New Mexico Bureau of Mines and Mineral Resources

Open-File Report 214

RECHARGE IN THE SALT LAKE COAL FIELD BASED ON CHLORIDE IN THE UNSATURATED ZONE

by

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INTRODUCTION

Problem and Purpose

The Salt Lake coal field is located north and west of the village of Quemado in northern Catron County, New Mexico (Figure 1). This coal field differs from most of those in the northwestern part of the state in that the coal generally lies below the regional water table and dewatering will be necessary for mining.

Although proper evaluation of mine-permit applications requires information on both pre-mining hydrogeology of the area and the potential hydrologic impact of specific mining activities, few data are currently available. Recent exploration and leasing activity have intensified the need for such information. In response to this need, the New Mexico Bureau of Mines and Mineral Resources undertook two hydrologic studies of the area. Love and others (1984) assessed the presence of alluvial valley floors and this report addresses ground-water recharge.

Recharge is an important factor in assessing hydrologic impact of mining, because it is a major component of the water budget of the area. However, recharge data are not available for the Salt Lake coal field. The purpose of this phase of the hydrogeologic study was, therefore, to determine rates and controls of recharge in various landscape settings typical of the Salt Lake coal field.

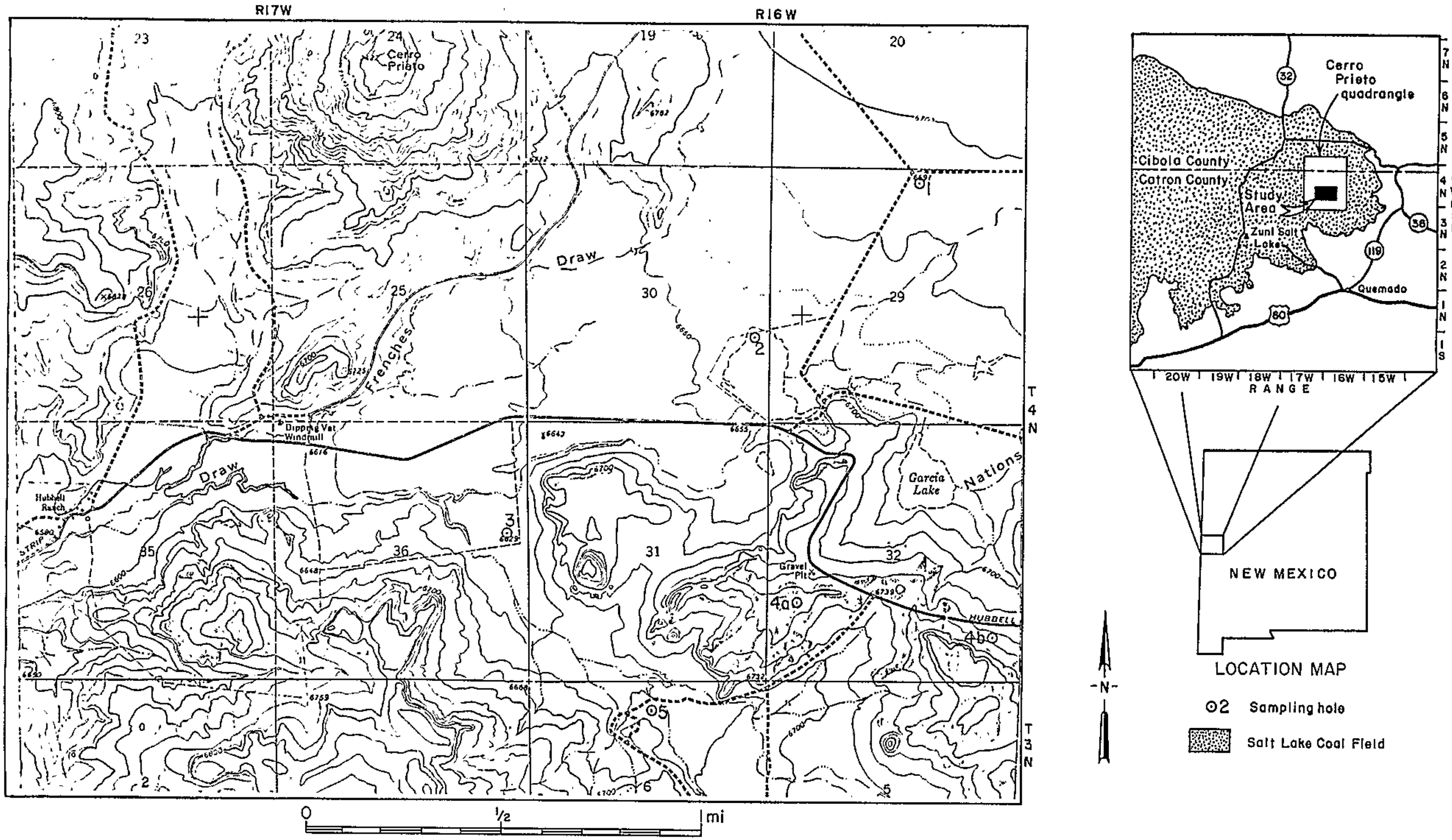

Figure 1. Location of study area and sampling holes in Cerro Prieto quadrangle.

Regional Setting

The Salt Lake coal field lies in a southwestern extension of the San Juan Basin, a large Laramide (Late Cretaceous - Early Tertiary) depression at the eastern edge of the Colorado Plateau. More specifically, it is situated in the Gallup Sag, a north-south-trending sub-basin of the major depression, lying southwest of the Zuni Uplift.

An area in Cerro Prieto quadrangle was chosen for study because current development activity (by the Salt River Project) is focused there (Figure 1). This area is likely to be the first and major area mined for coal. Thus, recharge data from there would be most needed in evaluating hydrologic impact of mining.

The geology and coal resources of the Cerro Prieto quadrangle have been described in detail by Campbell (1981 and 1984). The coal will be mined from the Moreno Hill Formation (Cretaceous) which lies at the surface or below alluvial cover throughout the quadrangle. According to Campbell (1984), the Moreno Hill is approximately 880 ft thick in the study area and consists of a lower, fluvial, coal-bearing member (440 ft thick), a middle, fluvial-sandstone member (80 ft thick), and an upper, predominantly fluvial-mudstone member (360 ft thick).

The Moreno Hill Formation is underlain by the Atarque Sandstone. This unit does not crop out in the study area, but has been described elsewhere by McLellan and others (1983). Campbell (1984) gave a thickness of 25 ft for the Atarque in the study area based on geophysical logs; McLellan and others (1983) gave a thickness of approximately 98 ft for a reference section in Cibola County.

Although work on the hydrogeologic system of the area is still under way, a few generalizations are possible. Water sources or aquifers include the alluvium, overlying the Moreno Hill Formation, and the Atarque Sandstone, below these coal-bearing strata. A well drilled by the Salt River Project has shown that the Dakota Sandstone is a significant, deep, artesian aquifer in the region; 160 gpm of good quality water flows from a depth of 1080 ft (Salt River Project, 1983). Local channel sandstones in the Moreno Hill may also provide small supplies of water where saturated. In some places, water in thin alluvial sequences may be perched on the less permeable strata of the Moreno Hill Formation. Water may also be perched on clay layers in the alluvium.

Climatic data on the area have been presented by Gabin and Lesperance (1977). The average annual precipitation at Quemado Ranger Station is 9.9 inches (based on 31 yrs of record) and potential evaporation is 31.04 inches, or three times the rainfall. Half the average annual precipitation occurs in thunderstorms (often heavy) during the period July through September. Such storms involve moisture from the Gulf of Mexico. Winter is the driest period, because much of the moisture in storms originating from the Pacific Ocean is lost in crossing the mountains west of the study area (Maker and others, 1972).

Based on a statewide map by the Soil Conservation Service (U.S. Bureau of Reclamation, 1976), northern Catron County is covered by moderately dark colored soils of the western Plateau region. More specifically, soils in the study area include Haplargids, Torriorthents, and Rockland (outcrop areas). More detailed mapping of the area soils is currently under way by the Soil Conservation Service.

As mapped by the Soil Conservation Service, vegetation in the Cerro Prieto quadrangle may be divided into two categories: trees and grasslands (U.S. Bureau of Reclamation, 1976). The trees consist mainly of piñon and juniper. They are often accompanied by an understory of grasses and forbs. The grasslands are dominated by grasses, but cholla, prickly-pear cacti, broom snakeweed, yucca, and varied forbs also occur.

APPROACH AND METHODS

Chloride Method

Recharge may be determined by various methods, employing either chemical or physical parameters. In this study, recharge was estimated from the amount of chloride in the water in the unsaturated zone. This method was selected because data on physical characteristics of the ground-water body are limited and it is relatively simple and inexpensive. Results are considered estimates because it is assumed that 1) recharge occurs only by piston flow, 2) precipitation is the sole source of chloride entering the ground, 3) precipitation has been constant through the time represented by the samples and 4) chloride content of precipitation has also been constant during this time. Nonetheless, recharge values obtained by this method compare favorably with results of other more expensive and complex methods, such as isotope or neutron-probe studies (Stone, 1984; Allison and others, in press).

In this method, recharge is determined from the relationship $R = Clp/Clsw \times P$, where R = recharge (inches/yr), Clp = average chloride concentration in local precipitation (mg/L), Clsw = average chloride concentration (mg/L) in the soil water, and P = average annual precipitation (inches/yr). Clp and P are either measured or obtained from the literature. Clsw is determined from plots of analytical results.

Although Clp in the study area is not known, it has been determined at Socorro, New Mexico, approximately 100 mi to the east. Clp at Socorro is 0.375 mg/L (Phillips and others, 1984). Precipitation at Quemado and Socorro is the same, approximately 10 inches, and Clp should be similar, based on distance from the ocean. P used for the study area is that reported by Gabin and Lesperance (1977) for Quemado Ranger Station: 9.9 inches.

Clsw varies from site to site and is the only part of the recharge equation that changes. Clsw is determined from chloride vs depth profiles. The median value or arithmetic mean may be used. In this study, the median value was used so as to reflect the extremes of the fluctuating profiles.

Recharge is inversely proportional to Clsw; the higher the Clsw, the lower the recharge and vice versa. Relatively higher moisture content also indicates relatively higher recharge.

Sampling

Recharge was determined at five landscape settings typical of the study area: thick alluvium, ephemeral lake, thin alluvium, tree-covered bedrock, and grass-covered bedrock (Table 1). Such settings represent the main combinations of geology, slope, vegetation, and land-use history found in the study area. Examples of these settings from the areas leased by Salt River Project were selected for sampling (Figure 1).

Although the six holes drilled cover the major settings, they represent only two soil types. According to preliminary maps for the Catron County Soil Survey, Holes 1, 2, 3, 4B, and 5 were drilled in soil unit 425, Catman-Hickman complex, and Hole 4A was drilled in unit 330, Tejana-Rockland complex (Rod McNatt, Soil Conservation Service, Datil, personal communication, 1984).

Table 1. Source of Samples

Hole	Setting	Location	Total Depth (ft)	Water-Level Depth (ft) [1]
1	Thick Alluvium	NW,NW, sec 29, T4N, R16W	67	63 (66)
2	Ephemeral Lake	NE,SE, sec 30, T4N, R16W	49	43 (46.5)
3	Thin Alluvium	SE,NE, sec 36, T4N, R17W	44	37 (37)
4a	Bedrock/Trees	NW,SW, sec 32, T4N, R16W	40	>40 [2]
4b	Bedrock/Trees	SE,SE, sec 32, T4N, R16W	44	>44 [2]
5	Bedrock/Grass	NW,NE, sec 6, T3N, R16W	59	54 (54)

[1] numbers in parentheses are measurements made with electrical water-level indicator; where water level had not stabilized, depth was adjusted according to observations from cores and chloride profiles.

[2] saturated zone not reached at this site

Samples of the unsaturated zone were obtained by means of a CME-55 hollow-stem-auger rig, under contract with Fox and Associates of New Mexico, Incorporated, Albuquerque. Holes were cored continuously, 5 ft at a time using a 5-ft split core barrel. Recovery in bedrock was generally 100% except in the upper 5-15 ft where it ranged from 0 (rare) to 80%. Recovery in alluvium ranged from 80-100%. Drilling was done without air, mud, or water circulation, in order to preserve natural soil-moisture content in the samples.

A single sample, placed in a 1-oz covered plastic jar and sealed with plastic electrical tape, served for both soil-moisture and chloride determinations. Such samples were taken at approximately 0.5-ft intervals in the upper 5 ft and at 1-ft intervals below that. Where recovery was less than 100%, a convention was adopted of assigning the material obtained to the upper part of the depth interval represented. For example, if only 3 ft were recovered from a depth of 4-9 ft, it was assumed to represent the interval 4-7 ft.

Analysis

Recharge determination by the chloride method involves several steps (Figure 2). First, soil moisture is determined gravimetrically. The oven-dried sample is then shaken mechanically for 6 hours with a known amount of deionized water to remove salt originally dissolved in the soil water. Next, the chloride content of this extract is determined by means of either a specific-ion electrode or mercuric-nitrate titration, if the concentration is below the detection limit of the electrode (1.85

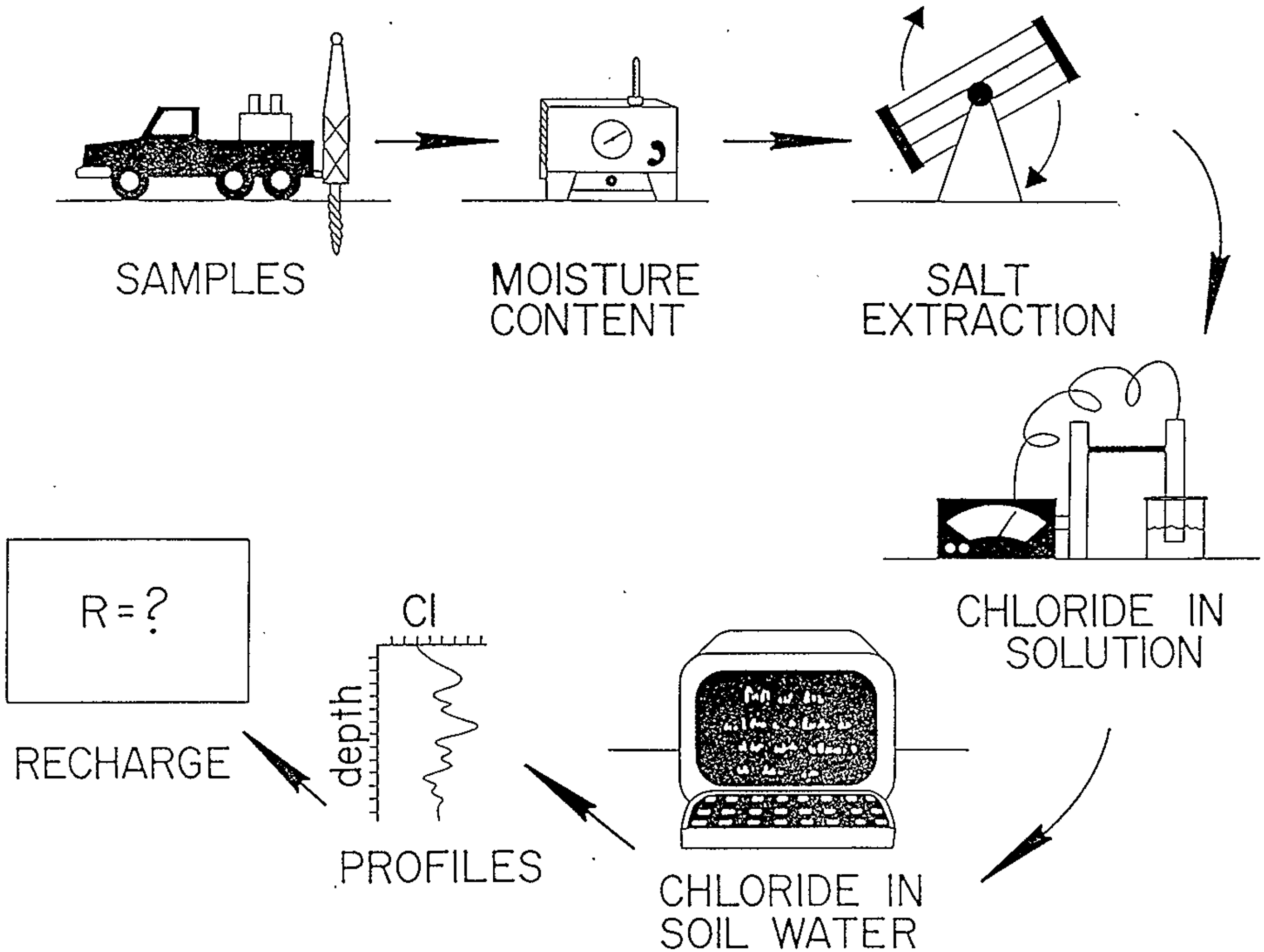

Figure 2. Flow diagram for chloride method.

mg/L). The chloride concentration of the original soil water is then calculated with a computer program, based on the chloride content of the extract, the soil-moisture content, the amount of dry sample used, and the amount of deionized water added (Appendix A).

