, relative to the brome grass growth on the various plot treatments, were made throughout the growing season. Germination appeared to be affected by the application of the KCl and NaCl waste materials, particularly the KCl 5 and NaCl 10 treatments. The brome grass was harvested in late June and again in mid-August, however, only the data and interpretation, thereof, for the June harvest were presented.

For each of the waste treatment types, the yield obtained for the lower waste application rates exceeded the yields obtained in the respective control treatments, and the maximum application rate resulted in the lowest yield. These trends are comparable to the results obtained in greenhouse trials using similar waste materials and application rates (Macyk et al. 1989b).

### 5.2 FIELD PLOT SOIL PROPERTIES

A total of 207 samples were collected in mid-August 1989. Samples representing the 0 to 15 cm depth were collected at all plots, and additional samples representing the 15 to 30 cm, 30 to 45 cm, 45 to 60 cm, and 60 to 90 cm depths were obtained at selected plots.

#### 5.2.1 Chemical Properties

The samples were analysed to determine pH and  $\text{CaCO}_3$  equivalent. Following waste application, only treatments FW 4, FW 5, and NaCl 10 might present a slight limitation to plant growth as a result of pH level. The  $\text{CaCO}_3$  equivalent values indicated a "good" rating in terms of soil suitability for plant growth for all treatments prior to and following waste application.

Table 13. Summary of degree of limitation relative to EC, SAR, and Cl<sup>-</sup> levels in 1988 and 1989.

| Waste Treatment | Degree of Limitation* |          |          |        |                 |          |
|-----------------|-----------------------|----------|----------|--------|-----------------|----------|
|                 | EC                    |          | SAR      |        | Cl <sup>-</sup> |          |
|                 | 1988                  | 1989     | 1988     | 1989   | 1988            | 1989     |
| FW 1            | none                  | none     | none     | none   | none            | none     |
| FW 2            | none                  | none     | none     | none   | none            | none     |
| FW 3            | none                  | none     | none     | none   | none            | none     |
| FW 4            | none                  | none     | none     | none   | none            | none     |
| FW 5            | none                  | none     | none     | none   | none            | none     |
| KCl 1           | none                  | none     | none     | none   | none            | none     |
| KCl 2           | none                  | none     | none     | none   | none            | none     |
| KCl 3           | slight                | slight   | none     | none   | slight          | none     |
| KCl 4           | slight                | slight   | none     | none   | slight          | none     |
| KCl 5           | slight                | slight   | none     | none   | severe          | slight   |
| NaCl 6          | none                  | none     | none     | none   | none            | none     |
| NaCl 7          | none                  | none     | slight   | none   | none            | none     |
| NaCl 8          | none                  | slight   | slight   | slight | none            | none     |
| NaCl 9          | slight                | none     | moderate | slight | none            | none     |
| NaCl 10         | moderate              | moderate | severe   | severe | severe          | moderate |

### 5.2.2 Saturated Paste Extract Data

Table 12 provides a summary of the degree of limitation associated with the EC, SAR, and Cl status of the plot treatments in 1988 and 1989.

### 5.2.3 Total Elemental Analysis Data

Elemental content levels increased or decreased slightly as a result of waste addition. Mean values, for the various elements determined, were within the range of values normally found in soils, except for Ca which was slightly below the minimum levels provided.

## 5.3 TISSUE ANALYSIS DATA

The effect of the addition of drilling wastes on the elemental enrichment of the brome grass was demonstrated by the enrichment ratio (ER). The tissue from the treated plots exhibited elevated levels of chloride, sodium and to a lesser extent copper in comparison with the tissue from the control plots. Tissue grown in the control plots had copper levels in the deficient range, however, the addition of waste resulted in some of the values increasing into the normal range for grasses.

Sodium levels in the tissue increased with increasing application rate of the different wastes, particularly the NaCl material. Substantial differences in the uptake of Na between 1988 and 1989 for the NaCl treatments were evident, due, likely, to the leaching of sodium from the zone of waste incorporation and out of the currently established root zone.

Tissue from a number of the treatments exhibited high levels of chloride in 1988, particularly the tissue from the KCl and NaCl treated plots. However, in 1989 the levels were considerably reduced largely due to the decrease in chloride levels in the root zone soil/waste material.

The concentration of potassium in the tissue from the treated plots changed very little relative to the control plots.

Magnesium uptake declined with increased waste application rate and in particular with the NaCl waste.

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APPENDIX I. Chemical properties of the soils and soil/waste mixtures  
in the ESSO field plots in 1989.

Chemical Properties of the Soils and Soil Waste Mixtures in the Esso Field Plots in 1989.

| Waste      | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | pH               |                   | CaCO <sub>3</sub><br>(%) |  |
|------------|------|------|--------------|---------------|------------------|-------------------|--------------------------|--|
|            |      |      |              |               | H <sub>2</sub> O | CaCl <sub>2</sub> |                          |  |
| Freshwater | 1    | 3    | 4            | 0-15          | 7.5              | 7.1               | 0.56                     |  |
| Freshwater | 1    | 9    | 18           | 0-15          | 7.5              | 7.1               | 0.96                     |  |
| Freshwater | 1    | 13   | 37           | 0-15          | 7.5              | 7.0               | 0.64                     |  |
| Freshwater | 1    | 13   | 38           | 15-30         | 7.7              | 7.3               | 2.31                     |  |
| Freshwater | 1    | 13   | 39           | 30-45         | 7.9              | 7.6               | 4.30                     |  |
| Freshwater | 1    | 13   | 40           | 45-60         | 8.0              | 7.6               | 4.50                     |  |
| Freshwater | 2    | 2    | 3            | 0-15          | 7.4              | 7.1               | 0.60                     |  |
| Freshwater | 2    | 8    | 17           | 0-15          | 7.6              | 7.3               | 0.76                     |  |
| Freshwater | 2    | 15   | 45           | 0-15          | 7.9              | 7.5               | 2.51                     |  |
| Freshwater | 3    | 1    | 1            | 0-15          | 7.4              | 7.2               | 0.64                     |  |
| Freshwater | 3    | 1    | 2            | 15-30         | 7.3              | 6.9               | 0.26                     |  |
| Freshwater | 3    | 6    | 12           | 0-15          | 7.7              | 7.4               | 1.29                     |  |
| Freshwater | 3    | 11   | 31           | 0-15          | 7.6              | 7.4               | 1.08                     |  |
| Freshwater | 3    | 11   | 32           | 0-15          | 7.9              | 7.5               | 1.04                     |  |
| Freshwater | 3    | 11   | 33           | 0-15          | 7.7              | 7.4               | 0.72                     |  |
| Freshwater | 3    | 11   | 34           | 0-15          | 7.6              | 7.2               | 0.68                     |  |
| Freshwater | 3    | 11   | 35           | 0-15          | 7.7              | 7.4               | 0.96                     |  |
| Freshwater | 4    | 5    | 10           | 0-15          | 8.1              | 7.6               | 0.89                     |  |
| Freshwater | 4    | 5    | 11           | 15-30         | 8.0              | 7.4               | 0.46                     |  |
| Freshwater | 4    | 7    | 13           | 0-15          | 7.9              | 7.5               | 1.49                     |  |
| Freshwater | 4    | 7    | 14           | 15-30         | 7.8              | 7.5               | 2.68                     |  |
| Freshwater | 4    | 7    | 15           | 30-45         | 8.1              | 7.8               | 6.84                     |  |
| Freshwater | 4    | 7    | 16           | 45-60         | 8.3              | 7.9               | 4.50                     |  |
| Freshwater | 4    | 12   | 36           | 0-15          | 7.9              | 7.6               | 0.82                     |  |
| Freshwater | 5    | 4    | 5            | 0-15          | 8.5              | 8.1               | 1.76                     |  |
| Freshwater | 5    | 4    | 6            | 0-15          | 8.3              | 8.1               | 1.92                     |  |
| Freshwater | 5    | 4    | 7            | 0-15          | 8.4              | 8.0               | 2.16                     |  |
| Freshwater | 5    | 4    | 8            | 0-15          | 7.9              | 7.5               | 0.73                     |  |
| Freshwater | 5    | 4    | 9            | 0-15          | 8.2              | 8.0               | 1.41                     |  |
| Freshwater | 5    | 10   | 19           | 0-15          | 8.5              | 8.0               | 2.62                     |  |
| Freshwater | 5    | 10   | 20           | 0-15          | 8.1              | 7.8               | 1.36                     |  |
| Freshwater | 5    | 10   | 21           | 0-15          | 8.3              | 8.1               | 2.31                     |  |
| Freshwater | 5    | 10   | 22           | 0-15          | 9.5              | 8.5               | 2.55                     |  |
| Freshwater | 5    | 10   | 23           | 0-15          | 7.9              | 7.5               | 1.04                     |  |
| Freshwater | 5    | 10   | 24           | 15-30         | 8.0              | 7.7               | 4.46                     |  |
| Freshwater | 5    | 10   | 25           | 15-30         | 7.8              | 7.4               | 2.31                     |  |
| Freshwater | 5    | 10   | 26           | 15-30         | 7.3              | 6.7               | 0.24                     |  |
| Freshwater | 5    | 10   | 27           | 15-30         | 7.9              | 7.7               | 2.83                     |  |
| Freshwater | 5    | 10   | 28           | 15-30         | 7.8              | 7.6               | 2.87                     |  |
| Freshwater | 5    | 10   | 29           | 30-45         | 8.0              | 7.7               | 4.54                     |  |
| Freshwater | 5    | 10   | 30           | 45-60         | 7.9              | 7.7               | 4.86                     |  |
| Freshwater | 5    | 14   | 41           | 0-15          | 8.1              | 7.9               | 2.11                     |  |
| Freshwater | 5    | 14   | 42           | 15-30         | 7.5              | 7.4               | 0.72                     |  |
| Freshwater | 5    | 14   | 43           | 30-45         | 7.7              | 7.4               | 1.00                     |  |
| Freshwater | 5    | 14   | 44           | 45-60         | 8.1              | 7.7               | 3.79                     |  |

Continued. Chemical Properties of the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | pH               |                   | CaCO <sub>3</sub> |                   |
|-------|------|------|--------------|---------------|------------------|-------------------|-------------------|-------------------|
|       |      |      |              |               | H <sub>2</sub> O | CaCl <sub>2</sub> | H <sub>2</sub> O  | CaCl <sub>2</sub> |
| KCI   | 1    | 17   | 58           | 0-15          | 7.7              | 7.1               | 0.71              | 0.71              |
| KCI   | 1    | 42   | 179          | 0-15          | 7.8              | 7.6               | 3.76              | 3.76              |
| KCI   | 1    | 42   | 180          | 0-15          | 7.8              | 7.6               | 2.93              | 2.93              |
| KCI   | 1    | 42   | 181          | 0-15          | 7.7              | 7.6               | 2.33              | 2.33              |
| KCI   | 1    | 42   | 182          | 0-15          | 7.9              | 7.7               | 3.48              | 3.48              |
| KCI   | 1    | 42   | 183          | 0-15          | 7.8              | 7.6               | 2.49              | 2.49              |
| KCI   | 1    | 43   | 184          | 0-15          | 7.7              | 7.5               | 2.34              | 2.34              |
|       |      |      |              |               |                  |                   |                   |                   |
| KCI   | 2    | 33   | 143          | 0-15          | 7.5              | 7.2               | 0.85              | 0.85              |
| KCI   | 2    | 40   | 177          | 0-15          | 7.7              | 7.6               | 1.15              | 1.15              |
| KCI   | 2    | 45   | 197          | 0-15          | 7.5              | 7.4               | 1.08              | 1.08              |
| KCI   | 2    | 45   | 198          | 0-15          | 6.9              | 6.8               | 0.28              | 0.28              |
| KCI   | 2    | 45   | 199          | 0-15          | 7.2              | 6.9               | 0.22              | 0.22              |
| KCI   | 2    | 45   | 200          | 0-15          | 7.6              | 7.4               | 0.64              | 0.64              |
| KCI   | 2    | 45   | 201          | 0-15          | 7.5              | 7.2               | 0.36              | 0.36              |
| KCI   | 2    | 45   | 202          | 15-30         | 5.6              | 6.3               | —                 | —                 |
| KCI   | 2    | 45   | 203          | 15-30         | 5.7              | 5.2               | —                 | —                 |
| KCI   | 2    | 45   | 204          | 15-30         | 5.6              | 5.3               | —                 | —                 |
| KCI   | 2    | 45   | 205          | 15-30         | 7.5              | 7.5               | 1.88              | 1.88              |
| KCI   | 2    | 45   | 206          | 15-30         | 7.6              | 7.6               | 2.36              | 2.36              |
| KCI   | 2    | 45   | 207          | 30-45         | 6.1              | 5.8               | —                 | —                 |
|       |      |      |              |               |                  |                   |                   |                   |
| KCI   | 3    | 21   | 73           | 0-15          | 7.6              | 7.3               | 0.64              | 0.64              |
| KCI   | 3    | 21   | 74           | 0-15          | 7.6              | 7.2               | 0.48              | 0.48              |
| KCI   | 3    | 21   | 75           | 0-15          | 7.3              | 7.1               | 0.36              | 0.36              |
| KCI   | 3    | 21   | 76           | 0-15          | 7.7              | 7.3               | 0.58              | 0.58              |
| KCI   | 3    | 21   | 77           | 0-15          | 7.8              | 7.3               | 0.36              | 0.36              |
| KCI   | 3    | 30   | 129          | 0-15          | 7.2              | 7.2               | 0.36              | 0.36              |
| KCI   | 3    | 39   | 176          | 0-15          | 7.7              | 7.5               | 1.78              | 1.78              |
|       |      |      |              |               |                  |                   |                   |                   |
| KCI   | 4    | 16   | 46           | 0-15          | 7.6              | 7.3               | 0.76              | 0.76              |
| KCI   | 4    | 16   | 47           | 0-15          | 7.7              | 7.4               | 0.84              | 0.84              |
| KCI   | 4    | 16   | 48           | 0-15          | 7.9              | 7.4               | 0.72              | 0.72              |
| KCI   | 4    | 16   | 49           | 0-15          | 7.6              | 7.4               | 0.60              | 0.60              |
| KCI   | 4    | 16   | 50           | 0-15          | 7.9              | 7.5               | 0.88              | 0.88              |
| KCI   | 4    | 16   | 51           | 15-30         | 7.6              | 7.0               | 0.30              | 0.30              |
| KCI   | 4    | 16   | 52           | 15-30         | 7.8              | 7.5               | 1.51              | 1.51              |
| KCI   | 4    | 16   | 53           | 15-30         | 7.1              | 7.0               | 0.30              | 0.30              |
| KCI   | 4    | 16   | 54           | 15-30         | 7.6              | 7.3               | 0.60              | 0.60              |
| KCI   | 4    | 16   | 55           | 15-30         | 7.5              | 7.4               | 1.07              | 1.07              |
| KCI   | 4    | 16   | 56           | 30-45         | 7.7              | 7.5               | 1.86              | 1.86              |
| KCI   | 4    | 16   | 57           | 45-60         | 7.9              | 7.5               | 3.41              | 3.41              |
| KCI   | 4    | 25   | 95           | 0-15          | 7.4              | 7.3               | 0.84              | 0.84              |
| KCI   | 4    | 25   | 96           | 0-15          | 7.6              | 7.6               | 0.84              | 0.84              |
| KCI   | 4    | 25   | 97           | 0-15          | 7.3              | 7.2               | 0.40              | 0.40              |
| KCI   | 4    | 25   | 98           | 0-15          | 7.5              | 7.6               | 0.80              | 0.80              |
| KCI   | 4    | 25   | 99           | 0-15          | 7.8              | 7.8               | 1.36              | 1.36              |

Continued. Chemical Properties of the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | pH               |                   | CaCO <sub>3</sub><br>(%) |                   |
|-------|------|------|--------------|---------------|------------------|-------------------|--------------------------|-------------------|
|       |      |      |              |               | H <sub>2</sub> O | CaCl <sub>2</sub> | CaCO <sub>3</sub>        | CaCl <sub>2</sub> |
| KCl   | 4    | 25   | 100          | 15-30         | 6.5              | 6.4               | 0.28                     |                   |
| KCl   | 4    | 25   | 101          | 15-30         | 5.0              | 5.0               | —                        |                   |
| KCl   | 4    | 25   | 102          | 15-30         | 5.8              | 5.7               | —                        |                   |
| KCl   | 4    | 25   | 103          | 15-30         | 7.0              | 6.8               | 0.20                     |                   |
| KCl   | 4    | 25   | 104          | 15-30         | 7.6              | 7.3               | 0.18                     |                   |
| KCl   | 4    | 25   | 105          | 30-45         | 5.4              | 5.4               | —                        |                   |
| KCl   | 4    | 25   | 106          | 45-60         | 5.2              | 4.9               | —                        |                   |
| KCl   | 4    | 29   | 124          | 0-15          | 7.3              | 7.2               | 0.32                     |                   |
| KCl   | 4    | 29   | 125          | 15-30         | 5.6              | 5.3               | —                        |                   |
| KCl   | 4    | 29   | 126          | 30-45         | 5.6              | 5.3               | —                        |                   |
| KCl   | 4    | 29   | 127          | 45-60         | 5.5              | 5.2               | —                        |                   |
| KCl   | 4    | 29   | 128          | 60-90         | 5.8              | 5.4               | —                        |                   |
|       |      |      |              |               |                  |                   |                          |                   |
| KCl   | 5    | 24   | 94           | 0-15          | 7.5              | 7.3               | 1.48                     |                   |
| KCl   | 5    | 26   | 107          | 0-15          | 7.6              | 7.4               | 0.67                     |                   |
| KCl   | 5    | 37   | 162          | 0-15          | 7.8              | 7.5               | 1.44                     |                   |
|       |      |      |              |               |                  |                   |                          |                   |
| NaCl  | 6    | 22   | 78           | 0-15          | 7.2              | 6.6               | 0.16                     |                   |
| NaCl  | 6    | 22   | 79           | 15-30         | 7.9              | 7.3               | 2.49                     |                   |
| NaCl  | 6    | 22   | 80           | 30-45         | 8.2              | 7.9               | 4.77                     |                   |
| NaCl  | 6    | 22   | 81           | 45-60         | 8.2              | 7.9               | 4.69                     |                   |
| NaCl  | 6    | 32   | 142          | 0-15          | 7.6              | 7.3               | 0.81                     |                   |
| NaCl  | 6    | 41   | 178          | 0-15          | 7.8              | 7.5               | 2.33                     |                   |
|       |      |      |              |               |                  |                   |                          |                   |
| NaCl  | 7    | 18   | 59           | 0-15          | 7.7              | 7.3               | 1.25                     |                   |
| NaCl  | 7    | 27   | 108          | 0-15          | 6.8              | 6.5               | 0.10                     |                   |
| NaCl  | 7    | 27   | 109          | 0-15          | 7.1              | 6.6               | 0.14                     |                   |
| NaCl  | 7    | 27   | 110          | 0-15          | 7.0              | 6.5               | 0.10                     |                   |
| NaCl  | 7    | 27   | 111          | 0-15          | 7.1              | 6.6               | 0.18                     |                   |
| NaCl  | 7    | 27   | 112          | 0-15          | 7.2              | 6.8               | 0.28                     |                   |
| NaCl  | 7    | 27   | 113          | 15-30         | 7.1              | 6.5               | 0.14                     |                   |
| NaCl  | 7    | 34   | 144          | 0-15          | 7.7              | 7.2               | 0.61                     |                   |
| NaCl  | 7    | 34   | 145          | 0-15          | 7.4              | 7.2               | 0.49                     |                   |
| NaCl  | 7    | 34   | 146          | 0-15          | 7.4              | 7.1               | 0.37                     |                   |
| NaCl  | 7    | 34   | 147          | 0-15          | 8.0              | 7.6               | 1.28                     |                   |
| NaCl  | 7    | 34   | 148          | 0-15          | 7.8              | 7.6               | 1.56                     |                   |
| NaCl  | 7    | 34   | 149          | 15-30         | 7.9              | 7.8               | 5.07                     |                   |
|       |      |      |              |               |                  |                   |                          |                   |
| NaCl  | 8    | 20   | 72           | 0-15          | 7.4              | 7.2               | 0.56                     |                   |
| NaCl  | 8    | 35   | 150          | 0-15          | 7.5              | 7.2               | 0.53                     |                   |
| NaCl  | 8    | 35   | 151          | 0-15          | 7.4              | 6.9               | 0.24                     |                   |
| NaCl  | 8    | 35   | 152          | 0-15          | 7.2              | 7.0               | 0.28                     |                   |
| NaCl  | 8    | 35   | 153          | 0-15          | 7.6              | 7.0               | 0.28                     |                   |
| NaCl  | 8    | 35   | 154          | 0-15          | 7.1              | 6.8               | 0.20                     |                   |
| NaCl  | 8    | 35   | 155          | 15-30         | 6.9              | 6.8               | 0.57                     |                   |
| NaCl  | 8    | 44   | 185          | 0-15          | 8.0              | 7.7               | 1.82                     |                   |
| NaCl  | 8    | 44   | 186          | 0-15          | 7.9              | 7.6               | 1.31                     |                   |
| NaCl  | 8    | 44   | 187          | 0-15          | 8.0              | 7.5               | 0.99                     |                   |
| NaCl  | 8    | 44   | 188          | 0-15          | 7.4              | 7.3               | 0.44                     |                   |
| NaCl  | 8    | 44   | 189          | 0-15          | 7.5              | 7.0               | 0.40                     |                   |

Continued. Chemical Properties of the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | H <sub>2</sub> O | pH  | CaCl <sub>2</sub> | CaCO <sub>3</sub><br>(%) |
|-------|------|------|--------------|---------------|------------------|-----|-------------------|--------------------------|
| NaCl  | 8    | 44   | 190          | 15-30         | 7.9              | 7.7 | 7.7               | 2.34                     |
| NaCl  | 8    | 44   | 191          | 15-30         | 7.7              | 7.6 | 7.6               | 1.82                     |
| NaCl  | 8    | 44   | 192          | 15-30         | 7.5              | 7.5 | 7.5               | 1.37                     |
| NaCl  | 8    | 44   | 193          | 15-30         | 6.8              | 6.6 | 6.6               | 0.18                     |
| NaCl  | 8    | 44   | 194          | 15-30         | 6.9              | 6.4 | 6.4               | 0.10                     |
| NaCl  | 8    | 44   | 195          | 30-45         | 7.7              | 7.5 | 7.5               | 1.67                     |
| NaCl  | 8    | 44   | 196          | 45-60         | 7.9              | 7.8 | 7.8               | 5.08                     |
| NaCl  | 9    | 19   | 60           | 0-15          | 7.6              | 7.1 | 7.1               | 0.34                     |
| NaCl  | 9    | 19   | 61           | 0-15          | 7.5              | 7.0 | 7.0               | 0.36                     |
| NaCl  | 9    | 19   | 62           | 0-15          | 7.7              | 7.3 | 7.3               | 0.87                     |
| NaCl  | 9    | 19   | 63           | 0-15          | 7.5              | 7.4 | 7.4               | 0.77                     |
| NaCl  | 9    | 19   | 64           | 0-15          | 7.8              | 7.2 | 7.2               | 0.44                     |
| NaCl  | 9    | 19   | 65           | 15-30         | 7.1              | 6.6 | 6.6               | 0.18                     |
| NaCl  | 9    | 19   | 66           | 15-30         | 7.1              | 7.1 | 7.1               | 0.52                     |
| NaCl  | 9    | 19   | 67           | 15-30         | 7.3              | 7.2 | 7.2               | 0.36                     |
| NaCl  | 9    | 19   | 68           | 15-30         | 8.0              | 7.8 | 7.8               | 5.57                     |
| NaCl  | 9    | 19   | 69           | 15-30         | 7.8              | 7.7 | 7.7               | 5.48                     |
| NaCl  | 9    | 19   | 70           | 30-45         | 7.7              | 7.4 | 7.4               | 0.68                     |
| NaCl  | 9    | 19   | 71           | 45-60         | 7.7              | 7.4 | 7.4               | 2.18                     |
| NaCl  | 9    | 31   | 130          | 0-15          | 7.7              | 7.4 | 7.4               | 0.36                     |
| NaCl  | 9    | 31   | 131          | 0-15          | 7.5              | 7.3 | 7.3               | 0.36                     |
| NaCl  | 9    | 31   | 132          | 0-15          | 7.7              | 7.3 | 7.3               | 0.36                     |
| NaCl  | 9    | 31   | 133          | 0-15          | 7.5              | 7.3 | 7.3               | 0.40                     |
| NaCl  | 9    | 31   | 134          | 0-15          | 7.5              | 7.1 | 7.1               | 0.10                     |
| NaCl  | 9    | 31   | 135          | 15-30         | 6.0              | 5.4 | 5.4               | —                        |
| NaCl  | 9    | 31   | 136          | 15-30         | 7.1              | 6.7 | 6.7               | 0.30                     |
| NaCl  | 9    | 31   | 137          | 15-30         | 6.5              | 6.1 | 6.1               | —                        |
| NaCl  | 9    | 31   | 138          | 15-30         | 6.1              | 5.7 | 5.7               | —                        |
| NaCl  | 9    | 31   | 139          | 15-30         | 7.1              | 6.7 | 6.7               | 0.53                     |
| NaCl  | 9    | 31   | 140          | 30-45         | 5.4              | 5.0 | 5.0               | —                        |
| NaCl  | 9    | 31   | 141          | 45-60         | 5.5              | 5.1 | 5.1               | —                        |
| NaCl  | 9    | 36   | 156          | 0-15          | 7.8              | 7.5 | 7.5               | 1.16                     |
| NaCl  | 9    | 36   | 157          | 0-15          | 7.7              | 7.5 | 7.5               | 1.24                     |
| NaCl  | 9    | 36   | 158          | 0-15          | 8.2              | 7.7 | 7.7               | 1.99                     |
| NaCl  | 9    | 36   | 159          | 0-15          | 8.1              | 7.6 | 7.6               | 1.32                     |
| NaCl  | 9    | 36   | 160          | 0-15          | 7.8              | 7.5 | 7.5               | 1.05                     |
| NaCl  | 9    | 36   | 161          | 15-30         | 7.4              | 7.2 | 7.2               | 0.73                     |
| NaCl  | 10   | 23   | 82           | 0-15          | 7.7              | 7.4 | 7.4               | 1.20                     |
| NaCl  | 10   | 23   | 83           | 0-15          | 7.7              | 7.5 | 7.5               | 1.36                     |
| NaCl  | 10   | 23   | 84           | 0-15          | 7.8              | 7.5 | 7.5               | 1.24                     |
| NaCl  | 10   | 23   | 85           | 0-15          | 7.4              | 7.2 | 7.2               | 0.64                     |
| NaCl  | 10   | 23   | 86           | 0-15          | 7.4              | 7.1 | 7.1               | 0.44                     |
| NaCl  | 10   | 23   | 87           | 15-30         | 7.2              | 6.7 | 6.7               | 2.80                     |
| NaCl  | 10   | 23   | 88           | 15-30         | 7.5              | 7.2 | 7.2               | 2.89                     |
| NaCl  | 10   | 23   | 89           | 15-30         | 7.8              | 7.7 | 7.7               | 3.73                     |
| NaCl  | 10   | 23   | 90           | 15-30         | 6.8              | 6.4 | 6.4               | 0.26                     |
| NaCl  | 10   | 23   | 91           | 15-30         | 6.1              | 5.7 | 5.7               | —                        |



| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | H <sub>2</sub> O | pH  | CaCl <sub>2</sub> | CaCO <sub>3</sub><br>(%) |
|-------|------|------|--------------|---------------|------------------|-----|-------------------|--------------------------|
| NaCl  | 10   | 23   | 92           | 30-45         | 8.1              | 7.9 | 7.9               | 5.29                     |
| NaCl  | 10   | 23   | 93           | 45-60         | 8.2              | 7.9 | 7.9               | 4.93                     |
| NaCl  | 10   | 28   | 114          | 0-15          | 7.5              | 7.4 | 7.4               | 0.95                     |
| NaCl  | 10   | 28   | 115          | 0-15          | 7.4              | 7.4 | 7.4               | 0.67                     |
| NaCl  | 10   | 28   | 116          | 0-15          | 7.1              | 7.0 | 7.0               | 0.26                     |
| NaCl  | 10   | 28   | 117          | 0-15          | 7.4              | 7.3 | 7.3               | 0.48                     |
| NaCl  | 10   | 28   | 118          | 0-15          | 7.4              | 7.2 | 7.2               | 0.40                     |
| NaCl  | 10   | 28   | 119          | 15-30         | 7.2              | 7.0 | 7.0               | 0.28                     |
| NaCl  | 10   | 28   | 120          | 15-30         | 7.1              | 6.9 | 6.9               | 0.28                     |
| NaCl  | 10   | 28   | 121          | 15-30         | 7.0              | 6.9 | 6.9               | 0.22                     |
| NaCl  | 10   | 28   | 122          | 15-30         | 6.8              | 6.8 | 6.8               | 0.06                     |
| NaCl  | 10   | 28   | 123          | 15-30         | 7.1              | 6.9 | 6.9               | 0.18                     |
| NaCl  | 10   | 38   | 163          | 0-15          | 7.6              | 7.7 | 7.7               | 1.20                     |
| NaCl  | 10   | 38   | 164          | 0-15          | 7.8              | 7.6 | 7.6               | 1.83                     |
| NaCl  | 10   | 38   | 165          | 0-15          | 7.7              | 7.6 | 7.6               | 1.40                     |
| NaCl  | 10   | 38   | 166          | 0-15          | 7.9              | 7.6 | 7.6               | 1.32                     |
| NaCl  | 10   | 38   | 167          | 0-15          | 7.7              | 7.7 | 7.7               | 1.64                     |
| NaCl  | 10   | 38   | 168          | 15-30         | 7.2              | 7.0 | 7.0               | 0.37                     |
| NaCl  | 10   | 38   | 169          | 15-30         | 7.4              | 7.2 | 7.2               | 0.37                     |
| NaCl  | 10   | 38   | 170          | 15-30         | 7.4              | 7.3 | 7.3               | 0.61                     |
| NaCl  | 10   | 38   | 171          | 15-30         | 7.0              | 6.8 | 6.8               | 0.29                     |
| NaCl  | 10   | 38   | 172          | 15-30         | 7.0              | 6.8 | 6.8               | 0.43                     |
| NaCl  | 10   | 38   | 173          | 30-45         | 6.5              | 6.2 | 6.2               | -                        |
| NaCl  | 10   | 38   | 174          | 45-60         | 6.8              | 6.5 | 6.5               | 0.16                     |
| NaCl  | 10   | 38   | 175          | 60-90         | 6.4              | 6.3 | 6.3               | -                        |

Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste      | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Zn     | Mn     | Ca    | Mg   | Na     | K<br>(mg/L) | Sr    | B     | Ba    | P      | Mo     |
|------------|------|------|--------------|---------------|--------|--------|-------|------|--------|-------------|-------|-------|-------|--------|--------|
| Freshwater | 1    | 3    | 4            | 0-15          | 0.059  | 1.975  | 189.8 | 40.8 | 14.56  | 8.57        | 0.360 | 0.762 | 0.157 | 0.248  | <0.050 |
| Freshwater | 1    | 9    | 18           | 0-15          | 0.107  | 1.905  | 237.3 | 46.9 | 17.56  | 11.11       | 0.398 | 0.995 | 0.244 | 0.349  | <0.050 |
| Freshwater | 1    | 13   | 37           | 0-15          | 0.120  | 7.336  | 228.6 | 49.8 | 27.21  | 12.03       | 0.369 | 0.869 | 0.269 | 0.322  | <0.050 |
| Freshwater | 1    | 13   | 38           | 15-30         | <0.020 | 0.416  | 113.1 | 29.2 | 14.78  | 5.21        | 0.174 | 0.644 | 0.128 | 0.138  | <0.050 |
| Freshwater | 1    | 13   | 39           | 30-45         | <0.020 | 0.029  | 49.8  | 12.1 | 10.56  | 4.27        | 0.067 | 0.676 | 0.050 | <0.100 | <0.050 |
| Freshwater | 1    | 13   | 40           | 45-60         | <0.020 | <0.006 | 40.6  | 10.0 | 10.97  | 3.48        | 0.049 | 0.500 | 0.028 | <0.100 | <0.050 |
| Freshwater | 2    | 2    | 3            | 0-15          | <0.020 | 2.142  | 286.4 | 47.4 | 97.87  | 19.27       | 0.687 | 0.249 | 0.203 | 0.416  | <0.050 |
| Freshwater | 2    | 8    | 17           | 0-15          | 0.033  | 2.534  | 235.4 | 41.3 | 73.63  | 11.03       | 0.548 | 0.819 | 0.184 | 0.285  | <0.050 |
| Freshwater | 2    | 15   | 45           | 0-15          | <0.020 | 0.415  | 149.8 | 23.7 | 55.98  | 5.94        | 0.274 | 1.368 | 0.120 | 0.293  | <0.050 |
| Freshwater | 3    | 1    | 1            | 0-15          | <0.020 | 2.211  | 240.4 | 42.1 | 85.93  | 16.40       | 0.586 | 1.104 | 0.188 | 0.311  | <0.050 |
| Freshwater | 3    | 1    | 2            | 15-30         | 0.040  | 9.494  | 160.0 | 43.5 | 46.17  | 20.62       | 0.394 | 0.367 | 0.236 | 0.428  | <0.050 |
| Freshwater | 3    | 6    | 12           | 0-15          | 0.257  | 0.980  | 294.8 | 52.9 | 75.70  | 10.11       | 0.659 | 0.987 | 0.167 | 0.247  | 0.058  |
| Freshwater | 3    | 11   | 31           | 0-15          | 0.029  | 2.997  | 227.8 | 42.0 | 104.59 | 11.37       | 0.493 | 1.013 | 0.139 | 0.281  | <0.050 |
| Freshwater | 3    | 11   | 32           | 0-15          | <0.020 | 0.473  | 115.4 | 19.4 | 43.42  | 6.79        | 0.242 | 0.658 | 0.090 | 0.178  | <0.050 |
| Freshwater | 3    | 11   | 33           | 0-15          | <0.020 | 1.328  | 183.9 | 30.7 | 40.22  | 6.67        | 0.358 | 0.776 | 0.149 | 0.181  | <0.050 |
| Freshwater | 3    | 11   | 34           | 0-15          | <0.020 | 4.596  | 209.0 | 34.8 | 54.82  | 15.48       | 0.491 | 0.579 | 0.144 | 0.261  | 0.054  |
| Freshwater | 3    | 11   | 35           | 0-15          | <0.020 | 1.602  | 233.4 | 39.8 | 141.83 | 15.56       | 0.725 | 0.830 | 0.133 | 0.203  | 0.087  |
| Freshwater | 4    | 5    | 10           | 0-15          | <0.020 | 0.055  | 173.4 | 23.8 | 74.87  | 9.63        | 0.421 | 1.022 | 0.120 | 0.244  | 0.060  |
| Freshwater | 4    | 5    | 11           | 15-30         | 0.546  | 0.331  | 111.1 | 18.5 | 45.55  | 7.72        | 0.215 | 0.841 | 0.149 | 0.181  | <0.050 |
| Freshwater | 4    | 7    | 13           | 0-15          | 0.081  | 1.038  | 195.6 | 34.1 | 74.12  | 9.56        | 0.433 | 1.125 | 0.222 | 0.347  | 0.053  |
| Freshwater | 4    | 7    | 14           | 15-30         | <0.020 | 0.035  | 71.8  | 17.3 | 40.72  | 5.08        | 0.143 | 0.946 | 0.069 | <0.100 | <0.050 |
| Freshwater | 4    | 7    | 15           | 30-45         | <0.020 | 0.009  | 47.2  | 23.9 | 21.22  | 5.65        | 0.148 | 0.735 | 0.133 | <0.100 | <0.050 |
| Freshwater | 4    | 7    | 16           | 45-60         | <0.020 | 0.007  | 39.8  | 23.0 | 23.52  | 6.61        | 0.228 | 0.362 | 0.049 | <0.100 | <0.050 |
| Freshwater | 4    | 12   | 36           | 0-15          | <0.020 | 1.228  | 259.9 | 40.2 | 92.71  | 13.77       | 0.548 | 0.950 | 0.158 | 0.247  | <0.050 |
| Freshwater | 5    | 4    | 5            | 0-15          | <0.020 | 0.065  | 223.1 | 21.5 | 177.11 | 14.43       | 0.609 | 1.394 | 0.144 | 0.410  | 0.172  |
| Freshwater | 5    | 4    | 6            | 0-15          | 0.033  | 0.138  | 470.8 | 48.5 | 192.21 | 13.23       | 0.906 | 1.113 | 0.175 | 0.223  | 0.229  |
| Freshwater | 5    | 4    | 7            | 0-15          | <0.020 | 0.068  | 201.3 | 25.1 | 160.52 | 11.93       | 0.544 | 0.373 | 0.103 | 0.330  | 0.159  |
| Freshwater | 5    | 4    | 8            | 0-15          | <0.020 | 0.533  | 204.2 | 28.4 | 82.26  | 9.51        | 0.466 | 0.717 | 0.187 | 0.281  | 0.051  |
| Freshwater | 5    | 4    | 9            | 0-15          | <0.020 | 0.114  | 251.1 | 26.7 | 176.84 | 12.01       | 0.647 | 0.960 | 0.163 | 0.392  | 0.145  |
| Freshwater | 5    | 10   | 19           | 0-15          | 0.055  | 0.035  | 177.1 | 24.3 | 153.25 | 10.02       | 0.556 | 0.945 | 0.089 | 0.235  | 0.158  |
| Freshwater | 5    | 10   | 20           | 0-15          | <0.020 | 0.049  | 231.0 | 38.1 | 67.68  | 18.24       | 0.659 | 1.021 | 0.126 | 0.273  | 0.118  |
| Freshwater | 5    | 10   | 21           | 0-15          | 0.040  | 0.048  | 204.8 | 23.5 | 169.79 | 12.04       | 0.609 | 1.256 | 0.086 | 0.330  | 0.188  |
| Freshwater | 5    | 10   | 22           | 0-15          | 0.040  | 0.041  | 335.3 | 36.4 | 138.12 | 11.21       | 0.701 | 1.092 | 0.136 | 0.228  | 0.229  |
| Freshwater | 5    | 10   | 23           | 0-15          | <0.020 | 0.034  | 148.8 | 24.4 | 71.31  | 14.94       | 0.355 | 0.886 | 0.088 | 0.521  | 0.130  |
| Freshwater | 5    | 10   | 24           | 15-30         | <0.020 | 0.083  | 64.5  | 17.8 | 83.77  | 2.60        | 0.079 | 0.561 | 0.049 | <0.100 | <0.050 |
| Freshwater | 5    | 10   | 25           | 15-30         | <0.020 | 0.062  | 89.1  | 19.6 | 44.80  | 11.78       | 0.142 | 0.491 | 0.102 | 0.168  | <0.050 |
| Freshwater | 5    | 10   | 26           | 15-30         | <0.020 | 5.887  | 97.2  | 18.2 | 30.52  | 18.22       | 0.173 | 0.772 | 0.177 | 0.339  | <0.050 |
| Freshwater | 5    | 10   | 27           | 15-30         | <0.020 | 0.044  | 94.6  | 19.7 | 70.60  | 4.43        | 0.149 | 0.488 | 0.087 | 0.151  | <0.050 |
| Freshwater | 5    | 10   | 28           | 15-30         | <0.020 | 0.860  | 200.9 | 42.0 | 99.41  | 7.47        | 0.272 | 0.503 | 0.117 | 0.188  | <0.050 |
| Freshwater | 5    | 10   | 29           | 30-45         | <0.020 | 0.015  | 85.9  | 26.2 | 47.61  | 2.76        | 0.090 | 0.669 | 0.080 | <0.100 | <0.050 |
| Freshwater | 5    | 10   | 30           | 45-60         | <0.020 | 0.011  | 38.9  | 27.3 | 24.74  | 3.43        | 0.095 | 0.381 | 0.072 | <0.100 | <0.050 |
| Freshwater | 5    | 14   | 41           | 0-15          | 0.024  | 0.159  | 338.3 | 44.4 | 202.50 | 9.89        | 0.722 | 1.548 | 0.143 | 0.210  | 0.128  |
| Freshwater | 5    | 14   | 42           | 15-30         | <0.020 | 0.148  | 104.4 | 31.3 | 49.67  | 1.95        | 0.108 | 1.093 | 0.076 | 0.121  | <0.050 |
| Freshwater | 5    | 14   | 43           | 30-45         | <0.020 | 0.048  | 60.1  | 20.0 | 21.04  | 1.43        | 0.064 | 0.578 | 0.042 | <0.100 | <0.050 |
| Freshwater | 5    | 14   | 44           | 45-60         | <0.020 | 0.010  | 48.3  | 14.8 | 12.51  | 1.59        | 0.043 | 0.556 | 0.038 | <0.100 | <0.050 |

Elements (Cr, V, Cd, Pb, Li, Ni, Se and Co) below detection limit are excluded from this table.

Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste      | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | S      | Si<br>(mg/L) | As    | SAR |
|------------|------|------|--------------|---------------|--------|--------------|-------|-----|
| Freshwater | 1    | 3    | 4            | 0-15          | 32.62  | 9.22         | 0.256 | 0   |
| Freshwater | 1    | 9    | 18           | 0-15          | 38.77  | 12.01        | 0.305 | 0   |
| Freshwater | 1    | 13   | 37           | 0-15          | 36.22  | 10.87        | 0.282 | 0   |
| Freshwater | 1    | 13   | 38           | 15-30         | 13.32  | 7.78         | 0.211 | 0   |
| Freshwater | 1    | 13   | 39           | 30-45         | 7.42   | 9.25         | 0.160 | 0   |
| Freshwater | 1    | 13   | 40           | 45-60         | 5.68   | 9.55         | 0.105 | 0   |
| Freshwater | 2    | 2    | 3            | 0-15          | 132.56 | 14.03        | 0.314 | 1   |
| Freshwater | 2    | 8    | 17           | 0-15          | 101.20 | 11.55        | 0.288 | 1   |
| Freshwater | 2    | 15   | 45           | 0-15          | 45.11  | 13.73        | 0.254 | 1   |
| Freshwater | 3    | 1    | 1            | 0-15          | 112.38 | 15.82        | 0.308 | 1   |
| Freshwater | 3    | 1    | 2            | 15-30         | 47.72  | 7.30         | 0.228 | 1   |
| Freshwater | 3    | 6    | 12           | 0-15          | 183.29 | 22.99        | 0.267 | 1   |
| Freshwater | 3    | 11   | 31           | 0-15          | 122.94 | 13.71        | 0.238 | 2   |
| Freshwater | 3    | 11   | 32           | 0-15          | 34.38  | 10.50        | 0.267 | 1   |
| Freshwater | 3    | 11   | 33           | 0-15          | 76.20  | 8.09         | 0.255 | 1   |
| Freshwater | 3    | 11   | 34           | 0-15          | 68.86  | 12.49        | 0.258 | 1   |
| Freshwater | 3    | 11   | 35           | 0-15          | 164.85 | 12.74        | 0.240 | 2   |
| Freshwater | 4    | 5    | 10           | 0-15          | 93.90  | 13.30        | 0.266 | 1   |
| Freshwater | 4    | 5    | 11           | 15-30         | 41.96  | 6.78         | 0.220 | 1   |
| Freshwater | 4    | 7    | 13           | 0-15          | 75.82  | 16.21        | 0.327 | 1   |
| Freshwater | 4    | 7    | 14           | 15-30         | 38.47  | 8.35         | 0.167 | 1   |
| Freshwater | 4    | 7    | 15           | 30-45         | 21.62  | 11.59        | 0.161 | 1   |
| Freshwater | 4    | 7    | 16           | 45-60         | 27.99  | 10.58        | 0.134 | 1   |
| Freshwater | 4    | 12   | 36           | 0-15          | 127.49 | 16.39        | 0.260 | 1   |
| Freshwater | 5    | 4    | 5            | 0-15          | 189.43 | 16.33        | 0.253 | 3   |
| Freshwater | 5    | 4    | 6            | 0-15          | 453.30 | 15.56        | 0.184 | 2   |
| Freshwater | 5    | 4    | 7            | 0-15          | 192.91 | 14.62        | 0.221 | 3   |
| Freshwater | 5    | 4    | 8            | 0-15          | 93.50  | 14.67        | 0.258 | 1   |
| Freshwater | 5    | 4    | 9            | 0-15          | 201.40 | 14.74        | 0.268 | 3   |
| Freshwater | 5    | 10   | 19           | 0-15          | 148.44 | 17.67        | 0.263 | 3   |
| Freshwater | 5    | 10   | 20           | 0-15          | 147.75 | 20.66        | 0.291 | 1   |
| Freshwater | 5    | 10   | 21           | 0-15          | 182.22 | 16.95        | 0.269 | 3   |
| Freshwater | 5    | 10   | 22           | 0-15          | 281.60 | 14.32        | 0.179 | 2   |
| Freshwater | 5    | 10   | 23           | 0-15          | 75.95  | 19.82        | 0.282 | 1   |
| Freshwater | 5    | 10   | 24           | 15-30         | 72.60  | 10.75        | 0.140 | 2   |
| Freshwater | 5    | 10   | 25           | 15-30         | 44.58  | 5.60         | 0.185 | 1   |
| Freshwater | 5    | 10   | 26           | 15-30         | 16.62  | 5.65         | 0.208 | 1   |
| Freshwater | 5    | 10   | 27           | 15-30         | 72.84  | 9.62         | 0.156 | 2   |
| Freshwater | 5    | 10   | 28           | 15-30         | 134.54 | 10.92        | 0.233 | 2   |
| Freshwater | 5    | 10   | 29           | 30-45         | 92.81  | 10.78        | 0.103 | 1   |
| Freshwater | 5    | 10   | 30           | 45-60         | 84.99  | 10.31        | 0.080 | 1   |
| Freshwater | 5    | 14   | 41           | 0-15          | 306.60 | 17.05        | 0.240 | 3   |
| Freshwater | 5    | 14   | 42           | 15-30         | 66.41  | 7.32         | 0.212 | 1   |
| Freshwater | 5    | 14   | 43           | 30-45         | 33.94  | 9.68         | 0.134 | 1   |
| Freshwater | 5    | 14   | 44           | 45-60         | 22.61  | 8.97         | 0.114 | 0   |

SAR = Sodium Adsorption Ratio; Elements (Cr, V, Cd, Pb, Li, Ni, Se and Co) below the detection limit are excluded from this table.

Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste  | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Sat'n<br>(%) | E.C.<br>(dS/m) | pH   | Alk   | HCO <sub>3</sub> | CO <sub>3</sub> | OH    | Cl      | Al    | Fe     | Ti     | Cu     |
|--------|------|------|--------------|---------------|--------------|----------------|------|-------|------------------|-----------------|-------|---------|-------|--------|--------|--------|
| (mg/L) |      |      |              |               |              |                |      |       |                  |                 |       |         |       |        |        |        |
| KCI    | 1    | 17   | 58           | 0-15          | 36.8         | 1.04           | 7.15 | 526.0 | 525.3            | 0.698           | 0.007 | 64.02   | 0.713 | 0.020  | 0.013  | <0.010 |
| KCI    | 1    | 42   | 179          | 0-15          | 33.5         | 0.77           | 7.40 | 476.0 | 474.9            | 1.124           | 0.013 | 8.77    | 0.647 | <0.010 | <0.010 | 0.015  |
| KCI    | 1    | 42   | 180          | 0-15          | 34.0         | 0.66           | 7.70 | 319.0 | 317.5            | 1.503           | 0.025 | 7.06    | 0.553 | 0.015  | <0.010 | 0.013  |
| KCI    | 1    | 42   | 181          | 0-15          | 33.0         | 0.68           | 7.60 | 355.0 | 353.7            | 1.328           | 0.020 | 38.81   | 0.569 | 0.022  | <0.010 | 0.016  |
| KCI    | 1    | 42   | 182          | 0-15          | 32.5         | 0.54           | 7.70 | 274.0 | 272.7            | 1.291           | 0.025 | 8.01    | 0.448 | 0.021  | <0.010 | 0.013  |
| KCI    | 1    | 42   | 183          | 0-15          | 34.0         | 0.74           | 7.50 | 432.0 | 430.7            | 1.284           | 0.016 | 5.77    | 0.680 | 0.032  | <0.010 | 0.022  |
| KCI    | 1    | 43   | 184          | 0-15          | 33.0         | 0.75           | 7.40 | 440.0 | 439.0            | 1.039           | 0.013 | 12.49   | 0.764 | 0.037  | 0.013  | 0.029  |
| KCI    | 2    | 33   | 143          | 0-15          | 37.5         | 0.80           | 7.10 | 474.0 | 473.4            | 0.561           | 0.006 | 18.44   | 0.716 | 0.031  | 0.013  | 0.013  |
| KCI    | 2    | 40   | 177          | 0-15          | 37.0         | 1.32           | 7.50 | 445.0 | 443.7            | 1.323           | 0.016 | 182.80  | 0.884 | 0.023  | 0.011  | 0.013  |
| KCI    | 2    | 45   | 197          | 0-15          | 35.5         | 0.77           | 7.50 | 343.0 | 342.0            | 1.020           | 0.016 | 58.06   | 0.564 | 0.027  | <0.010 | 0.025  |
| KCI    | 2    | 45   | 198          | 0-15          | 33.0         | 1.77           | 7.00 | 299.0 | 298.7            | 0.281           | 0.005 | 415.80  | 1.134 | 0.047  | 0.015  | 0.014  |
| KCI    | 2    | 45   | 199          | 0-15          | 31.0         | 0.94           | 7.10 | 472.0 | 471.4            | 0.559           | 0.006 | 101.90  | 0.803 | 0.068  | <0.010 | 0.024  |
| KCI    | 2    | 45   | 200          | 0-15          | 35.5         | 1.00           | 7.30 | 507.0 | 506.0            | 0.951           | 0.010 | 54.29   | 0.849 | 0.046  | 0.011  | 0.015  |
| KCI    | 2    | 45   | 201          | 0-15          | 35.0         | 1.22           | 7.30 | 450.0 | 449.1            | 0.844           | 0.010 | 144.30  | 0.898 | 0.043  | 0.012  | 0.015  |
| KCI    | 2    | 45   | 202          | 15-30         | 35.5         | 0.89           | 7.10 | 312.0 | 311.6            | 0.369           | 0.006 | 122.40  | 0.687 | 0.018  | <0.010 | 0.018  |
| KCI    | 2    | 45   | 203          | 15-30         | 23.0         | 0.48           | 6.40 | 41.2  | 41.2             | 0.010           | 0.001 | 137.50  | 0.475 | 0.088  | <0.010 | 0.018  |
| KCI    | 2    | 45   | 204          | 15-30         | 31.5         | 0.80           | 6.10 | 51.0  | 51.0             | 0.006           | 0.001 | 211.20  | 0.608 | 0.092  | <0.010 | 0.013  |
| KCI    | 2    | 45   | 205          | 15-30         | 35.0         | 1.15           | 7.25 | 459.0 | 458.2            | 0.767           | 0.009 | 135.90  | 0.868 | 0.028  | <0.010 | 0.023  |
| KCI    | 2    | 45   | 206          | 15-30         | 32.5         | 1.10           | 7.55 | 294.0 | 293.0            | 0.981           | 0.018 | 181.20  | 0.775 | 0.025  | <0.010 | 0.017  |
| KCI    | 2    | 45   | 207          | 30-45         | 34.5         | 0.25           | 6.30 | 47.7  | 47.7             | 0.009           | 0.001 | 51.43   | 0.312 | 0.088  | 0.018  | 0.015  |
| KCI    | 3    | 21   | 73           | 0-15          | 46.5         | 1.79           | 7.30 | 439.0 | 438.2            | 0.823           | 0.010 | 248.40  | 0.697 | 0.026  | <0.010 | <0.010 |
| KCI    | 3    | 21   | 74           | 0-15          | 42.5         | 1.16           | 7.20 | 494.0 | 493.3            | 0.736           | 0.008 | 72.24   | 0.553 | 0.064  | <0.010 | <0.010 |
| KCI    | 3    | 21   | 75           | 0-15          | 42.5         | 2.24           | 6.90 | 511.0 | 510.6            | 0.382           | 0.004 | 389.70  | 1.150 | <0.010 | <0.010 | <0.010 |
| KCI    | 3    | 21   | 76           | 0-15          | 46.0         | 1.23           | 7.30 | 544.0 | 543.0            | 1.020           | 0.010 | 57.18   | 0.457 | 0.014  | <0.010 | <0.010 |
| KCI    | 3    | 21   | 77           | 0-15          | 43.0         | 0.87           | 7.60 | 422.0 | 420.4            | 1.579           | 0.020 | 31.84   | 0.400 | 0.024  | <0.010 | <0.010 |
| KCI    | 3    | 30   | 129          | 0-15          | 39.5         | 2.63           | 7.10 | 393.0 | 392.5            | 0.465           | 0.006 | 618.60  | 1.289 | 0.030  | 0.016  | <0.010 |
| KCI    | 3    | 39   | 176          | 0-15          | 33.5         | 1.96           | 7.55 | 354.0 | 352.8            | 1.181           | 0.018 | 430.00  | 1.233 | 0.055  | 0.026  | 0.049  |
| KCI    | 4    | 16   | 46           | 0-15          | 36.5         | 1.26           | 7.30 | 546.0 | 545.0            | 1.024           | 0.010 | 54.56   | 0.872 | 0.040  | <0.010 | <0.010 |
| KCI    | 4    | 16   | 47           | 0-15          | 36.5         | 1.26           | 7.40 | 443.0 | 441.9            | 1.046           | 0.013 | 59.20   | 0.727 | 0.027  | <0.010 | <0.010 |
| KCI    | 4    | 16   | 48           | 0-15          | 41.5         | 0.83           | 7.60 | 404.0 | 402.5            | 1.512           | 0.020 | 19.20   | 0.565 | 0.033  | <0.010 | <0.010 |
| KCI    | 4    | 16   | 49           | 0-15          | 41.0         | 1.36           | 7.50 | 448.0 | 446.7            | 1.332           | 0.016 | 75.05   | 0.785 | 0.035  | <0.010 | <0.010 |
| KCI    | 4    | 16   | 50           | 0-15          | 43.5         | 1.06           | 7.40 | 445.0 | 443.9            | 1.051           | 0.013 | 30.16   | 0.583 | 0.040  | <0.010 | <0.010 |
| KCI    | 4    | 16   | 51           | 15-30         | 37.0         | 0.77           | 7.30 | 390.0 | 389.3            | 0.731           | 0.010 | 60.22   | 0.623 | 0.050  | <0.010 | <0.010 |
| KCI    | 4    | 16   | 52           | 15-30         | 34.0         | 0.57           | 7.70 | 222.0 | 220.9            | 1.046           | 0.025 | 47.96   | 0.431 | 0.014  | <0.010 | <0.010 |
| KCI    | 4    | 16   | 53           | 15-30         | 35.5         | 0.44           | 7.50 | 216.0 | 215.3            | 0.642           | 0.016 | 20.53   | 0.400 | 0.029  | <0.010 | <0.010 |
| KCI    | 4    | 16   | 54           | 15-30         | 34.0         | 0.77           | 7.50 | 309.0 | 308.1            | 0.919           | 0.016 | 74.05   | 0.575 | 0.023  | <0.010 | 0.019  |
| KCI    | 4    | 16   | 55           | 15-30         | 30.0         | 0.61           | 7.80 | 200.0 | 198.8            | 1.186           | 0.032 | 39.32   | 0.441 | 0.020  | <0.010 | 0.013  |
| KCI    | 4    | 16   | 56           | 30-45         | 34.0         | 0.31           | 7.90 | 139.0 | 137.9            | 1.038           | 0.040 | 23.98   | 0.305 | 0.011  | <0.010 | 0.017  |
| KCI    | 4    | 16   | 57           | 45-60         | 35.0         | 0.26           | 8.00 | 119.0 | 117.8            | 1.119           | 0.050 | 12.80   | 0.300 | 0.024  | <0.010 | 0.020  |
| KCI    | 4    | 25   | 95           | 0-15          | 38.5         | 6.57           | 7.20 | 288.0 | 287.6            | 0.429           | 0.008 | 1882.00 | 2.222 | 0.030  | <0.010 | 0.012  |
| KCI    | 4    | 25   | 96           | 0-15          | 36.5         | 5.99           | 7.30 | 247.0 | 246.5            | 0.463           | 0.010 | 1561.00 | 2.230 | 0.030  | 0.025  | <0.010 |
| KCI    | 4    | 25   | 97           | 0-15          | 35.0         | 2.77           | 7.20 | 277.0 | 276.6            | 0.413           | 0.008 | 615.20  | 1.143 | 0.037  | 0.015  | <0.010 |
| KCI    | 4    | 25   | 98           | 0-15          | 38.0         | 4.63           | 7.40 | 204.0 | 203.5            | 0.482           | 0.013 | 1330.00 | 1.796 | 0.021  | 0.019  | <0.010 |
| KCI    | 4    | 25   | 99           | 0-15          | 37.3         | 3.88           | 7.60 | 251.0 | 250.0            | 0.939           | 0.020 | 930.55  | 1.372 | 0.020  | 0.014  | <0.010 |

Sat'n = Saturation; E.C. = Electrical Conductivity; Alk. = Alkalinity (mg CaCO<sub>3</sub>/L); Elements (Cr, V, Cd, Pb, Li and Se) below the detection limit are excluded from this table.



Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Zn     | Mn     | Ca    | Mg    | Na     | K       | Sr<br>(mg/L) | B      | Ba    | P      | Mo     | Ni     |
|-------|------|------|--------------|---------------|--------|--------|-------|-------|--------|---------|--------------|--------|-------|--------|--------|--------|
| KCI   | 1    | 17   | 58           | 0-15          | 0.027  | 2.211  | 183.9 | 37.8  | 23.61  | 49.90   | 0.304        | 0.692  | 0.297 | 0.219  | <0.050 | <0.030 |
| KCI   | 1    | 42   | 179          | 0-15          | 0.050  | 1.086  | 151.8 | 36.6  | 14.23  | 5.83    | 0.209        | <0.040 | 0.134 | 0.289  | <0.050 | <0.030 |
| KCI   | 1    | 42   | 180          | 0-15          | 0.048  | 0.991  | 128.5 | 31.0  | 15.42  | 5.87    | 0.200        | <0.040 | 0.118 | 0.177  | <0.050 | <0.030 |
| KCI   | 1    | 42   | 181          | 0-15          | 0.096  | 0.571  | 122.6 | 27.4  | 25.04  | 7.41    | 0.187        | <0.040 | 0.114 | 0.168  | <0.050 | <0.030 |
| KCI   | 1    | 42   | 182          | 0-15          | 0.029  | 0.444  | 98.5  | 23.7  | 13.61  | 5.76    | 0.151        | <0.040 | 0.088 | 0.155  | <0.050 | <0.030 |
| KCI   | 1    | 42   | 183          | 0-15          | 0.038  | 1.549  | 150.2 | 32.2  | 15.83  | 6.39    | 0.214        | <0.040 | 0.149 | 0.268  | <0.050 | <0.030 |
| KCI   | 1    | 43   | 184          | 0-15          | 0.083  | 1.489  | 158.3 | 33.1  | 14.10  | 8.32    | 0.226        | <0.040 | 0.161 | 0.254  | <0.050 | <0.030 |
| KCI   | 2    | 33   | 143          | 0-15          | 0.067  | 1.698  | 167.4 | 36.7  | 20.15  | 8.91    | 0.249        | <0.040 | 0.150 | 0.277  | <0.050 | <0.030 |
| KCI   | 2    | 40   | 177          | 0-15          | 0.069  | 0.917  | 199.0 | 40.7  | 65.69  | 42.99   | 0.400        | 0.058  | 0.291 | 0.227  | <0.050 | <0.030 |
| KCI   | 2    | 45   | 197          | 0-15          | 0.051  | 0.309  | 119.5 | 21.2  | 26.83  | 54.47   | 0.238        | 0.070  | 0.171 | 0.602  | <0.050 | <0.030 |
| KCI   | 2    | 45   | 198          | 0-15          | 0.065  | 2.003  | 249.8 | 50.9  | 45.56  | 79.90   | 0.461        | 0.082  | 0.382 | 0.280  | <0.050 | <0.030 |
| KCI   | 2    | 45   | 199          | 0-15          | 0.071  | 1.409  | 166.9 | 32.7  | 29.99  | 46.77   | 0.294        | 0.071  | 0.263 | 0.456  | <0.050 | <0.030 |
| KCI   | 2    | 45   | 200          | 0-15          | 0.071  | 2.656  | 189.7 | 34.9  | 27.02  | 39.78   | 0.357        | 0.064  | 0.310 | 0.425  | <0.050 | <0.030 |
| KCI   | 2    | 45   | 201          | 0-15          | 0.062  | 4.037  | 203.6 | 38.1  | 41.16  | 65.57   | 0.420        | 0.062  | 0.302 | 0.399  | <0.050 | <0.030 |
| KCI   | 2    | 45   | 202          | 15-30         | 0.053  | 0.439  | 149.5 | 30.3  | 20.38  | 24.16   | 0.305        | <0.040 | 0.264 | 0.147  | <0.050 | <0.030 |
| KCI   | 2    | 45   | 203          | 15-30         | 0.207  | 0.541  | 58.8  | 12.1  | 17.55  | 26.53   | 0.128        | 0.057  | 0.166 | 0.159  | <0.050 | <0.030 |
| KCI   | 2    | 45   | 204          | 15-30         | 0.195  | 0.781  | 100.8 | 23.7  | 21.08  | 30.66   | 0.226        | 0.046  | 0.312 | 0.113  | <0.050 | <0.030 |
| KCI   | 2    | 45   | 205          | 15-30         | 0.050  | 1.504  | 204.0 | 49.6  | 26.62  | 14.21   | 0.322        | 0.043  | 0.277 | 0.289  | <0.050 | <0.030 |
| KCI   | 2    | 45   | 206          | 15-30         | 0.036  | 0.419  | 176.1 | 42.8  | 34.44  | 17.36   | 0.296        | <0.040 | 0.224 | 0.202  | <0.050 | <0.030 |
| KCI   | 2    | 45   | 207          | 30-45         | 0.037  | 0.121  | 30.4  | 8.2   | 8.74   | 8.78    | 0.073        | <0.040 | 0.061 | <0.100 | <0.050 | <0.030 |
| KCI   | 3    | 21   | 73           | 0-15          | <0.020 | 2.781  | 203.2 | 33.8  | 56.69  | 259.50  | 0.532        | 0.941  | 0.265 | 0.499  | <0.050 | <0.030 |
| KCI   | 3    | 21   | 74           | 0-15          | <0.020 | 2.692  | 168.1 | 28.7  | 32.98  | 142.41  | 0.390        | 1.079  | 0.294 | 0.469  | <0.050 | <0.030 |
| KCI   | 3    | 21   | 75           | 0-15          | 0.025  | 6.531  | 322.1 | 58.3  | 61.96  | 198.71  | 0.707        | 0.148  | 0.363 | 0.381  | <0.050 | <0.030 |
| KCI   | 3    | 21   | 76           | 0-15          | <0.020 | 2.802  | 150.1 | 25.3  | 41.37  | 190.65  | 0.379        | 0.157  | 0.247 | 0.310  | <0.050 | <0.030 |
| KCI   | 3    | 21   | 77           | 0-15          | <0.020 | 2.625  | 127.3 | 23.2  | 26.79  | 99.62   | 0.277        | 0.098  | 0.240 | 0.297  | <0.050 | <0.030 |
| KCI   | 3    | 30   | 129          | 0-15          | 0.039  | 3.688  | 347.7 | 67.4  | 96.86  | 204.50  | 0.766        | <0.040 | 0.447 | 0.271  | <0.050 | <0.030 |
| KCI   | 3    | 39   | 176          | 0-15          | <0.020 | 1.150  | 237.1 | 47.0  | 155.53 | 80.01   | 0.510        | <0.040 | 0.337 | 0.305  | <0.050 | <0.030 |
| KCI   | 4    | 16   | 46           | 0-15          | <0.020 | 1.956  | 207.1 | 32.8  | 25.61  | 135.56  | 0.502        | 1.485  | 0.359 | 0.264  | <0.050 | <0.030 |
| KCI   | 4    | 16   | 47           | 0-15          | <0.020 | 0.923  | 177.9 | 29.3  | 32.55  | 164.05  | 0.436        | 0.943  | 0.275 | 0.234  | <0.050 | <0.030 |
| KCI   | 4    | 16   | 48           | 0-15          | <0.020 | 0.380  | 126.9 | 20.4  | 17.23  | 104.55  | 0.317        | 1.011  | 0.231 | 0.253  | <0.050 | <0.030 |
| KCI   | 4    | 16   | 49           | 0-15          | <0.020 | 1.578  | 198.2 | 32.9  | 30.27  | 173.92  | 0.537        | 1.141  | 0.291 | 0.333  | 0.052  | <0.030 |
| KCI   | 4    | 16   | 50           | 0-15          | <0.020 | 0.871  | 139.3 | 23.5  | 27.35  | 157.04  | 0.297        | 1.037  | 0.238 | 0.193  | 0.059  | <0.030 |
| KCI   | 4    | 16   | 51           | 15-30         | <0.020 | 3.219  | 140.8 | 29.1  | 18.58  | 24.56   | 0.231        | 0.829  | 0.196 | 0.251  | <0.050 | <0.030 |
| KCI   | 4    | 16   | 52           | 15-30         | <0.020 | 0.179  | 103.8 | 19.7  | 19.18  | 10.43   | 0.157        | 0.881  | 0.092 | 0.112  | <0.050 | <0.030 |
| KCI   | 4    | 16   | 53           | 15-30         | <0.020 | 0.052  | 81.8  | 17.2  | 14.06  | 4.71    | 0.130        | 0.580  | 0.058 | <0.100 | <0.050 | <0.030 |
| KCI   | 4    | 16   | 54           | 15-30         | <0.020 | 0.435  | 124.8 | 29.0  | 21.96  | 30.67   | 0.204        | 0.873  | 0.188 | 0.104  | <0.050 | <0.030 |
| KCI   | 4    | 16   | 55           | 15-30         | <0.020 | 0.121  | 92.5  | 17.5  | 24.26  | 41.98   | 0.176        | 0.649  | 0.152 | <0.100 | <0.050 | <0.030 |
| KCI   | 4    | 16   | 56           | 30-45         | <0.020 | 0.010  | 51.2  | 13.1  | 11.44  | 2.45    | 0.067        | 0.747  | 0.039 | <0.100 | <0.050 | <0.030 |
| KCI   | 4    | 16   | 57           | 45-60         | <0.020 | <0.006 | 40.6  | 11.6  | 10.86  | 2.11    | 0.055        | 0.763  | 0.029 | <0.100 | <0.050 | <0.030 |
| KCI   | 4    | 25   | 95           | 0-15          | 0.024  | 2.093  | 649.1 | 101.6 | 228.60 | 1000.00 | 2.147        | 0.224  | 0.398 | 0.178  | <0.050 | <0.030 |
| KCI   | 4    | 25   | 96           | 0-15          | 0.024  | 1.687  | 665.0 | 100.8 | 226.80 | 890.60  | 2.824        | 0.263  | 0.361 | 0.219  | 0.059  | <0.030 |
| KCI   | 4    | 25   | 97           | 0-15          | 0.043  | 1.401  | 295.6 | 51.5  | 99.55  | 369.80  | 0.824        | 0.131  | 0.267 | 0.237  | <0.050 | <0.030 |
| KCI   | 4    | 25   | 98           | 0-15          | <0.020 | 0.404  | 511.3 | 98.2  | 176.67 | 558.50  | 1.643        | 0.168  | 0.266 | 0.119  | <0.050 | <0.030 |
| KCI   | 4    | 25   | 99           | 0-15          | 0.023  | 0.353  | 372.6 | 69.7  | 144.52 | 604.55  | 1.191        | 0.177  | 0.269 | 0.161  | 0.056  | <0.030 |

Elements (Cr, V, Cd, Pb, Li and Se) below the detection limit are excluded from this table.

Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Conc. (mg/L) |                 |       |       | SAR |
|-------|------|------|--------------|---------------|--------------|-----------------|-------|-------|-----|
|       |      |      |              |               | Co           | SO <sub>4</sub> | Si    | As    |     |
| KCl   | 1    | 17   | 58           | 0-15          | <0.010       | 36.39           | 8.28  | 0.309 | 0   |
| KCl   | 1    | 42   | 179          | 0-15          | <0.010       | 26.76           | 12.31 | 0.292 | 0   |
| KCl   | 1    | 42   | 180          | 0-15          | <0.010       | 122.19          | 8.71  | 0.247 | 0   |
| KCl   | 1    | 42   | 181          | 0-15          | <0.010       | 34.99           | 8.29  | 0.227 | 1   |
| KCl   | 1    | 42   | 182          | 0-15          | <0.010       | 71.79           | 7.72  | 0.205 | 0   |
| KCl   | 1    | 42   | 183          | 0-15          | <0.010       | 60.19           | 9.28  | 0.271 | 0   |
| KCl   | 1    | 43   | 184          | 0-15          | <0.010       | 54.24           | 8.75  | 0.294 | 0   |
|       |      |      |              |               |              |                 |       |       |     |
| KCl   | 2    | 33   | 143          | 0-15          | <0.010       | 16.67           | 8.48  | 0.153 | 0   |
| KCl   | 2    | 40   | 177          | 0-15          | <0.010       | 130.43          | 9.70  | 0.241 | 1   |
| KCl   | 2    | 45   | 197          | 0-15          | <0.010       | 82.67           | 6.37  | 0.207 | 1   |
| KCl   | 2    | 45   | 198          | 0-15          | <0.010       | 94.56           | 5.39  | 0.231 | 1   |
| KCl   | 2    | 45   | 199          | 0-15          | <0.010       | 46.78           | 6.03  | 0.241 | 1   |
| KCl   | 2    | 45   | 200          | 0-15          | <0.010       | 56.63           | 7.73  | 0.315 | 0   |
| KCl   | 2    | 45   | 201          | 0-15          | <0.010       | 124.19          | 7.07  | 0.257 | 1   |
| KCl   | 2    | 45   | 202          | 15-30         | <0.010       | 65.92           | 2.82  | 0.242 | 0   |
| KCl   | 2    | 45   | 203          | 15-30         | <0.010       | 31.66           | 8.85  | 0.068 | 1   |
| KCl   | 2    | 45   | 204          | 15-30         | <0.010       | 52.84           | 6.60  | 0.066 | 0   |
| KCl   | 2    | 45   | 205          | 15-30         | <0.010       | 63.94           | 10.84 | 0.261 | 0   |
| KCl   | 2    | 45   | 206          | 15-30         | <0.010       | 108.52          | 7.70  | 0.194 | 1   |
| KCl   | 2    | 45   | 207          | 30-45         | <0.010       | 17.95           | 6.65  | 0.076 | 0   |
|       |      |      |              |               |              |                 |       |       |     |
| KCl   | 3    | 21   | 73           | 0-15          | <0.010       | 204.02          | 14.21 | 0.246 | 1   |
| KCl   | 3    | 21   | 74           | 0-15          | <0.010       | 118.02          | 12.80 | 0.293 | 1   |
| KCl   | 3    | 21   | 75           | 0-15          | <0.010       | 216.24          | 11.25 | 0.282 | 1   |
| KCl   | 3    | 21   | 76           | 0-15          | <0.010       | 122.85          | 9.54  | 0.293 | 1   |
| KCl   | 3    | 21   | 77           | 0-15          | <0.010       | 69.93           | 7.29  | 0.280 | 1   |
| KCl   | 3    | 30   | 129          | 0-15          | <0.010       | 211.30          | 8.46  | 0.084 | 1   |
| KCl   | 3    | 39   | 176          | 0-15          | <0.010       | 160.15          | 8.48  | 0.106 | 2   |
|       |      |      |              |               |              |                 |       |       |     |
| KCl   | 4    | 16   | 46           | 0-15          | <0.010       | 180.37          | 10.17 | 0.266 | 0   |
| KCl   | 4    | 16   | 47           | 0-15          | <0.010       | 259.78          | 8.73  | 0.243 | 1   |
| KCl   | 4    | 16   | 48           | 0-15          | <0.010       | 100.37          | 9.80  | 0.243 | 0   |
| KCl   | 4    | 16   | 49           | 0-15          | <0.010       | 308.52          | 12.19 | 0.256 | 1   |
| KCl   | 4    | 16   | 50           | 0-15          | <0.010       | 154.40          | 9.81  | 0.247 | 1   |
| KCl   | 4    | 16   | 51           | 15-30         | <0.010       | 32.46           | 6.00  | 0.249 | 0   |
| KCl   | 4    | 16   | 52           | 15-30         | <0.010       | 58.70           | 5.27  | 0.164 | 0   |
| KCl   | 4    | 16   | 53           | 15-30         | <0.010       | 31.35           | 1.95  | 0.183 | 0   |
| KCl   | 4    | 16   | 54           | 15-30         | <0.010       | 81.38           | 4.64  | 0.188 | 0   |
| KCl   | 4    | 16   | 55           | 15-30         | <0.010       | 112.54          | 4.10  | 0.149 | 1   |
| KCl   | 4    | 16   | 56           | 30-45         | <0.010       | 17.91           | 7.24  | 0.131 | 0   |
| KCl   | 4    | 16   | 57           | 45-60         | <0.010       | 13.81           | 8.06  | 0.118 | 0   |
| KCl   | 4    | 25   | 95           | 0-15          | <0.010       | 662.77          | 7.93  | 0.082 | 2   |
| KCl   | 4    | 25   | 96           | 0-15          | <0.010       | 1023.22         | 7.67  | 0.144 | 2   |
| KCl   | 4    | 25   | 97           | 0-15          | <0.010       | 321.44          | 6.58  | 0.116 | 1   |
| KCl   | 4    | 25   | 98           | 0-15          | <0.010       | 578.28          | 6.43  | 0.085 | 2   |
| KCl   | 4    | 25   | 99           | 0-15          | <0.010       | 597.27          | 9.15  | 0.083 | 2   |

SAR = Sodium Adsorption Ratio; Elements (Cr, V, Cd, Pb, Li and Se) below the detection limit are excluded from this table.



Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Sat'n<br>(%) | E.C.<br>(dS/m) | pH   | Alk   | HCO <sub>3</sub> | CO <sub>3</sub> | OH    | Cl<br>(mg/L) | Al     | Fe     | Ti     | Cu     |
|-------|------|------|--------------|---------------|--------------|----------------|------|-------|------------------|-----------------|-------|--------------|--------|--------|--------|--------|
| KCl   | 4    | 25   | 100          | 15-30         | 41.5         | 1.95           | 6.60 | 210.0 | 209.9            | 0.079           | 0.002 | 872.80       | 1.060  | 0.160  | 0.018  | 0.012  |
| KCl   | 4    | 25   | 101          | 15-30         | 41.0         | 2.13           | 5.70 | 22.0  | 22.0             | 0.001           | 0.000 | 680.70       | 1.071  | 0.012  | 0.013  | <0.010 |
| KCl   | 4    | 25   | 102          | 15-30         | 40.5         | 1.86           | 6.30 | 59.0  | 59.0             | 0.011           | 0.001 | 523.70       | 0.874  | 0.012  | <0.010 | <0.010 |
| KCl   | 4    | 25   | 103          | 15-30         | 37.5         | 2.10           | 7.05 | 238.0 | 237.7            | 0.251           | 0.006 | 500.60       | 0.947  | 0.024  | <0.010 | <0.010 |
| KCl   | 4    | 25   | 104          | 15-30         | 41.5         | 0.85           | 7.30 | 285.0 | 284.5            | 0.535           | 0.010 | 118.40       | 0.591  | 0.068  | 0.011  | 0.020  |
| KCl   | 4    | 25   | 105          | 30-45         | 37.5         | 0.98           | 6.00 | 21.0  | 21.0             | 0.002           | 0.001 | 304.00       | 0.493  | 0.017  | <0.010 | <0.010 |
| KCl   | 4    | 25   | 106          | 45-60         | 34.5         | 0.21           | 6.20 | 17.0  | 17.0             | 0.003           | 0.001 | 51.57        | 0.206  | 0.367  | 0.028  | <0.010 |
| KCl   | 4    | 29   | 124          | 0-15          | 36.5         | 2.34           | 7.10 | 406.0 | 405.5            | 0.480           | 0.006 | 463.10       | 0.962  | 0.039  | 0.011  | 0.011  |
| KCl   | 4    | 29   | 125          | 15-30         | 43.5         | 0.86           | 6.15 | 25.0  | 25.0             | 0.003           | 0.001 | 232.50       | 0.333  | 0.011  | <0.010 | <0.010 |
| KCl   | 4    | 29   | 126          | 30-45         | 38.0         | 0.46           | 6.40 | 20.0  | 20.0             | 0.005           | 0.001 | 137.70       | <0.010 | <0.010 | <0.010 | <0.010 |
| KCl   | 4    | 29   | 127          | 45-60         | 35.0         | 0.15           | 6.60 | 18.0  | 18.0             | 0.007           | 0.002 | 34.84        | <0.010 | 0.053  | <0.010 | <0.010 |
| KCl   | 4    | 29   | 128          | 60-90         | 32.0         | 0.09           | 7.00 | 29.0  | 29.0             | 0.027           | 0.005 | 10.19        | 0.384  | 0.260  | 0.016  | <0.010 |
| KCl   | 5    | 24   | 94           | 0-15          | 41.0         | 0.69           | 7.20 | 432.0 | 431.3            | 0.644           | 0.008 | 10.96        | 0.616  | 0.041  | <0.010 | 0.011  |
| KCl   | 5    | 26   | 107          | 0-15          | 35.0         | 3.05           | 7.50 | 298.0 | 297.1            | 0.886           | 0.016 | 596.30       | 1.167  | 0.031  | 0.014  | <0.010 |
| KCl   | 5    | 37   | 162          | 0-15          | 35.5         | 1.04           | 7.45 | 417.0 | 415.9            | 1.105           | 0.014 | 108.80       | 0.774  | 0.084  | 0.014  | 0.024  |
| NaCl  | 6    | 22   | 78           | 0-15          | 39.0         | 0.82           | 6.80 | 490.0 | 489.7            | 0.291           | 0.003 | 19.50        | 0.611  | 0.046  | <0.010 | <0.010 |
| NaCl  | 6    | 22   | 79           | 15-30         | 40.5         | 0.76           | 7.30 | 458.0 | 457.1            | 0.859           | 0.010 | 18.23        | 0.405  | <0.010 | <0.010 | <0.010 |
| NaCl  | 6    | 22   | 80           | 30-45         | 33.0         | 0.24           | 8.11 | 129.0 | 127.4            | 1.562           | 0.064 | 8.20         | <0.010 | <0.010 | <0.010 | <0.010 |
| NaCl  | 6    | 22   | 81           | 45-60         | 33.5         | 0.23           | 8.10 | 106.0 | 104.7            | 1.254           | 0.063 | 7.04         | <0.010 | <0.010 | <0.010 | <0.010 |
| NaCl  | 6    | 32   | 142          | 0-15          | 38.0         | 0.84           | 7.20 | 491.5 | 490.8            | 0.732           | 0.008 | 27.60        | 0.763  | 0.033  | 0.014  | 0.015  |
| NaCl  | 6    | 41   | 178          | 0-15          | 36.0         | 1.01           | 7.40 | 479.0 | 477.9            | 1.131           | 0.013 | 65.29        | 0.802  | 0.025  | <0.010 | 0.014  |
| NaCl  | 7    | 18   | 59           | 0-15          | 40.0         | 0.98           | 7.30 | 538.0 | 537.0            | 1.009           | 0.010 | 45.34        | 0.723  | 0.048  | 0.013  | <0.010 |
| NaCl  | 7    | 27   | 108          | 0-15          | 39.0         | 1.17           | 6.60 | 358.0 | 357.9            | 0.134           | 0.002 | 173.30       | 0.700  | 0.133  | 0.013  | 0.017  |
| NaCl  | 7    | 27   | 109          | 0-15          | 35.0         | 0.82           | 6.95 | 437.0 | 436.6            | 0.366           | 0.004 | 39.56        | 0.563  | 0.087  | <0.010 | <0.010 |
| NaCl  | 7    | 27   | 110          | 0-15          | 37.5         | 0.91           | 6.80 | 443.0 | 442.7            | 0.263           | 0.003 | 56.75        | 0.653  | 0.077  | 0.014  | <0.010 |
| NaCl  | 7    | 27   | 111          | 0-15          | 39.0         | 1.04           | 6.90 | 494.0 | 493.6            | 0.369           | 0.004 | 83.79        | 0.748  | 0.053  | 0.016  | 0.024  |
| NaCl  | 7    | 27   | 112          | 0-15          | 41.5         | 2.02           | 7.10 | 462.0 | 461.4            | 0.547           | 0.006 | 428.40       | 0.737  | 0.102  | 0.013  | <0.010 |
| NaCl  | 7    | 27   | 113          | 15-30         | 36.0         | 0.63           | 6.80 | 290.0 | 289.8            | 0.172           | 0.003 | 56.29        | 0.489  | 0.097  | 0.010  | 0.016  |
| NaCl  | 7    | 34   | 144          | 0-15          | 41.5         | 1.17           | 7.20 | 464.0 | 463.3            | 0.691           | 0.008 | 117.10       | 0.705  | 0.055  | 0.013  | 0.019  |
| NaCl  | 7    | 34   | 145          | 0-15          | 35.5         | 2.27           | 7.20 | 453.0 | 452.3            | 0.675           | 0.008 | 509.00       | 1.024  | 0.054  | 0.015  | 0.041  |
| NaCl  | 7    | 34   | 146          | 0-15          | 39.5         | 1.38           | 7.10 | 420.0 | 419.5            | 0.497           | 0.006 | 233.40       | 0.768  | 0.058  | 0.012  | 0.016  |
| NaCl  | 7    | 34   | 147          | 0-15          | 34.5         | 0.82           | 7.70 | 279.0 | 277.7            | 1.314           | 0.025 | 89.36        | 0.468  | 0.033  | <0.010 | 0.020  |
| NaCl  | 7    | 34   | 148          | 0-15          | 37.0         | 1.48           | 7.70 | 347.0 | 345.3            | 1.635           | 0.025 | 314.90       | 0.535  | 0.029  | <0.010 | 0.027  |
| NaCl  | 7    | 34   | 149          | 15-30         | 32.0         | 0.53           | 7.90 | 123.0 | 122.0            | 0.918           | 0.040 | 93.66        | 0.301  | 0.016  | <0.010 | <0.010 |
| NaCl  | 8    | 20   | 72           | 0-15          | 43.5         | 2.27           | 7.10 | 567.0 | 566.3            | 0.671           | 0.006 | 475.00       | 0.788  | 0.024  | <0.010 | <0.010 |
| NaCl  | 8    | 35   | 150          | 0-15          | 40.0         | 2.40           | 7.10 | 666.0 | 665.2            | 0.788           | 0.006 | 442.50       | 0.966  | 0.101  | 0.021  | 0.022  |
| NaCl  | 8    | 35   | 151          | 0-15          | 38.5         | 1.12           | 7.10 | 493.0 | 492.4            | 0.583           | 0.006 | 119.00       | 0.676  | 0.081  | 0.016  | 0.026  |
| NaCl  | 8    | 35   | 152          | 0-15          | 40.0         | 1.61           | 7.00 | 443.0 | 442.6            | 0.416           | 0.005 | 395.50       | 0.903  | 0.065  | 0.017  | 0.016  |
| NaCl  | 8    | 35   | 153          | 0-15          | 41.0         | 1.54           | 7.10 | 639.0 | 638.2            | 0.756           | 0.006 | 146.20       | 0.874  | 0.105  | 0.026  | 0.026  |
| NaCl  | 8    | 35   | 154          | 0-15          | 44.5         | 1.58           | 6.90 | 386.0 | 385.7            | 0.288           | 0.004 | 314.10       | 1.016  | 0.076  | 0.020  | 0.029  |
| NaCl  | 8    | 35   | 155          | 15-30         | 39.0         | 2.85           | 6.70 | 568.0 | 567.7            | 0.268           | 0.003 | 782.10       | 1.401  | 0.124  | 0.026  | 0.016  |
| NaCl  | 8    | 44   | 185          | 0-15          | 35.5         | 1.39           | 7.70 | 407.0 | 405.1            | 1.917           | 0.025 | 211.40       | 0.492  | 0.057  | <0.010 | 0.033  |
| NaCl  | 8    | 44   | 186          | 0-15          | 34.0         | 1.68           | 7.65 | 504.0 | 501.9            | 2.116           | 0.022 | 285.00       | 0.587  | 0.060  | <0.010 | 0.029  |
| NaCl  | 8    | 44   | 187          | 0-15          | 40.5         | 1.17           | 7.50 | 444.0 | 442.7            | 1.320           | 0.016 | 171.20       | 0.620  | 0.086  | <0.010 | 0.027  |
| NaCl  | 8    | 44   | 188          | 0-15          | 36.5         | 2.07           | 7.40 | 432.0 | 431.0            | 1.020           | 0.013 | 530.50       | 0.943  | 0.059  | 0.012  | 0.025  |
| NaCl  | 8    | 44   | 189          | 0-15          | 39.0         | 1.08           | 7.00 | 571.0 | 570.5            | 0.537           | 0.005 | 58.73        | 0.884  | 0.171  | 0.014  | 0.023  |

Sat'n = Saturation; E.C. = Electrical Conductivity; Alkalinity (mg CaCO<sub>3</sub>/L); Elements (Cr, V, Cd, Pb, Li and Se) below the detection limit are excluded from this table.

Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plot in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Zn     | Mn     | Ca    | Mg   | Na     | K<br>(mg/L) | Sr    | B      | Ba    | P      | Mo     | Ni     |
|-------|------|------|--------------|---------------|--------|--------|-------|------|--------|-------------|-------|--------|-------|--------|--------|--------|
|       |      |      |              |               |        |        |       |      |        |             |       |        |       |        |        |        |
| KCl   | 4    | 25   | 100          | 15-30         | 0.120  | 12.572 | 248.3 | 47.9 | 67.47  | 140.85      | 0.572 | 0.183  | 0.609 | 0.384  | <0.050 | <0.030 |
| KCl   | 4    | 25   | 101          | 15-30         | 0.108  | 1.539  | 261.8 | 84.9 | 65.15  | 33.16       | 0.758 | <0.040 | 0.389 | <0.100 | <0.050 | 0.114  |
| KCl   | 4    | 25   | 102          | 15-30         | 0.051  | 1.169  | 218.7 | 81.6 | 60.99  | 26.74       | 0.569 | <0.040 | 0.261 | <0.100 | <0.050 | 0.063  |
| KCl   | 4    | 25   | 103          | 15-30         | 0.026  | 4.258  | 244.1 | 47.9 | 71.39  | 205.90      | 0.627 | <0.040 | 0.464 | 0.156  | <0.050 | <0.030 |
| KCl   | 4    | 25   | 104          | 15-30         | <0.020 | 1.318  | 129.9 | 41.6 | 21.63  | 28.71       | 0.283 | <0.040 | 0.183 | 0.316  | <0.050 | <0.030 |
| KCl   | 4    | 25   | 105          | 30-45         | 0.095  | 0.347  | 108.6 | 45.6 | 24.89  | 5.54        | 0.294 | <0.040 | 0.212 | <0.100 | <0.050 | 0.062  |
| KCl   | 4    | 25   | 106          | 45-60         | 0.044  | 0.062  | 18.8  | 7.0  | 14.10  | 3.87        | 0.049 | <0.040 | 0.033 | <0.100 | <0.050 | <0.030 |
| KCl   | 4    | 29   | 124          | 0-15          | <0.020 | 1.971  | 250.4 | 42.1 | 151.52 | 249.40      | 0.647 | <0.040 | 0.342 | 0.330  | <0.050 | <0.030 |
| KCl   | 4    | 29   | 125          | 15-30         | 0.023  | 0.384  | 82.3  | 21.6 | 53.38  | 36.20       | 0.212 | <0.040 | 0.145 | <0.100 | <0.050 | 0.032  |
| KCl   | 4    | 29   | 126          | 30-45         | <0.020 | 0.172  | 48.0  | 13.4 | 17.76  | 21.85       | 0.126 | <0.040 | 0.090 | <0.100 | <0.050 | <0.030 |
| KCl   | 4    | 29   | 127          | 45-60         | <0.020 | 0.077  | 12.7  | 3.8  | 9.86   | 10.52       | 0.030 | <0.040 | 0.022 | <0.100 | <0.050 | <0.030 |
| KCl   | 4    | 29   | 128          | 60-90         | <0.020 | 0.012  | 5.5   | 2.8  | 12.07  | 6.58        | 0.028 | <0.040 | 0.006 | <0.100 | <0.050 | <0.030 |
| KCl   | 5    | 24   | 94           | 0-15          | <0.020 | 0.964  | 137.9 | 29.7 | 11.96  | 19.44       | 0.235 | <0.040 | 0.178 | 0.244  | <0.050 | <0.030 |
| KCl   | 5    | 26   | 107          | 0-15          | <0.020 | 0.702  | 307.6 | 46.2 | 109.91 | 487.40      | 0.933 | 0.106  | 0.294 | 0.274  | 0.061  | <0.030 |
| KCl   | 5    | 37   | 162          | 0-15          | <0.020 | 1.170  | 161.4 | 31.0 | 79.20  | 43.22       | 0.307 | <0.040 | 0.248 | 0.333  | <0.050 | <0.030 |
| NaCl  | 6    | 22   | 78           | 0-15          | 0.039  | 4.238  | 164.9 | 39.0 | 13.47  | 18.29       | 0.284 | 0.084  | 0.226 | 0.412  | <0.050 | <0.030 |
| NaCl  | 6    | 22   | 79           | 15-30         | <0.020 | 1.929  | 136.5 | 42.5 | 14.26  | 15.63       | 0.271 | 0.094  | 0.212 | 0.252  | <0.050 | <0.030 |
| NaCl  | 6    | 22   | 80           | 30-45         | <0.020 | 0.112  | 25.9  | 15.0 | 11.47  | 5.14        | 0.082 | <0.040 | 0.029 | <0.100 | <0.050 | <0.030 |
| NaCl  | 6    | 22   | 81           | 45-60         | <0.020 | 0.009  | 23.2  | 15.1 | 12.34  | 5.23        | 0.097 | 0.045  | 0.017 | <0.100 | <0.050 | <0.030 |
| NaCl  | 6    | 32   | 142          | 0-15          | 0.040  | 2.271  | 177.2 | 37.9 | 15.43  | 11.10       | 0.249 | <0.040 | 0.176 | 0.388  | <0.050 | <0.030 |
| NaCl  | 6    | 41   | 178          | 0-15          | 0.094  | 1.475  | 182.9 | 43.8 | 25.71  | 7.95        | 0.287 | <0.040 | 0.192 | 0.226  | <0.050 | <0.030 |
| NaCl  | 7    | 18   | 59           | 0-15          | <0.020 | 1.308  | 149.3 | 29.6 | 94.39  | 11.96       | 0.251 | 0.685  | 0.175 | 0.264  | <0.050 | <0.030 |
| NaCl  | 7    | 27   | 108          | 0-15          | 0.094  | 4.144  | 136.3 | 33.2 | 140.68 | 11.34       | 0.237 | <0.040 | 0.197 | 0.435  | <0.050 | <0.030 |
| NaCl  | 7    | 27   | 109          | 0-15          | 0.043  | 2.253  | 123.5 | 28.3 | 75.97  | 9.91        | 0.206 | <0.040 | 0.148 | 0.375  | <0.050 | <0.030 |
| NaCl  | 7    | 27   | 110          | 0-15          | 0.078  | 4.110  | 146.2 | 33.6 | 68.72  | 10.76       | 0.249 | <0.040 | 0.181 | 0.478  | <0.050 | <0.030 |
| NaCl  | 7    | 27   | 111          | 0-15          | 0.115  | 4.111  | 176.7 | 42.3 | 55.52  | 19.16       | 0.324 | <0.040 | 0.227 | 0.364  | <0.050 | <0.030 |
| NaCl  | 7    | 27   | 112          | 0-15          | 0.088  | 2.926  | 164.7 | 37.6 | 347.00 | 12.11       | 0.322 | <0.040 | 0.198 | 0.475  | <0.050 | <0.030 |
| NaCl  | 7    | 27   | 113          | 15-30         | 0.089  | 2.129  | 103.4 | 25.9 | 37.97  | 11.91       | 0.181 | <0.040 | 0.160 | 0.337  | <0.050 | <0.030 |
| NaCl  | 7    | 34   | 144          | 0-15          | 0.066  | 1.285  | 154.7 | 26.9 | 120.90 | 60.88       | 0.299 | <0.040 | 0.228 | 0.400  | <0.050 | <0.030 |
| NaCl  | 7    | 34   | 145          | 0-15          | 0.074  | 2.546  | 243.9 | 44.4 | 243.50 | 94.59       | 0.501 | <0.040 | 0.303 | 0.410  | <0.050 | <0.030 |
| NaCl  | 7    | 34   | 146          | 0-15          | 0.046  | 2.664  | 171.3 | 32.8 | 138.23 | 37.33       | 0.313 | <0.040 | 0.257 | 0.426  | <0.050 | <0.030 |
| NaCl  | 7    | 34   | 147          | 0-15          | 0.022  | 0.201  | 102.1 | 19.4 | 85.26  | 35.36       | 0.209 | <0.040 | 0.138 | 0.175  | <0.050 | <0.030 |
| NaCl  | 7    | 34   | 148          | 0-15          | 0.057  | 0.405  | 124.8 | 24.9 | 270.70 | 21.67       | 0.244 | <0.040 | 0.159 | 0.209  | <0.050 | <0.030 |
| NaCl  | 7    | 34   | 149          | 15-30         | <0.020 | 0.049  | 57.0  | 21.2 | 46.72  | 6.15        | 0.112 | <0.040 | 0.068 | <0.100 | <0.050 | <0.030 |
| NaCl  | 8    | 20   | 72           | 0-15          | <0.020 | 4.701  | 224.9 | 45.6 | 290.10 | 18.31       | 0.386 | 0.565  | 0.349 | 0.338  | <0.050 | <0.030 |
| NaCl  | 8    | 35   | 150          | 0-15          | 0.117  | 3.735  | 200.1 | 41.5 | 443.40 | 11.18       | 0.375 | <0.040 | 0.237 | 0.738  | <0.050 | <0.030 |
| NaCl  | 8    | 35   | 151          | 0-15          | 0.077  | 2.886  | 134.1 | 28.0 | 161.68 | 10.31       | 0.236 | <0.040 | 0.201 | 0.460  | <0.050 | <0.030 |
| NaCl  | 8    | 35   | 152          | 0-15          | 0.058  | 3.864  | 200.0 | 39.4 | 164.61 | 35.13       | 0.366 | <0.040 | 0.303 | 0.504  | <0.050 | <0.030 |
| NaCl  | 8    | 35   | 153          | 0-15          | 0.075  | 4.764  | 171.1 | 34.7 | 240.60 | 23.33       | 0.312 | <0.040 | 0.290 | 0.723  | <0.050 | <0.030 |
| NaCl  | 8    | 35   | 154          | 0-15          | 0.060  | 3.675  | 216.0 | 47.4 | 112.39 | 45.85       | 0.408 | <0.040 | 0.318 | 0.458  | <0.050 | <0.030 |
| NaCl  | 8    | 35   | 155          | 15-30         | 0.106  | 9.093  | 305.9 | 68.8 | 404.30 | 14.19       | 0.523 | <0.040 | 0.439 | 0.660  | <0.050 | <0.030 |
| NaCl  | 8    | 44   | 185          | 0-15          | 0.094  | 0.465  | 89.2  | 16.9 | 268.50 | 4.48        | 0.151 | 0.061  | 0.110 | 0.275  | <0.050 | <0.030 |
| NaCl  | 8    | 44   | 186          | 0-15          | 0.075  | 0.806  | 118.6 | 20.6 | 314.50 | 6.39        | 0.218 | 0.095  | 0.135 | 0.472  | <0.050 | <0.030 |
| NaCl  | 8    | 44   | 187          | 0-15          | 0.081  | 1.381  | 117.4 | 20.9 | 182.69 | 10.63       | 0.202 | 0.057  | 0.158 | 0.540  | <0.050 | <0.030 |
| NaCl  | 8    | 44   | 188          | 0-15          | 0.103  | 4.084  | 205.3 | 38.7 | 266.90 | 12.61       | 0.360 | 0.044  | 0.265 | 0.360  | <0.050 | <0.030 |
| NaCl  | 8    | 44   | 189          | 0-15          | 0.083  | 3.429  | 162.0 | 29.7 | 119.58 | 11.21       | 0.302 | 0.063  | 0.196 | 0.387  | <0.050 | <0.030 |

Elements (Cr, V, Cd, Pb, Li and Se) below the detection limit are excluded from this table.

Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plot in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Co     | SO <sub>4</sub><br>(mg/L) | Si    | As     | SAR |
|-------|------|------|--------------|---------------|--------|---------------------------|-------|--------|-----|
| KCl   | 4    | 25   | 100          | 15-30         | <0.010 | 141.39                    | 9.33  | 0.072  | 1   |
| KCl   | 4    | 25   | 101          | 15-30         | <0.010 | 142.17                    | 9.11  | <0.030 | 1   |
| KCl   | 4    | 25   | 102          | 15-30         | <0.010 | 176.03                    | 8.83  | <0.030 | 1   |
| KCl   | 4    | 25   | 103          | 15-30         | <0.010 | 200.72                    | 3.46  | 0.066  | 1   |
| KCl   | 4    | 25   | 104          | 15-30         | <0.010 | 60.79                     | 2.66  | 0.081  | 0   |
| KCl   | 4    | 25   | 105          | 30-45         | <0.010 | 26.44                     | 10.59 | <0.030 | 1   |
| KCl   | 4    | 25   | 106          | 45-60         | <0.010 | 11.07                     | 16.19 | <0.030 | 1   |
| KCl   | 4    | 29   | 124          | 0-15          | <0.010 | 254.80                    | 8.84  | 0.111  | 2   |
| KCl   | 4    | 29   | 125          | 15-30         | <0.010 | 73.86                     | 9.45  | <0.030 | 1   |
| KCl   | 4    | 29   | 126          | 30-45         | <0.010 | 14.02                     | 12.26 | <0.030 | 1   |
| KCl   | 4    | 29   | 127          | 45-60         | <0.010 | 9.10                      | 13.60 | <0.030 | 1   |
| KCl   | 4    | 29   | 128          | 60-90         | <0.010 | 11.30                     | 13.78 | <0.030 | 1   |
| KCl   | 5    | 24   | 94           | 0-15          | <0.010 | 19.12                     | 8.60  | 0.105  | 0   |
| KCl   | 5    | 26   | 107          | 0-15          | <0.010 | 586.94                    | 8.40  | 0.082  | 2   |
| KCl   | 5    | 37   | 162          | 0-15          | <0.010 | 90.91                     | 8.82  | 0.207  | 1   |
| NaCl  | 6    | 22   | 78           | 0-15          | <0.010 | 17.09                     | 8.83  | 0.273  | 0   |
| NaCl  | 6    | 22   | 79           | 15-30         | <0.010 | 12.99                     | 9.04  | 0.274  | 0   |
| NaCl  | 6    | 22   | 80           | 30-45         | <0.010 | 9.04                      | 8.36  | 0.142  | 0   |
| NaCl  | 6    | 22   | 81           | 45-60         | <0.010 | 11.74                     | 8.23  | 0.145  | 0   |
| NaCl  | 6    | 32   | 142          | 0-15          | <0.010 | 19.44                     | 9.39  | 0.168  | 0   |
| NaCl  | 6    | 41   | 178          | 0-15          | <0.010 | 73.80                     | 9.21  | 0.291  | 0   |
| NaCl  | 7    | 18   | 59           | 0-15          | <0.010 | 31.49                     | 9.44  | 0.315  | 2   |
| NaCl  | 7    | 27   | 108          | 0-15          | <0.010 | 77.27                     | 9.97  | 0.105  | 3   |
| NaCl  | 7    | 27   | 109          | 0-15          | <0.010 | 32.79                     | 8.56  | 0.135  | 2   |
| NaCl  | 7    | 27   | 110          | 0-15          | <0.010 | 55.36                     | 9.10  | 0.123  | 1   |
| NaCl  | 7    | 27   | 111          | 0-15          | <0.010 | 47.48                     | 8.59  | 0.113  | 1   |
| NaCl  | 7    | 27   | 112          | 0-15          | <0.010 | 112.60                    | 9.00  | 0.197  | 6   |
| NaCl  | 7    | 27   | 113          | 15-30         | <0.010 | 30.07                     | 7.42  | 0.103  | 1   |
| NaCl  | 7    | 34   | 144          | 0-15          | <0.010 | 108.43                    | 9.84  | 0.126  | 2   |
| NaCl  | 7    | 34   | 145          | 0-15          | <0.010 | 153.71                    | 8.09  | 0.122  | 4   |
| NaCl  | 7    | 34   | 146          | 0-15          | <0.010 | 58.28                     | 7.60  | 0.197  | 3   |
| NaCl  | 7    | 34   | 147          | 0-15          | <0.010 | 97.74                     | 5.81  | 0.115  | 2   |
| NaCl  | 7    | 34   | 148          | 0-15          | <0.010 | 144.96                    | 7.02  | 0.117  | 6   |
| NaCl  | 7    | 34   | 149          | 15-30         | <0.010 | 36.77                     | 11.15 | 0.074  | 1   |
| NaCl  | 8    | 20   | 72           | 0-15          | <0.010 | 48.58                     | 9.32  | 0.268  | 5   |
| NaCl  | 8    | 35   | 150          | 0-15          | <0.010 | 118.08                    | 12.59 | 0.156  | 7   |
| NaCl  | 8    | 35   | 151          | 0-15          | <0.010 | 32.02                     | 8.78  | 0.131  | 3   |
| NaCl  | 8    | 35   | 152          | 0-15          | <0.010 | 55.38                     | 8.41  | 0.121  | 3   |
| NaCl  | 8    | 35   | 153          | 0-15          | <0.010 | 70.68                     | 10.35 | 0.164  | 4   |
| NaCl  | 8    | 35   | 154          | 0-15          | <0.010 | 70.23                     | 9.42  | 0.108  | 2   |
| NaCl  | 8    | 35   | 155          | 15-30         | <0.010 | 74.37                     | 11.28 | 0.150  | 5   |
| NaCl  | 8    | 44   | 185          | 0-15          | <0.010 | 77.27                     | 7.90  | 0.273  | 7   |
| NaCl  | 8    | 44   | 186          | 0-15          | <0.010 | 84.91                     | 9.64  | 0.315  | 7   |
| NaCl  | 8    | 44   | 187          | 0-15          | <0.010 | 49.03                     | 8.30  | 0.276  | 4   |
| NaCl  | 8    | 44   | 188          | 0-15          | <0.010 | 50.68                     | 6.20  | 0.259  | 4   |
| NaCl  | 8    | 44   | 189          | 0-15          | <0.010 | 36.30                     | 6.83  | 0.318  | 2   |

SAR = Sodium Adsorption Ratio; Elements (Cr, V, Cd, Pb, Li and Se) below the detection limit are excluded from this table.



Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Sat'n<br>(%) | E.C.<br>(dS/m) | pH   | Alk   | HCO <sub>3</sub> | CO <sub>3</sub> | OH    | Cl<br>(mg/L) | Al     | Fe     | Ti     | Cu     |
|-------|------|------|--------------|---------------|--------------|----------------|------|-------|------------------|-----------------|-------|--------------|--------|--------|--------|--------|
| NaCl  | 8    | 44   | 190          | 15-30         | 34.5         | 0.70           | 7.70 | 258.0 | 256.8            | 1.215           | 0.025 | 106.50       | 0.414  | 0.020  | <0.010 | 0.022  |
| NaCl  | 8    | 44   | 191          | 15-30         | 33.5         | 1.31           | 7.50 | 305.0 | 304.1            | 0.907           | 0.016 | 251.20       | 0.671  | 0.016  | <0.010 | 0.020  |
| NaCl  | 8    | 44   | 192          | 15-30         | 32.0         | 0.93           | 7.30 | 333.0 | 332.0            | 0.990           | 0.016 | 151.90       | 0.581  | 0.029  | <0.010 | 0.023  |
| NaCl  | 8    | 44   | 193          | 15-30         | 38.5         | 1.66           | 6.80 | 478.0 | 477.7            | 0.284           | 0.003 | 324.70       | 1.072  | 0.132  | 0.020  | 0.031  |
| NaCl  | 8    | 44   | 194          | 15-30         | 37.5         | 1.27           | 6.70 | 454.0 | 453.8            | 0.214           | 0.003 | 221.40       | 1.134  | 0.864  | 0.034  | 0.039  |
| NaCl  | 8    | 44   | 195          | 30-45         | 31.0         | 0.43           | 7.80 | 153.0 | 152.1            | 0.907           | 0.032 | 51.00        | 0.405  | 0.026  | <0.010 | 0.025  |
| NaCl  | 8    | 44   | 196          | 45-60         | 34.5         | 0.33           | 8.00 | 115.0 | 113.9            | 1.081           | 0.050 | 41.13        | 0.298  | 0.011  | <0.010 | 0.013  |
| NaCl  | 9    | 19   | 60           | 0-15          | 42.0         | 1.40           | 7.20 | 548.0 | 547.2            | 0.816           | 0.008 | 171.60       | 0.815  | 0.080  | 0.013  | <0.010 |
| NaCl  | 9    | 19   | 61           | 0-15          | 42.0         | 2.79           | 7.10 | 529.0 | 528.4            | 0.626           | 0.006 | 639.10       | 1.039  | 0.089  | 0.015  | <0.010 |
| NaCl  | 9    | 19   | 62           | 0-15          | 39.0         | 2.67           | 7.30 | 585.0 | 583.9            | 1.097           | 0.010 | 563.90       | 1.028  | 0.063  | 0.013  | <0.010 |
| NaCl  | 9    | 19   | 63           | 0-15          | 43.0         | 1.28           | 7.60 | 556.0 | 553.9            | 2.081           | 0.020 | 109.00       | 0.705  | 0.082  | 0.011  | <0.010 |
| NaCl  | 9    | 19   | 64           | 0-15          | 41.5         | 1.19           | 7.40 | 527.0 | 525.7            | 1.244           | 0.013 | 101.70       | 0.833  | 0.065  | 0.012  | <0.010 |
| NaCl  | 9    | 19   | 65           | 15-30         | 41.5         | 1.07           | 6.90 | 409.0 | 408.7            | 0.305           | 0.004 | 140.40       | 0.723  | 0.124  | 0.016  | 0.014  |
| NaCl  | 9    | 19   | 66           | 15-30         | 38.0         | 2.07           | 7.20 | 451.0 | 450.3            | 0.672           | 0.008 | 444.70       | 1.013  | 0.025  | 0.012  | <0.010 |
| NaCl  | 9    | 19   | 67           | 15-30         | 38.5         | 2.69           | 7.00 | 490.0 | 489.5            | 0.461           | 0.005 | 666.00       | 1.035  | <0.010 | <0.010 | <0.010 |
| NaCl  | 9    | 19   | 68           | 15-30         | 36.5         | 1.07           | 7.90 | 58.2  | 57.7             | 0.435           | 0.040 | 241.20       | 0.284  | <0.010 | <0.010 | <0.010 |
| NaCl  | 9    | 19   | 69           | 15-30         | 36.0         | 0.75           | 7.80 | 129.0 | 128.2            | 0.765           | 0.032 | 172.80       | 0.251  | <0.010 | <0.010 | <0.010 |
| NaCl  | 9    | 19   | 70           | 30-45         | 38.0         | 0.39           | 7.65 | 219.0 | 218.1            | 0.920           | 0.022 | 23.84        | <0.200 | <0.010 | <0.010 | <0.010 |
| NaCl  | 9    | 19   | 71           | 45-60         | 36.0         | 0.26           | 7.90 | 79.8  | 79.2             | 0.596           | 0.040 | 24.07        | <0.200 | <0.010 | <0.010 | <0.010 |
| NaCl  | 9    | 31   | 130          | 0-15          | 36.0         | 2.23           | 7.50 | 457.0 | 455.6            | 1.358           | 0.016 | 510.50       | 0.565  | 0.070  | <0.010 | 0.010  |
| NaCl  | 9    | 31   | 131          | 0-15          | 42.0         | 2.66           | 7.30 | 571.0 | 569.9            | 1.071           | 0.010 | 616.40       | 0.977  | 0.058  | 0.015  | 0.011  |
| NaCl  | 9    | 31   | 132          | 0-15          | 39.0         | 2.20           | 7.30 | 499.0 | 498.1            | 0.936           | 0.010 | 465.10       | 0.730  | 0.053  | <0.010 | <0.010 |
| NaCl  | 9    | 31   | 133          | 0-15          | 41.5         | 1.77           | 7.20 | 495.0 | 494.3            | 0.737           | 0.008 | 354.60       | 0.875  | 0.046  | 0.013  | <0.010 |
| NaCl  | 9    | 31   | 134          | 0-15          | 37.5         | 1.51           | 7.20 | 504.0 | 503.2            | 0.751           | 0.008 | 258.60       | 0.643  | 0.051  | 0.012  | 0.016  |
| NaCl  | 9    | 31   | 135          | 15-30         | 34.0         | 0.73           | 6.40 | 26.0  | 26.0             | 0.006           | 0.001 | 206.10       | <0.200 | <0.010 | <0.010 | <0.010 |
| NaCl  | 9    | 31   | 136          | 15-30         | 39.5         | 1.44           | 7.20 | 357.0 | 356.5            | 0.532           | 0.008 | 258.80       | 0.699  | 0.015  | <0.010 | <0.010 |
| NaCl  | 9    | 31   | 137          | 15-30         | 38.5         | 1.62           | 6.80 | 166.0 | 165.9            | 0.098           | 0.003 | 465.60       | 0.545  | 0.016  | <0.010 | <0.010 |
| NaCl  | 9    | 31   | 138          | 15-30         | 37.5         | 0.78           | 6.60 | 72.8  | 72.8             | 0.027           | 0.002 | 242.60       | 0.269  | <0.010 | <0.010 | <0.010 |
| NaCl  | 9    | 31   | 139          | 15-30         | 38.0         | 1.23           | 7.10 | 380.0 | 379.5            | 0.450           | 0.006 | 225.80       | 0.683  | 0.012  | <0.010 | <0.010 |
| NaCl  | 9    | 31   | 140          | 30-45         | 40.5         | 0.82           | 6.20 | 89.6  | 89.6             | 0.013           | 0.001 | 209.10       | 0.228  | 0.013  | <0.010 | <0.010 |
| NaCl  | 9    | 31   | 141          | 45-60         | 41.0         | 0.68           | 6.10 | 58.3  | 58.3             | 0.007           | 0.001 | 75.33        | 0.538  | 0.052  | 0.010  | 0.019  |
| NaCl  | 9    | 36   | 156          | 0-15          | 36.5         | 1.15           | 7.50 | 555.0 | 553.3            | 1.650           | 0.016 | 890.60       | 1.126  | 0.091  | 0.019  | 0.026  |
| NaCl  | 9    | 36   | 157          | 0-15          | 35.0         | 3.23           | 7.30 | 440.0 | 439.2            | 0.825           | 0.018 | 60.41        | 0.585  | 0.075  | 0.014  | 0.013  |
| NaCl  | 9    | 36   | 158          | 0-15          | 38.0         | 1.26           | 7.55 | 604.0 | 602.0            | 2.014           | 0.018 | 17.56        | 0.691  | 0.096  | 0.014  | 0.013  |
| NaCl  | 9    | 36   | 159          | 0-15          | 35.0         | 0.74           | 7.60 | 440.0 | 438.3            | 1.647           | 0.020 | 36.16        | 0.681  | 0.053  | 0.015  | 0.018  |
| NaCl  | 9    | 36   | 160          | 0-15          | 37.0         | 0.93           | 7.50 | 518.0 | 516.4            | 1.540           | 0.016 | 15.28        | 0.364  | <0.010 | <0.010 | <0.010 |
| NaCl  | 9    | 36   | 161          | 15-30         | 40.5         | 0.43           | 7.70 | 243.0 | 241.8            | 1.145           | 0.025 |              |        |        |        |        |
| NaCl  | 10   | 23   | 82           | 0-15          | 39.5         | 3.15           | 7.40 | 411.0 | 410.0            | 0.970           | 0.013 | 831.00       | 0.580  | 0.050  | <0.010 | <0.010 |
| NaCl  | 10   | 23   | 83           | 0-15          | 43.5         | 10.29          | 7.20 | 426.0 | 425.4            | 0.635           | 0.008 | 3677.00      | 1.831  | 0.042  | <0.010 | <0.010 |
| NaCl  | 10   | 23   | 84           | 0-15          | 50.0         | 2.81           | 7.40 | 426.0 | 425.0            | 1.006           | 0.013 | 719.50       | 0.514  | 0.110  | <0.010 | <0.010 |
| NaCl  | 10   | 23   | 85           | 0-15          | 41.0         | 5.55           | 7.10 | 450.0 | 449.5            | 0.533           | 0.006 | 1771.00      | 1.220  | 0.060  | <0.010 | <0.010 |
| NaCl  | 10   | 23   | 86           | 0-15          | 41.5         | 3.27           | 7.10 | 453.0 | 452.5            | 0.536           | 0.006 | 874.60       | 0.950  | 0.083  | 0.015  | 0.032  |
| NaCl  | 10   | 23   | 87           | 15-30         | 38.0         | 2.12           | 7.00 | 464.0 | 463.6            | 0.436           | 0.005 | 460.20       | 0.683  | 0.137  | <0.010 | 0.018  |
| NaCl  | 10   | 23   | 88           | 15-30         | 39.0         | 3.71           | 7.10 | 429.0 | 428.5            | 0.508           | 0.006 | 1058.00      | 0.875  | <0.010 | <0.010 | <0.010 |
| NaCl  | 10   | 23   | 89           | 15-30         | 36.0         | 1.47           | 7.80 | 164.0 | 163.0            | 0.973           | 0.032 | 420.70       | 0.498  | <0.010 | <0.010 | 0.012  |
| NaCl  | 10   | 23   | 90           | 15-30         | 35.0         | 1.71           | 6.80 | 268.0 | 267.8            | 0.159           | 0.003 | 449.90       | 0.801  | 0.051  | 0.012  | 0.026  |
| NaCl  | 10   | 23   | 91           | 15-30         | 35.0         | 1.30           | 6.40 | 53.2  | 53.2             | 0.013           | 0.001 | 403.60       | 0.464  | 0.021  | <0.010 | <0.010 |

Sat'n = Saturation; E.C. = Electrical Conductivity; Alk. = Alkalinity (mg/L); Elements (Cr, V, Cd, Pb, Li and Se) below the detection limit are excluded from this table.

Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Zn     | Mn     | Ca    | Mg   | Na      | K     | Sr<br>(mg/L) | B      | Ba    | P      | Mo     | Ni     |
|-------|------|------|--------------|---------------|--------|--------|-------|------|---------|-------|--------------|--------|-------|--------|--------|--------|
| NaCl  | 8    | 44   | 190          | 15-30         | 0.043  | 0.360  | 76.3  | 17.2 | 80.39   | 4.92  | 0.120        | <0.040 | 0.088 | 0.142  | <0.050 | <0.030 |
| NaCl  | 8    | 44   | 191          | 15-30         | 0.046  | 0.484  | 146.1 | 38.5 | 116.91  | 8.70  | 0.248        | <0.040 | 0.164 | 0.194  | <0.050 | <0.030 |
| NaCl  | 8    | 44   | 192          | 15-30         | 0.053  | 0.668  | 121.6 | 24.2 | 86.95   | 9.47  | 0.192        | 0.043  | 0.162 | 0.271  | <0.050 | <0.030 |
| NaCl  | 8    | 44   | 193          | 15-30         | 0.115  | 13.691 | 216.8 | 42.4 | 131.79  | 18.65 | 0.391        | 0.106  | 0.460 | 0.647  | <0.050 | <0.030 |
| NaCl  | 8    | 44   | 194          | 15-30         | 0.112  | 9.324  | 154.7 | 32.2 | 135.57  | 18.72 | 0.289        | 0.111  | 0.335 | 0.727  | <0.050 | <0.030 |
| NaCl  | 8    | 44   | 195          | 30-45         | 0.032  | 0.045  | 65.5  | 14.1 | 25.49   | 3.92  | 0.093        | <0.040 | 0.051 | 0.137  | <0.050 | <0.030 |
| NaCl  | 8    | 44   | 196          | 45-60         | 0.092  | 0.015  | 47.6  | 12.3 | 13.57   | 2.12  | 0.062        | <0.040 | 0.040 | <0.100 | <0.050 | <0.030 |
| NaCl  | 9    | 19   | 60           | 0-15          | <0.020 | 2.734  | 164.6 | 32.9 | 170.95  | 24.51 | 0.316        | 0.922  | 0.264 | 0.402  | <0.050 | <0.030 |
| NaCl  | 9    | 19   | 61           | 0-15          | 0.102  | 6.386  | 215.2 | 40.2 | 471.80  | 18.92 | 0.400        | 0.898  | 0.304 | 0.473  | <0.050 | <0.030 |
| NaCl  | 9    | 19   | 62           | 0-15          | 0.097  | 4.128  | 228.7 | 43.5 | 421.10  | 14.91 | 0.422        | 1.142  | 0.274 | 0.394  | <0.050 | <0.030 |
| NaCl  | 9    | 19   | 63           | 0-15          | <0.020 | 2.144  | 147.4 | 28.1 | 177.68  | 18.99 | 0.285        | 1.079  | 0.202 | 0.377  | 0.05   | <0.030 |
| NaCl  | 9    | 19   | 64           | 0-15          | <0.020 | 4.953  | 178.7 | 33.6 | 104.09  | 21.29 | 0.353        | 0.848  | 0.273 | 0.448  | <0.050 | <0.030 |
| NaCl  | 9    | 19   | 65           | 15-30         | 0.046  | 9.597  | 145.1 | 32.7 | 75.58   | 37.87 | 0.304        | 0.596  | 0.289 | 0.377  | <0.050 | <0.030 |
| NaCl  | 9    | 19   | 66           | 15-30         | 0.050  | 3.534  | 232.0 | 52.4 | 215.40  | 16.25 | 0.368        | 1.052  | 0.345 | 0.260  | <0.050 | <0.030 |
| NaCl  | 9    | 19   | 67           | 15-30         | <0.020 | 6.061  | 296.9 | 70.0 | 262.50  | 24.69 | 0.494        | 0.880  | 0.458 | 0.274  | <0.050 | <0.030 |
| NaCl  | 9    | 19   | 68           | 15-30         | <0.020 | 0.008  | 104.5 | 26.3 | 105.07  | 5.27  | 0.132        | 0.639  | 0.121 | <0.100 | <0.050 | <0.030 |
| NaCl  | 9    | 19   | 69           | 15-30         | <0.020 | 0.006  | 91.2  | 22.5 | 48.41   | 4.37  | 0.102        | 0.396  | 0.092 | <0.100 | <0.050 | <0.030 |
| NaCl  | 9    | 19   | 70           | 30-45         | <0.020 | 0.164  | 66.1  | 17.6 | 10.51   | 8.36  | 0.084        | 0.365  | 0.070 | <0.100 | <0.050 | <0.030 |
| NaCl  | 9    | 19   | 71           | 45-60         | <0.020 | 0.068  | 38.9  | 11.1 | 9.49    | 3.95  | 0.041        | 0.544  | 0.027 | <0.100 | <0.050 | <0.030 |
| NaCl  | 9    | 31   | 130          | 0-15          | 0.065  | 0.965  | 130.1 | 24.3 | 437.70  | 13.37 | 0.261        | <0.040 | 0.155 | 0.381  | <0.050 | <0.030 |
| NaCl  | 9    | 31   | 131          | 0-15          | 0.081  | 4.495  | 237.1 | 49.5 | 400.20  | 16.88 | 0.434        | <0.040 | 0.306 | 0.384  | <0.050 | <0.030 |
| NaCl  | 9    | 31   | 132          | 0-15          | 0.062  | 1.513  | 173.4 | 36.9 | 367.80  | 11.44 | 0.328        | <0.040 | 0.191 | 0.399  | <0.050 | <0.030 |
| NaCl  | 9    | 31   | 133          | 0-15          | 0.047  | 3.045  | 205.3 | 41.9 | 210.80  | 13.57 | 0.367        | <0.040 | 0.224 | 0.359  | <0.050 | <0.030 |
| NaCl  | 9    | 31   | 134          | 0-15          | 0.071  | 2.752  | 141.3 | 29.6 | 239.20  | 12.38 | 0.238        | <0.040 | 0.204 | 0.397  | <0.050 | <0.030 |
| NaCl  | 9    | 31   | 135          | 15-30         | 0.074  | 0.128  | 28.6  | 8.7  | 122.04  | 13.90 | 0.067        | <0.040 | 0.056 | <0.100 | <0.050 | <0.030 |
| NaCl  | 9    | 31   | 136          | 15-30         | 0.037  | 1.659  | 166.1 | 40.4 | 147.38  | 19.16 | 0.293        | <0.040 | 0.219 | 0.145  | <0.050 | <0.030 |
| NaCl  | 9    | 31   | 137          | 15-30         | 0.042  | 0.718  | 130.0 | 42.8 | 188.70  | 18.60 | 0.235        | <0.040 | 0.225 | <0.100 | <0.050 | <0.030 |
| NaCl  | 9    | 31   | 138          | 15-30         | <0.020 | 0.362  | 58.6  | 18.9 | 79.40   | 17.01 | 0.140        | <0.040 | 0.105 | <0.100 | <0.050 | <0.030 |
| NaCl  | 9    | 31   | 139          | 15-30         | 0.026  | 1.112  | 161.5 | 34.5 | 97.95   | 18.60 | 0.299        | <0.040 | 0.199 | 0.135  | <0.050 | <0.030 |
| NaCl  | 9    | 31   | 140          | 30-45         | 0.066  | 0.223  | 50.7  | 17.2 | 93.08   | 21.66 | 0.129        | <0.040 | 0.114 | <0.100 | <0.050 | <0.030 |
| NaCl  | 9    | 31   | 141          | 45-60         | 0.091  | 0.085  | 37.8  | 13.4 | 85.01   | 16.82 | 0.088        | <0.040 | 0.084 | <0.100 | <0.050 | <0.030 |
| NaCl  | 9    | 36   | 156          | 0-15          | 0.029  | 1.151  | 108.9 | 20.5 | 228.60  | 8.17  | 0.197        | <0.040 | 0.130 | 0.481  | <0.050 | <0.030 |
| NaCl  | 9    | 36   | 157          | 0-15          | 0.064  | 1.902  | 231.8 | 45.6 | 643.10  | 9.30  | 0.377        | <0.040 | 0.210 | 0.449  | <0.050 | <0.030 |
| NaCl  | 9    | 36   | 158          | 0-15          | <0.020 | 0.822  | 90.2  | 18.2 | 290.75  | 5.50  | 0.173        | <0.040 | 0.111 | 0.341  | <0.050 | <0.030 |
| NaCl  | 9    | 36   | 159          | 0-15          | <0.020 | 0.777  | 124.9 | 26.2 | 68.94   | 8.14  | 0.204        | <0.040 | 0.115 | 0.258  | <0.050 | <0.030 |
| NaCl  | 9    | 36   | 160          | 0-15          | <0.020 | 1.104  | 126.5 | 25.6 | 127.73  | 11.28 | 0.258        | <0.040 | 0.149 | 0.282  | <0.050 | <0.030 |
| NaCl  | 9    | 36   | 161          | 15-30         | <0.020 | 0.035  | 74.5  | 18.2 | 20.23   | 8.75  | 0.116        | <0.040 | 0.065 | <0.100 | <0.050 | <0.030 |
| NaCl  | 10   | 23   | 82           | 0-15          | 0.079  | 0.993  | 158.0 | 26.6 | 631.20  | 13.09 | 0.332        | 0.138  | 0.156 | 1.355  | <0.050 | <0.030 |
| NaCl  | 10   | 23   | 83           | 0-15          | 0.240  | 3.742  | 451.8 | 85.1 | 2194.80 | 47.05 | 0.956        | 0.118  | 0.316 | 0.459  | <0.050 | <0.030 |
| NaCl  | 10   | 23   | 84           | 0-15          | 0.056  | 1.503  | 132.0 | 23.0 | 565.00  | 17.44 | 0.266        | 0.092  | 0.158 | 0.893  | <0.050 | <0.030 |
| NaCl  | 10   | 23   | 85           | 0-15          | 0.220  | 3.760  | 301.6 | 56.6 | 1065.50 | 23.54 | 0.624        | 0.090  | 0.313 | 0.536  | <0.050 | <0.030 |
| NaCl  | 10   | 23   | 86           | 0-15          | 0.106  | 2.678  | 171.7 | 33.4 | 600.90  | 16.70 | 0.340        | 0.091  | 0.221 | 0.559  | <0.050 | <0.030 |
| NaCl  | 10   | 23   | 87           | 15-30         | 0.085  | 4.050  | 151.4 | 31.6 | 324.60  | 20.94 | 0.267        | 0.067  | 0.233 | 0.505  | <0.050 | <0.030 |
| NaCl  | 10   | 23   | 88           | 15-30         | 0.073  | 4.465  | 254.2 | 99.5 | 519.00  | 18.58 | 0.589        | 0.047  | 0.443 | 0.189  | <0.050 | <0.030 |
| NaCl  | 10   | 23   | 89           | 15-30         | 0.033  | 0.228  | 115.3 | 51.2 | 158.69  | 12.05 | 0.314        | <0.040 | 0.213 | <0.100 | <0.050 | <0.030 |
| NaCl  | 10   | 23   | 90           | 15-30         | 0.088  | 10.108 | 180.6 | 45.5 | 163.34  | 26.18 | 0.356        | 0.047  | 0.352 | 0.268  | <0.050 | <0.030 |
| NaCl  | 10   | 23   | 91           | 15-30         | 0.103  | 1.132  | 92.1  | 30.1 | 161.44  | 5.51  | 0.195        | <0.040 | 0.161 | <0.100 | <0.050 | <0.030 |

Elements (Cr, V, Cd, Pb, Li and Se) below the detection limit are excluded from this table.

Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Co     | SO <sub>4</sub><br>(mg/L) | Si    | As     | SAR |
|-------|------|------|--------------|---------------|--------|---------------------------|-------|--------|-----|
| NaCl  | 8    | 44   | 190          | 15-30         | <0.010 | 30.18                     | 5.12  | 0.191  | 2   |
| NaCl  | 8    | 44   | 191          | 15-30         | <0.010 | 50.04                     | 8.85  | 0.235  | 2   |
| NaCl  | 8    | 44   | 192          | 15-30         | <0.010 | 28.70                     | 5.94  | 0.239  | 2   |
| NaCl  | 8    | 44   | 193          | 15-30         | <0.010 | 26.82                     | 7.96  | 0.261  | 2   |
| NaCl  | 8    | 44   | 194          | 15-30         | 0.012  | 26.62                     | 7.61  | 0.215  | 3   |
| NaCl  | 8    | 44   | 195          | 30-45         | <0.010 | 20.12                     | 3.70  | 0.140  | 1   |
| NaCl  | 8    | 44   | 196          | 45-60         | <0.010 | 13.98                     | 7.33  | 0.106  | 0   |
| NaCl  | 9    | 19   | 60           | 0-15          | <0.010 | 34.54                     | 9.75  | 0.291  | 3   |
| NaCl  | 9    | 19   | 61           | 0-15          | <0.010 | 119.07                    | 9.47  | 0.299  | 8   |
| NaCl  | 9    | 19   | 62           | 0-15          | <0.010 | 121.77                    | 10.89 | 0.319  | 7   |
| NaCl  | 9    | 19   | 63           | 0-15          | <0.010 | 92.61                     | 13.88 | 0.313  | 4   |
| NaCl  | 9    | 19   | 64           | 0-15          | <0.010 | 54.64                     | 11.37 | 0.296  | 2   |
| NaCl  | 9    | 19   | 65           | 15-30         | <0.010 | 19.63                     | 7.96  | 0.235  | 1   |
| NaCl  | 9    | 19   | 66           | 15-30         | <0.010 | 77.21                     | 8.28  | 0.245  | 3   |
| NaCl  | 9    | 19   | 67           | 15-30         | <0.010 | 77.54                     | 7.93  | 0.233  | 4   |
| NaCl  | 9    | 19   | 68           | 15-30         | <0.010 | 98.25                     | 10.07 | 0.133  | 2   |
| NaCl  | 9    | 19   | 69           | 15-30         | <0.010 | 36.24                     | 9.77  | 0.138  | 1   |
| NaCl  | 9    | 19   | 70           | 30-45         | <0.010 | 16.88                     | 6.45  | 0.169  | 0   |
| NaCl  | 9    | 19   | 71           | 45-60         | <0.010 | 13.02                     | 8.63  | 0.119  | 0   |
| NaCl  | 9    | 31   | 130          | 0-15          | <0.010 | 91.75                     | 7.79  | 0.187  | 9   |
| NaCl  | 9    | 31   | 131          | 0-15          | <0.010 | 69.66                     | 8.96  | 0.155  | 6   |
| NaCl  | 9    | 31   | 132          | 0-15          | <0.010 | 94.92                     | 9.52  | 0.135  | 7   |
| NaCl  | 9    | 31   | 133          | 0-15          | <0.010 | 58.75                     | 8.07  | 0.120  | 4   |
| NaCl  | 9    | 31   | 134          | 0-15          | <0.010 | 37.77                     | 6.47  | 0.140  | 5   |
| NaCl  | 9    | 31   | 135          | 15-30         | <0.010 | 54.96                     | 8.66  | <0.030 | 5   |
| NaCl  | 9    | 31   | 136          | 15-30         | <0.010 | 110.62                    | 5.45  | 0.089  | 3   |
| NaCl  | 9    | 31   | 137          | 15-30         | <0.010 | 50.21                     | 6.49  | 0.099  | 4   |
| NaCl  | 9    | 31   | 138          | 15-30         | <0.010 | 22.15                     | 7.65  | <0.030 | 2   |
| NaCl  | 9    | 31   | 139          | 15-30         | <0.010 | 24.54                     | 4.68  | 0.093  | 2   |
| NaCl  | 9    | 31   | 140          | 30-45         | <0.010 | 28.89                     | 13.32 | <0.030 | 3   |
| NaCl  | 9    | 31   | 141          | 45-60         | <0.010 | 28.77                     | 13.50 | <0.030 | 3   |
| NaCl  | 9    | 36   | 156          | 0-15          | <0.010 | 100.28                    | 9.23  | 0.161  | 5   |
| NaCl  | 9    | 36   | 157          | 0-15          | <0.010 | 263.55                    | 8.77  | 0.119  | 10  |
| NaCl  | 9    | 36   | 158          | 0-15          | <0.010 | 139.42                    | 12.20 | 0.137  | 7   |
| NaCl  | 9    | 36   | 159          | 0-15          | <0.010 | 39.86                     | 8.29  | 0.125  | 1   |
| NaCl  | 9    | 36   | 160          | 0-15          | <0.010 | 73.47                     | 10.25 | 0.121  | 3   |
| NaCl  | 9    | 36   | 161          | 15-30         | <0.010 | 20.03                     | 3.77  | 0.093  | 1   |
| NaCl  | 10   | 23   | 82           | 0-15          | <0.010 | 160.06                    | 13.16 | 0.244  | 12  |
| NaCl  | 10   | 23   | 83           | 0-15          | <0.010 | 438.47                    | 13.78 | 0.271  | 25  |
| NaCl  | 10   | 23   | 84           | 0-15          | <0.010 | 98.07                     | 12.91 | 0.281  | 12  |
| NaCl  | 10   | 23   | 85           | 0-15          | <0.010 | 165.12                    | 12.36 | 0.260  | 15  |
| NaCl  | 10   | 23   | 86           | 0-15          | <0.010 | 103.16                    | 10.40 | 0.297  | 11  |
| NaCl  | 10   | 23   | 87           | 15-30         | <0.010 | 44.93                     | 6.93  | 0.265  | 6   |
| NaCl  | 10   | 23   | 88           | 15-30         | <0.010 | 112.87                    | 14.67 | 0.271  | 7   |
| NaCl  | 10   | 23   | 89           | 15-30         | <0.010 | 25.90                     | 7.78  | 0.083  | 3   |
| NaCl  | 10   | 23   | 90           | 15-30         | <0.010 | 32.63                     | 6.21  | 0.083  | 3   |
| NaCl  | 10   | 23   | 91           | 15-30         | <0.010 | 43.97                     | 6.46  | 0.041  | 4   |

SAR = Sodium Adsorption Ratio; Elements (Cr, V, Cd, Pb, Li and Se) below the detection limit are excluded from this table.



Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Sat'n<br>(%) | E.C.<br>(dS/m) | pH   | Alk   | HCO <sub>3</sub> | CO <sub>3</sub> | OH    | Cl<br>(mg/L) | Al     | Fe     | Ti     | Cu     |
|-------|------|------|--------------|---------------|--------------|----------------|------|-------|------------------|-----------------|-------|--------------|--------|--------|--------|--------|
| NaCl  | 10   | 23   | 92           | 30-45         | 35.5         | 0.71           | 7.80 | 114.0 | 113.3            | 0.676           | 0.032 | 172.30       | 0.314  | <0.010 | <0.010 | <0.010 |
| NaCl  | 10   | 23   | 93           | 45-60         | 36.0         | 0.34           | 8.00 | 158.0 | 156.5            | 1.485           | 0.050 | 30.17        | <0.200 | 0.016  | <0.010 | <0.010 |
| NaCl  | 10   | 28   | 114          | 0-15          | 43.5         | 4.90           | 7.35 | 432.0 | 431.1            | 0.909           | 0.011 | 1473.00      | 1.005  | 0.103  | 0.017  | <0.010 |
| NaCl  | 10   | 28   | 115          | 0-15          | 45.0         | 8.63           | 7.20 | 288.0 | 287.6            | 0.429           | 0.008 | 3100.00      | 1.758  | 0.055  | 0.020  | <0.010 |
| NaCl  | 10   | 28   | 116          | 0-15          | 38.5         | 7.22           | 7.00 | 429.0 | 428.6            | 0.403           | 0.005 | 2328.00      | 1.588  | 0.082  | 0.020  | 0.019  |
| NaCl  | 10   | 28   | 117          | 0-15          | 37.5         | 7.54           | 7.20 | 454.0 | 453.3            | 0.676           | 0.008 | 2459.00      | 1.504  | 0.078  | 0.017  | 0.016  |
| NaCl  | 10   | 28   | 118          | 0-15          | 36.5         | 5.22           | 7.30 | 326.0 | 325.4            | 0.611           | 0.010 | 1683.00      | 1.047  | 0.057  | 0.013  | <0.010 |
| NaCl  | 10   | 28   | 119          | 15-30         | 41.0         | 2.18           | 7.10 | 198.0 | 197.8            | 0.234           | 0.006 | 632.10       | 0.672  | 0.014  | <0.010 | <0.010 |
| NaCl  | 10   | 28   | 120          | 15-30         | 35.5         | 1.69           | 7.10 | 193.0 | 192.8            | 0.228           | 0.006 | 473.20       | 0.626  | 0.037  | <0.010 | 0.010  |
| NaCl  | 10   | 28   | 121          | 15-30         | 33.5         | 4.27           | 7.00 | 362.0 | 361.7            | 0.340           | 0.005 | 1359.00      | 1.461  | 0.045  | 0.018  | <0.010 |
| NaCl  | 10   | 28   | 122          | 15-30         | 41.5         | 3.90           | 6.90 | 235.0 | 234.8            | 0.175           | 0.004 | 1270.00      | 1.024  | 0.020  | 0.011  | 0.019  |
| NaCl  | 10   | 28   | 123          | 15-30         | 35.5         | 1.49           | 7.20 | 251.0 | 250.6            | 0.374           | 0.008 | 357.30       | 0.515  | 0.036  | <0.010 | 0.012  |
| NaCl  | 10   | 38   | 163          | 0-15          | 39.0         | 6.35           | 7.60 | 233.0 | 232.1            | 0.872           | 0.020 | 2175.00      | 1.628  | 0.086  | 0.031  | 0.038  |
| NaCl  | 10   | 38   | 164          | 0-15          | 32.0         | 1.08           | 7.50 | 428.0 | 426.7            | 1.272           | 0.016 | 135.20       | 0.970  | 0.092  | 0.028  | 0.049  |
| NaCl  | 10   | 38   | 165          | 0-15          | 32.5         | 2.64           | 7.50 | 467.0 | 465.6            | 1.388           | 0.016 | 661.80       | 1.333  | 0.123  | 0.033  | 0.058  |
| NaCl  | 10   | 38   | 166          | 0-15          | 36.5         | 2.71           | 7.60 | 456.0 | 454.3            | 1.706           | 0.020 | 642.60       | 1.091  | 0.139  | 0.029  | 0.054  |
| NaCl  | 10   | 38   | 167          | 0-15          | 37.5         | 9.08           | 7.60 | 219.0 | 218.2            | 0.820           | 0.020 | 3390.00      | 2.368  | 0.072  | 0.039  | 0.049  |
| NaCl  | 10   | 38   | 168          | 15-30         | 36.0         | 1.63           | 7.30 | 276.0 | 275.5            | 0.518           | 0.010 | 378.00       | 0.958  | 0.076  | 0.026  | 0.045  |
| NaCl  | 10   | 38   | 169          | 15-30         | 34.5         | 0.80           | 7.40 | 253.0 | 252.4            | 0.597           | 0.013 | 129.60       | 0.817  | 0.070  | 0.023  | 0.045  |
| NaCl  | 10   | 38   | 170          | 15-30         | 33.5         | 0.84           | 7.40 | 286.0 | 285.3            | 0.675           | 0.013 | 127.60       | 0.821  | 0.076  | 0.024  | 0.053  |
| NaCl  | 10   | 38   | 171          | 15-30         | 36.5         | 0.93           | 7.20 | 292.0 | 291.6            | 0.435           | 0.008 | 160.30       | 0.886  | 0.123  | 0.027  | 0.060  |
| NaCl  | 10   | 38   | 172          | 15-30         | 45.0         | 1.66           | 6.90 | 296.0 | 295.8            | 0.221           | 0.004 | 402.80       | 1.145  | 0.270  | 0.039  | 0.047  |
| NaCl  | 10   | 38   | 173          | 30-45         | 34.5         | 1.53           | 7.00 | 76.1  | 76.0             | 0.072           | 0.005 | 438.50       | 0.776  | 0.041  | 0.023  | 0.033  |
| NaCl  | 10   | 38   | 174          | 45-60         | 41.0         | 1.29           | 7.20 | 85.8  | 85.7             | 0.128           | 0.008 | 353.80       | 0.833  | 0.153  | 0.027  | 0.033  |
| NaCl  | 10   | 38   | 175          | 60-90         | 40.5         | 1.51           | 6.90 | 53.7  | 53.7             | 0.040           | 0.004 | 453.70       | 0.782  | 0.066  | 0.023  | 0.032  |

Sat'n = Saturation; E.C. = Electrical Conductivity; Alk. = Alkalinity (mg CaCO<sub>3</sub>/L); Elements (Cr, V, Cd, Pb, Li and Se) below the detection limit are excluded from this table.

Continued. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Zn     | Mn     | Ca    | Mg    | Na      | K<br>(mg/L) | Sr    | B      | Ba    | P      | Mo     | Ni     |
|-------|------|------|--------------|---------------|--------|--------|-------|-------|---------|-------------|-------|--------|-------|--------|--------|--------|
| NaCl  | 10   | 23   | 92           | 30-45         | <0.020 | 0.018  | 66.6  | 38.2  | 32.25   | 7.77        | 0.219 | <0.040 | 0.095 | <0.100 | <0.050 | <0.030 |
| NaCl  | 10   | 23   | 93           | 45-60         | <0.020 | 0.025  | 35.9  | 21.2  | 15.03   | 6.06        | 0.121 | <0.040 | 0.050 | <0.100 | <0.050 | <0.030 |
| NaCl  | 10   | 28   | 114          | 0-15          | 0.140  | 2.504  | 210.3 | 33.8  | 1056.30 | 21.88       | 0.460 | <0.040 | 0.197 | 0.877  | <0.050 | <0.030 |
| NaCl  | 10   | 28   | 115          | 0-15          | 0.182  | 2.106  | 419.1 | 80.8  | 1789.70 | 22.62       | 0.821 | <0.040 | 0.293 | 0.370  | <0.050 | <0.030 |
| NaCl  | 10   | 28   | 116          | 0-15          | 0.191  | 5.080  | 364.6 | 69.8  | 1443.80 | 20.56       | 0.684 | <0.040 | 0.273 | 0.735  | <0.050 | <0.030 |
| NaCl  | 10   | 28   | 117          | 0-15          | 0.203  | 2.168  | 337.0 | 60.8  | 1607.40 | 17.35       | 0.673 | <0.040 | 0.284 | 0.430  | <0.050 | <0.030 |
| NaCl  | 10   | 28   | 118          | 0-15          | 0.109  | 1.176  | 233.5 | 41.6  | 1063.10 | 15.71       | 0.462 | <0.040 | 0.273 | 0.350  | <0.050 | <0.030 |
| NaCl  | 10   | 28   | 119          | 15-30         | 0.035  | 11.631 | 169.2 | 37.4  | 289.00  | 26.87       | 0.364 | <0.040 | 0.416 | 0.203  | <0.050 | <0.030 |
| NaCl  | 10   | 28   | 120          | 15-30         | 0.026  | 4.507  | 158.0 | 38.3  | 189.18  | 15.81       | 0.290 | <0.040 | 0.221 | 0.194  | <0.050 | <0.030 |
| NaCl  | 10   | 28   | 121          | 15-30         | 0.116  | 4.141  | 373.6 | 80.1  | 592.60  | 18.85       | 0.612 | <0.040 | 0.280 | 0.317  | <0.050 | <0.030 |
| NaCl  | 10   | 28   | 122          | 15-30         | 0.104  | 2.850  | 246.8 | 63.3  | 623.90  | 11.86       | 0.446 | <0.040 | 0.293 | 0.160  | <0.050 | <0.030 |
| NaCl  | 10   | 28   | 123          | 15-30         | 0.035  | 1.237  | 124.2 | 27.6  | 207.50  | 14.74       | 0.223 | <0.040 | 0.161 | 0.229  | <0.050 | <0.030 |
| NaCl  | 10   | 38   | 163          | 0-15          | <0.020 | 0.600  | 337.7 | 68.7  | 1285.00 | 16.79       | 0.633 | <0.040 | 0.324 | 0.322  | <0.050 | <0.030 |
| NaCl  | 10   | 38   | 164          | 0-15          | <0.020 | 0.745  | 144.6 | 28.7  | 121.14  | 12.13       | 0.260 | <0.040 | 0.158 | 0.359  | <0.050 | 0.038  |
| NaCl  | 10   | 38   | 165          | 0-15          | 0.043  | 1.742  | 215.6 | 49.6  | 435.40  | 12.22       | 0.382 | <0.040 | 0.275 | 0.390  | <0.050 | 0.042  |
| NaCl  | 10   | 38   | 166          | 0-15          | 0.066  | 1.149  | 152.4 | 28.1  | 571.60  | 12.71       | 0.294 | <0.040 | 0.186 | 0.514  | <0.050 | 0.043  |
| NaCl  | 10   | 38   | 167          | 0-15          | <0.020 | 0.554  | 506.8 | 101.9 | 1936.90 | 17.37       | 0.921 | <0.040 | 0.371 | 0.397  | <0.050 | 0.034  |
| NaCl  | 10   | 38   | 168          | 15-30         | <0.020 | 0.650  | 136.2 | 27.8  | 243.70  | 13.72       | 0.242 | <0.040 | 0.155 | 0.229  | <0.050 | 0.034  |
| NaCl  | 10   | 38   | 169          | 15-30         | <0.020 | 0.867  | 116.5 | 26.3  | 57.39   | 12.69       | 0.204 | <0.040 | 0.143 | 0.203  | <0.050 | 0.037  |
| NaCl  | 10   | 38   | 170          | 15-30         | <0.020 | 2.470  | 120.3 | 26.8  | 65.06   | 18.78       | 0.218 | <0.040 | 0.196 | 0.289  | <0.050 | 0.037  |
| NaCl  | 10   | 38   | 171          | 15-30         | 0.021  | 1.618  | 113.1 | 25.0  | 101.10  | 15.20       | 0.214 | <0.040 | 0.177 | 0.268  | <0.050 | 0.033  |
| NaCl  | 10   | 38   | 172          | 15-30         | 0.025  | 9.455  | 153.0 | 37.1  | 204.80  | 24.13       | 0.289 | <0.040 | 0.365 | 0.574  | <0.050 | 0.040  |
| NaCl  | 10   | 38   | 173          | 30-45         | 0.020  | 0.156  | 104.2 | 25.4  | 207.90  | 17.03       | 0.221 | <0.040 | 0.150 | <0.100 | <0.050 | 0.031  |
| NaCl  | 10   | 38   | 174          | 45-60         | <0.020 | 0.096  | 83.2  | 19.4  | 195.25  | 14.45       | 0.167 | <0.040 | 0.113 | <0.100 | <0.050 | <0.030 |
| NaCl  | 10   | 38   | 175          | 60-90         | <0.020 | 0.104  | 99.8  | 26.0  | 208.40  | 16.27       | 0.204 | <0.040 | 0.125 | <0.100 | <0.050 | 0.032  |

Elements (Cr, V, Cd, Pb, Li and Se) below the detection limit are excluded from this table.