Resulting chloride values are plotted against depth on arithmetic graph paper. The profiles produced typically show an increase in the chloride content through the root zone to a maximum value, that is more or less maintained to the water table. The average chloride value below the peak is what is used as Clsw to estimate recharge in an undisturbed area. In areas where land-use has been modified, the pre-modification rate is based on the average chloride content of the lower part of the profile, whereas, current or post-modification recharge is based on the average chloride content of the upper part of the profile.

In profiles where the chloride content decreases with depth below the peak, one of two conditions may be assumed. Either fresh water is reaching the lower part of the profile by other than piston flow, or conditions at the site were more favorable for recharge at the time represented by the lower part of the profile. In the case of non-piston flow, fresh water moves rapidly downward along fractures, roots, animal burrows, or other highly conductive features. If this is not the case, precipitation, chloride input, and/or recharge can be assumed to have changed with time (Allison and others, in press).

Plots of cumulative chloride content (g/m^2) vs cumulative water content (m) on arithmetic graph paper help identify periods of change at sites where the chloride content decreases markedly with depth. Cumulative chloride is obtained as follows:

$$\sum_i (\theta vi \cdot Clswi) \cdot di,$$

where vi = volumetric water content (m^3/m^3) at depth i (volumetric water content = gravimetric water content • bulk density), Clswi = chloride content (g/m^3) at depth i, and di = sample interval length at depth i (Appendix B); similarly, cumulative water content is the $\sum_i (\theta vi \cdot di)$.

Such plots should give a straight line if there has been no change in precipitation, chloride input, and/or recharge. If there has been a change in any of these conditions, the plots result in curved lines. These curves are often characterized by straight-line segments, representing periods of constant conditions. The age of the end points of such segments may be estimated from the relationship A = Clsw/Clp • P, where A = age (yrs), Clsw = cumulative chloride content (g/m^2) of the water in the unsaturated zone at that point, Clp = modern chloride content (g/m^3) of precipitation, and P = modern average annual precipitation (m/yr). Additionally, recharge rates for each segment of the cumulative chloride vs cumulative water plot may be estimated as for the chloride vs depth plots, using the modern chloride content of precipitation (mg/L), the average chloride content (mg/L) of the soil water in the samples corresponding to the segment, and modern precipitation (inches/yr). Clsw values used in this study are shown in Tables 2 and 3.

Table 2. Determination of Soil-Water Chloride (Clsw) From Chloride *vs* Depth Plots

Hole	Setting	Cl min (mg/L)	Cl max (mg/L)	Range (mg/L)	Range/2 (mg/L)	Clsw[1] (mg/L)
1	Thick Alluvium	9.66	83.09	73.42	36.71	46.37
2	Ephemeral Lake[2]	43.87 200.97	44.13 285.48	0.26 84.51	0.13 42.25	44.00 243.22
3	Thin Alluvium	15.59	72.10	56.51	28.25	43.84
4a	Bedrock/ Trees[3]	NA	NA	NA	NA	NA
4b	Bedrock/ Trees	42.9	109.7	66.8	33.4	76.3
5	Bedrock/ Grass	17.1	144.5	127.4	63.7	80.8

[1] = median chloride value; = Range/2 + Cl min

[2] top figure is for upper part of profile; bottom figure is for lower part.

[3] profile had not leveled off so determination could not be made

Table 3. Determination of Soil-Water Chloride (Clsw) From Cumulative Chloride vs Cumulative Water Plots

Hole (Setting)	Segment/ Point	Cl min (mg/L)	Cl max (mg/L)	Range (mg/L)	Range/2 (mg/L)	Clsw[1] (mg/L)
1	R5	650.41	1716.50	1066.09	533.04	1183.46
(Thick Alluvium)	R4	186.28	650.41	464.13	232.06	418.34
	R3	66.17	189.52	123.35	61.67	127.84
	R2	13.64	89.30	75.66	37.83	51.47
	R1	9.66	83.09	73.43	36.71	46.37
2	R6	44.13	160.28	116.15	58.07	102.20
(Ephemeral Lake)	R5	160.28	1285.99	1122.71	561.36	721.63
	R4	205.73	386.17	180.44	90.22	295.95
	R3	200.97	246.06	45.09	22.54	223.51
	R2	178.73	222.51	43.78	21.89	200.62
	R1	50.99	178.73	127.74	63.87	114.86
3[2]	R4	-	-	-	-	787.34
(Thin Alluvium)	R3	-	-	-	-	350.16
	R2	-	-	-	-	201.27
	R1	-	-	-	-	25.66
4a	R5	413.46	641.10	227.64	113.82	527.28
(Bedrock/ Trees)	R4	288.70	464.49	175.74	87.87	376.57
	R3	210.44	343.94	133.50	66.75	277.19
	R2	95.99	210.44	114.45	57.22	153.21
	R1	48.77	95.99	47.22	23.61	72.38

Table 3. continued

Hole (Setting)	Segment/ Point	Cl min (mg/L)	Cl max (mg/L)	Range (mg/L)	Range/2 (mg/L)	Clsw[1] (mg/L)
4b	R4	283.80	464.77	180.97	90.48	374.28
(Bedrock/ Trees)	R3	225.74	606.92	381.18	190.59	416.33
	R2	167.73	297.46	129.73	64.86	232.59
	R1	42.94	167.73	124.79	62.39	105.33
5	R4	984.51	1800.80	816.29	408.14	1392.65
(Bedrock/ Grass)	R3	412.39	984.51	572.12	286.06	698.45
	R2	54.33	412.39	358.06	179.03	233.36
	R1	17.16	54.33	37.17	18.58	35.74

[1] = median chloride value; = Range/2 + Cl min

[2] straight line segments not discernible; clsw for selected points where recharge calculated = chloride content of soil water at that point

RESULTS AND DISCUSSION

Hole 1: Thick Alluvium

Samples for this setting were obtained from a hole on the east side of the corral located at the sharp bend in the road extending southeast from Cerro Prieto windmill. This bend occurs at the boundary between sections 20 and 29. More specifically, Hole 1 is located in NW, NW, sec. 29, T4N, R16W (Figure 1).

The site was selected to represent the valley of Frenches Draw, where the coal-bearing strata are overlain by a maximum thickness of alluvium. The site is flat so flooding or runon should be minimal to nonexistent.

Hole 1 penetrated 67 ft of alluvium. Because of the unconsolidated nature of this material, recovery was only 80% in most cores. Samples were wetter below 60 ft and the water table was penetrated by the last two cores (59-67 ft). Measurement with an electrical water-level indicator gave a depth to water of 67 ft, however, the moisture and chloride profiles (Figure 3) suggest the water table may be slightly shallower (approximately 63 ft).

Soil moisture fluctuates rather uniformly between 0.03 and 0.18 g/g. The median is approximately 0.10 g/g (Figure 3).

The chloride *vs* depth profile is more or less typical of those from the study area. A peak of 1000-2000 mg/L is reached within 2 or 3 ft of the ground surface, then the chloride content decreases with depth to less than 100 mg/L. Clsw below the peak at Hole 1 is 43.37 mg/L (Table 2).

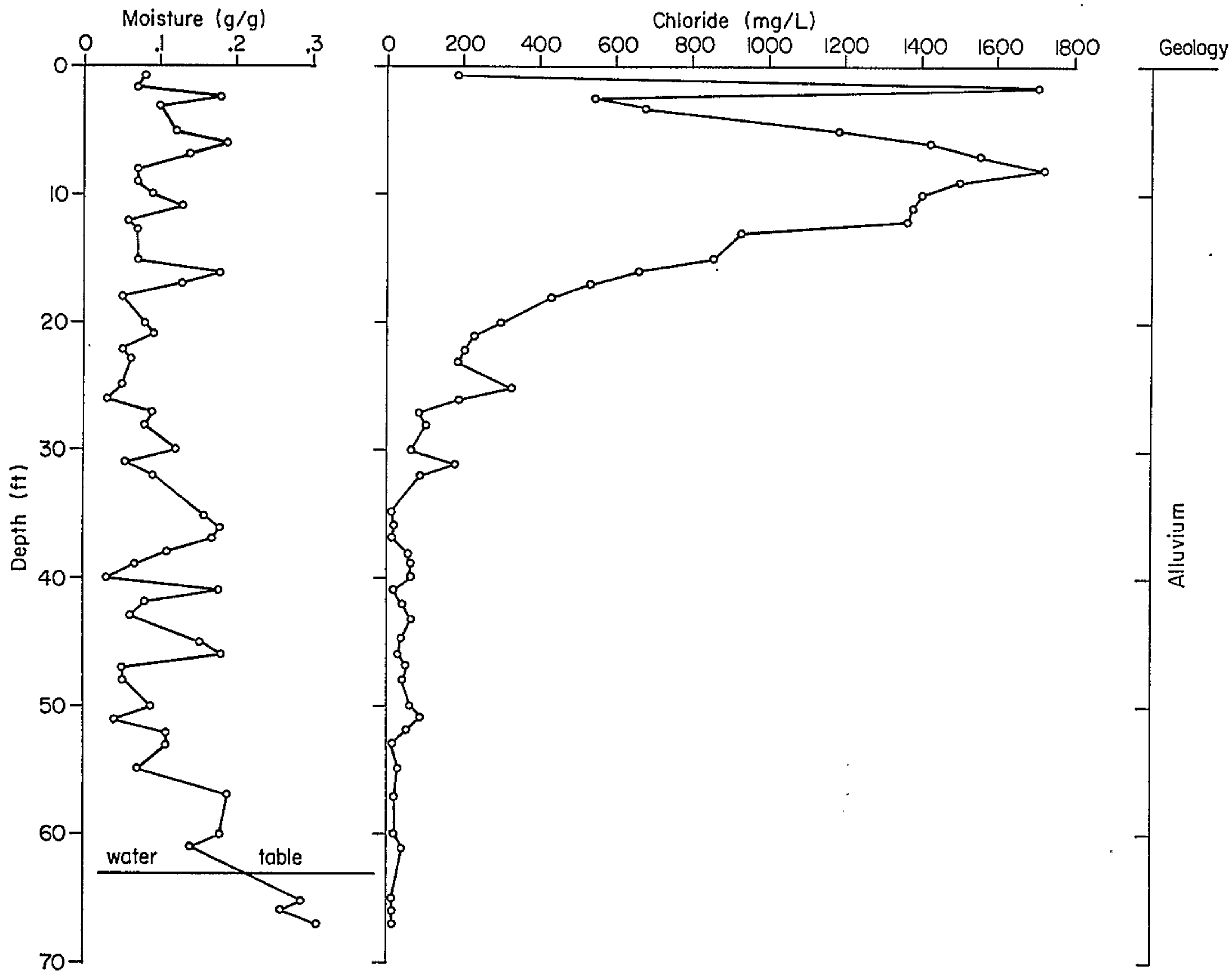

Figure 3. Results from Hole 1, thick alluvium.

Using a modern precipitation value of 9.9 inches/yr (Quemado Ranger Station) and a chloride content of precipitation value of 0.375 (Socorro), recharge for the time represented by the lower part of the profile at Hole 1 is determined to be 0.08 inch/yr. This, the highest value in the study area, was obtained for two other holes drilled through alluvium (Holes 2 and 3, Table 4).

Because the chloride content decreases below the peak at this and all other holes in the study area, a change in environmental conditions during the period represented is very likely. Plots of cumulative chloride content vs cumulative water content bear this out. At least five more or less straight-line segments, each characterized by a different recharge rate, are recognized in such a plot for Hole 1 (Figure 4; Table 5).

Recharge decreases steadily up the hole. During the period 10,270 - 10,013 yrs BP (before present), recharge is determined to have been 0.08 inch/yr. From 10,013 to 9,723 yrs BP, recharge was apparently 0.07 inch/yr. Between 9,723 and 9,469 yrs ago recharge was 0.03 inch/yr. Recharge in the period 9,469 - 8,498 yrs BP was 0.01 inch/yr. The profile levels off above that, giving a recharge rate of 0.003 inch/yr for the interval 8,498 - 1,244 yrs BP.

The age determined for the soil water at the bottom of Hole 1 (67 ft) is 10,270 yrs (early Holocene). This is reasonable based on the fairly thick Holocene section at this site (John Hawley, New Mexico Bureau of Mines and Mineral Resources, personal communication, 1984). Depths corresponding to other segments are given in Table 5.

Table 4. Summary of Recharge Determinations From Chloride *vs* Depth Plots

Hole	Setting	Recharge (inch/yr)[1]
1	Thick Alluvium	0.08
2	Ephemeral Lake	0.08 [2] 0.02
3	Thin Alluvium	0.08
4a	Bedrock/Trees	NA [3]
4b	Bedrock/Trees	0.05
5	Bedrock/Grass	0.05

[1] based on $R = \frac{Clp}{Clsw} \cdot P$, where Clp = 0.375 mg/L, Clsw as in Table 1, and P = 9.9 inches/yr

[2] top figure is for upper part of profile; bottom figure is for lower part

[3] chloride profile had not leveled off so determination could not be made

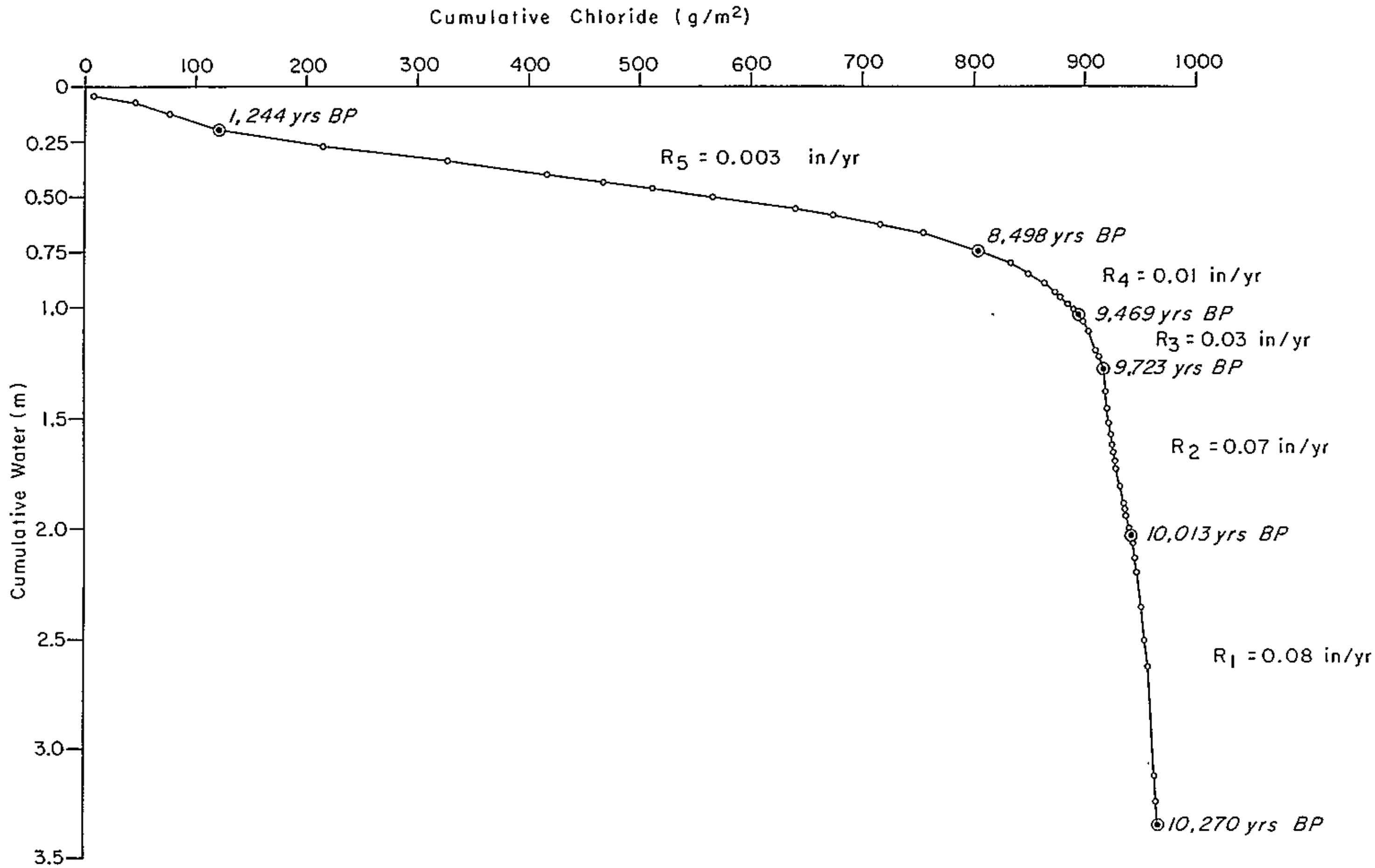

Figure 4. Chloride vs water, Hole I (thick alluvium)

Table 5. Summary of Recharge Determinations From Cumulative Chloride *vs* Cumulative Water Plots

Hole (Setting)	Segment/ Point	Depth (ft)	Age (yrs BP)	Recharge (inch/yr)[1]
1	R5	16-3	8,498 - 1,244	0.003
(Thick Alluvium)	R4	26-16	9,469 - 8,498	0.01
	R3	32-26	9,723 - 9,469	0.03
	R2	51-32	10,013 - 9,723	0.07
	R1	67-51	10,270 - 10,013	0.08
2	R6	10-4	777 - 460	0.04
(Ephemeral Lake)	R5	22-10	7,130 - 777	0.004
	R4	37-22	9,929 - 7,130	0.01
	R3	42-37	11,394 - 9,929	0.017
	R2	46-42	12,236 - 11,394	0.018
	R1	49-46	12,594 - 12,236	0.03
3[2]	R4	13	14,708	0.005
(Thin Alluvium)	R3	18	17,356	0.01
	R2	26	19,729	0.02
	R1	43	21,190	0.14
4a	R5	15-8	4,303 - 2,401	0.007
(Bedrock/ Trees)	R4	22-15	5,520 - 4,303	0.0098
	R3	28-22	6,152 - 5,520	0.01
	R2	32-28	6,463 - 6,152	0.02
	R1	40-32	6,720 - 6,463	0.05

Table 5. continued

Hole (Setting)	Segment/ Point	Depth (ft)	Age (yrs BP)	Recharge (inch/yr)[1]
4b	R4	14-5	3,132 - 1,568	0.007
(Bedrock/ Trees)	R3	23-14	4,259 - 3,132	0.006
	R2	28-23	4,697 - 4,259	0.02
	R1	44-28	5,208 - 4,697	0.03
5	R4	13-7	10,052 - 4,005	0.003
(Bedrock/ (Grass)	R3	20-13	12,937 - 10,052	0.01
	R2	45-20	14,809 - 12,937	0.02
	R1	59-45	15,315 - 14,809	0.01

[1] based on $R = \frac{Clp}{Clsw} \cdot P$ where Clp = 0.375 mg/L, Clsw as in Table 3, and P = 9.9 inches/yr

[2] straight-line segments not discernible; recharge calculated for selected points instead

Hole 2: Ephemeral Lake

Samples for this setting were obtained from a hole just south of the road transecting the northern edge of the ephemeral lake referred to by Salt River Project personnel as Thompson Lake. More specifically, Hole 2 is locted in NE, SE, sec. 30, T4N, R16W (Figure 1).

The site was selected to represent the various natural and manmade depressions in the area. Runoff periodically ponds at such sites and recharge there should be a maximum for the area.

Hole 2 penetrated 49 ft of alluvium. Recovery was generally 80%. Water level (perched?) was reached between 39 and 44 ft. Drilling was continued an additional 5 ft to verify that a zone of saturation had been penetrated. Measurement with an electrical water-level indicator gave a depth to water of 46 ft 4 inches, however, as shown in Figure 5, the chloride concentration for the lower samples indicate a slightly shallower water table (approximately 43 ft).

Moisture content varies from 00.4 to 0.33 g/g. Water content increases gradually with depth. The median value is 0.18 g/g (Figure 5).

The chloride vs depth profile for the ephemeral lake setting differs from that for the other settings (Figure 4). The peak is displaced downward to a depth of approximately 15 ft and a zone of low chloride content lies above the peak. Clsw in this upper segment of the profile is 44.00 mg/L, whereas, that below the peak is 243.22 mg/L (Table 2).

Recharge calculated for the part of the profile below the

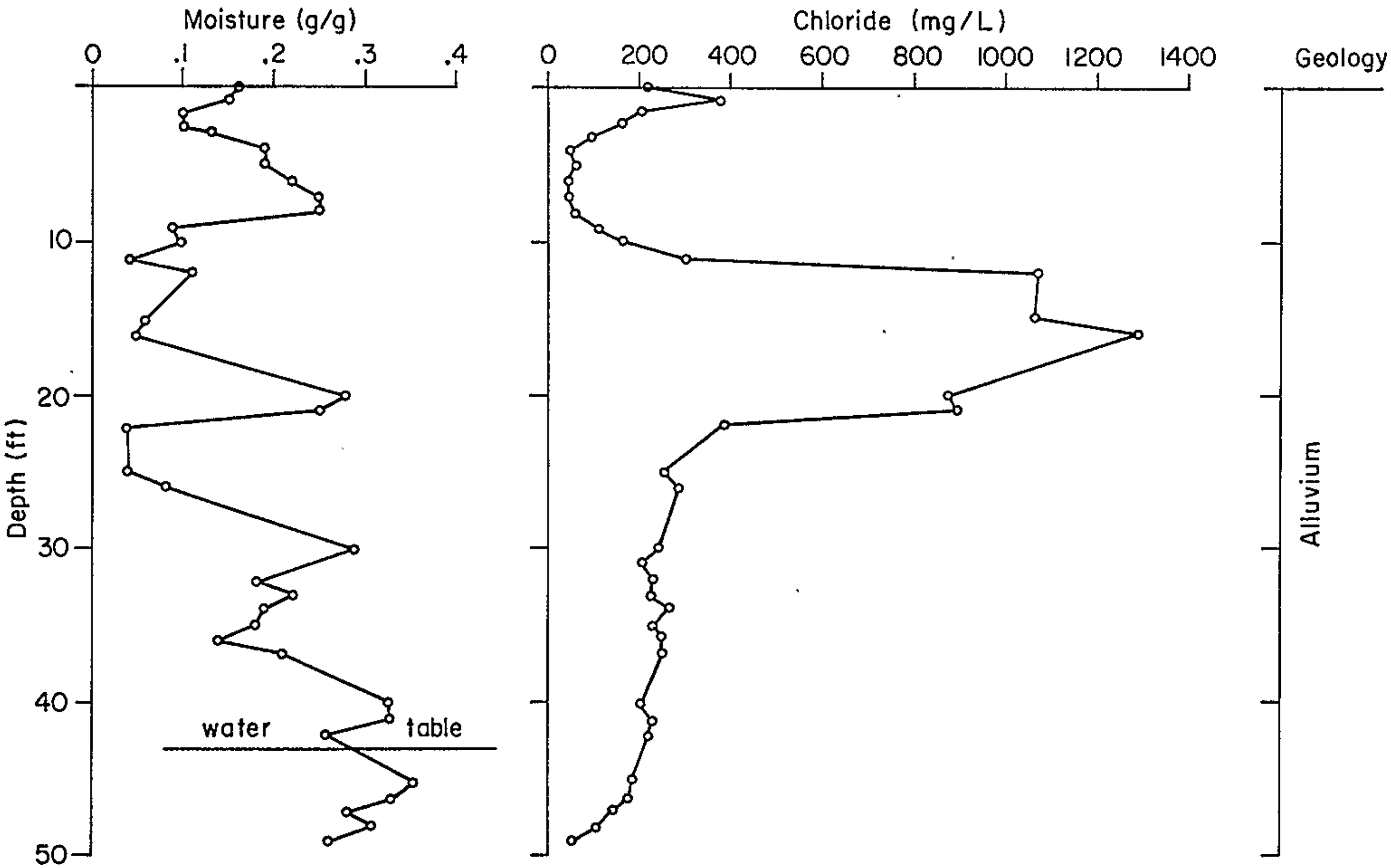

Figure 5. Results from Hole 2, ephemeral lake.

peak is only 0.02 inch/yr. However, recharge determined for the upper part of the profile (above the chloride peak) is 0.08 inch/yr, the same as at Hole 1 (Table 3). The increased recharge in the upper segment may correspond to aggradation or deposition of valley fill.

A cumulative chloride vs cumulative water plot for Hole 2 suggests that recharge has decreased through time there as well, but not as drastically as at Hole 1 (Figure 6; Table 5). Five segments are distinguished in the plot for Hole 2. Recharge decreased steadily between 12,594 and 7,130 yrs BP. From there to 777 yrs ago recharge was markedly lower at 0.004 inch/yr. Then recharge increased between 777 and 460 yrs ago.

Between 12,594 and 12,236 yrs ago, recharge was 0.03 inch/yr. From 12,236 to 11,394 yrs BP, recharge was 0.018 inch/yr. Recharge was virtually unchanged, 0.017 inch/yr, in the period 11,394 - 9,929 yrs BP. Between 9,929 and 7,130 yrs ago recharge was 0.01 inch/yr. After that recharge declined to 0.004 inch/yr (7,130 - 77 yrs BP). Between 777 and 460 yrs ago there was apparently an order-of-magnitude increase in recharge to 0.04 inch/yr. This may have been caused by late Holocene deposition in this part of the valley. Active aggradation would presumably be accompanied by enhanced recharge.

The soil water at the bottom of Hole 2 (49 ft) is dated at 12,236 yrs BP (late Pleistocene). This is somewhat older than expected for this depth in view of results at Hole 1 (Figure 4). However, Holocene fill may be thinner here because of the proximity to the valley margin (Figure 1).

The greater age at Hole 2 is brought about by a greater

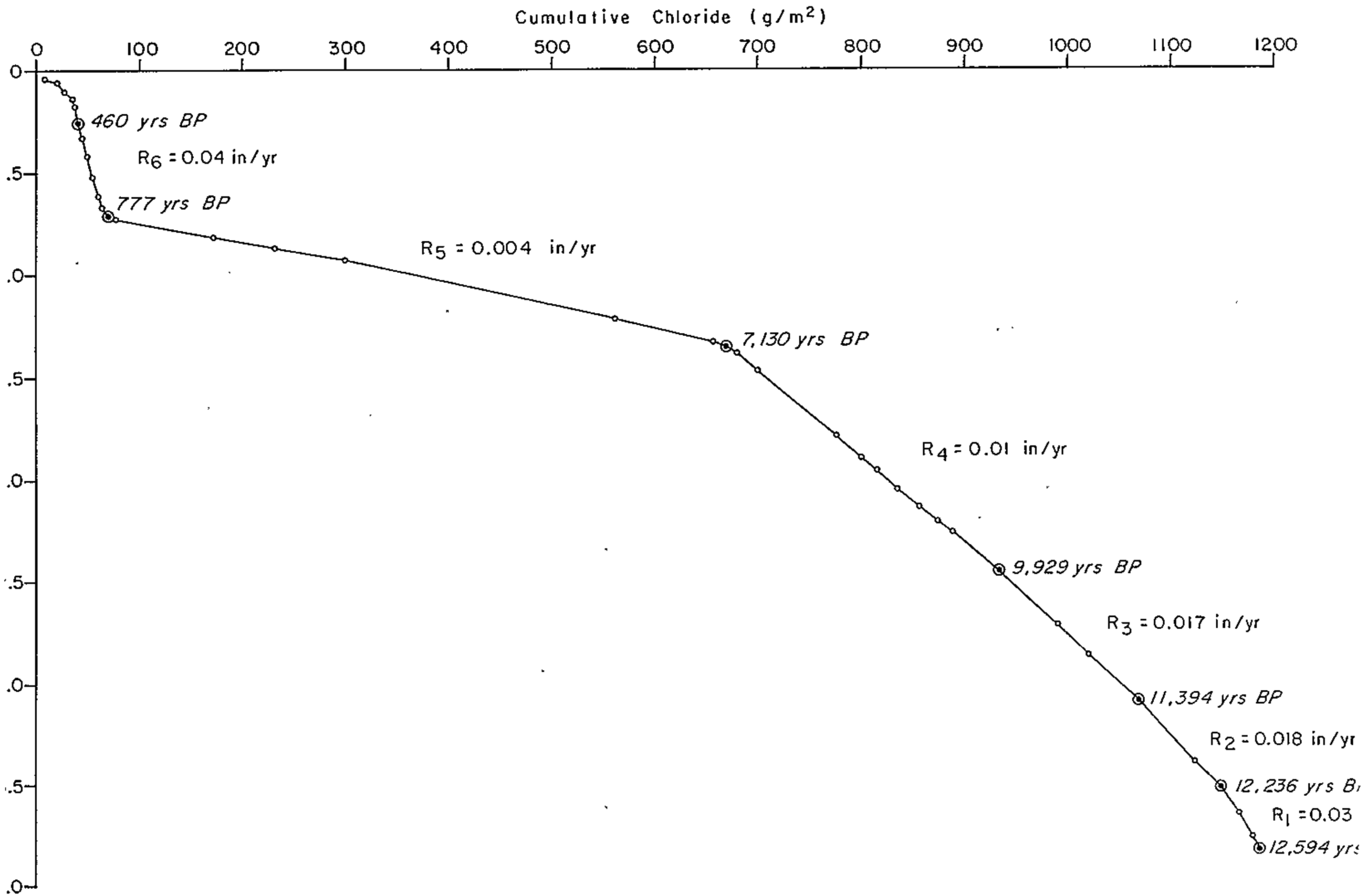

Figure 6. Chloride vs Water, Hole 2 (ephemeral lake)

soil-water chloride content there. Chloride input may be greater at Hole 2 because of its ephemeral lake setting. Evaporation of lake waters leaves salt at the surface. Wind activity redistributes this during dry periods, potentially adding salt to lake-margin areas such as this. Subsequent rainfall/runoff events mobilize the salt, thus facilitating its movement into the ground with recharging waters.