Concluded. Saturated Paste Extract Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Co     | SO <sub>4</sub><br>(mg/L) | Si    | As    | SAR |
|-------|------|------|--------------|---------------|--------|---------------------------|-------|-------|-----|
| NaCl  | 10   | 23   | 92           | 30-45         | <0.010 | 13.36                     | 8.78  | 0.070 | 1   |
| NaCl  | 10   | 23   | 93           | 45-60         | <0.010 | 12.34                     | 8.48  | 0.068 | 0   |
| NaCl  | 10   | 28   | 114          | 0-15          | <0.010 | 286.23                    | 13.82 | 0.115 | 18  |
| NaCl  | 10   | 28   | 115          | 0-15          | <0.010 | 329.56                    | 8.42  | 0.095 | 21  |
| NaCl  | 10   | 28   | 116          | 0-15          | <0.010 | 271.22                    | 9.88  | 0.116 | 18  |
| NaCl  | 10   | 28   | 117          | 0-15          | <0.010 | 283.99                    | 8.04  | 0.099 | 21  |
| NaCl  | 10   | 28   | 118          | 0-15          | <0.010 | 164.40                    | 6.63  | 0.085 | 17  |
| NaCl  | 10   | 28   | 119          | 15-30         | <0.010 | 71.13                     | 5.19  | 0.065 | 5   |
| NaCl  | 10   | 28   | 120          | 15-30         | <0.010 | 37.82                     | 4.51  | 0.073 | 3   |
| NaCl  | 10   | 28   | 121          | 15-30         | <0.010 | 138.82                    | 5.81  | 0.157 | 7   |
| NaCl  | 10   | 28   | 122          | 15-30         | <0.010 | 108.64                    | 6.84  | 0.093 | 9   |
| NaCl  | 10   | 28   | 123          | 15-30         | <0.010 | 60.82                     | 5.01  | 0.095 | 4   |
| NaCl  | 10   | 38   | 163          | 0-15          | <0.010 | 275.09                    | 7.37  | 0.115 | 17  |
| NaCl  | 10   | 38   | 164          | 0-15          | 0.013  | 54.13                     | 9.70  | 0.163 | 2   |
| NaCl  | 10   | 38   | 165          | 0-15          | 0.014  | 136.36                    | 9.23  | 0.151 | 7   |
| NaCl  | 10   | 38   | 166          | 0-15          | 0.015  | 203.84                    | 10.55 | 0.127 | 11  |
| NaCl  | 10   | 38   | 167          | 0-15          | 0.011  | 514.64                    | 10.22 | 0.109 | 21  |
| NaCl  | 10   | 38   | 168          | 15-30         | 0.015  | 76.19                     | 4.18  | 0.119 | 5   |
| NaCl  | 10   | 38   | 169          | 15-30         | 0.013  | 28.21                     | 4.15  | 0.113 | 1   |
| NaCl  | 10   | 38   | 170          | 15-30         | 0.013  | 28.33                     | 4.46  | 0.112 | 1   |
| NaCl  | 10   | 38   | 171          | 15-30         | 0.014  | 25.76                     | 5.23  | 0.175 | 2   |
| NaCl  | 10   | 38   | 172          | 15-30         | 0.020  | 34.73                     | 9.11  | 0.141 | 4   |
| NaCl  | 10   | 38   | 173          | 30-45         | 0.014  | 82.25                     | 3.69  | 0.076 | 5   |
| NaCl  | 10   | 38   | 174          | 45-60         | 0.011  | 76.49                     | 3.82  | 0.072 | 5   |
| NaCl  | 10   | 38   | 175          | 60-90         | 0.014  | 81.92                     | 4.44  | 0.058 | 5   |

SAR = Sodium Adsorption Ratio; Elements (Cr, V, Cd, Pb, Li and Se) below the detection limit are excluded from this table.

APPENDIX III. Total elemental analysis data for the soils and soil/waste mixtures in the ESSO field plots in 1989.

Total Elemental Analysis Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste      | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Mn    | Na    | K     | Ca   | Mg    | P<br>(mg/g) | Al   | Fe    | Ti   | Ba    | Cu    | Zn<br>(ug/g) | Mo    |
|------------|------|------|--------------|---------------|-------|-------|-------|------|-------|-------------|------|-------|------|-------|-------|--------------|-------|
| Freshwater | 1    | 3    | 4            | 0-15          | 0.318 | 6.81  | 11.31 | 5.45 | 2.121 | 0.464       | 34.0 | 14.87 | 1.99 | 3.495 | 7.96  | 44.9         | 17.2  |
| Freshwater | 1    | 9    | 18           | 0-15          | 0.354 | 6.90  | 11.67 | 3.54 | 2.114 | 0.546       | 33.1 | 14.48 | 1.96 | 1.000 | 14.62 | 22.2         | 13.9  |
| Freshwater | 1    | 13   | 37           | 0-15          | 0.376 | 6.21  | 10.29 | 3.12 | 1.849 | 0.456       | 31.0 | 13.30 | 1.97 | 1.178 | 14.77 | 33.0         | 17.7  |
| Freshwater | 1    | 13   | 38           | 15-30         | 0.393 | 6.26  | 10.24 | 4.85 | 3.303 | 0.369       | 32.7 | 17.80 | 1.96 | 2.034 | 19.63 | 37.1         | 19.9  |
| Freshwater | 1    | 13   | 39           | 30-45         | 0.326 | 5.96  | 10.70 | 6.04 | 3.859 | 0.409       | 30.1 | 17.36 | 2.08 | 1.693 | 12.62 | 47.8         | 16.4  |
| Freshwater | 1    | 13   | 40           | 45-60         | 0.324 | 5.93  | 10.81 | 7.20 | 4.440 | 0.412       | 31.2 | 19.58 | 2.06 | 1.591 | 10.16 | 41.5         | 17.3  |
| Freshwater | 2    | 2    | 3            | 0-15          | 0.321 | 7.49  | 11.56 | 3.67 | 2.018 | 0.704       | 32.2 | 13.64 | 2.04 | 1.260 | 8.29  | 26.1         | 16.6  |
| Freshwater | 2    | 8    | 17           | 0-15          | 0.354 | 7.41  | 11.99 | 3.31 | 2.116 | 0.532       | 34.2 | 14.45 | 2.00 | 0.918 | 8.33  | 38.7         | 18.0  |
| Freshwater | 2    | 15   | 45           | 0-15          | 0.373 | 7.22  | 12.39 | 4.81 | 2.713 | 0.702       | 36.6 | 19.64 | 2.47 | 1.422 | <2.70 | 46.3         | <14.0 |
| Freshwater | 3    | 1    | 1            | 0-15          | 0.472 | 11.07 | 16.84 | 5.90 | 3.116 | 0.695       | 47.5 | 19.04 | 3.06 | 2.189 | 11.74 | 90.2         | 25.7  |
| Freshwater | 3    | 1    | 2            | 15-30         | 0.554 | 7.32  | 11.28 | 4.43 | 1.571 | 0.340       | 31.8 | 12.48 | 2.01 | 1.548 | 6.57  | 37.9         | 16.7  |
| Freshwater | 3    | 6    | 12           | 0-15          | 0.373 | 7.31  | 11.56 | 4.39 | 2.131 | 0.534       | 31.0 | 13.59 | 2.01 | 1.204 | 8.27  | 32.6         | 17.0  |
| Freshwater | 3    | 11   | 31           | 0-15          | 0.368 | 7.09  | 11.45 | 3.91 | 2.380 | 0.523       | 32.0 | 13.00 | 1.92 | 1.432 | 12.81 | 41.6         | 19.7  |
| Freshwater | 3    | 11   | 32           | 0-15          | 0.337 | 6.45  | 10.87 | 2.99 | 2.129 | 0.539       | 33.2 | 16.94 | 1.97 | 1.093 | 16.37 | 41.7         | 19.4  |
| Freshwater | 3    | 11   | 33           | 0-15          | 0.286 | 6.26  | 10.23 | 4.63 | 2.401 | 0.419       | 33.0 | 14.78 | 2.00 | 2.276 | 19.47 | 46.0         | 19.5  |
| Freshwater | 3    | 11   | 34           | 0-15          | 0.326 | 6.81  | 10.07 | 3.57 | 2.027 | 0.409       | 30.8 | 12.49 | 2.10 | 1.509 | 11.66 | 35.3         | 16.7  |
| Freshwater | 3    | 11   | 35           | 0-15          | 0.346 | 6.75  | 10.31 | 3.01 | 1.938 | 0.438       | 31.4 | 14.24 | 2.07 | 1.098 | 19.16 | 41.8         | 15.9  |
| Freshwater | 4    | 5    | 10           | 0-15          | 0.352 | 7.17  | 12.01 | 3.46 | 2.248 | 0.548       | 34.1 | 15.02 | 1.97 | 0.891 | 13.66 | 29.0         | 19.2  |
| Freshwater | 4    | 5    | 11           | 15-30         | 0.315 | 7.14  | 12.28 | 4.46 | 2.408 | 0.545       | 37.0 | 17.08 | 1.91 | 1.443 | 11.42 | 23.6         | 19.6  |
| Freshwater | 4    | 7    | 13           | 0-15          | 0.339 | 7.14  | 11.70 | 4.49 | 2.664 | 0.577       | 33.0 | 14.39 | 2.05 | 1.572 | 8.28  | 28.1         | 16.6  |
| Freshwater | 4    | 7    | 14           | 15-30         | 0.369 | 6.82  | 12.17 | 4.92 | 3.055 | 0.406       | 33.7 | 18.76 | 2.03 | 2.087 | 10.02 | 24.2         | 16.3  |
| Freshwater | 4    | 7    | 15           | 30-45         | 0.367 | 5.88  | 12.37 | 6.46 | 4.122 | 0.460       | 29.0 | 19.39 | 2.14 | 1.352 | 12.32 | 35.3         | 14.5  |
| Freshwater | 4    | 7    | 16           | 45-60         | 0.295 | 6.31  | 11.94 | 6.95 | 4.364 | 0.438       | 30.3 | 18.62 | 1.96 | 1.852 | 12.65 | 28.6         | 16.8  |
| Freshwater | 4    | 12   | 36           | 0-15          | 0.300 | 6.30  | 10.28 | 3.75 | 2.361 | 0.439       | 32.5 | 14.16 | 2.08 | 1.629 | 13.61 | 38.9         | 19.1  |
| Freshwater | 5    | 4    | 5            | 0-15          | 0.353 | 7.27  | 11.99 | 4.12 | 2.734 | 0.626       | 33.5 | 16.60 | 2.06 | 0.656 | 12.12 | 51.8         | 17.9  |
| Freshwater | 5    | 4    | 6            | 0-15          | 0.332 | 7.11  | 11.88 | 4.20 | 2.425 | 0.576       | 31.7 | 15.78 | 2.02 | 0.754 | 11.38 | 32.1         | 17.7  |
| Freshwater | 5    | 4    | 7            | 0-15          | 0.324 | 6.92  | 11.92 | 2.85 | 1.907 | 0.617       | 31.1 | 16.24 | 2.01 | 0.298 | 14.11 | 26.8         | 19.1  |
| Freshwater | 5    | 4    | 8            | 0-15          | 0.312 | 7.03  | 12.13 | 3.31 | 2.117 | 0.533       | 34.5 | 15.29 | 2.02 | 0.748 | 10.32 | 29.7         | 17.7  |
| Freshwater | 5    | 4    | 9            | 0-15          | 0.358 | 7.26  | 11.99 | 3.22 | 2.165 | 0.611       | 33.3 | 15.67 | 2.07 | 0.575 | 12.09 | 52.9         | 19.4  |
| Freshwater | 5    | 10   | 19           | 0-15          | 0.343 | 6.94  | 11.84 | 5.45 | 2.916 | 0.565       | 32.0 | 15.41 | 1.98 | 0.747 | 11.51 | 35.5         | 18.8  |
| Freshwater | 5    | 10   | 20           | 0-15          | 0.388 | 7.45  | 12.04 | 3.47 | 2.097 | 0.613       | 32.1 | 13.48 | 2.00 | 0.695 | 8.53  | 32.5         | <14.0 |
| Freshwater | 5    | 10   | 21           | 0-15          | 0.344 | 7.40  | 12.40 | 5.03 | 3.388 | 0.642       | 34.6 | 16.69 | 2.11 | 0.961 | 10.89 | 42.7         | 16.9  |
| Freshwater | 5    | 10   | 22           | 0-15          | 0.334 | 6.83  | 11.69 | 3.44 | 2.164 | 0.572       | 29.8 | 15.41 | 1.99 | 0.566 | 12.18 | 37.8         | 16.0  |
| Freshwater | 5    | 10   | 23           | 0-15          | 0.397 | 7.38  | 11.15 | 4.70 | 2.691 | 0.542       | 31.4 | 11.58 | 2.03 | 1.145 | 7.87  | 42.1         | 15.5  |
| Freshwater | 5    | 10   | 24           | 15-30         | 0.318 | 5.84  | 11.86 | 4.22 | 2.740 | 0.432       | 28.9 | 17.65 | 1.93 | 1.477 | 11.64 | 37.2         | 15.3  |
| Freshwater | 5    | 10   | 25           | 15-30         | 0.393 | 6.83  | 12.33 | 4.41 | 2.700 | 0.442       | 33.2 | 16.80 | 2.09 | 1.879 | 10.49 | 42.4         | 18.8  |
| Freshwater | 5    | 10   | 26           | 15-30         | 0.354 | 6.39  | 10.86 | 3.53 | 1.770 | 0.330       | 30.7 | 11.25 | 1.84 | 1.530 | 9.99  | 32.5         | 18.4  |
| Freshwater | 5    | 10   | 27           | 15-30         | 0.289 | 6.44  | 11.74 | 5.11 | 2.893 | 0.501       | 31.3 | 16.60 | 1.88 | 2.127 | 14.81 | 38.0         | 19.5  |
| Freshwater | 5    | 10   | 28           | 15-30         | 0.332 | 6.84  | 12.15 | 5.94 | 3.502 | 0.497       | 32.2 | 15.88 | 2.03 | 2.661 | 25.65 | 50.5         | 19.6  |
| Freshwater | 5    | 10   | 29           | 30-45         | 0.349 | 5.93  | 12.60 | 4.38 | 2.960 | 0.451       | 29.6 | 12.02 | 1.99 | 1.258 | 17.77 | 44.4         | 18.6  |
| Freshwater | 5    | 10   | 30           | 45-60         | 0.374 | 6.04  | 12.89 | 3.98 | 2.689 | 0.470       | 30.3 | 18.31 | 2.02 | 1.227 | 17.33 | 47.3         | 20.1  |
| Freshwater | 5    | 14   | 41           | 0-15          | 0.359 | 7.12  | 11.20 | 5.04 | 2.795 | 0.533       | 35.2 | 17.84 | 2.35 | 1.387 | <2.70 | 61.3         | <14.0 |
| Freshwater | 5    | 14   | 42           | 15-30         | 0.290 | 6.51  | 11.24 | 5.68 | 2.813 | 0.401       | 39.3 | 19.45 | 2.19 | 3.103 | 15.57 | 48.3         | 19.3  |
| Freshwater | 5    | 14   | 43           | 30-45         | 0.353 | 6.18  | 12.52 | 5.21 | 2.942 | 0.431       | 39.4 | 24.22 | 2.45 | 2.869 | 50.93 | 66.6         | 16.6  |
| Freshwater | 5    | 14   | 44           | 45-60         | 0.240 | 5.63  | 10.17 | 6.81 | 4.256 | 0.396       | 37.2 | 17.75 | 2.05 | 2.235 | 16.71 | 39.3         | 16.7  |



Continued. Total Elemental Analysis Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste      | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | V     | Cr   | Ni    | Sr<br>(ug/g) | Li     | Zr    |
|------------|------|------|--------------|---------------|-------|------|-------|--------------|--------|-------|
| Freshwater | 1    | 3    | 4            | 0-15          | 40.56 | 58.0 | 16.17 | 102.4        | 14.12  | 86.5  |
| Freshwater | 1    | 9    | 18           | 0-15          | 37.27 | 45.8 | 12.91 | 94.8         | 12.18  | 75.3  |
| Freshwater | 1    | 13   | 37           | 0-15          | 45.53 | 44.8 | 22.15 | 91.1         | 21.66  | 95.5  |
| Freshwater | 1    | 13   | 38           | 15-30         | 58.59 | 58.9 | 32.92 | 94.2         | 26.88  | 109.0 |
| Freshwater | 1    | 13   | 39           | 30-45         | 56.91 | 46.7 | 24.97 | 84.8         | 20.13  | 99.9  |
| Freshwater | 1    | 13   | 40           | 45-60         | 54.64 | 57.9 | 22.51 | 86.2         | 17.85  | 94.4  |
| Freshwater | 2    | 2    | 3            | 0-15          | 37.57 | 59.3 | 17.32 | 106.4        | 12.69  | 89.5  |
| Freshwater | 2    | 8    | 17           | 0-15          | 41.90 | 51.8 | 20.68 | 101.0        | 14.77  | 81.1  |
| Freshwater | 2    | 15   | 45           | 0-15          | 49.82 | 62.2 | <8.50 | 104.8        | <10.90 | 79.8  |
| Freshwater | 3    | 1    | 1            | 0-15          | 55.74 | 78.1 | 23.47 | 157.7        | 19.07  | 122.1 |
| Freshwater | 3    | 1    | 2            | 15-30         | 34.64 | 58.4 | 14.92 | 103.7        | 12.64  | 77.1  |
| Freshwater | 3    | 6    | 12           | 0-15          | 41.33 | 46.3 | 12.78 | 96.4         | 13.53  | 78.7  |
| Freshwater | 3    | 11   | 31           | 0-15          | 42.35 | 41.7 | 20.23 | 99.6         | 18.65  | 83.9  |
| Freshwater | 3    | 11   | 32           | 0-15          | 52.17 | 56.8 | 28.38 | 93.3         | 23.27  | 93.8  |
| Freshwater | 3    | 11   | 33           | 0-15          | 50.77 | 52.3 | 27.36 | 101.5        | 24.46  | 98.9  |
| Freshwater | 3    | 11   | 34           | 0-15          | 40.83 | 48.0 | 18.89 | 106.9        | 19.44  | 90.5  |
| Freshwater | 3    | 11   | 35           | 0-15          | 45.55 | 51.5 | 20.66 | 102.3        | 18.92  | 85.6  |
| Freshwater | 4    | 5    | 10           | 0-15          | 44.09 | 53.0 | 20.13 | 95.6         | 16.06  | 82.9  |
| Freshwater | 4    | 5    | 11           | 15-30         | 46.20 | 67.7 | 26.55 | 102.2        | 17.52  | 90.3  |
| Freshwater | 4    | 7    | 13           | 0-15          | 42.75 | 46.0 | 16.56 | 100.5        | 15.23  | 89.2  |
| Freshwater | 4    | 7    | 14           | 15-30         | 47.18 | 72.5 | 27.41 | 89.4         | 15.55  | 88.8  |
| Freshwater | 4    | 7    | 15           | 30-45         | 57.49 | 61.6 | 25.73 | 76.7         | 19.44  | 89.5  |
| Freshwater | 4    | 7    | 16           | 45-60         | 47.30 | 69.0 | 27.78 | 86.4         | 16.78  | 84.4  |
| Freshwater | 4    | 12   | 36           | 0-15          | 48.52 | 46.8 | 23.52 | 98.3         | 22.77  | 98.3  |
| Freshwater | 5    | 4    | 5            | 0-15          | 52.04 | 52.0 | 20.21 | 99.5         | 16.92  | 91.7  |
| Freshwater | 5    | 4    | 6            | 0-15          | 47.78 | 62.9 | 25.28 | 91.0         | 16.18  | 84.2  |
| Freshwater | 5    | 4    | 7            | 0-15          | 50.33 | 60.7 | 23.05 | 80.0         | 18.35  | 87.5  |
| Freshwater | 5    | 4    | 8            | 0-15          | 43.72 | 51.3 | 19.40 | 92.8         | 16.70  | 84.7  |
| Freshwater | 5    | 4    | 9            | 0-15          | 49.56 | 56.2 | 19.44 | 93.2         | 16.60  | 86.3  |
| Freshwater | 5    | 10   | 19           | 0-15          | 47.74 | 65.1 | 29.87 | 86.7         | 16.16  | 78.6  |
| Freshwater | 5    | 10   | 20           | 0-15          | 41.31 | 42.4 | 14.66 | 97.6         | 13.86  | 80.5  |
| Freshwater | 5    | 10   | 21           | 0-15          | 51.87 | 55.9 | 20.35 | 102.9        | 17.48  | 86.5  |
| Freshwater | 5    | 10   | 22           | 0-15          | 46.68 | 54.3 | 18.77 | 81.4         | 16.49  | 76.6  |
| Freshwater | 5    | 10   | 23           | 0-15          | 36.65 | 41.3 | 13.84 | 104.8        | 13.84  | 83.6  |
| Freshwater | 5    | 10   | 24           | 15-30         | 51.81 | 56.8 | 21.00 | 70.3         | 17.12  | 89.5  |
| Freshwater | 5    | 10   | 25           | 15-30         | 48.10 | 54.4 | 20.70 | 88.2         | 17.24  | 87.0  |
| Freshwater | 5    | 10   | 26           | 15-30         | 35.59 | 43.8 | 18.43 | 90.4         | 17.15  | 85.0  |
| Freshwater | 5    | 10   | 27           | 15-30         | 50.11 | 57.0 | 23.95 | 86.6         | 19.50  | 93.8  |
| Freshwater | 5    | 10   | 28           | 15-30         | 49.67 | 59.5 | 27.56 | 92.5         | 19.65  | 94.2  |
| Freshwater | 5    | 10   | 29           | 30-45         | 57.76 | 53.6 | 29.53 | 67.9         | 23.00  | 88.9  |
| Freshwater | 5    | 10   | 30           | 45-60         | 58.17 | 62.6 | 31.93 | 67.1         | 22.03  | 89.1  |
| Freshwater | 5    | 14   | 41           | 0-15          | 43.71 | 53.2 | <8.50 | 105.7        | 22.95  | 70.6  |
| Freshwater | 5    | 14   | 42           | 15-30         | 60.42 | 50.9 | 26.38 | 107.4        | <10.90 | 107.6 |
| Freshwater | 5    | 14   | 43           | 30-45         | 61.52 | 63.5 | 25.72 | 85.0         | 14.62  | 96.8  |
| Freshwater | 5    | 14   | 44           | 45-60         | 55.70 | 76.9 | 35.37 | 88.0         | 22.84  | 103.6 |

Continued. Total Elemental Analysis Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Mn    | Na   | K     | Ca   | Mg   | P<br>(mg/g) | Al   | Fe    | Ti   | Ba   | Cu    | Zn<br>(ug/g) | Mo    | V     |
|-------|------|------|--------------|---------------|-------|------|-------|------|------|-------------|------|-------|------|------|-------|--------------|-------|-------|
| KCI   | 1    | 17   | 58           | 0-15          | 0.390 | 6.49 | 11.34 | 4.40 | 2.39 | 0.503       | 33.2 | 14.26 | 1.98 | 1.63 | 7.83  | 49.5         | 14.7  | 43.04 |
| KCI   | 1    | 42   | 179          | 0-15          | 0.361 | 6.28 | 11.15 | 6.16 | 3.69 | 0.476       | 29.8 | 15.85 | 1.89 | 2.00 | 4.09  | 43.2         | <14.0 | 40.66 |
| KCI   | 1    | 42   | 180          | 0-15          | 0.353 | 6.55 | 11.42 | 5.14 | 3.25 | 0.461       | 31.2 | 15.50 | 1.91 | 2.00 | 4.94  | 62.0         | 15.4  | 42.78 |
| KCI   | 1    | 42   | 181          | 0-15          | 0.366 | 6.57 | 11.47 | 5.53 | 3.35 | 0.482       | 32.9 | 15.96 | 1.92 | 2.70 | 3.83  | 54.2         | <14.0 | 43.78 |
| KCI   | 1    | 42   | 182          | 0-15          | 0.354 | 6.28 | 11.32 | 4.61 | 2.73 | 0.448       | 29.8 | 16.17 | 1.92 | 1.63 | 5.01  | 51.2         | 15.3  | 45.37 |
| KCI   | 1    | 42   | 183          | 0-15          | 0.367 | 6.55 | 10.99 | 4.07 | 2.66 | 0.453       | 30.2 | 15.18 | 1.83 | 1.92 | 4.91  | 67.7         | <14.0 | 39.58 |
| KCI   | 1    | 43   | 184          | 0-15          | 0.347 | 6.34 | 11.37 | 4.07 | 2.81 | 0.460       | 30.4 | 16.23 | 1.74 | 1.71 | 6.36  | 69.7         | 15.8  | 43.52 |
| KCI   | 2    | 33   | 143          | 0-15          | 0.311 | 6.17 | 10.27 | 5.24 | 3.41 | 0.392       | 31.5 | 12.98 | 1.71 | 3.38 | 24.21 | 41.4         | 22.5  | 52.79 |
| KCI   | 2    | 40   | 177          | 0-15          | 0.350 | 6.42 | 10.88 | 5.00 | 3.01 | 0.428       | 32.2 | 14.80 | 1.80 | 3.88 | 4.44  | 64.3         | <14.0 | 39.98 |
| KCI   | 2    | 45   | 197          | 0-15          | 0.376 | 7.00 | 12.55 | 4.76 | 2.63 | 0.577       | 35.7 | 16.61 | 2.13 | 4.24 | 5.25  | 61.0         | <14.0 | 43.24 |
| KCI   | 2    | 45   | 198          | 0-15          | 0.266 | 7.20 | 12.04 | 4.58 | 1.58 | 0.791       | 34.3 | 12.11 | 2.01 | 4.70 | <2.70 | 86.9         | <14.0 | 30.40 |
| KCI   | 2    | 45   | 199          | 0-15          | 0.281 | 7.07 | 11.73 | 4.72 | 1.95 | 0.638       | 34.2 | 12.79 | 2.07 | 4.41 | 3.82  | 45.3         | <14.0 | 32.47 |
| KCI   | 2    | 45   | 200          | 0-15          | 0.390 | 7.28 | 11.80 | 3.43 | 1.86 | 0.432       | 32.3 | 12.65 | 1.96 | 2.83 | 11.10 | 44.1         | 17.5  | 38.58 |
| KCI   | 2    | 45   | 201          | 0-15          | 0.368 | 7.57 | 11.89 | 4.74 | 1.70 | 0.411       | 32.8 | 11.77 | 2.16 | 4.71 | 7.56  | 44.3         | <14.0 | 33.05 |
| KCI   | 2    | 45   | 202          | 15-30         | 0.383 | 5.79 | 12.12 | 3.71 | 1.91 | 0.392       | 38.2 | 19.54 | 2.01 | 3.26 | 13.88 | 58.4         | 19.4  | 57.20 |
| KCI   | 2    | 45   | 203          | 15-30         | 0.138 | 6.38 | 10.34 | 3.48 | 1.17 | 1.077       | 30.5 | 11.06 | 1.76 | 4.15 | 6.58  | 33.8         | <14.0 | 27.27 |
| KCI   | 2    | 45   | 204          | 15-30         | 0.203 | 5.90 | 12.22 | 3.10 | 1.50 | 0.696       | 36.6 | 19.66 | 1.95 | 3.25 | 14.33 | 46.6         | 23.4  | 58.03 |
| KCI   | 2    | 45   | 205          | 15-30         | 0.406 | 6.80 | 11.68 | 3.81 | 2.09 | 0.432       | 29.3 | 13.87 | 2.04 | 2.11 | 14.96 | 41.5         | 16.1  | 42.87 |
| KCI   | 2    | 45   | 206          | 15-30         | 0.340 | 6.60 | 11.94 | 3.79 | 2.48 | 0.436       | 31.1 | 16.39 | 1.90 | 1.88 | 16.81 | 41.3         | 14.5  | 49.16 |
| KCI   | 2    | 45   | 207          | 30-45         | 0.464 | 6.05 | 12.49 | 3.60 | 2.12 | 0.389       | 38.7 | 20.67 | 2.02 | 4.53 | 22.26 | 59.5         | 23.6  | 57.97 |
| KCI   | 3    | 21   | 73           | 0-15          | 0.385 | 7.14 | 11.13 | 3.97 | 2.31 | 0.520       | 30.4 | 11.49 | 1.87 | 2.16 | 10.09 | 80.7         | 17.2  | 41.99 |
| KCI   | 3    | 21   | 74           | 0-15          | 0.379 | 7.12 | 11.62 | 4.29 | 1.98 | 0.475       | 31.7 | 12.09 | 2.04 | 2.47 | 8.84  | 47.5         | 14.6  | 40.13 |
| KCI   | 3    | 21   | 75           | 0-15          | 0.407 | 6.95 | 11.94 | 3.76 | 1.83 | 0.471       | 32.7 | 13.06 | 2.02 | 1.76 | 7.42  | 45.4         | <14.0 | 41.03 |
| KCI   | 3    | 21   | 76           | 0-15          | 0.422 | 6.69 | 11.09 | 5.35 | 2.62 | 0.448       | 31.8 | 12.08 | 1.86 | 3.79 | 10.49 | 59.0         | 15.2  | 39.35 |
| KCI   | 3    | 21   | 77           | 0-15          | 0.404 | 6.51 | 10.28 | 4.24 | 2.44 | 0.417       | 29.2 | 11.12 | 1.81 | 2.67 | 15.91 | 56.7         | 16.7  | 38.04 |
| KCI   | 3    | 30   | 129          | 0-15          | 0.419 | 7.18 | 12.34 | 3.98 | 2.45 | 0.490       | 33.9 | 13.50 | 1.88 | 1.95 | 19.06 | 61.8         | 21.7  | 49.68 |
| KCI   | 3    | 39   | 176          | 0-15          | 0.347 | 6.54 | 11.21 | 4.50 | 2.82 | 0.456       | 31.1 | 14.57 | 1.88 | 2.89 | 5.42  | 56.9         | <14.0 | 43.34 |
| KCI   | 4    | 16   | 46           | 0-15          | 0.352 | 6.34 | 10.24 | 4.57 | 2.40 | 0.429       | 32.4 | 14.47 | 1.98 | 2.75 | 9.77  | 35.8         | 18.2  | 42.87 |
| KCI   | 4    | 16   | 47           | 0-15          | 0.360 | 7.46 | 13.18 | 3.65 | 2.06 | 0.470       | 39.8 | 18.59 | 2.38 | 1.73 | <2.70 | 44.4         | <14.0 | 43.70 |
| KCI   | 4    | 16   | 48           | 0-15          | 0.381 | 6.70 | 10.98 | 4.12 | 2.19 | 0.441       | 34.5 | 15.23 | 2.16 | 1.96 | <2.70 | 39.5         | <14.0 | 42.30 |
| KCI   | 4    | 16   | 49           | 0-15          | 0.413 | 6.93 | 11.28 | 4.09 | 2.40 | 0.513       | 32.5 | 13.96 | 1.97 | 1.91 | 7.85  | 48.8         | <14.0 | 41.73 |
| KCI   | 4    | 16   | 50           | 0-15          | 0.412 | 6.85 | 11.93 | 3.48 | 2.19 | 0.495       | 33.3 | 15.36 | 1.95 | 1.10 | 10.53 | 50.2         | 14.4  | 47.01 |
| KCI   | 4    | 16   | 51           | 15-30         | 0.340 | 6.45 | 10.56 | 3.64 | 2.03 | 0.455       | 31.7 | 13.72 | 1.89 | 1.53 | 9.45  | 42.2         | <14.0 | 39.73 |
| KCI   | 4    | 16   | 52           | 15-30         | 0.287 | 6.62 | 10.96 | 5.56 | 3.46 | 0.462       | 34.5 | 15.15 | 1.83 | 2.98 | 8.14  | 42.3         | 15.0  | 45.44 |
| KCI   | 4    | 16   | 53           | 15-30         | 0.189 | 5.98 | 11.66 | 4.65 | 3.22 | 0.351       | 40.1 | 16.42 | 1.93 | 3.10 | 8.73  | 41.8         | 17.5  | 52.36 |
| KCI   | 4    | 16   | 54           | 15-30         | 0.325 | 6.48 | 11.54 | 4.76 | 2.50 | 0.401       | 35.9 | 17.51 | 2.00 | 2.28 | 9.36  | 39.1         | 14.0  | 49.13 |
| KCI   | 4    | 16   | 55           | 15-30         | 0.272 | 6.62 | 11.32 | 5.87 | 3.47 | 0.391       | 35.6 | 16.57 | 1.82 | 3.46 | 11.05 | 46.4         | 14.6  | 46.64 |
| KCI   | 4    | 16   | 56           | 30-45         | 0.350 | 6.82 | 11.35 | 5.14 | 3.49 | 0.418       | 35.7 | 16.38 | 1.92 | 2.67 | 10.65 | 41.0         | <14.0 | 50.88 |
| KCI   | 4    | 16   | 57           | 45-60         | 0.328 | 6.24 | 11.89 | 4.73 | 3.17 | 0.426       | 33.3 | 18.06 | 2.05 | 1.83 | 13.05 | 46.1         | 14.3  | 57.14 |
| KCI   | 4    | 25   | 95           | 0-15          | 0.320 | 7.35 | 12.34 | 4.46 | 2.62 | 0.446       | 34.7 | 12.48 | 1.98 | 3.01 | 10.28 | 41.1         | 15.0  | 44.16 |
| KCI   | 4    | 25   | 96           | 0-15          | 0.350 | 7.37 | 12.65 | 4.18 | 2.63 | 0.510       | 34.1 | 13.48 | 1.97 | 2.41 | 12.62 | 46.2         | 15.6  | 48.07 |
| KCI   | 4    | 25   | 97           | 0-15          | 0.353 | 7.49 | 12.60 | 4.02 | 2.39 | 0.465       | 32.7 | 13.70 | 1.96 | 2.18 | 14.47 | 66.9         | 19.3  | 46.30 |
| KCI   | 4    | 25   | 98           | 0-15          | 0.359 | 7.59 | 13.71 | 5.71 | 3.46 | 0.489       | 39.8 | 20.56 | 2.02 | 3.23 | 20.23 | 64.1         | 19.7  | 59.00 |
| KCI   | 4    | 25   | 99           | 0-15          | 0.356 | 7.40 | 13.69 | 4.25 | 2.96 | 0.517       | 36.0 | 16.42 | 2.01 | 1.96 | 19.31 | 68.6         | 19.3  | 58.72 |