Hole 3: Thin Alluvium

Samples for this setting were obtained from a hole drilled approximately 10 ft southwest of a Salt River Project coal exploration hole. More specifically, Hole 3 lies just west of the road in SE, NE, sec. 36, T4N, R17W (Figure 1).

This site was selected to represent areas where the coal-bearing sequence is overlain by thin alluvium as in valley- or mesa-margin areas. Recharge rate should be mainly influenced by the permeability of the alluvium and topography. This location is fairly flat so runon is not considered to be significant.

Hole 3 penetrated 44 ft of alluvium. Unlike Holes 1 and 2, recovery was generally 100%. Water was encountered before bedrock was reached. The first core which appeared wet was that m the interval 39-44 ft. Measurement with an electrical water-level indicator, however, gave a depth of 37 ft 1 inch. This reading is probably good, based on the chloride profile (Figure 7).

Moisture content ranges from 0.1 to 0.3 g/g and gradually increases with depth. The median value is 0.2 g/g (Figure 5).

The distribution of chloride content of the soil water is

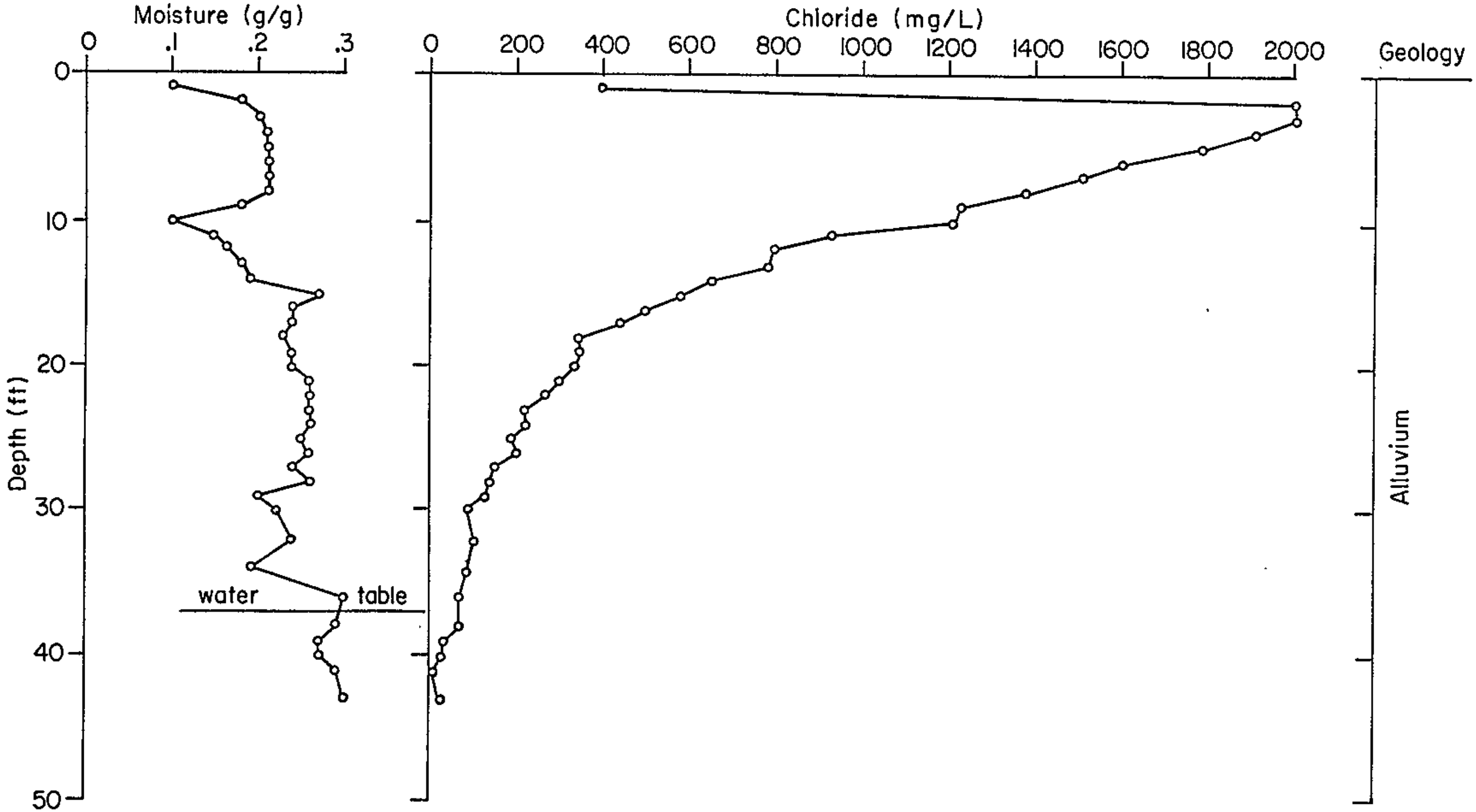

Figure 7. Results from Hole 3, thin alluvium.

similar to that in Hole 1. A peak of approximately 2000 mg/L is reached at a depth of 2 ft. Below the peak, chloride steadily decreases with depth to a low value of 72 mg/L just above the water table. The sample just below the water table has a chloride content of 76 mg/L, indicating the soil water is in equilibrium with the ground water, with respect to chloride content (Figure 5). Clsw is calculated to be 43.84 (Table 2).

Recharge determined for this setting is 0.07 inch/yr. This value corresponds to that obtained at all but one of the other sites where a substantial thickness of alluvium was penetrated (Table 3).

A cumulative chloride vs cumulative water plot for Hole 3 indicates recharge has decreased through time there as at Holes 1 and 2. No distinct line segments are discernable, however, so dates and corresponding recharge rates at selected points were determined for reference (Figure 8). Recharge was 0.14 inch/yr 21,190 yrs ago, 0.02 inch/yr 19,729 yrs ago, 0.01 inch/yr 17,356 yrs ago, and 0.005 inch/yr 14,708 yrs ago.

The soil water at the bottom of Hole 3 (43 ft) is the oldest encountered in the study: 21,190 yrs (late Pleistocene). Although the hole was still in alluvium at this depth, bedrock was probably not far below and a Pleistocene age is reasonable.

Hole 4: Bedrock/Trees

Samples for this setting were taken in two separate holes. The first (Hole 2a) was drilled on the hill south of the gravel pit in section 32 (Figure 1). It penetrated 9 ft of alluvium and 31 ft of the lower member of the Moreno Hill Formation before

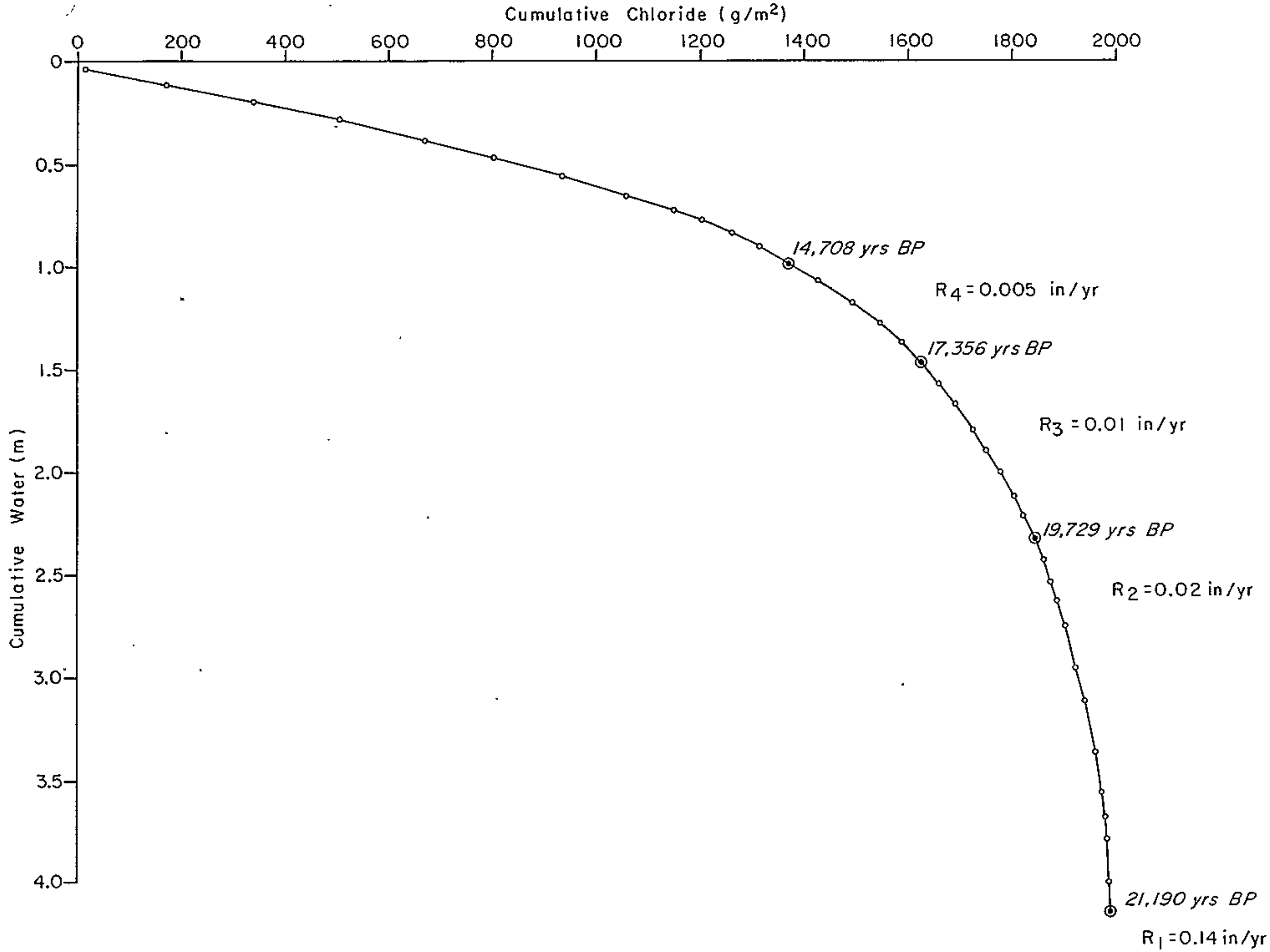

Figure 8. Chloride vs Water, Hole 3 (thin alluvium)

auger refusal at 40 ft in a hard gray mudstone. In an effort to obtain deeper samples in such a setting, Hole 2b was drilled approximately 1 mi to the east in SE, SE, sec. 32, T4N, R16W (Figure 1). It penetrated 6 ft of alluvium and 38 ft of lower Moreno Hill Formation. Auger refusal was reached in this hole at a depth of 44 ft.

This site was selected to represent the tree-covered bedrock areas lying above the valley floors. Recharge in such a setting should be lower than in valley settings because bedrock is less permeable than the alluvium and trees should extract more water than typical valley vegetation.

Soil moisture at both holes hovers about 0.10 g/g (Figures 9 and 10). In hole 4a the range is 0.05-0.16 g/g, whereas, that in Hole 4b is 0.04-0.20 g/g.

Chloride concentration is also similar at the two holes (Figures 9 and 10). In Hole 4a the peak is approximately 1000 mg/L at a depth of 2.5 ft; at Hole 4b the peak is approx imately 900 mg/L at a depth of 3 ft. Hole 4a does not appear to be deep enough to detect a stable chloride value. However, in Hole 4b the chloride concentration seems to be stabilized below approximately 30 ft. Clsw for Hole 4b is 76.3 mg/L (Table 2).

Recharge can be determined by the chloride method only where a steady chloride concentration has been attained by the profile. Thus, no recharge determination was attempted for Hole 4a. Recharge at Hole 4b is 0.04 mg/L, approximately half the rate for alluvial settings (Table 3).

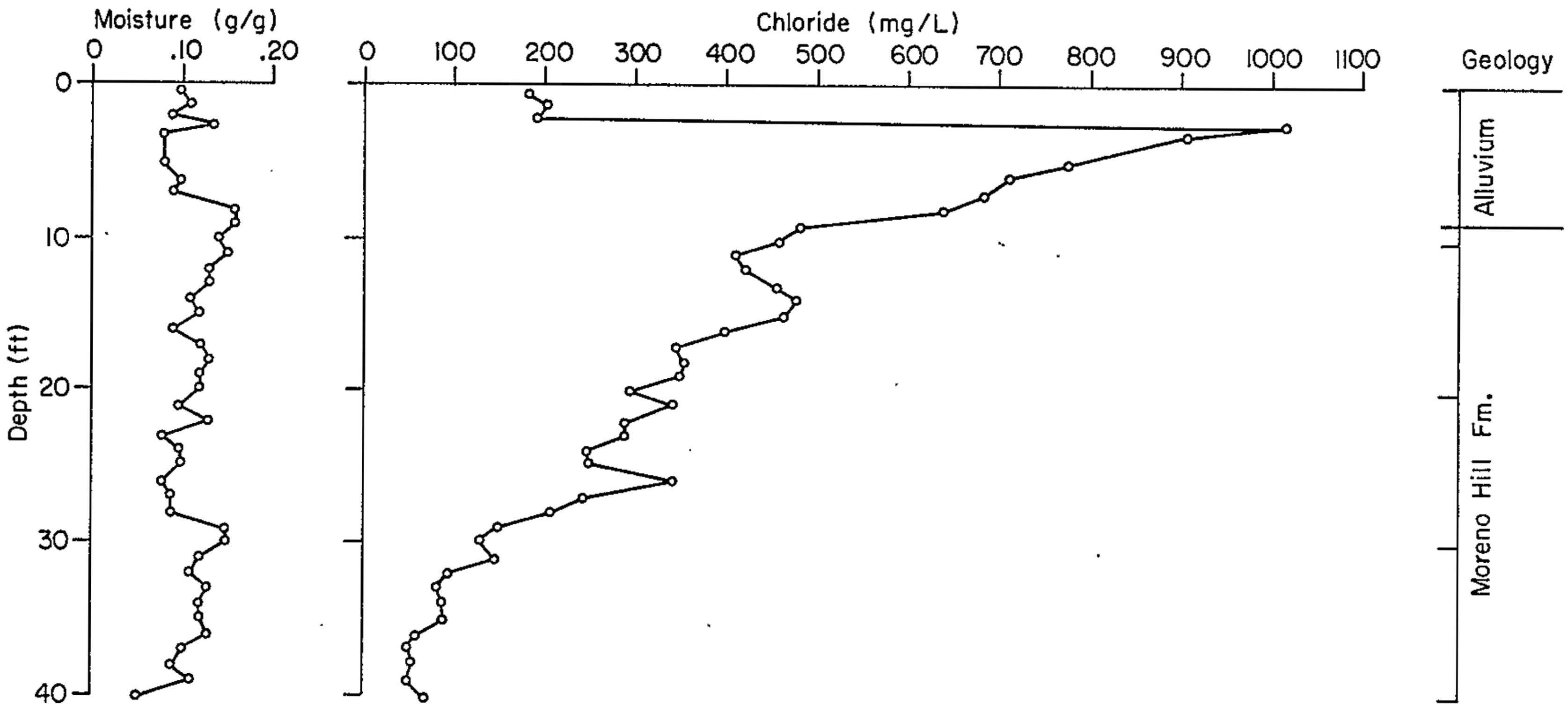

Figure 9. Results from Hole 4a, bedrock/trees.

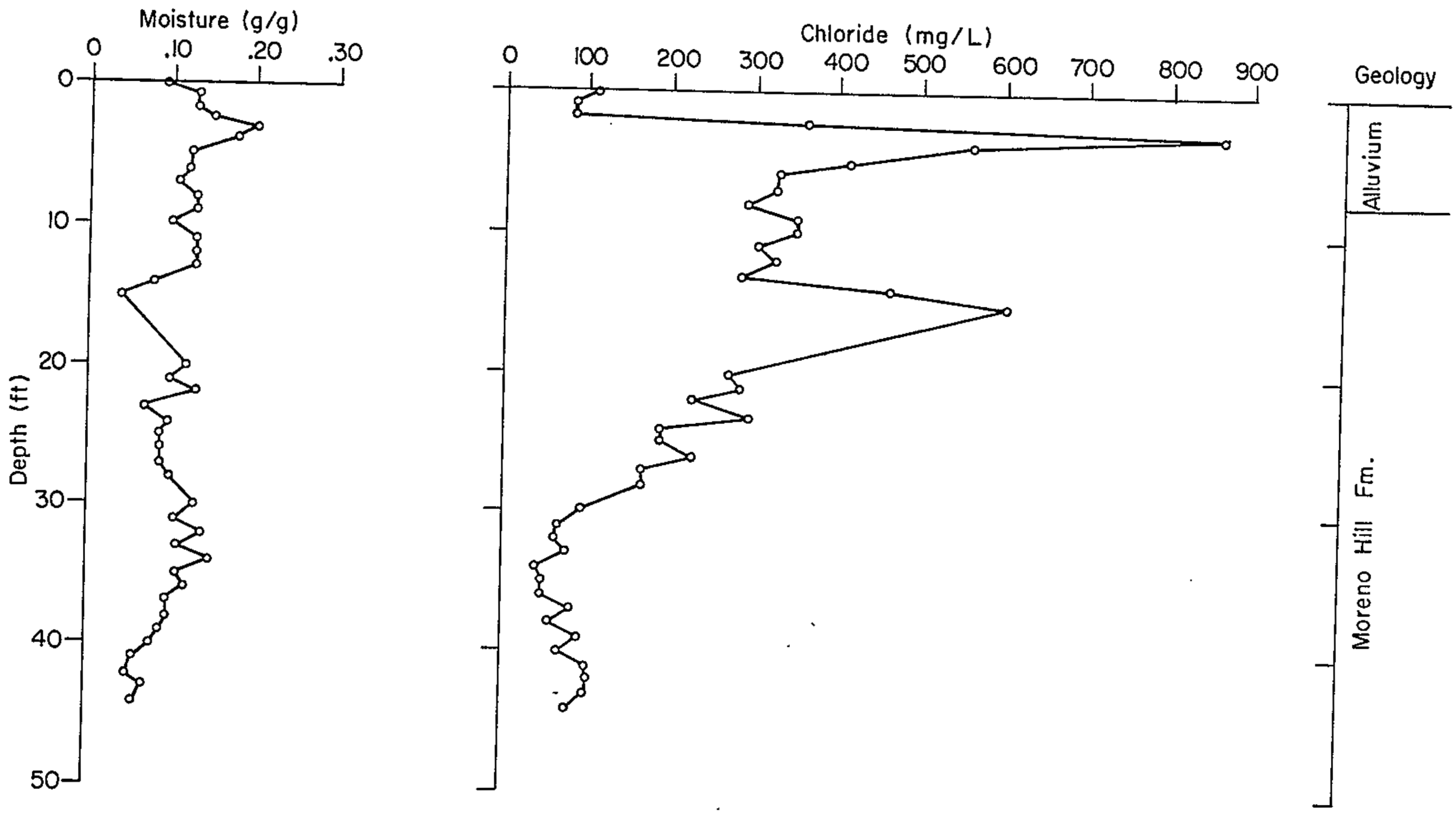

Figure 10. Results from Hole 4b, bedrock/trees.

Plots of cumulative chloride vs cumulative water for Holes 4a and 4b are similar (Figures 11 and 12). Both indicate recharge has continually decreased through time.

At Hole 4a, five straight-line segments are recognized (Figure 11). Between 6,720 and 6,463 yrs BP, recharge was 0.05 inch/yr. From 6,463 to 6,150 yrs ago, recharge was 0.02 inch/yr. In the period 6,152 - 5,520 yrs BP, recharge was 0.01 inch/yr. Recharge changed .pn 34
little between then and 4,303 yrs BP: 0.0098 inch/yr. From 4,303 to 2,401 yrs ago recharge was 0.007 inch/yr.

At Hole 4b, four straight-line segments are distinguished (Figure 12). From 5,208 to 4,697 yrs BP, recharge was 0.03 inch/yr. Between 4,697 and 4,259 yrs ago, recharge was 0.02 inch/yr. In the period 4,259 - 3,132 yrs BP, recharge was 0.006 inch/yr. Recharge increased slightly between 3,132 and 1,568 yrs ago to 0.007 inch/yr.

The ages of soil water at the bottom of both holes fall within the middle Holocene. This is reasonable as alluvium is very thin at these sites and the holes bottom in Cretaceous bedrock (Figures 9 and 10).

Hole 5: Bedrock/Grass

Samples for this setting were obtained from a hole drilled just south of the road to the abandoned homestead in the northern part of sec. 6 (Figure 1). More specifically, Hole 5 is in NW, NE, sec. 6, T3N, R16W.

This site was selected to represent grass-covered bedrock areas, a minor landscape setting in the study area. Because of

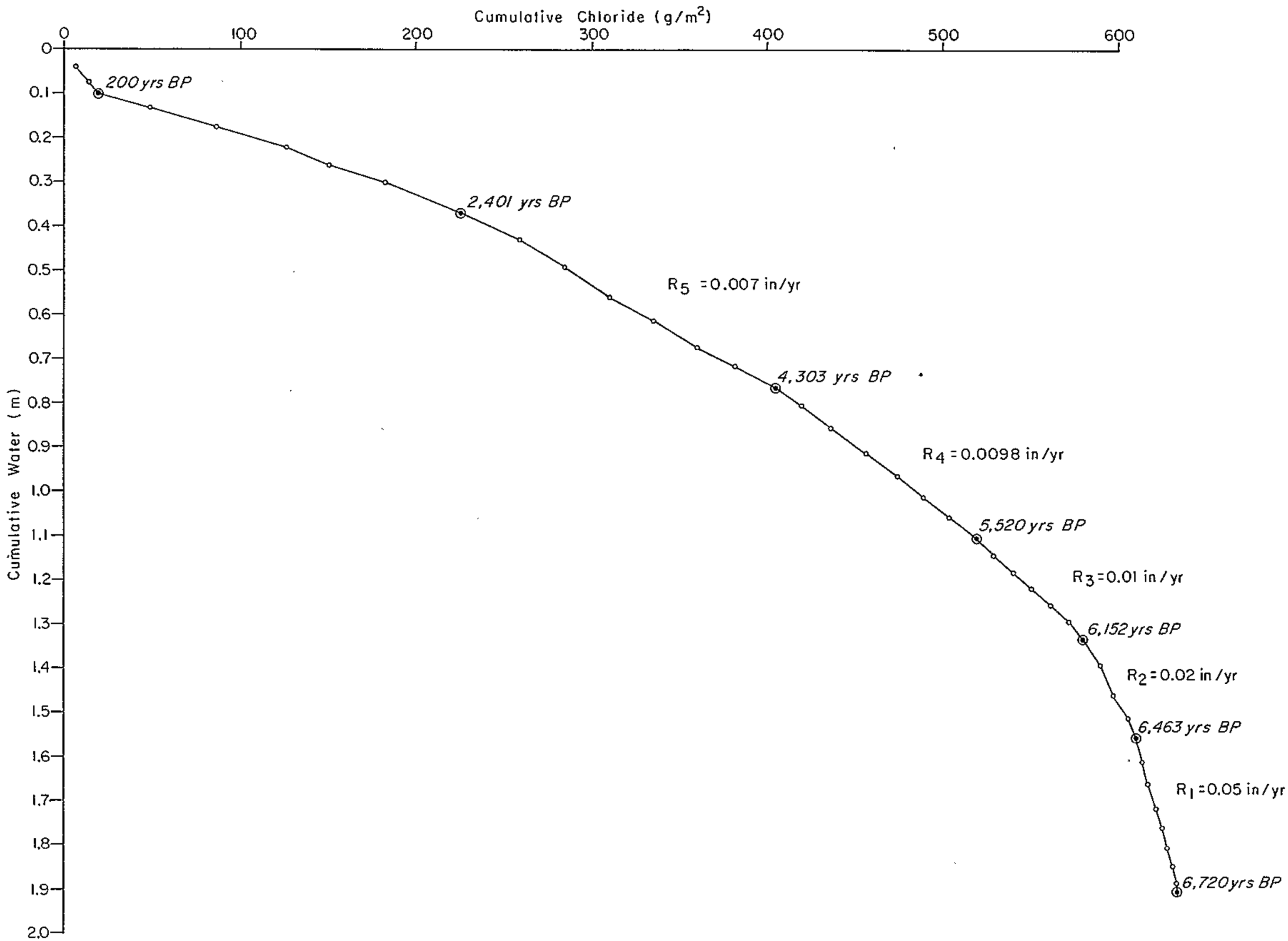

Figure 11. Chloride vs Water, Hole 4a (bedrock/trees)

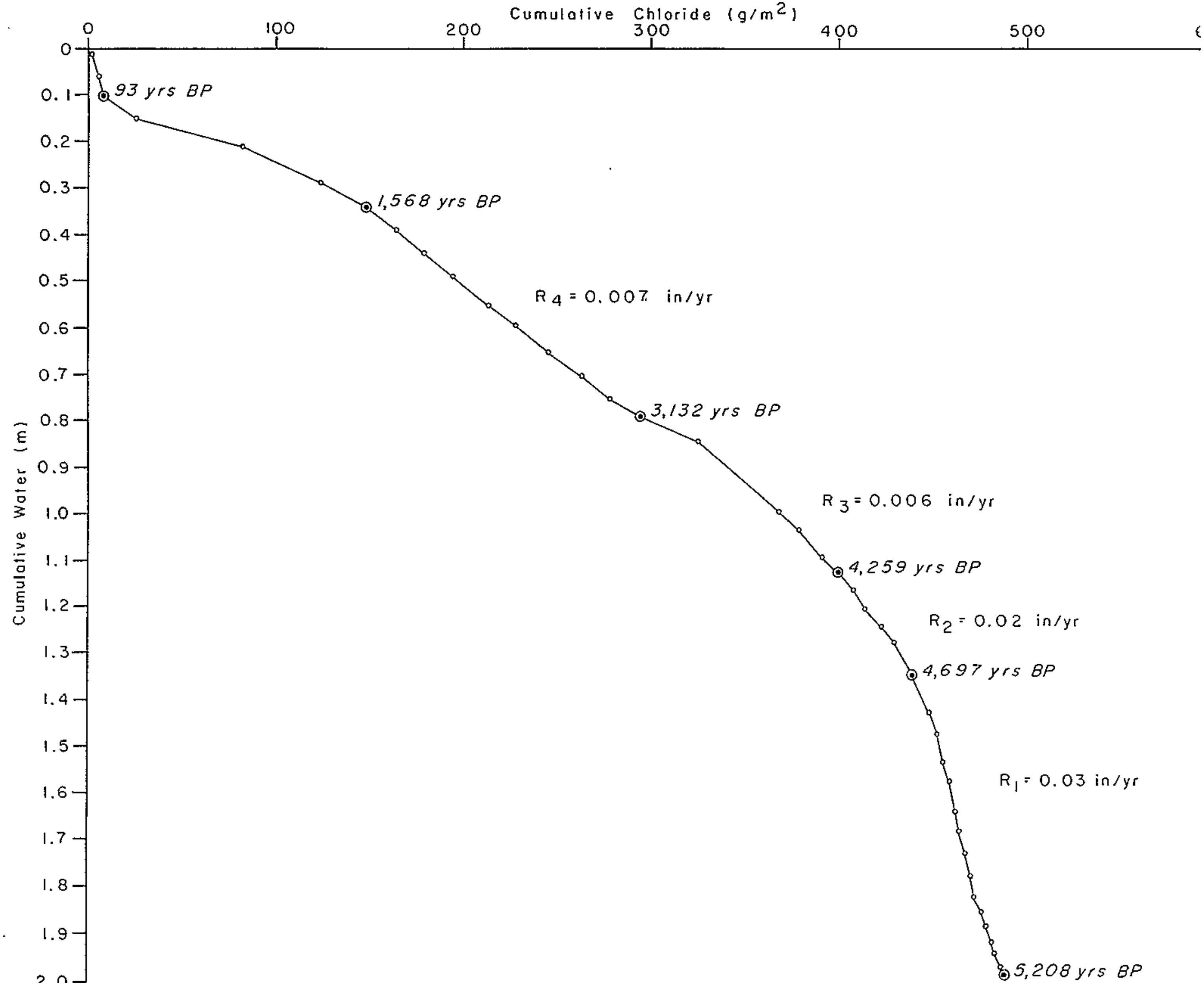

Figure 12, Chloride vs water, Hole 4b (bedrock/trees) the valley location, however, bedrock was only penetrated near the bottom of the hole.

Hole 5 was 59 ft deep and penetrated 54 ft of alluvium and 5 ft of lower Moreno Hill Formation. The Moreno Hill consisted almost entirely of coal. Water table was encountered at the alluvium/bedrock contact at a depth of 54 ft, but measurement with an electrical water-level indicator after drilling gave a depth to water of 59 ft. Water level apparently dropped as drilling proceeded in this fractured medium.

Soil moisture ranges from approximately 0.04 to 0.40 g/g (Figure 13). The median value is approximately 0.20 g/g.

Chloride content increases to a peak of 1800.80 mg/L at a depth of 7 ft, then drops to less than 200 by a depth of 21 ft (Figure 13). There is a very slight decrease with depth below that. Clsw for this hole is 80.8 mg/L (Table 2).

Recharge determined at this setting is 0.04 inch/yr. This is the same value obtained for the Bedrock/Trees setting (Hole 4b; Table 3).

A cumulative chloride vs cumulative water plot for Hole 5 shows that recharge has decreased through time at this site as at all others studied (Figure 14). Four straight-line segments are distinguished.

Between 15,315 and 14,809 yrs BP, recharge was 0.10 inch/yr. In the period 14,809 - 12,937 yrs BP, recharge was 0.02 inch/yr. From 12,937 to 10,052 yrs ago, recharge was 0.01 inch/yr. After that recharge rate declined to 0.003 inch/yr (10,052 - 4,005 yrs ago).