Continued. Total Elemental Analysis Data for the Soils and Soil/Waste Mixtures in the Esso Field Plot in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Cr   | Ni     | Sr<br>(ug/g) | Li     | Zr    |
|-------|------|------|--------------|---------------|------|--------|--------------|--------|-------|
| KCl   | 1    | 17   | 58           | 0-15          | 42.1 | 19.79  | 92.7         | 15.88  | 82.2  |
| KCl   | 1    | 42   | 179          | 0-15          | 46.5 | 11.51  | 77.7         | <11.00 | 74.2  |
| KCl   | 1    | 42   | 180          | 0-15          | 48.0 | 15.90  | 80.3         | <11.00 | 77.3  |
| KCl   | 1    | 42   | 181          | 0-15          | 47.1 | 13.41  | 86.5         | <11.00 | 80.5  |
| KCl   | 1    | 42   | 182          | 0-15          | 48.0 | 12.40  | 71.5         | <11.00 | 74.7  |
| KCl   | 1    | 42   | 183          | 0-15          | 46.7 | 13.92  | 78.1         | <11.00 | 69.6  |
| KCl   | 1    | 43   | 184          | 0-15          | 45.6 | 16.29  | 72.5         | 11.45  | 71.0  |
| KCl   | 2    | 33   | 143          | 0-15          | 48.7 | 34.12  | 87.8         | 27.41  | 112.6 |
| KCl   | 2    | 40   | 177          | 0-15          | 45.5 | 12.54  | 90.4         | <11.00 | 77.6  |
| KCl   | 2    | 45   | 197          | 0-15          | 49.0 | 45.24  | 102.5        | 13.25  | 85.2  |
| KCl   | 2    | 45   | 198          | 0-15          | 39.5 | 16.14  | 106.0        | 11.03  | 72.6  |
| KCl   | 2    | 45   | 199          | 0-15          | 44.2 | 13.37  | 103.4        | 13.64  | 80.5  |
| KCl   | 2    | 45   | 200          | 0-15          | 43.3 | 16.10  | 96.9         | 18.04  | 84.9  |
| KCl   | 2    | 45   | 201          | 0-15          | 40.9 | 14.84  | 109.2        | 14.84  | 88.2  |
| KCl   | 2    | 45   | 202          | 15-30         | 48.1 | 22.26  | 87.4         | 22.50  | 97.7  |
| KCl   | 2    | 45   | 203          | 15-30         | 36.8 | 10.47  | 95.0         | 12.66  | 75.7  |
| KCl   | 2    | 45   | 204          | 15-30         | 54.0 | 24.83  | 87.2         | 26.03  | 87.2  |
| KCl   | 2    | 45   | 205          | 15-30         | 47.8 | 22.10  | 81.9         | 20.10  | 97.6  |
| KCl   | 2    | 45   | 206          | 15-30         | 52.7 | 22.67  | 80.0         | 22.67  | 90.7  |
| KCl   | 2    | 45   | 207          | 30-45         | 54.1 | 26.14  | 96.5         | 25.10  | 103.3 |
| KCl   | 3    | 21   | 73           | 0-15          | 44.4 | 23.45  | 103.6        | 20.18  | 82.9  |
| KCl   | 3    | 21   | 74           | 0-15          | 41.6 | 17.20  | 104.4        | 15.52  | 80.5  |
| KCl   | 3    | 21   | 75           | 0-15          | 42.4 | 18.08  | 99.0         | 15.76  | 77.0  |
| KCl   | 3    | 21   | 76           | 0-15          | 38.8 | 19.15  | 104.4        | 16.53  | 85.5  |
| KCl   | 3    | 21   | 77           | 0-15          | 43.0 | 23.12  | 98.0         | 19.39  | 88.0  |
| KCl   | 3    | 30   | 129          | 0-15          | 49.7 | 25.42  | 99.6         | 22.53  | 95.0  |
| KCl   | 3    | 39   | 176          | 0-15          | 51.2 | 18.22  | 85.7         | <11.00 | 73.4  |
| KCl   | 4    | 16   | 46           | 0-15          | 58.6 | 24.42  | 107.7        | 15.46  | 86.3  |
| KCl   | 4    | 16   | 47           | 0-15          | 48.3 | <8.50  | 116.4        | <11.00 | 70.7  |
| KCl   | 4    | 16   | 48           | 0-15          | 43.8 | <8.50  | 111.8        | <11.00 | 71.0  |
| KCl   | 4    | 16   | 49           | 0-15          | 42.7 | 21.11  | 103.6        | 14.24  | 85.2  |
| KCl   | 4    | 16   | 50           | 0-15          | 49.2 | 19.34  | 99.2         | 13.47  | 73.2  |
| KCl   | 4    | 16   | 51           | 15-30         | 55.0 | 25.92  | 92.8         | 15.02  | 85.0  |
| KCl   | 4    | 16   | 52           | 15-30         | 43.9 | 23.11  | 96.9         | 15.50  | 77.7  |
| KCl   | 4    | 16   | 53           | 15-30         | 45.9 | 22.07  | 95.7         | 18.74  | 95.2  |
| KCl   | 4    | 16   | 54           | 15-30         | 55.2 | 24.80  | 97.6         | 16.84  | 87.7  |
| KCl   | 4    | 16   | 55           | 15-30         | 50.4 | 26.15  | 101.1        | 17.52  | 85.7  |
| KCl   | 4    | 16   | 56           | 30-45         | 42.4 | 25.30  | 95.1         | 17.31  | 78.6  |
| KCl   | 4    | 16   | 57           | 45-60         | 56.4 | 25.86  | 80.5         | 19.46  | 92.6  |
| KCl   | 4    | 25   | 95           | 0-15          | 43.9 | 17.22  | 105.0        | 15.55  | 89.4  |
| KCl   | 4    | 25   | 96           | 0-15          | 43.5 | 15.57  | 105.5        | 16.92  | 84.0  |
| KCl   | 4    | 25   | 97           | 0-15          | 53.9 | 28.60  | 104.9        | 16.90  | 89.2  |
| KCl   | 4    | 25   | 98           | 0-15          | 60.7 | 418.35 | 113.8        | 23.04  | 103.1 |
| KCl   | 4    | 25   | 99           | 0-15          | 48.5 | 78.83  | 102.4        | 21.45  | 92.8  |

Continued. Total Elemental Analysis Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Mn    | Na   | K     | Ca   | Mg<br>(mg/g) | Al    | Fe   | Ti    | Ba   | Cu   | Zn    | Mo<br>(ug/g) | V     |
|-------|------|------|--------------|---------------|-------|------|-------|------|--------------|-------|------|-------|------|------|-------|--------------|-------|
| KCl   | 4    | 25   | 100          | 15-30         | 0.436 | 7.75 | 11.68 | 3.44 | 1.84         | 0.452 | 32.4 | 11.60 | 1.84 | 1.50 | 15.07 | 47.9         | 19.6  |
| KCl   | 4    | 25   | 101          | 15-30         | 0.300 | 6.90 | 13.91 | 4.02 | 2.81         | 0.363 | 45.7 | 22.58 | 2.33 | 2.78 | 24.07 | 51.0         | 25.3  |
| KCl   | 4    | 25   | 102          | 15-30         | 0.317 | 6.89 | 13.46 | 4.31 | 3.05         | 0.347 | 43.8 | 21.18 | 2.11 | 3.23 | 22.31 | 54.6         | 24.2  |
| KCl   | 4    | 25   | 103          | 15-30         | 0.456 | 7.02 | 12.96 | 5.13 | 2.90         | 0.392 | 39.1 | 18.63 | 1.98 | 2.82 | 16.46 | 51.9         | 23.3  |
| KCl   | 4    | 25   | 104          | 15-30         | 0.324 | 6.61 | 11.87 | 4.78 | 2.86         | 0.327 | 38.3 | 16.75 | 1.94 | 3.44 | 14.38 | 54.2         | 24.3  |
| KCl   | 4    | 25   | 105          | 30-45         | 0.283 | 6.73 | 12.65 | 3.82 | 2.41         | 0.383 | 41.2 | 19.61 | 2.03 | 1.75 | 26.57 | 45.8         | 25.8  |
| KCl   | 4    | 25   | 106          | 45-60         | 0.318 | 6.75 | 12.46 | 4.29 | 3.01         | 0.390 | 40.4 | 18.05 | 2.06 | 3.43 | 23.90 | 42.0         | 23.6  |
| KCl   | 4    | 29   | 124          | 0-15          | 0.353 | 7.04 | 12.14 | 3.88 | 2.40         | 0.474 | 33.3 | 13.21 | 1.84 | 2.25 | 25.01 | 60.0         | 23.1  |
| KCl   | 4    | 29   | 125          | 15-30         | 0.389 | 7.40 | 16.05 | 3.87 | 2.24         | 0.508 | 46.4 | 22.18 | 2.32 | 1.50 | 32.84 | 69.3         | 30.8  |
| KCl   | 4    | 29   | 126          | 30-45         | 0.340 | 7.30 | 14.14 | 4.56 | 3.01         | 0.500 | 43.7 | 19.83 | 2.23 | 3.62 | 24.15 | 61.6         | 24.9  |
| KCl   | 4    | 29   | 127          | 45-60         | 0.269 | 7.20 | 13.42 | 4.24 | 2.80         | 0.462 | 40.4 | 17.14 | 1.99 | 2.30 | 27.37 | 60.0         | 25.1  |
| KCl   | 4    | 29   | 128          | 60-90         | 0.304 | 7.40 | 13.49 | 4.96 | 3.58         | 0.490 | 42.6 | 18.19 | 2.04 | 3.25 | 19.12 | 93.2         | 22.5  |
| KCl   | 5    | 24   | 94           | 0-15          | 0.424 | 6.67 | 11.57 | 5.05 | 2.95         | 0.445 | 31.9 | 14.01 | 1.92 | 2.56 | 10.13 | 45.0         | 15.6  |
| KCl   | 5    | 26   | 107          | 0-15          | 0.346 | 7.37 | 12.61 | 4.71 | 2.57         | 0.513 | 33.7 | 14.46 | 1.92 | 2.81 | 18.65 | 68.4         | 21.0  |
| KCl   | 5    | 37   | 162          | 0-15          | 0.374 | 6.77 | 11.64 | 4.33 | 2.65         | 0.434 | 32.4 | 14.52 | 1.90 | 3.32 | 16.47 | 41.2         | 19.8  |
| NaCl  | 6    | 22   | 78           | 0-15          | 0.339 | 6.98 | 10.90 | 4.51 | 2.05         | 0.453 | 32.6 | 11.74 | 2.00 | 3.38 | 13.61 | 66.2         | 19.6  |
| NaCl  | 6    | 22   | 79           | 15-30         | 0.422 | 6.15 | 11.06 | 4.26 | 2.96         | 0.487 | 29.2 | 15.57 | 1.80 | 1.66 | 19.20 | 53.2         | 20.2  |
| NaCl  | 6    | 22   | 80           | 30-45         | 0.341 | 5.51 | 11.16 | 4.11 | 2.80         | 0.422 | 25.9 | 16.14 | 1.84 | 1.19 | 18.40 | 51.3         | 18.6  |
| NaCl  | 6    | 22   | 81           | 45-60         | 0.327 | 5.96 | 11.38 | 6.30 | 3.78         | 0.430 | 28.3 | 16.26 | 1.86 | 1.95 | 11.60 | 55.0         | 13.6  |
| NaCl  | 6    | 32   | 142          | 0-15          | 0.372 | 6.25 | 10.48 | 2.95 | 1.71         | 0.425 | 28.7 | 11.95 | 1.75 | 1.77 | 22.64 | 46.0         | 19.9  |
| NaCl  | 6    | 41   | 178          | 0-15          | 0.351 | 6.37 | 11.61 | 4.05 | 2.66         | 0.466 | 30.7 | 15.06 | 1.84 | 2.04 | 5.78  | 62.6         | 14.9  |
| NaCl  | 7    | 18   | 59           | 0-15          | 0.388 | 6.69 | 11.33 | 3.53 | 2.24         | 0.463 | 32.5 | 14.19 | 1.99 | 1.11 | 11.33 | 45.3         | 16.9  |
| NaCl  | 7    | 27   | 108          | 0-15          | 0.432 | 6.93 | 10.95 | 4.63 | 2.35         | 0.419 | 33.7 | 13.37 | 1.96 | 3.27 | 16.12 | 89.8         | 19.0  |
| NaCl  | 7    | 27   | 109          | 0-15          | 0.449 | 6.71 | 10.62 | 3.97 | 1.75         | 0.399 | 30.5 | 11.15 | 1.81 | 2.26 | 21.36 | 47.6         | 24.1  |
| NaCl  | 7    | 27   | 110          | 0-15          | 0.381 | 6.88 | 10.64 | 4.46 | 2.24         | 0.427 | 31.4 | 11.43 | 1.81 | 2.34 | 19.54 | 62.4         | 24.2  |
| NaCl  | 7    | 27   | 111          | 0-15          | 0.388 | 6.81 | 11.37 | 4.25 | 2.28         | 0.495 | 33.1 | 13.23 | 1.82 | 2.01 | 25.00 | 50.0         | 23.9  |
| NaCl  | 7    | 27   | 112          | 0-15          | 0.397 | 6.89 | 11.01 | 4.24 | 2.24         | 0.399 | 32.0 | 12.64 | 1.86 | 2.61 | 21.56 | 49.7         | 21.0  |
| NaCl  | 7    | 27   | 113          | 15-30         | 0.360 | 7.01 | 11.67 | 4.69 | 2.66         | 0.415 | 34.4 | 13.28 | 1.84 | 3.58 | 24.07 | 48.4         | 26.2  |
| NaCl  | 7    | 34   | 144          | 0-15          | 0.325 | 6.49 | 10.97 | 4.37 | 2.72         | 0.458 | 30.8 | 12.22 | 1.67 | 3.33 | 25.09 | 51.0         | 21.5  |
| NaCl  | 7    | 34   | 145          | 0-15          | 0.360 | 6.48 | 10.14 | 4.20 | 2.19         | 0.400 | 29.0 | 10.72 | 1.74 | 3.70 | 20.66 | 49.7         | 20.1  |
| NaCl  | 7    | 34   | 146          | 0-15          | 0.348 | 6.36 | 10.33 | 3.55 | 2.08         | 0.413 | 29.5 | 12.00 | 1.59 | 2.63 | 26.36 | 39.9         | 22.6  |
| NaCl  | 7    | 34   | 147          | 0-15          | 0.295 | 6.33 | 11.47 | 3.27 | 2.31         | 0.421 | 31.9 | 15.03 | 1.81 | 1.88 | 27.80 | 44.8         | 21.5  |
| NaCl  | 7    | 34   | 148          | 0-15          | 0.255 | 5.36 | 9.03  | 3.82 | 2.44         | 0.341 | 25.9 | 11.85 | 1.50 | 2.53 | 25.74 | 44.4         | 26.0  |
| NaCl  | 7    | 34   | 149          | 15-30         | 0.289 | 5.25 | 9.82  | 4.63 | 2.63         | 0.366 | 23.2 | 13.66 | 1.56 | 1.68 | 28.86 | 53.6         | 18.2  |
| NaCl  | 8    | 20   | 72           | 0-15          | 0.456 | 7.02 | 11.39 | 3.69 | 1.90         | 0.479 | 32.8 | 13.99 | 1.95 | 1.23 | 10.95 | 49.7         | 14.5  |
| NaCl  | 8    | 35   | 150          | 0-15          | 0.274 | 4.91 | 7.44  | 1.71 | 0.99         | 0.284 | 20.3 | 7.68  | 1.29 | 1.00 | 12.76 | 34.5         | 15.8  |
| NaCl  | 8    | 35   | 151          | 0-15          | 0.287 | 5.20 | 7.90  | 3.42 | 1.56         | 0.296 | 23.3 | 9.85  | 1.38 | 2.96 | 13.84 | 30.8         | 15.8  |
| NaCl  | 8    | 35   | 152          | 0-15          | 0.255 | 4.68 | 7.17  | 2.89 | 1.19         | 0.264 | 20.9 | 7.69  | 1.33 | 2.63 | 7.25  | 26.6         | <12.0 |
| NaCl  | 8    | 35   | 153          | 0-15          | 0.304 | 5.35 | 7.96  | 2.83 | 1.33         | 0.309 | 22.7 | 8.10  | 1.40 | 2.78 | 9.14  | 31.8         | <12.7 |
| NaCl  | 8    | 35   | 154          | 0-15          | 0.260 | 4.88 | 7.53  | 4.24 | 1.97         | 0.323 | 21.1 | 7.58  | 1.29 | 3.06 | 9.57  | 26.4         | <12.9 |
| NaCl  | 8    | 35   | 155          | 15-30         | 0.529 | 7.63 | 10.34 | 4.02 | 2.11         | 0.433 | 29.9 | 11.07 | 1.86 | 3.37 | 16.25 | 43.3         | 17.1  |
| NaCl  | 8    | 44   | 185          | 0-15          | 0.338 | 6.59 | 10.64 | 5.36 | 3.02         | 0.405 | 30.5 | 14.14 | 1.88 | 2.70 | 4.27  | 56.9         | <13.3 |
| NaCl  | 8    | 44   | 186          | 0-15          | 0.370 | 6.87 | 11.18 | 4.40 | 2.62         | 0.488 | 30.9 | 13.13 | 1.93 | 2.95 | 4.20  | 75.3         | 15.8  |
| NaCl  | 8    | 44   | 187          | 0-15          | 0.361 | 6.82 | 10.82 | 4.14 | 2.14         | 0.482 | 30.5 | 12.51 | 1.86 | 3.64 | <2.60 | 60.3         | <13.0 |
| NaCl  | 8    | 44   | 188          | 0-15          | 0.419 | 7.51 | 12.03 | 4.33 | 1.86         | 0.388 | 33.2 | 12.97 | 2.24 | 4.41 | <2.54 | 66.6         | <12.7 |
| NaCl  | 8    | 44   | 189          | 0-15          | 0.399 | 7.19 | 12.32 | 3.12 | 1.69         | 0.430 | 34.4 | 15.48 | 2.18 | 2.75 | 3.80  | 53.2         | 15.0  |



Continued. Total Elemental Analysis Data for the Soils and Soil/Waste Mixtures in the Esso Field Plot in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Cr   | Ni    | Sr<br>(ug/g) | Li     | Zr    |
|-------|------|------|--------------|---------------|------|-------|--------------|--------|-------|
| KCl   | 4    | 25   | 100          | 15-30         | 43.4 | 27.76 | 100.5        | 18.77  | 83.6  |
| KCl   | 4    | 25   | 101          | 15-30         | 63.8 | 41.48 | 98.8         | 25.86  | 121.1 |
| KCl   | 4    | 25   | 102          | 15-30         | 62.4 | 35.75 | 103.7        | 25.00  | 110.2 |
| KCl   | 4    | 25   | 103          | 15-30         | 57.9 | 27.44 | 101.3        | 24.97  | 105.9 |
| KCl   | 4    | 25   | 104          | 15-30         | 55.9 | 29.60 | 101.2        | 24.89  | 102.9 |
| KCl   | 4    | 25   | 105          | 30-45         | 65.2 | 37.89 | 94.5         | 26.33  | 109.0 |
| KCl   | 4    | 25   | 106          | 45-60         | 54.4 | 30.47 | 100.9        | 24.69  | 114.8 |
| KCl   | 4    | 29   | 124          | 0-15          | 46.6 | 27.44 | 101.0        | 23.55  | 103.7 |
| KCl   | 4    | 29   | 125          | 15-30         | 73.7 | 43.18 | 97.5         | 33.87  | 123.6 |
| KCl   | 4    | 29   | 126          | 30-45         | 64.2 | 30.82 | 106.9        | 25.17  | 116.1 |
| KCl   | 4    | 29   | 127          | 45-60         | 53.1 | 33.79 | 102.8        | 28.48  | 112.8 |
| KCl   | 4    | 29   | 128          | 60-90         | 58.3 | 28.53 | 110.8        | 22.46  | 108.7 |
| KCl   | 5    | 24   | 94           | 0-15          | 54.8 | 22.35 | 89.6         | 14.81  | 94.3  |
| KCl   | 5    | 26   | 107          | 0-15          | 52.9 | 27.46 | 105.7        | 21.25  | 94.1  |
| KCl   | 5    | 37   | 162          | 0-15          | 50.2 | 34.32 | 92.0         | 21.14  | 101.6 |
| NaCl  | 6    | 22   | 78           | 0-15          | 46.8 | 25.87 | 103.2        | 20.69  | 90.9  |
| NaCl  | 6    | 22   | 79           | 15-30         | 56.6 | 36.59 | 78.6         | 24.65  | 92.1  |
| NaCl  | 6    | 22   | 80           | 30-45         | 56.6 | 33.34 | 65.3         | 24.60  | 96.3  |
| NaCl  | 6    | 22   | 81           | 45-60         | 46.9 | 18.51 | 78.2         | 16.04  | 87.6  |
| NaCl  | 6    | 32   | 142          | 0-15          | 42.5 | 34.08 | 78.4         | 23.88  | 98.0  |
| NaCl  | 6    | 41   | 178          | 0-15          | 50.6 | 15.18 | 76.9         | 11.08  | 70.6  |
| NaCl  | 7    | 18   | 59           | 0-15          | 41.6 | 23.17 | 87.9         | 18.39  | 100.0 |
| NaCl  | 7    | 27   | 108          | 0-15          | 47.3 | 22.46 | 96.7         | 21.93  | 96.4  |
| NaCl  | 7    | 27   | 109          | 0-15          | 43.7 | 24.55 | 91.8         | 25.29  | 102.6 |
| NaCl  | 7    | 27   | 110          | 0-15          | 46.1 | 25.51 | 96.9         | 21.71  | 99.6  |
| NaCl  | 7    | 27   | 111          | 0-15          | 47.5 | 29.17 | 96.7         | 28.34  | 107.8 |
| NaCl  | 7    | 27   | 112          | 0-15          | 50.5 | 27.61 | 94.9         | 24.72  | 100.5 |
| NaCl  | 7    | 27   | 113          | 15-30         | 53.5 | 32.72 | 101.1        | 26.50  | 111.4 |
| NaCl  | 7    | 34   | 144          | 0-15          | 43.6 | 33.91 | 89.6         | 28.40  | 100.4 |
| NaCl  | 7    | 34   | 145          | 0-15          | 40.5 | 30.72 | 93.2         | 23.38  | 98.4  |
| NaCl  | 7    | 34   | 146          | 0-15          | 51.1 | 56.25 | 85.6         | 27.99  | 104.4 |
| NaCl  | 7    | 34   | 147          | 0-15          | 55.6 | 38.83 | 80.2         | 28.81  | 101.7 |
| NaCl  | 7    | 34   | 148          | 0-15          | 44.7 | 35.76 | 72.3         | 27.36  | 101.3 |
| NaCl  | 7    | 34   | 149          | 15-30         | 50.9 | 40.26 | 62.6         | 29.35  | 114.7 |
| NaCl  | 8    | 20   | 72           | 0-15          | 50.9 | 23.18 | 94.0         | 19.36  | 81.0  |
| NaCl  | 8    | 35   | 150          | 0-15          | 28.8 | 15.83 | 57.0         | 14.07  | 66.9  |
| NaCl  | 8    | 35   | 151          | 0-15          | 35.3 | 22.88 | 72.9         | 18.08  | 74.8  |
| NaCl  | 8    | 35   | 152          | 0-15          | 26.3 | 11.84 | 64.3         | 12.33  | 68.4  |
| NaCl  | 8    | 35   | 153          | 0-15          | 29.0 | 15.50 | 70.9         | 13.97  | 70.6  |
| NaCl  | 8    | 35   | 154          | 0-15          | 28.2 | 15.77 | 66.5         | 13.45  | 66.5  |
| NaCl  | 8    | 35   | 155          | 15-30         | 41.6 | 29.75 | 98.4         | 18.73  | 89.5  |
| NaCl  | 8    | 44   | 185          | 0-15          | 45.9 | 15.48 | 85.7         | <10.67 | 80.4  |
| NaCl  | 8    | 44   | 186          | 0-15          | 39.3 | 11.36 | 89.4         | 10.62  | 73.4  |
| NaCl  | 8    | 44   | 187          | 0-15          | 37.3 | 9.39  | 89.5         | <10.43 | 69.4  |
| NaCl  | 8    | 44   | 188          | 0-15          | 41.9 | 7.63  | 105.5        | 10.17  | 96.6  |
| NaCl  | 8    | 44   | 189          | 0-15          | 46.9 | 15.65 | 96.6         | 11.85  | 87.6  |