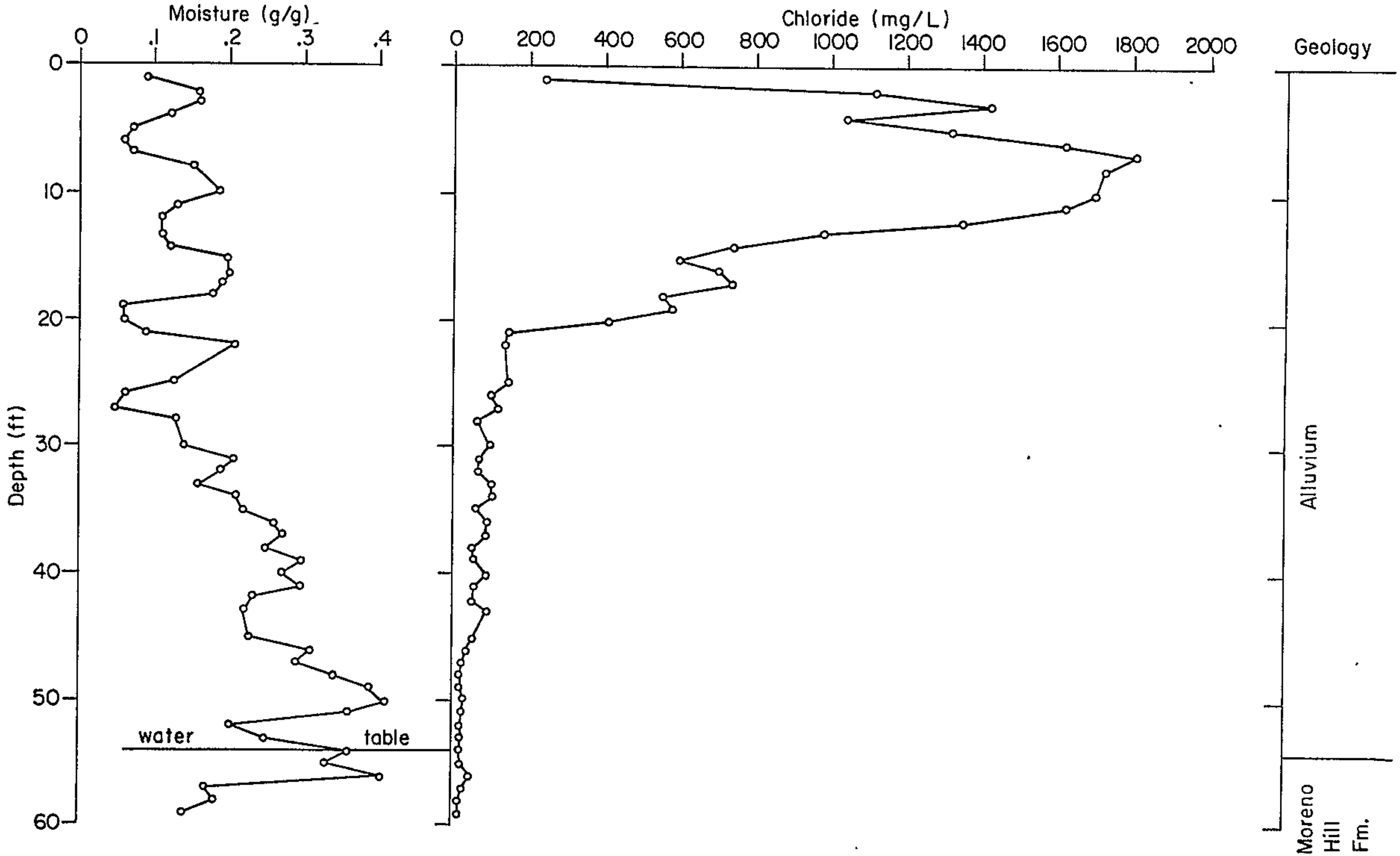

Figure 13. Results from Hole 5, bedrock/grass.

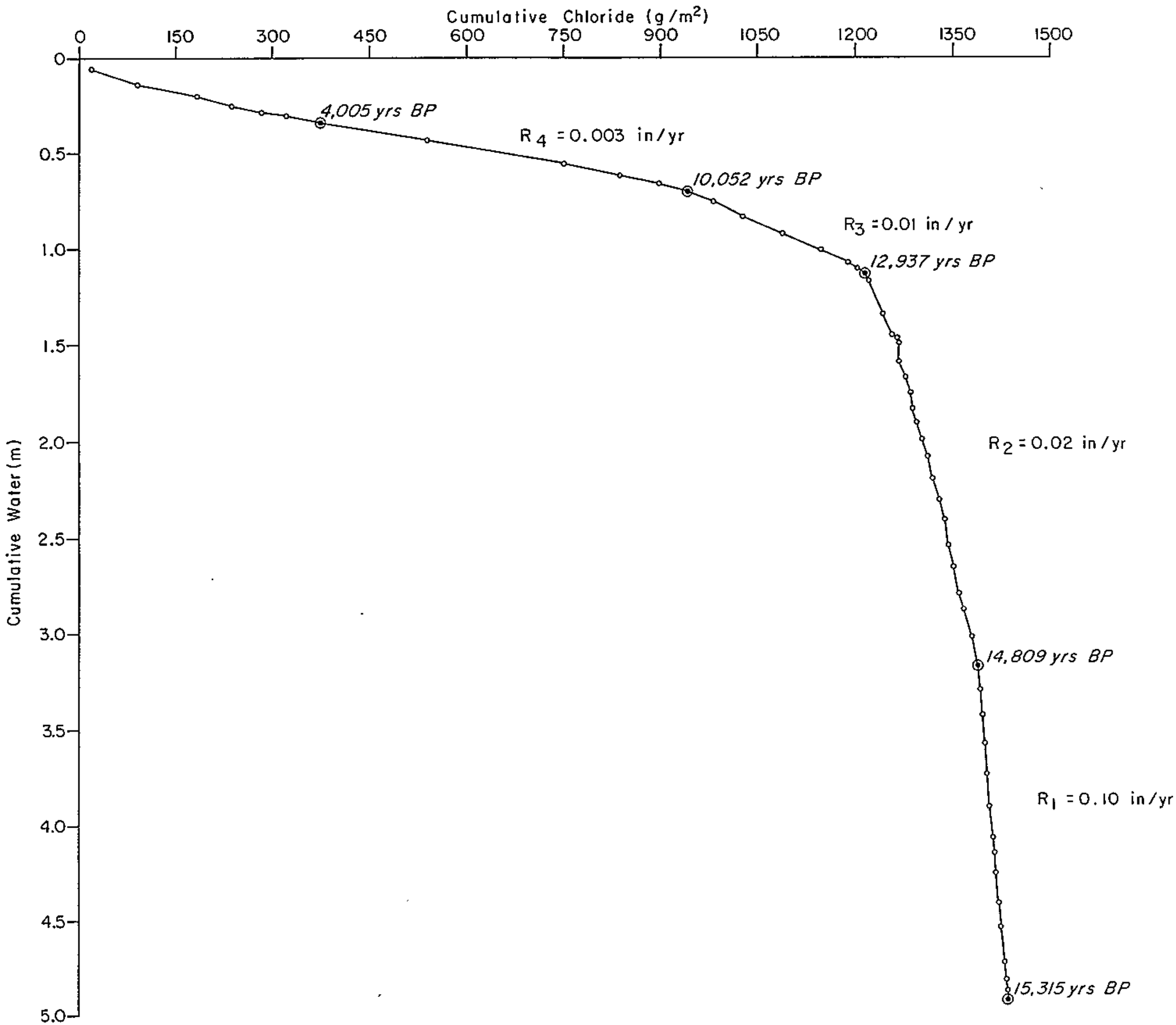

Figure 14. Chloride vs Water, Hole 5 (bedrock/grass)

Soil water at the bottom of Hole 5 (59 ft) is dated at 15,315 (late Pleistocene). Cretaceous bedrock is encountered just above the bottom of the hole so such an age is reasonable (Figure 13).

SUMMARY AND CONCLUSIONS

Holes were not as deep as anticipated because water table was reached at 37-63 ft in the study area. Nonetheless, information obtained from the samples was generally sufficient for recharge determinations.

The chloride content of soil water is much higher in the upper parts of the profiles than in the lower parts. Some of this may merely be a result of concentration of salt due to uptake of water but not salt by vegetation near the surface. Some of it may be due to environmental changes: decreased precipitation, increased chloride input (in precipitation and dryfall), or decreased recharge. Cumulative chloride *vs* cumulative water plots bear this out.

Based on chloride *vs* depth plots, recharge is lowest (0.02 inch/yr) for some previous time at the ephemeral lake setting. Modern recharge there is 0.08 inch/yr. This value was also obtained from other alluvial settings. An intermediate recharge value (0.05 inch/yr) characterizes the bedrock settings, regardless of vegetative cover (trees or grass).

Recharge rates determined from cumulative chloride *vs* cumulative water plots do not always match those determined from chloride *vs* depth plots. In most cases, however, values are of the same order of magnitude (Tables 4 and 5). Discrepancies are probably due to differences in size of the intervals considered in the recharge calculations. The main variable is the Clsw (average soil-water chloride content) for the interval selected. Averages based on a thick interval differ from those based on thin intervals (Tables 2 and 3).

A maximum recharge value should have been associated with the ephemeral lake setting, yet the value obtained there is the same as for other alluvial settings. This may be explained by the fact that samples for this setting were obtained near the margin of such a lake and thus the recharge value determined is a minimum value for this setting. Samples should have been taken from a hole in the center of such a lake or upslope of any confining structure, in the case of manmade lakes. A more optimum site for Hole 1 would have been SE, SE, SE, sec. 30, T4N, R16W.

Similarly, all but 5 ft of the material penetrated in Hole 5 was alluvium. Thus, results for that hole may be more representative of an alluvial setting than of a Bedrock/Grass setting.

The timing of apparent changes in recharge determined in this study is reasonable in view of Quaternary paleoclimate reconstructions for the region. Work on the nearby San Agustin Plains by Markgraf and others (1983) provides a means of checking the Salt Lake results. According to them, conditions between 10,000 and 8,500 yrs BP were more mesic (moderate) than earlier or later Quaternary climates. At 8,000 yrs BP, the onset of drier conditions began and by 5,000 yrs ago, San Agustin Lake was dessicated. Calculated ages of soil water and the decline in recharge rates with time, based on cumulative chloride vs cumulative water plots (Figures 4,6,8,11,12, and 14), generally reflect the San Agustin Plains history. Additional work on the relationship between paleoclimate reconstructions from soil-water chloride and other methods would be beneficial.

The Pleistocene/early Holocene recharge rates provide worst-case values for the area. In other words, they represent the highest known recharge the area has experienced under natural conditions. They should be useful in assissing recharge rates that may result from various post-mining reclamation practices.

The recharge estimates given here were not checked by other methods. Funds were not available for other chemical or physical methods (stable-isotope, tritium, or neutron-probe studies) and data are not generally available for the determination of recharge from the configuration of the water table and aquifer properties (as outlined by Ferris and others, 1962, p. 131-132). However, results of the chloride method have generally been corroborated by other methods where this has been attempted (Stone, 1984a; Allison and others, in press). Results also seem reasonable in view of a recent recharge study employing the chloride method in similar strata at the Navajo Mine (Stone, 1984b).

ACKNOWLEDGEMENTS

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APPENDIX A

Data Used For Chloride *vs* Depth Plots

Explanation

SLCF01 = Salt Lake Coal Field Hole 1

Dry Wt. Soil = weight of soil used in salt extraction

Wt. Wtr. Added = weight of deionized water used in salt extraction

SLCF01

Sample No.	Sample Depth (ft)	Moist. Content (gm/gm)	Dry Wt. Soil (gm)	Wt. Wtr. Added (gm)	Cl in Extract (ppm)	Cl in Soil Wtr. (mg/l)
1	0.75	0.08	25.29	77.59	4.90	185.46
2	1.50	0.07	24.48	77.61	36.50	1706.49
3	2.25	0.18	22.13	74.73	28.50	546.60
4	3.00	0.10	34.03	66.17	33.50	678.69
5	5.00	0.12	24.69	78.55	45.00	1180.16
6	6.00	0.19	27.13	73.00	100.00	1414.73
7	7.00	0.14	27.08	71.78	80.00	1556.21
8	8.00	0.07	27.21	69.73	47.00	1716.50
9	9.00	0.07	37.22	68.04	60.00	1497.39
10	10.00	0.09	37.83	68.87	68.00	1405.48
11	11.00	0.13	27.82	65.54	79.00	1384.18
12	12.00	0.06	36.99	64.33	50.00	1369.19
13	13.00	0.07	38.47	68.75	38.00	926.02
14	15.00	0.07	26.74	68.64	23.00	854.96
15	16.00	0.18	22.99	74.39	37.00	650.41
16	17.00	0.13	34.53	64.31	38.00	527.13
17	18.00	0.05	39.22	79.77	11.80	437.92
18	20.00	0.08	28.63	75.81	9.20	295.11
19	21.00	0.09	36.14	71.76	10.50	232.42
20	22.00	0.05	40.27	66.52	6.60	207.50
21	23.00	0.06	40.87	76.38	6.40	186.28
22	25.00	0.05	40.10	65.17	9.40	328.49
23	26.00	0.03	45.34	62.89	4.00	189.52
24	27.00	0.09	36.79	67.70	3.90	80.25
25	28.00	0.08	38.23	69.17	4.40	99.92
26	30.00	0.12	32.25	65.87	3.80	66.17
27	31.00	0.05	39.01	63.43	6.00	180.16
28	32.00	0.09	36.53	71.53	4.00	89.30
30	35.00	0.16	26.16	65.33	0.99	15.19
31	36.00	0.18	26.61	77.84	1.32	21.08
32	37.00	0.17	31.00	73.41	0.99	13.64
33	38.00	0.11	30.26	76.28	2.31	52.63
34	39.00	0.07	38.80	65.28	2.31	55.61
35	40.00	0.03	38.88	73.33	0.83	56.49
36	41.00	0.18	31.24	77.11	1.49	20.68
37	42.00	0.08	42.42	78.36	1.65	40.25
38	43.00	0.06	39.00	63.76	1.98	50.01
39	45.00	0.15	31.33	68.88	2.63	38.51
40	46.00	0.18	28.87	69.62	2.70	37.17
41	47.00	0.05	41.81	70.46	1.32	44.78
42	48.00	0.05	40.22	66.19	1.32	40.19
43	50.00	0.09	37.47	70.32	2.40	49.56
44	51.00	0.04	44.83	68.35	1.98	83.09
45	52.00	0.11	38.98	69.01	2.60	42.38
46	53.00	0.11	34.77	72.91	0.83	16.45
47	55.00	0.07	45.56	73.09	1.32	32.40
49	57.00	0.19	43.33	75.48	2.58	23.97
50	60.00	0.18	37.02	64.04	1.98	19.34

Sample No.	Sample Depth (ft)	Moist. Content (gm/gm)	Dry Wt. Soil (gm)	Wt. Wtr. Added (gm)	Cl in Extract (ppm)	Cl in Soil Wtr. (mg/l)
51	61.00	0.14	49.18	81.66	2.91	35.77
53	65.00	0.29	43.78	72.77	1.67	9.66
54	66.00	0.26	41.64	65.87	2.64	16.01
55	67.00	0.31	33.92	68.41	2.80	18.34

SLCF02

Sample No.	Sample Depth (ft)	Moist. Content (gm/gm)	Dry Wt. Soil (gm)	Wt. Wtr. Added (gm)	Cl in Extract (ppm)	Cl in Soil Wtr. (mg/l)
55	0.00	0.16	24.61	74.88	11.00	212.69
56	0.75	0.15	28.37	72.35	22.00	378.34
57	1.50	0.10	35.44	66.30	10.50	206.75
58	2.25	0.10	32.05	74.62	6.50	157.87
59	3.00	0.13	26.26	68.61	4.50	91.96
60	4.00	0.19	34.10	70.92	4.00	44.13
61	5.00	0.19	28.43	69.29	4.80	60.38
62	6.00	0.22	28.85	69.04	4.20	44.87
63	7.00	0.25	29.23	72.54	4.40	43.87
64	8.00	0.25	30.06	66.10	5.80	50.33
65	9.00	0.09	36.77	64.50	5.50	111.68
66	10.00	0.10	33.39	74.76	7.00	160.28
67	11.00	0.04	41.09	60.46	9.20	304.47
68	12.00	0.11	38.30	62.20	70.00	1078.57
69	15.00	0.06	43.17	75.43	38.00	1073.78
70	16.00	0.05	45.64	67.07	42.00	1285.99
71	20.00	0.28	29.27	71.79	100.00	877.33
72	21.00	0.25	30.20	68.51	99.00	891.85
73	22.00	0.04	45.03	67.48	11.50	386.17
74	25.00	0.04	43.43	71.23	7.00	255.70
75	26.00	0.08	42.49	61.72	16.00	285.48
76	30.00	0.29	48.35	93.93	35.50	240.71
77	31.00	0.24	40.47	79.66	25.00	205.73
78	32.00	0.18	46.09	74.88	25.00	229.18
79	33.00	0.22	35.48	71.31	24.50	228.57
80	34.00	0.19	35.91	69.58	26.00	260.67
81	35.00	0.18	39.72	67.34	24.00	230.84
82	36.00	0.14	41.82	75.15	19.00	246.18
83	37.00	0.21	47.35	75.81	33.00	246.06
84	40.00	0.33	46.64	71.54	43.50	200.97
85	41.00	0.33	42.27	77.56	41.00	230.10
86	42.00	0.26	50.07	60.33	47.50	222.51
87	45.00	0.35	41.81	67.03	40.00	182.26
88	46.00	0.33	42.68	73.40	34.00	178.73
89	47.00	0.28	46.14	68.69	26.00	138.10
90	48.00	0.31	47.12	75.93	22.00	113.04
91	49.00	0.26	50.11	67.32	10.00	50.99

SLCF03

Sample No.	Sample Depth (ft)	Moist. Content (gm/gm)	Dry Wt. Soil (gm)	Wt. Wtr. Added (gm)	Cl in Extract (ppm)	Cl in Soil Wtr. (mg/l)
92	1.00	0.10	22.55	65.93	14.40	405.90
93	2.00	0.18	21.06	68.47	110.00	2008.45
94	3.00	0.20	26.94	62.35	174.00	2004.55
95	4.00	0.21	29.77	70.92	165.00	1912.70
96	5.00	0.21	25.65	73.13	130.00	1786.31
97	6.00	0.21	25.64	84.63	102.00	1603.88
98	7.00	0.21	26.12	79.94	105.00	1514.53
99	8.00	0.21	28.02	74.66	110.00	1372.85
100	9.00	0.18	22.74	83.25	60.00	1235.84
101	10.00	0.10	23.63	80.68	34.50	1210.20
102	11.00	0.15	26.43	74.23	49.00	927.52
103	12.00	0.16	27.16	69.68	50.50	794.91
104	13.00	0.18	26.22	69.23	54.00	787.34
105	14.00	0.19	21.42	71.64	37.50	648.91
106	15.00	0.27	22.99	74.11	50.00	593.14
107	16.00	0.24	27.08	70.89	47.50	510.19
108	17.00	0.24	21.90	76.75	30.00	445.81
109	18.00	0.23	26.20	75.59	28.50	350.16
110	19.00	0.24	25.23	78.20	28.00	355.61
111	20.00	0.24	29.28	84.02	29.00	341.14
112	21.00	0.26	22.24	77.94	22.00	297.37
113	22.00	0.26	27.26	76.96	26.00	279.75
114	23.00	0.26	25.85	82.29	18.40	221.93
115	24.00	0.26	26.46	84.99	18.00	222.77
116	25.00	0.25	21.36	70.62	14.00	186.72
117	26.00	0.26	25.05	71.73	18.00	201.27
118	27.00	0.24	21.11	76.31	10.00	150.67
119	28.00	0.26	29.08	85.39	12.40	141.89
120	29.00	0.20	26.37	86.66	8.00	131.30
121	30.00	0.22	28.76	73.08	8.30	93.83
123	32.00	0.24	32.04	78.78	10.20	104.09
125	34.00	0.19	30.80	70.62	7.50	89.71
127	36.00	0.30	30.66	68.24	9.60	72.10
129	38.00	0.29	34.24	69.11	11.00	76.00
130	39.00	0.27	41.02	79.22	5.20	37.30
131	40.00	0.27	36.26	77.63	4.00	31.71
132	41.00	0.29	45.94	79.00	2.60	15.59
134	43.00	0.30	38.13	78.46	3.80	25.66

SLCF4A

Sample No.	Sample Depth (ft)	Moist. Content (gm/gm)	Dry Wt. Soil (gm)	Wt. Wtr. Added (gm)	Cl in Extract (ppm)	Cl in Soil Wtr. (mg/l)
135	0.50	0.10	32.01	94.48	6.30	181.70
136	1.25	0.11	37.32	69.16	12.00	203.68
137	2.00	0.09	41.90	70.26	10.50	196.68
138	2.50	0.14	27.69	72.08	56.50	1017.76
139	3.00	0.08	31.25	75.68	31.50	909.89
140	5.00	0.08	37.42	74.26	32.00	774.25
141	6.00	0.10	32.25	79.71	29.50	708.05
142	7.00	0.09	34.80	83.79	24.50	684.68
143	8.00	0.16	27.56	86.58	32.00	641.10
144	9.00	0.16	36.29	78.47	36.00	480.43
145	10.00	0.14	32.40	89.64	23.00	459.04
146	11.00	0.15	31.31	69.72	27.00	413.46
147	12.00	0.13	35.03	69.11	27.00	425.17
148	13.00	0.13	27.39	75.61	21.00	456.27
149	14.00	0.11	22.86	67.77	18.00	479.21
150	15.00	0.12	34.35	64.88	29.00	464.44
151	16.00	0.09	33.67	71.56	17.00	400.05
152	17.00	0.12	32.26	84.86	16.00	341.90
153	18.00	0.13	33.96	78.01	19.50	354.49
154	19.00	0.12	29.31	71.80	17.00	350.51
155	20.00	0.12	31.47	71.24	16.50	299.77
156	21.00	0.10	30.78	66.37	16.00	341.45
157	22.00	0.13	25.59	70.84	13.50	288.70
158	23.00	0.08	26.01	73.99	8.20	293.10
159	24.00	0.10	27.58	75.31	9.20	248.42
160	25.00	0.10	29.65	67.30	10.50	250.42
161	26.00	0.08	20.04	77.18	7.00	343.94
162	27.00	0.09	30.19	72.40	9.10	242.14
163	28.00	0.09	32.33	69.00	9.00	210.44
164	29.00	0.15	30.27	84.20	8.10	148.81
165	30.00	0.15	29.79	76.10	7.30	127.67
166	31.00	0.12	25.16	81.67	5.40	146.89
167	32.00	0.11	30.88	68.59	4.90	95.99
168	33.00	0.13	28.96	67.98	4.40	81.67
169	34.00	0.12	25.86	62.30	4.20	87.33
170	35.00	0.12	32.74	73.62	5.20	94.99
171	36.00	0.13	32.38	78.90	3.30	60.27
172	37.00	0.10	34.60	74.19	2.30	48.77
173	38.00	0.09	36.85	76.34	2.30	55.24
174	39.00	0.11	29.12	69.20	2.30	51.19
175	40.00	0.05	35.58	72.06	1.60	67.88

SLCF4B

Sample No.	Sample Depth (ft)	Moist. Content (gm/gm)	Dry Wt. Soil (gm)	Wt. Wtr. Added (gm)	Cl in Extract (ppm)	Cl in Soil Wtr. (mg/l)
176	0.00	0.09	31.29	87.17	3.40	108.89
177	0.75	0.13	29.43	73.60	4.80	89.89
178	1.50	0.13	29.99	79.03	4.20	82.65
179	2.25	0.15	31.65	76.66	23.00	360.01
180	3.00	0.20	28.60	81.44	62.00	861.35
181	3.75	0.18	34.99	79.90	43.50	558.47
182	5.00	0.12	30.48	80.98	19.00	416.22
183	6.00	0.12	35.69	77.81	18.00	327.91
184	7.00	0.11	32.86	73.34	16.50	327.84
185	8.00	0.13	34.29	80.61	15.50	286.57
186	9.00	0.13	34.99	73.19	22.50	354.15
187	10.00	0.10	26.64	63.43	14.50	353.74
188	11.00	0.13	22.61	62.39	14.00	306.48
189	12.00	0.13	24.67	71.72	14.50	327.79
190	13.00	0.13	31.75	70.95	17.00	283.80
191	14.00	0.08	28.91	75.74	13.50	464.77
192	15.00	0.04	36.99	78.90	12.00	606.92
193	20.00	0.12	32.72	71.34	15.50	273.62
194	21.00	0.10	34.30	81.72	12.50	290.20
195	22.00	0.13	25.70	75.20	9.70	225.74
196	23.00	0.07	29.82	65.15	9.50	297.46
197	24.00	0.10	34.29	74.88	8.90	192.06
198	25.00	0.09	32.45	77.18	7.40	194.87
199	26.00	0.09	29.38	75.31	7.80	227.68
200	27.00	0.09	31.02	64.94	7.40	169.21
201	28.00	0.10	27.86	68.53	7.00	167.73
202	30.00	0.13	27.60	68.42	5.20	97.74
203	31.00	0.11	28.82	70.92	3.30	72.88
204	32.00	0.14	27.19	71.73	3.40	65.71
205	33.00	0.11	27.69	66.33	3.60	78.29
206	34.00	0.15	29.76	71.93	2.60	42.94
207	35.00	0.11	25.96	73.52	2.00	49.34
208	36.00	0.12	29.64	74.07	2.30	48.24
209	37.00	0.11	23.91	65.21	3.20	82.81
210	38.00	0.10	31.17	68.33	2.70	59.38
211	39.00	0.09	32.18	69.81	4.00	94.28
212	40.00	0.08	23.38	61.90	2.00	68.05
213	41.00	0.06	32.07	73.61	2.80	109.67
214	42.00	0.06	28.75	70.01	2.40	105.68
215	43.00	0.07	30.21	82.53	2.60	101.66
216	44.00	0.06	33.45	68.56	2.50	84.46

SLCF05

Sample No.	Sample Depth (ft)	Moist. Content (gm/gm)	Dry Wt. Soil (gm)	Wt. Wtr. Added (gm)	Cl in Extract (ppm)	Cl in Soil Wtr. (mg/l)
217	1.00	0.10	34.98	80.16	10.00	241.20
218	2.00	0.16	31.14	77.21	70.00	1116.67
219	3.00	0.16	24.04	89.83	62.00	1428.07
220	4.00	0.12	26.02	75.94	44.50	1039.79
221	5.00	0.08	33.48	75.48	44.00	1318.69
222	6.00	0.06	38.65	82.47	48.00	1618.67
223	7.00	0.07	37.23	78.02	62.50	1800.80
224	8.00	0.15	27.68	78.30	94.00	1720.92
225	10.00	0.19	24.32	79.77	98.00	1695.93
226	11.00	0.13	33.23	79.89	86.00	1613.77
227	12.00	0.11	36.17	80.17	64.00	1338.38
228	13.00	0.11	24.65	75.61	36.50	984.51
229	14.00	0.12	29.68	78.49	34.00	736.16
230	15.00	0.20	22.61	73.19	37.00	596.22
231	16.00	0.20	28.91	76.67	53.00	699.40
232	17.00	0.19	24.56	69.59	48.00	732.23
233	18.00	0.18	28.00	81.53	35.00	554.97
234	19.00	0.06	35.41	89.67	14.50	586.51
235	20.00	0.06	34.87	78.04	11.50	412.39
236	21.00	0.09	39.10	75.67	6.70	147.22
237	22.00	0.21	28.13	72.85	11.40	139.24
238	25.00	0.13	26.90	83.00	6.20	144.55
239	26.00	0.06	41.70	78.49	3.00	97.58
240	27.00	0.05	38.17	74.75	3.30	117.56
241	28.00	0.13	29.40	71.48	3.10	57.86
242	30.00	0.14	25.21	82.36	4.00	94.09
243	31.00	0.21	23.67	70.25	5.10	73.27
244	32.00	0.19	24.73	76.26	4.40	69.88
245	33.00	0.16	28.80	84.41	5.30	98.32
246	34.00	0.21	28.48	73.94	8.60	104.24
247	35.00	0.23	27.99	75.05	5.40	64.23
248	36.00	0.26	22.96	76.38	7.40	93.23
249	37.00	0.27	27.42	76.21	8.20	84.65
250	38.00	0.25	20.89	80.78	3.70	57.37
251	39.00	0.30	15.52	69.98	4.20	63.62
252	40.00	0.27	22.56	70.20	7.60	87.57
253	41.00	0.30	23.59	73.60	5.40	57.03
254	42.00	0.23	27.00	69.82	5.00	55.94
255	43.00	0.22	18.98	83.55	4.50	88.86
256	45.00	0.24	24.61	70.12	4.50	54.33
257	46.00	0.31	28.19	76.79	4.00	35.30
258	47.00	0.29	25.89	78.27	2.60	27.19
259	48.00	0.34	22.92	71.93	2.60	24.02
260	49.00	0.39	26.57	77.12	2.30	17.16
261	50.00	0.42	22.99	69.22	3.90	28.14
262	51.00	0.36	26.95	82.26	3.80	31.89
263	52.00	0.20	60.26	82.21	3.80	25.94
264	53.00	0.25	40.16	72.97	3.70	26.43

Sample No.	Sample Depth (ft)	Moist. Content (gm/gm)	Dry Wt. Soil (gm)	Wt. Wtr. Added (gm)	Cl in Extract (ppm)	Cl in Soil Wtr. (mg/l)
265	54.00	0.37	19.12	64.61	3.20	29.61
266	55.00	0.33	19.03	74.07	2.00	23.48
267	56.00	0.41	16.13	61.31	4.50	41.51
268	57.00	0.17	35.59	73.90	2.00	24.70
269	58.00	0.18	32.91	83.17	1.30	18.58
270	59.00	0.14	29.08	81.57	1.10	21.95

APPENDIX B

Data Used For Cumulative Chloride *vs* Cumulative Water Plots

Explanation

SLCF01 = Salt Lake Coal Field Hole 1

Vol. Water Content = Volumetric Water Content (gravimetric water content   bulk density)

SLCF01

Sample No.	Sample Interval Length (m)	Vol. Water Content (cu m/cu m)	Cl in Soil (g/cu m)	Cl in Soil (g/sq m)	Cum. Cl in Soil (g/sq m)	Vol. Water Cont. (m)	Cum. Vol. Wtr. Content (m)
1	0.34	0.11	20.77	7.06	7.06	.04	0.04
2	0.23	0.10	167.24	38.46	45.53	.02	0.06
3	0.23	0.25	137.74	31.68	77.21	.06	0.12
4	0.42	0.14	95.02	39.91	117.11	.06	0.18
5	0.46	0.17	198.27	91.20	208.32	.08	0.25
6	0.30	0.27	376.32	112.90	321.21	.08	0.33
7	0.30	0.20	305.02	91.51	412.72	.06	0.39
8	0.30	0.10	168.22	50.47	463.18	.03	0.42
9	0.30	0.10	146.74	44.02	507.21	.03	0.45
10	0.30	0.13	177.09	53.13	560.33	.04	0.49
11	0.30	0.18	251.92	75.58	635.91	.05	0.54
12	0.30	0.08	115.01	34.50	670.41	.03	0.57
13	0.46	0.10	90.75	41.74	712.16	.05	0.61
14	0.46	0.10	83.79	38.54	750.70	.05	0.66
15	0.30	0.25	163.90	49.17	799.87	.08	0.74
16	0.30	0.18	95.94	28.78	828.65	.05	0.79
17	0.46	0.07	30.65	14.10	842.75	.03	0.82
18	0.46	0.11	33.05	15.20	857.96	.05	0.87
19	0.30	0.13	29.28	8.79	866.74	.04	0.91
20	0.30	0.07	14.52	4.36	871.10	.02	0.93
21	0.46	0.08	15.65	7.20	878.30	.04	0.97
22	0.46	0.07	22.99	10.58	888.88	.03	1.00
23	0.30	0.04	7.96	2.39	891.26	.01	1.02
24	0.30	0.13	10.11	3.03	894.30	.04	1.05
25	0.46	0.11	11.19	5.15	899.44	.05	1.11
26	0.46	0.17	11.12	5.11	904.56	.08	1.18
27	0.30	0.07	12.61	3.78	908.34	.02	1.20
28	0.61	0.13	11.25	6.86	915.21	.08	1.28
30	0.61	0.22	3.40	2.08	917.28	.14	1.42
31	0.30	0.25	5.31	1.59	918.87	.08	1.49
32	0.30	0.24	3.25	0.97	919.85	.07	1.56
33	0.30	0.15	8.11	2.43	922.28	.05	1.61
34	0.30	0.10	5.45	1.63	923.91	.03	1.64
35	0.30	0.04	2.37	0.71	924.63	.01	1.65
36	0.30	0.25	5.21	1.56	926.19	.08	1.73
37	0.30	0.11	4.51	1.35	927.54	.03	1.76
38	0.46	0.08	4.20	1.93	929.47	.04	1.80
39	0.46	0.21	8.09	3.72	933.19	.10	1.90
40	0.30	0.25	9.37	2.81	936.00	.08	1.97
41	0.30	0.07	3.13	0.94	936.95	.02	1.99
42	0.46	0.07	2.81	1.29	938.24	.03	2.03
43	0.46	0.13	6.24	2.87	941.11	.06	2.08
44	0.30	0.06	4.65	1.40	942.51	.02	2.10
45	0.30	0.15	6.53	1.96	944.47	.05	2.15
46	0.46	0.15	2.53	1.17	945.63	.07	2.22
47	0.61	0.10	3.18	1.94	947.57	.06	2.28
49	0.76	0.27	6.38	4.85	952.41	.20	2.48