Continued. Total Elemental Analysis Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Mn     | Na   | K     | Ca   | Mg   | P      | Al   | Fe    | Ti   | Ba   | Cu    | Zn   | Mo    | V     |
|-------|------|------|--------------|---------------|--------|------|-------|------|------|--------|------|-------|------|------|-------|------|-------|-------|
|       |      |      |              |               | (mg/g) |      |       |      |      | (ug/g) |      |       |      |      |       |      |       |       |
| NaCl  | 8    | 44   | 190          | 15-30         | 0.340  | 6.66 | 12.63 | 3.05 | 1.82 | 0.426  | 32.0 | 17.23 | 2.07 | 1.64 | 9.72  | 50.0 | 15.3  | 45.82 |
| NaCl  | 8    | 44   | 191          | 15-30         | 0.366  | 6.93 | 12.69 | 3.92 | 2.44 | 0.499  | 34.7 | 17.40 | 2.12 | 2.84 | 8.19  | 55.4 | 15.4  | 47.23 |
| NaCl  | 8    | 44   | 192          | 15-30         | 0.361  | 6.96 | 11.95 | 4.19 | 2.22 | 0.478  | 32.4 | 13.81 | 2.07 | 3.39 | 3.10  | 48.2 | <12.8 | 32.76 |
| NaCl  | 8    | 44   | 193          | 15-30         | 0.510  | 7.35 | 11.21 | 3.93 | 1.59 | 0.378  | 31.0 | 11.28 | 2.07 | 3.91 | 4.73  | 46.2 | 15.3  | 28.10 |
| NaCl  | 8    | 44   | 194          | 15-30         | 0.445  | 7.38 | 11.09 | 3.91 | 1.39 | 0.381  | 30.7 | 11.14 | 2.04 | 4.04 | <2.60 | 48.1 | 13.3  | 26.80 |
| NaCl  | 8    | 44   | 195          | 30-45         | 0.355  | 7.23 | 12.87 | 5.26 | 3.34 | 0.525  | 37.5 | 18.78 | 2.04 | 3.26 | 6.35  | 53.0 | <13.8 | 46.92 |
| NaCl  | 8    | 44   | 196          | 45-60         | 0.365  | 6.45 | 12.60 | 5.43 | 3.21 | 0.444  | 29.8 | 18.30 | 2.09 | 1.74 | 7.15  | 67.4 | <12.3 | 49.20 |
| NaCl  | 9    | 19   | 60           | 0-15          | 0.450  | 6.76 | 11.20 | 4.46 | 2.14 | 0.509  | 32.8 | 12.79 | 1.96 | 2.96 | 6.99  | 40.4 | 14.2  | 37.70 |
| NaCl  | 9    | 19   | 61           | 0-15          | 0.423  | 7.34 | 11.43 | 4.71 | 2.17 | 0.547  | 33.6 | 13.23 | 2.07 | 3.57 | 8.07  | 44.6 | 14.9  | 37.05 |
| NaCl  | 9    | 19   | 62           | 0-15          | 0.379  | 6.84 | 10.60 | 4.53 | 2.44 | 0.432  | 31.7 | 12.75 | 1.97 | 3.00 | 7.95  | 41.3 | <12.8 | 37.71 |
| NaCl  | 9    | 19   | 63           | 0-15          | 0.445  | 6.86 | 10.25 | 5.37 | 2.54 | 0.402  | 28.9 | 10.19 | 1.99 | 3.30 | 6.44  | 44.8 | 13.4  | 31.14 |
| NaCl  | 9    | 19   | 64           | 0-15          | 0.419  | 6.61 | 9.99  | 4.02 | 1.92 | 0.369  | 28.4 | 10.35 | 1.90 | 2.86 | 4.75  | 43.2 | 12.3  | 30.55 |
| NaCl  | 9    | 19   | 65           | 15-30         | 0.520  | 6.75 | 10.70 | 4.86 | 2.27 | 0.548  | 32.7 | 12.58 | 2.00 | 3.50 | 5.25  | 67.2 | 13.2  | 35.73 |
| NaCl  | 9    | 19   | 66           | 15-30         | 0.414  | 7.21 | 12.85 | 4.54 | 2.50 | 0.515  | 37.9 | 16.67 | 2.12 | 1.94 | 11.71 | 74.2 | 16.1  | 51.21 |
| NaCl  | 9    | 19   | 67           | 15-30         | 0.399  | 6.74 | 11.09 | 4.36 | 2.15 | 0.439  | 33.2 | 14.25 | 1.92 | 2.40 | 7.97  | 59.5 | 12.9  | 42.19 |
| NaCl  | 9    | 19   | 68           | 15-30         | 0.346  | 6.31 | 12.13 | 6.02 | 3.89 | 0.463  | 30.5 | 18.01 | 2.12 | 1.46 | 11.80 | 53.1 | <12.2 | 57.52 |
| NaCl  | 9    | 19   | 69           | 15-30         | 0.390  | 6.71 | 13.16 | 6.32 | 3.86 | 0.481  | 33.0 | 19.63 | 2.22 | 1.90 | 15.82 | 61.8 | 13.8  | 61.79 |
| NaCl  | 9    | 19   | 70           | 30-45         | 0.378  | 7.44 | 13.68 | 5.93 | 3.23 | 0.525  | 42.8 | 20.45 | 2.24 | 3.40 | 12.69 | 54.0 | 19.7  | 60.47 |
| NaCl  | 9    | 19   | 71           | 45-60         | 0.342  | 7.17 | 14.11 | 6.14 | 3.62 | 0.529  | 41.0 | 21.93 | 2.30 | 2.67 | 19.26 | 93.5 | 20.5  | 68.68 |
| NaCl  | 9    | 31   | 130          | 0-15          | 0.361  | 7.08 | 11.12 | 4.65 | 2.85 | 0.423  | 33.2 | 13.10 | 1.88 | 2.56 | 17.96 | 47.8 | 22.3  | 47.50 |
| NaCl  | 9    | 31   | 131          | 0-15          | 0.453  | 7.30 | 11.72 | 4.68 | 2.26 | 0.473  | 33.9 | 14.23 | 2.00 | 3.32 | 12.79 | 52.6 | 19.2  | 44.54 |
| NaCl  | 9    | 31   | 132          | 0-15          | 0.381  | 7.02 | 11.26 | 4.12 | 2.19 | 0.433  | 33.1 | 13.87 | 1.88 | 3.06 | 17.46 | 60.0 | 20.4  | 49.46 |
| NaCl  | 9    | 31   | 133          | 0-15          | 0.480  | 6.93 | 11.42 | 4.89 | 2.32 | 0.468  | 33.4 | 13.52 | 2.00 | 3.98 | 14.09 | 48.0 | 19.0  | 47.14 |
| NaCl  | 9    | 31   | 134          | 0-15          | 0.406  | 6.75 | 10.43 | 4.11 | 1.88 | 0.433  | 30.0 | 11.08 | 1.81 | 3.60 | 15.54 | 35.0 | 18.3  | 43.16 |
| NaCl  | 9    | 31   | 135          | 15-30         | 0.285  | 6.96 | 12.63 | 3.60 | 2.26 | 0.470  | 38.4 | 17.41 | 1.95 | 2.15 | 24.80 | 55.4 | 26.7  | 61.44 |
| NaCl  | 9    | 31   | 136          | 15-30         | 0.373  | 7.27 | 13.18 | 4.41 | 2.51 | 0.510  | 38.9 | 17.53 | 2.05 | 2.78 | 23.70 | 48.2 | 26.7  | 61.14 |
| NaCl  | 9    | 31   | 137          | 15-30         | 0.318  | 7.08 | 13.10 | 4.40 | 2.68 | 0.441  | 39.6 | 17.60 | 2.01 | 3.77 | 23.28 | 48.4 | 22.2  | 62.77 |
| NaCl  | 9    | 31   | 138          | 15-30         | 0.298  | 6.67 | 12.60 | 3.73 | 2.41 | 0.447  | 38.1 | 17.44 | 1.87 | 2.13 | 28.97 | 48.8 | 23.7  | 64.56 |
| NaCl  | 9    | 31   | 139          | 15-30         | 0.354  | 7.06 | 12.62 | 4.58 | 2.16 | 0.538  | 36.1 | 17.44 | 1.90 | 3.57 | 21.73 | 41.9 | 22.2  | 57.27 |
| NaCl  | 9    | 31   | 140          | 30-45         | 0.293  | 7.16 | 14.01 | 3.73 | 2.42 | 0.473  | 42.1 | 19.33 | 2.07 | 3.02 | 30.06 | 48.6 | 27.0  | 71.16 |
| NaCl  | 9    | 31   | 141          | 45-60         | 0.270  | 7.10 | 13.47 | 4.17 | 2.88 | 0.446  | 41.3 | 18.24 | 2.05 | 3.96 | 24.98 | 48.1 | 25.3  | 67.08 |
| NaCl  | 9    | 36   | 156          | 0-15          | 0.368  | 6.76 | 11.48 | 3.48 | 2.30 | 0.437  | 32.3 | 14.86 | 1.90 | 2.39 | 16.57 | 45.7 | 21.0  | 49.95 |
| NaCl  | 9    | 36   | 157          | 0-15          | 0.400  | 7.17 | 11.32 | 4.41 | 2.71 | 0.419  | 32.7 | 13.98 | 1.90 | 3.06 | 14.77 | 42.6 | 18.3  | 49.32 |
| NaCl  | 9    | 36   | 158          | 0-15          | 0.356  | 6.72 | 11.21 | 4.20 | 2.44 | 0.424  | 29.7 | 14.40 | 1.93 | 2.00 | 18.40 | 45.6 | 17.9  | 52.68 |
| NaCl  | 9    | 36   | 159          | 0-15          | 0.356  | 6.66 | 11.31 | 4.43 | 2.82 | 0.451  | 32.6 | 14.39 | 1.91 | 3.16 | 25.12 | 42.7 | 23.2  | 54.43 |
| NaCl  | 9    | 36   | 160          | 0-15          | 0.334  | 6.60 | 11.39 | 3.54 | 2.38 | 0.436  | 31.7 | 14.10 | 1.88 | 2.40 | 17.70 | 43.1 | 19.0  | 48.47 |
| NaCl  | 9    | 36   | 161          | 15-30         | 0.309  | 7.47 | 13.93 | 5.43 | 3.37 | 0.571  | 42.1 | 19.64 | 2.15 | 3.95 | 21.01 | 48.1 | 22.1  | 66.90 |
| NaCl  | 10   | 23   | 82           | 0-15          | 0.368  | 7.19 | 11.20 | 4.74 | 2.84 | 0.580  | 32.3 | 13.21 | 1.91 | 2.89 | 14.99 | 45.2 | 13.9  | 41.97 |
| NaCl  | 10   | 23   | 83           | 0-15          | 0.391  | 7.95 | 10.96 | 4.38 | 2.37 | 0.424  | 29.3 | 11.54 | 1.91 | 2.59 | 12.20 | 48.5 | 16.3  | 41.78 |
| NaCl  | 10   | 23   | 84           | 0-15          | 0.430  | 7.36 | 11.09 | 4.15 | 2.45 | 0.479  | 30.5 | 11.46 | 1.85 | 2.23 | 10.58 | 49.9 | 15.5  | 41.52 |
| NaCl  | 10   | 23   | 85           | 0-15          | 0.410  | 7.66 | 10.89 | 5.04 | 2.65 | 0.427  | 32.1 | 11.72 | 1.87 | 3.87 | 15.63 | 44.1 | 16.2  | 38.37 |
| NaCl  | 10   | 23   | 86           | 0-15          | 0.418  | 7.35 | 11.25 | 2.65 | 1.40 | 0.436  | 29.5 | 11.15 | 1.87 | 0.95 | 9.13  | 35.2 | 12.8  | 36.94 |
| NaCl  | 10   | 23   | 87           | 15-30         | 0.382  | 7.42 | 11.14 | 4.58 | 2.25 | 0.416  | 32.5 | 11.67 | 1.88 | 2.95 | 8.91  | 36.5 | 18.7  | 36.80 |
| NaCl  | 10   | 23   | 88           | 15-30         | 0.402  | 6.67 | 11.04 | 5.09 | 3.01 | 0.400  | 28.2 | 13.55 | 1.81 | 2.05 | 11.23 | 40.4 | <12.4 | 44.16 |
| NaCl  | 10   | 23   | 89           | 15-30         | 0.357  | 6.33 | 11.55 | 5.72 | 3.40 | 0.442  | 29.8 | 16.03 | 1.86 | 2.24 | 11.69 | 44.2 | 15.5  | 49.55 |
| NaCl  | 10   | 23   | 90           | 15-30         | 0.672  | 6.93 | 12.20 | 3.96 | 1.98 | 0.436  | 34.7 | 15.70 | 1.93 | 1.73 | 7.37  | 72.1 | 16.1  | 45.79 |
| NaCl  | 10   | 23   | 91           | 15-30         | 0.267  | 6.99 | 12.03 | 4.22 | 2.84 | 0.390  | 38.6 | 15.37 | 2.09 | 3.24 | 9.15  | 43.8 | 16.1  | 51.02 |

Continued. Total Elemental Analysis Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Cr   | Ni    | Sr<br>(ug/g) | Li     | Zr    |
|-------|------|------|--------------|---------------|------|-------|--------------|--------|-------|
| NaCl  | 8    | 44   | 190          | 15-30         | 51.8 | 19.44 | 75.4         | 17.82  | 80.8  |
| NaCl  | 8    | 44   | 191          | 15-30         | 51.1 | 15.66 | 89.4         | 14.94  | 91.3  |
| NaCl  | 8    | 44   | 192          | 15-30         | 44.9 | 11.09 | 93.6         | 10.83  | 82.0  |
| NaCl  | 8    | 44   | 193          | 15-30         | 39.5 | 9.46  | 101.8        | 12.52  | 85.7  |
| NaCl  | 8    | 44   | 194          | 15-30         | 41.6 | 8.33  | 104.3        | <10.40 | 87.2  |
| NaCl  | 8    | 44   | 195          | 30-45         | 56.6 | 17.94 | 99.4         | 14.08  | 102.9 |
| NaCl  | 8    | 44   | 196          | 45-60         | 54.0 | 18.16 | 76.8         | 14.00  | 87.8  |
| NaCl  | 9    | 19   | 60           | 0-15          | 41.7 | 16.73 | 100.4        | 14.73  | 89.9  |
| NaCl  | 9    | 19   | 61           | 0-15          | 48.4 | 18.65 | 103.1        | 15.88  | 92.5  |
| NaCl  | 9    | 19   | 62           | 0-15          | 44.4 | 20.27 | 98.5         | 15.39  | 81.3  |
| NaCl  | 9    | 19   | 63           | 0-15          | 39.5 | 16.65 | 99.9         | 13.16  | 88.1  |
| NaCl  | 9    | 19   | 64           | 0-15          | 39.6 | 15.10 | 95.5         | 11.55  | 84.7  |
| NaCl  | 9    | 19   | 65           | 15-30         | 41.7 | 26.74 | 100.4        | 14.24  | 79.7  |
| NaCl  | 9    | 19   | 66           | 15-30         | 49.8 | 28.93 | 97.6         | 19.06  | 90.2  |
| NaCl  | 9    | 19   | 67           | 15-30         | 45.2 | 22.04 | 97.3         | 15.71  | 83.7  |
| NaCl  | 9    | 19   | 68           | 15-30         | 47.4 | 26.55 | 74.5         | 17.94  | 90.5  |
| NaCl  | 9    | 19   | 69           | 15-30         | 62.3 | 31.14 | 80.8         | 18.79  | 99.4  |
| NaCl  | 9    | 19   | 70           | 30-45         | 60.5 | 30.50 | 111.2        | 19.98  | 95.3  |
| NaCl  | 9    | 19   | 71           | 45-60         | 73.0 | 36.49 | 95.5         | 22.81  | 110.2 |
| NaCl  | 9    | 31   | 130          | 0-15          | 49.2 | 23.35 | 94.6         | 20.80  | 94.7  |
| NaCl  | 9    | 31   | 131          | 0-15          | 48.8 | 11.37 | 96.4         | 15.87  | 99.0  |
| NaCl  | 9    | 31   | 132          | 0-15          | 48.9 | 60.30 | 93.1         | 18.78  | 97.9  |
| NaCl  | 9    | 31   | 133          | 0-15          | 43.6 | 41.99 | 97.3         | 17.34  | 104.8 |
| NaCl  | 9    | 31   | 134          | 0-15          | 41.4 | 35.76 | 92.5         | 18.99  | 95.2  |
| NaCl  | 9    | 31   | 135          | 15-30         | 72.7 | 51.80 | 93.4         | 26.18  | 103.6 |
| NaCl  | 9    | 31   | 136          | 15-30         | 76.8 | 51.98 | 97.5         | 25.32  | 109.1 |
| NaCl  | 9    | 31   | 137          | 15-30         | 62.2 | 39.75 | 98.6         | 25.37  | 110.1 |
| NaCl  | 9    | 31   | 138          | 15-30         | 62.4 | 50.76 | 91.6         | 27.86  | 108.4 |
| NaCl  | 9    | 31   | 139          | 15-30         | 58.3 | 40.91 | 97.2         | 23.78  | 107.9 |
| NaCl  | 9    | 31   | 140          | 30-45         | 76.6 | 50.61 | 96.1         | 31.60  | 115.9 |
| NaCl  | 9    | 31   | 141          | 45-60         | 61.1 | 41.82 | 101.0        | 27.43  | 108.1 |
| NaCl  | 9    | 36   | 156          | 0-15          | 50.9 | 29.67 | 89.0         | 20.53  | 97.2  |
| NaCl  | 9    | 36   | 157          | 0-15          | 44.3 | 28.54 | 90.4         | 19.28  | 98.6  |
| NaCl  | 9    | 36   | 158          | 0-15          | 50.7 | 31.00 | 83.9         | 21.93  | 93.8  |
| NaCl  | 9    | 36   | 159          | 0-15          | 50.5 | 33.78 | 90.2         | 23.73  | 99.1  |
| NaCl  | 9    | 36   | 160          | 0-15          | 51.0 | 31.55 | 89.2         | 21.29  | 96.4  |
| NaCl  | 9    | 36   | 161          | 15-30         | 64.7 | 40.36 | 105.1        | 24.05  | 110.6 |
| NaCl  | 10   | 23   | 82           | 0-15          | 46.3 | 17.17 | 96.8         | 16.35  | 90.5  |
| NaCl  | 10   | 23   | 83           | 0-15          | 55.5 | 21.80 | 92.4         | 15.31  | 84.3  |
| NaCl  | 10   | 23   | 84           | 0-15          | 42.1 | 13.84 | 93.9         | 14.93  | 82.0  |
| NaCl  | 10   | 23   | 85           | 0-15          | 40.6 | 12.22 | 99.5         | 14.78  | 87.0  |
| NaCl  | 10   | 23   | 86           | 0-15          | 41.5 | 20.21 | 86.5         | 13.90  | 76.7  |
| NaCl  | 10   | 23   | 87           | 15-30         | 40.8 | 13.80 | 102.1        | 14.38  | 79.1  |
| NaCl  | 10   | 23   | 88           | 15-30         | 43.2 | 14.47 | 79.8         | 14.97  | 87.1  |
| NaCl  | 10   | 23   | 89           | 15-30         | 53.6 | 20.08 | 82.1         | 15.50  | 86.9  |
| NaCl  | 10   | 23   | 90           | 15-30         | 46.8 | 14.21 | 94.7         | 15.53  | 83.2  |
| NaCl  | 10   | 23   | 91           | 15-30         | 49.6 | 19.69 | 99.0         | 18.58  | 94.8  |

Continued. Total Elemental Analysis Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Mn    | Na   | K     | Ca   | Mg<br>(mg/g) | P     | Al   | Fe    | Ti   | Ba   | Cu    | Zn<br>(ug/g) | Mo    | V     |
|-------|------|------|--------------|---------------|-------|------|-------|------|--------------|-------|------|-------|------|------|-------|--------------|-------|-------|
| NaCl  | 10   | 23   | 92           | 30-45         | 0.325 | 6.00 | 11.72 | 6.74 | 4.35         | 0.429 | 28.9 | 16.82 | 1.92 | 1.88 | 13.84 | 53.4         | 14.4  | 53.97 |
| NaCl  | 10   | 23   | 93           | 45-60         | 0.344 | 5.97 | 11.48 | 4.89 | 3.11         | 0.415 | 27.4 | 16.35 | 1.85 | 1.72 | 17.98 | 52.4         | <12.4 | 52.44 |
| NaCl  | 10   | 28   | 114          | 0-15          | 0.570 | 7.57 | 10.70 | 5.13 | 2.44         | 0.469 | 29.1 | 10.96 | 1.94 | 3.11 | 24.22 | 45.8         | 23.4  | 47.12 |
| NaCl  | 10   | 28   | 115          | 0-15          | 0.395 | 7.96 | 11.38 | 3.99 | 2.40         | 0.470 | 31.4 | 16.26 | 1.87 | 1.85 | 29.39 | 54.4         | 32.0  | 52.61 |
| NaCl  | 10   | 28   | 116          | 0-15          | 0.397 | 7.44 | 10.31 | 4.76 | 2.31         | 0.434 | 29.6 | 10.90 | 1.73 | 4.03 | 23.34 | 55.1         | 22.5  | 45.05 |
| NaCl  | 10   | 28   | 117          | 0-15          | 0.351 | 7.54 | 11.12 | 3.96 | 2.41         | 0.451 | 32.3 | 13.37 | 1.81 | 2.01 | 23.91 | 52.5         | 26.2  | 52.20 |
| NaCl  | 10   | 28   | 118          | 0-15          | 0.358 | 7.35 | 11.22 | 4.19 | 2.33         | 0.515 | 32.7 | 12.96 | 1.80 | 2.22 | 24.82 | 55.3         | 26.8  | 53.34 |
| NaCl  | 10   | 28   | 119          | 15-30         | 0.573 | 7.73 | 12.92 | 4.60 | 2.50         | 0.449 | 36.6 | 15.38 | 2.07 | 2.80 | 24.86 | 85.1         | 27.9  | 56.39 |
| NaCl  | 10   | 28   | 120          | 15-30         | 0.412 | 6.89 | 12.26 | 4.77 | 2.63         | 0.433 | 36.7 | 16.71 | 1.93 | 3.22 | 26.61 | 77.5         | 27.9  | 60.86 |
| NaCl  | 10   | 28   | 121          | 15-30         | 0.349 | 7.04 | 11.22 | 4.47 | 2.28         | 0.418 | 29.4 | 10.77 | 1.68 | 2.81 | 25.72 | 68.9         | 25.4  | 44.64 |
| NaCl  | 10   | 28   | 122          | 15-30         | 0.380 | 6.89 | 11.98 | 4.30 | 2.39         | 0.433 | 37.6 | 17.44 | 1.94 | 2.69 | 22.37 | 101.1        | 25.9  | 61.74 |
| NaCl  | 10   | 28   | 123          | 15-30         | 0.343 | 7.06 | 11.83 | 4.90 | 2.70         | 0.481 | 35.4 | 14.13 | 1.87 | 3.84 | 24.65 | 57.2         | 24.9  | 56.62 |
| NaCl  | 10   | 38   | 163          | 0-15          | 0.343 | 7.00 | 10.40 | 5.26 | 2.80         | 0.390 | 30.3 | 13.90 | 1.84 | 3.37 | 8.52  | 41.0         | 16.8  | 37.20 |
| NaCl  | 10   | 38   | 164          | 0-15          | 0.335 | 6.40 | 10.50 | 5.35 | 2.96         | 0.403 | 29.0 | 13.34 | 1.83 | 2.63 | 11.12 | 59.8         | 16.4  | 40.33 |
| NaCl  | 10   | 38   | 165          | 0-15          | 0.331 | 6.70 | 10.51 | 5.24 | 2.90         | 0.419 | 29.4 | 12.47 | 1.83 | 3.20 | 11.03 | 48.0         | 16.8  | 39.14 |
| NaCl  | 10   | 38   | 166          | 0-15          | 0.343 | 6.46 | 10.31 | 5.09 | 2.91         | 0.393 | 29.6 | 12.29 | 1.80 | 3.26 | 9.85  | 40.5         | 18.4  | 40.20 |
| NaCl  | 10   | 38   | 167          | 0-15          | 0.335 | 6.96 | 10.79 | 3.57 | 2.26         | 0.406 | 29.4 | 14.13 | 1.88 | 2.44 | 34.71 | 74.3         | 17.8  | 44.66 |
| NaCl  | 10   | 38   | 168          | 15-30         | 0.353 | 6.52 | 10.72 | 4.82 | 2.34         | 0.413 | 33.2 | 14.02 | 1.81 | 3.79 | 10.24 | 37.2         | 19.9  | 42.31 |
| NaCl  | 10   | 38   | 169          | 15-30         | 0.311 | 7.35 | 11.53 | 4.72 | 2.61         | 0.411 | 35.6 | 16.45 | 1.84 | 3.34 | 12.08 | 50.8         | 23.3  | 48.04 |
| NaCl  | 10   | 38   | 170          | 15-30         | 0.373 | 6.42 | 10.70 | 5.15 | 2.71         | 0.394 | 32.6 | 13.57 | 1.81 | 4.02 | 9.63  | 44.2         | 19.0  | 40.78 |
| NaCl  | 10   | 38   | 171          | 15-30         | 0.352 | 6.68 | 10.96 | 4.06 | 1.67         | 0.427 | 32.7 | 13.95 | 1.82 | 3.05 | 10.78 | 48.0         | 19.8  | 41.60 |
| NaCl  | 10   | 38   | 172          | 15-30         | 0.462 | 6.79 | 10.38 | 4.65 | 1.81         | 0.426 | 30.1 | 14.22 | 1.81 | 4.18 | 6.91  | 46.1         | 14.6  | 32.77 |
| NaCl  | 10   | 38   | 173          | 30-45         | 0.332 | 6.05 | 11.77 | 3.89 | 2.37         | 0.434 | 37.4 | 18.06 | 1.86 | 3.73 | 12.11 | 47.2         | 18.0  | 52.89 |
| NaCl  | 10   | 38   | 174          | 45-60         | 0.351 | 7.54 | 14.24 | 4.61 | 2.69         | 0.508 | 43.1 | 19.98 | 2.22 | 4.41 | 12.74 | 47.9         | 21.0  | 58.06 |
| NaCl  | 10   | 38   | 175          | 60-90         | 0.060 | 6.93 | 13.42 | 4.22 | 2.40         | 0.493 | 42.0 | 20.76 | 2.15 | 4.39 | 9.32  | 77.6         | 17.0  | 58.41 |

Concluded. Total Elemental Analysis Data for the Soils and Soil/Waste Mixtures in the Esso Field Plots in 1989.

| Waste | Rate | Plot | FSN<br>(TME) | Depth<br>(cm) | Cr   | Ni    | Sr<br>(ug/g) | Li    | Zr    |
|-------|------|------|--------------|---------------|------|-------|--------------|-------|-------|
| NaCl  | 10   | 23   | 92           | 30-45         | 54.8 | 20.20 | 78.9         | 18.27 | 87.5  |
| NaCl  | 10   | 23   | 93           | 45-60         | 56.9 | 25.72 | 72.4         | 19.73 | 90.6  |
| NaCl  | 10   | 28   | 114          | 0-15          | 49.8 | 28.75 | 95.3         | 25.56 | 106.7 |
| NaCl  | 10   | 28   | 115          | 0-15          | 57.6 | 33.80 | 94.6         | 31.45 | 117.6 |
| NaCl  | 10   | 28   | 116          | 0-15          | 51.6 | 32.57 | 98.0         | 24.70 | 109.7 |
| NaCl  | 10   | 28   | 117          | 0-15          | 53.5 | 32.91 | 92.6         | 29.31 | 104.4 |
| NaCl  | 10   | 28   | 118          | 0-15          | 51.9 | 31.66 | 96.7         | 29.67 | 107.8 |
| NaCl  | 10   | 28   | 119          | 15-30         | 57.9 | 38.70 | 102.8        | 25.89 | 115.3 |
| NaCl  | 10   | 28   | 120          | 15-30         | 69.0 | 40.31 | 98.3         | 28.98 | 111.7 |
| NaCl  | 10   | 28   | 121          | 15-30         | 45.2 | 30.45 | 96.7         | 28.08 | 102.9 |
| NaCl  | 10   | 28   | 122          | 15-30         | 56.2 | 29.82 | 93.4         | 27.26 | 114.2 |
| NaCl  | 10   | 28   | 123          | 15-30         | 52.0 | 29.80 | 100.2        | 28.99 | 110.0 |
| NaCl  | 10   | 38   | 163          | 0-15          | 43.3 | 20.30 | 91.6         | 12.75 | 81.2  |
| NaCl  | 10   | 38   | 164          | 0-15          | 46.7 | 48.95 | 84.3         | 14.74 | 81.8  |
| NaCl  | 10   | 38   | 165          | 0-15          | 42.2 | 42.18 | 87.9         | 16.26 | 90.4  |
| NaCl  | 10   | 38   | 166          | 0-15          | 41.0 | 32.75 | 87.3         | 16.51 | 84.4  |
| NaCl  | 10   | 38   | 167          | 0-15          | 48.6 | 24.99 | 79.1         | 15.73 | 89.5  |
| NaCl  | 10   | 38   | 168          | 15-30         | 50.7 | 23.18 | 92.4         | 15.63 | 81.9  |
| NaCl  | 10   | 38   | 169          | 15-30         | 50.2 | 22.78 | 93.3         | 17.02 | 89.5  |
| NaCl  | 10   | 38   | 170          | 15-30         | 46.7 | 18.12 | 92.6         | 13.59 | 80.4  |
| NaCl  | 10   | 38   | 171          | 15-30         | 43.7 | 17.72 | 91.2         | 15.41 | 86.5  |
| NaCl  | 10   | 38   | 172          | 15-30         | 39.2 | 14.85 | 92.4         | 11.01 | 78.6  |
| NaCl  | 10   | 38   | 173          | 30-45         | 48.7 | 23.23 | 86.2         | 16.56 | 83.0  |
| NaCl  | 10   | 38   | 174          | 45-60         | 58.1 | 28.61 | 106.2        | 17.28 | 109.9 |
| NaCl  | 10   | 38   | 175          | 60-90         | 54.3 | 15.91 | 96.0         | 12.61 | 83.6  |