Sample No.	Sample Interval Length (m)	Vol. Water Content (cu m/cu m)	Cl in Soil (g/cu m)	Cl in Soil (g/sq m)	Cum. Cl in Soil (g/sq m)	Vol. Water Cont. (m)	Cum. Vol. Wtr. Content (m)
50	0.61	0.25	4.87	2.97	955.39	.15	2.63
51	0.76	0.20	7.01	5.33	960.71	.15	2.78
53	0.76	0.41	3.92	2.98	963.70	.31	3.09
54	0.30	0.36	5.83	1.75	965.44	.11	3.20
55	0.15	0.43	7.96	1.19	966.64	.07	3.26

SLCF02

Sample No.	Sample Interval Length (m)	Vol. Water Content (cu m/cu m)	Cl in Soil (g/cu m)	Cl in Soil (g/sq m)	Cum. Cl in Soil (g/sq m)	Vol. Water Cont. (m)	Cum. Vol. Wtr. Content (m)
55	0.11	0.22	47.64	5.24	5.24	.02	0.02
56	0.23	0.21	79.45	18.27	23.51	.05	0.07
57	0.23	0.14	28.95	6.66	30.17	.03	0.11
58	0.23	0.14	22.10	5.08	35.26	.03	0.14
59	0.27	0.18	16.74	4.52	39.77	.05	0.19
60	0.30	0.27	11.74	3.52	43.30	.08	0.27
61	0.30	0.27	16.06	4.82	48.11	.08	0.35
62	0.30	0.31	13.82	4.15	52.26	.09	0.44
63	0.30	0.35	15.35	4.61	56.87	.10	0.54
64	0.30	0.35	17.62	5.28	62.15	.10	0.65
65	0.30	0.13	14.07	4.22	66.37	.04	0.69
66	0.30	0.14	22.44	6.73	73.10	.04	0.73
67	0.30	0.06	17.05	5.12	78.22	.02	0.75
68	0.61	0.15	166.10	101.32	179.54	.09	0.84
69	0.61	0.08	90.20	55.02	234.56	.05	0.89
70	0.76	0.07	90.02	68.41	302.98	.05	0.94
71	0.76	0.39	343.91	261.37	564.35	.30	1.24
72	0.30	0.35	312.15	93.64	657.99	.10	1.35
73	0.61	0.06	21.63	13.19	671.19	.03	1.38
74	0.61	0.06	14.32	8.73	679.92	.03	1.41
75	0.76	0.11	31.97	24.30	704.22	.09	1.50
76	0.76	0.41	97.73	74.27	778.49	.31	1.81
77	0.30	0.34	69.13	20.74	799.23	.10	1.91
78	0.30	0.25	57.75	17.33	816.56	.08	1.98
79	0.30	0.31	70.40	21.12	837.68	.09	2.08
80	0.30	0.27	69.34	20.80	858.48	.08	2.16
81	0.30	0.25	58.17	17.45	875.93	.08	2.23
82	0.30	0.20	48.25	14.48	890.41	.06	2.29
83	0.61	0.29	72.34	44.13	934.53	.18	2.47
84	0.61	0.46	92.85	56.64	991.17	.28	2.75
85	0.30	0.46	106.31	31.89	1023.06	.14	2.89
86	0.61	0.36	80.99	49.41	1072.47	.22	3.11
87	0.61	0.49	89.31	54.48	1126.95	.30	3.41
88	0.30	0.46	82.57	24.77	1151.72	.14	3.55
89	0.30	0.39	54.14	16.24	1167.96	.12	3.67
90	0.30	0.43	49.06	14.72	1182.68	.13	3.80
91	0.15	0.36	18.56	2.78	1185.46	.05	3.85

SLCF03

Sample No.	Sample Interval Length (m)	Vol. Water Content (cu m/cu m)	Cl in Soil (g/cu m)	Cl in Soil (g/sq m)	Cum. Cl in Soil (g/sq m)	Vol. Water Cont. (m)	Cum. Vol. Wtr. Content (m)
92	0.46	0.14	56.83	26.14	26.14	.06	0.06
93	0.30	0.25	506.13	151.84	177.98	.08	0.14
94	0.30	0.28	561.27	168.38	346.36	.08	0.22
95	0.30	0.29	562.33	168.70	515.06	.09	0.31
96	0.30	0.29	525.18	157.55	672.61	.09	0.40
97	0.30	0.29	471.54	141.46	814.08	.09	0.49
98	0.30	0.29	445.27	133.58	947.66	.09	0.58
99	0.30	0.29	403.62	121.09	1068.74	.09	0.67
100	0.30	0.25	311.43	93.43	1162.17	.08	0.74
101	0.30	0.14	169.43	50.83	1213.00	.04	0.78
102	0.30	0.21	194.78	58.43	1271.43	.06	0.85
103	0.30	0.22	178.06	53.42	1324.85	.07	0.91
104	0.30	0.25	198.41	59.52	1384.38	.08	0.99
105	0.30	0.27	172.61	51.78	1436.16	.08	1.07
106	0.30	0.38	224.21	67.26	1503.42	.11	1.18
107	0.30	0.34	171.42	51.43	1554.85	.10	1.28
108	0.30	0.34	149.79	44.94	1599.79	.10	1.38
109	0.30	0.32	112.75	33.83	1633.61	.10	1.48
110	0.30	0.34	119.48	35.85	1669.46	.10	1.58
111	0.30	0.34	114.62	34.39	1703.84	.10	1.68
112	0.30	0.36	108.24	32.47	1736.32	.11	1.79
113	0.30	0.36	101.83	30.55	1766.86	.11	1.90
114	0.30	0.36	80.78	24.23	1791.10	.11	2.01
115	0.30	0.36	81.09	24.33	1815.43	.11	2.12
116	0.30	0.35	65.35	19.61	1835.03	.10	2.22
117	0.30	0.36	73.26	21.98	1857.01	.11	2.33
118	0.30	0.34	50.63	15.19	1872.20	.10	2.43
119	0.30	0.36	51.65	15.49	1887.69	.11	2.54
120	0.30	0.28	36.76	11.03	1898.72	.08	2.63
121	0.46	0.31	28.90	13.29	1912.02	.14	2.77
123	0.61	0.34	34.97	21.33	1933.35	.20	2.97
125	0.61	0.27	23.86	14.56	1947.91	.16	3.14
127	0.61	0.42	30.28	18.47	1966.38	.26	3.39
129	0.46	0.41	30.86	14.19	1980.57	.19	3.58
130	0.30	0.38	14.10	4.23	1984.80	.11	3.69
131	0.30	0.38	11.99	3.60	1988.40	.11	3.81
132	0.46	0.41	6.33	2.91	1991.31	.19	3.99
134	0.30	0.42	10.78	3.23	1994.54	.13	4.12

SLCF4A

Sample No.	Sample Interval Length (m)	Vol. Water Content (cu m/cu m)	Cl in Soil (g/cu m)	Cl in Soil (g/sq m)	Cum. Cl in Soil (g/sq m)	Vol. Water Cont. (m)	Cum. Vol. Wtr. Content (m)
135	0.27	0.14	25.44	6.87	6.87	.04	0.04
136	0.23	0.15	31.37	7.21	14.08	.04	0.07
137	0.19	0.13	24.78	4.71	18.79	.02	0.10
138	0.15	0.20	199.48	29.92	48.71	.03	0.13
139	0.38	0.11	101.91	38.72	87.44	.04	0.17
140	0.46	0.11	86.72	39.89	127.33	.05	0.22
141	0.30	0.14	99.13	29.74	157.07	.04	0.26
142	0.30	0.13	86.27	25.88	182.95	.04	0.30
143	0.30	0.22	143.61	43.08	226.03	.07	0.37
144	0.30	0.22	107.62	32.28	258.31	.07	0.43
145	0.30	0.20	89.97	26.99	285.30	.06	0.49
146	0.30	0.21	86.83	26.05	311.35	.06	0.56
147	0.30	0.18	77.38	23.21	334.57	.05	0.61
148	0.30	0.18	83.04	24.91	359.48	.05	0.67
149	0.30	0.15	73.80	22.14	381.62	.05	0.71
150	0.30	0.17	78.03	23.41	405.03	.05	0.76
151	0.30	0.13	50.41	15.12	420.15	.04	0.80
152	0.30	0.17	57.44	17.23	437.38	.05	0.85
153	0.30	0.18	64.52	19.36	456.74	.05	0.91
154	0.30	0.17	58.89	17.67	474.40	.05	0.96
155	0.30	0.17	50.36	15.11	489.51	.05	1.01
156	0.30	0.14	47.80	14.34	503.85	.04	1.05
157	0.30	0.18	52.54	15.76	519.61	.05	1.10
158	0.30	0.11	32.83	9.85	529.46	.03	1.14
159	0.30	0.14	34.78	10.43	539.90	.04	1.18
160	0.30	0.14	35.06	10.52	550.41	.04	1.22
161	0.30	0.11	38.52	11.56	561.97	.03	1.25
162	0.30	0.13	30.51	9.15	571.12	.04	1.29
163	0.30	0.13	26.52	7.95	579.08	.04	1.33
164	0.30	0.21	31.25	9.38	588.45	.06	1.39
165	0.30	0.21	26.81	8.04	596.50	.06	1.46
166	0.30	0.17	24.68	7.40	603.90	.05	1.51
167	0.30	0.15	14.78	4.43	608.33	.05	1.55
168	0.30	0.18	14.86	4.46	612.79	.05	1.61
169	0.30	0.17	14.67	4.40	617.19	.05	1.66
170	0.30	0.17	15.96	4.79	621.98	.05	1.71
171	0.30	0.18	10.97	3.29	625.27	.05	1.76
172	0.30	0.14	6.83	2.05	627.32	.04	1.80
173	0.30	0.13	6.96	2.09	629.41	.04	1.84
174	0.30	0.15	7.88	2.36	631.77	.05	1.89
175	0.15	0.07	4.75	0.71	632.49	.01	1.90

SLCF4B

Sample No.	Sample Interval Length (m)	Vol. Water Content (cu m/cu m)	Cl in Soil (g/cu m)	Cl in Soil (g/sq m)	Cum. Cl in Soil (g/sq m)	Vol. Water Cont. (m)	Cum. Vol. Wtr. Content (m)
176	0.11	0.13	13.72	1.51	1.51	.01	0.01
177	0.23	0.18	16.36	3.76	5.27	.04	0.06
178	0.23	0.18	15.04	3.46	8.73	.04	0.10
179	0.23	0.21	75.60	17.39	26.12	.05	0.15
180	0.23	0.28	241.18	55.47	81.59	.06	0.21
181	0.30	0.25	140.73	42.22	123.81	.08	0.29
182	0.34	0.17	69.92	23.77	147.59	.06	0.34
183	0.30	0.17	55.09	16.53	164.11	.05	0.39
184	0.30	0.15	50.49	15.15	179.26	.05	0.44
185	0.30	0.18	52.16	15.65	194.91	.05	0.49
186	0.30	0.18	64.46	19.34	214.24	.05	0.55
187	0.30	0.14	49.52	14.86	229.10	.04	0.59
188	0.30	0.18	55.78	16.73	245.83	.05	0.65
189	0.30	0.18	59.66	17.90	263.73	.05	0.70
190	0.30	0.18	51.65	15.50	279.23	.05	0.75
191	0.30	0.11	52.05	15.62	294.84	.03	0.79
192	0.91	0.06	33.99	30.93	325.77	.05	0.84
193	0.91	0.17	45.97	41.83	367.60	.15	0.99
194	0.30	0.14	40.63	12.19	379.79	.04	1.03
195	0.30	0.18	41.08	12.33	392.12	.05	1.09
196	0.30	0.10	29.15	8.75	400.86	.03	1.12
197	0.30	0.14	26.89	8.07	408.93	.04	1.16
198	0.30	0.13	24.55	7.37	416.29	.04	1.20
199	0.30	0.13	28.69	8.61	424.90	.04	1.24
200	0.30	0.13	21.32	6.40	431.30	.04	1.27
201	0.46	0.14	23.48	10.80	442.10	.06	1.34
202	0.46	0.18	17.79	8.18	450.28	.08	1.42
203	0.30	0.15	11.22	3.37	453.65	.05	1.47
204	0.30	0.20	12.88	3.86	457.51	.06	1.53
205	0.30	0.15	12.06	3.62	461.13	.05	1.57
206	0.30	0.21	9.02	2.71	463.83	.06	1.64
207	0.30	0.15	7.60	2.28	466.11	.05	1.68
208	0.30	0.17	8.10	2.43	468.54	.05	1.73
209	0.30	0.15	12.75	3.83	472.37	.05	1.78
210	0.30	0.14	8.31	2.49	474.86	.04	1.82
211	0.30	0.13	11.88	3.56	478.43	.04	1.86
212	0.30	0.11	7.62	2.29	480.71	.03	1.89
213	0.30	0.08	9.21	2.76	483.48	.03	1.92
214	0.30	0.08	8.88	2.66	486.14	.03	1.94
215	0.30	0.10	9.96	2.99	489.13	.03	1.97
216	0.15	0.08	7.09	1.06	490.19	.01	1.98

SLCF05

Sample No.	Sample Interval Length (m)	Vol. Water Content (cu m/cu m)	Cl in Soil (g/cu m)	Cl in Soil (g/sq m)	Cum. Cl in Soil (g/sq m)	Vol. Water Cont. (m)	Cum. Vol. Wtr. Content (m)
217	0.46	0.14	33.77	15.53	15.53	.06	0.06
218	0.30	0.22	250.13	75.04	90.57	.07	0.13
219	0.30	0.22	319.89	95.97	186.54	.07	0.20
220	0.30	0.17	174.68	52.41	238.95	.05	0.25
221	0.30	0.11	147.69	44.31	283.25	.03	0.28
222	0.30	0.08	135.97	40.79	324.04	.03	0.31
223	0.30	0.10	176.48	52.94	376.99	.03	0.34
224	0.46	0.21	361.39	166.24	543.23	.10	0.43
225	0.46	0.27	451.12	207.51	750.74	.12	0.56
226	0.30	0.18	293.71	88.11	838.85	.05	0.61
227	0.30	0.15	206.11	61.83	900.69	.05	0.66
228	0.30	0.15	151.61	45.48	946.17	.05	0.70
229	0.30	0.17	123.67	37.10	983.27	.05	0.75
230	0.30	0.28	166.94	50.08	1033.36	.08	0.84
231	0.30	0.28	195.83	58.75	1092.11	.08	0.92
232	0.30	0.27	194.77	58.43	1150.54	.08	1.00
233	0.30	0.25	139.85	41.96	1192.49	.08	1.08
234	0.30	0.08	49.27	14.78	1207.27	.03	1.10
235	0.30	0.08	34.64	10.39	1217.67	.03	1.13
236	0.30	0.13	18.55	5.56	1223.23	.04	1.17
237	0.61	0.29	40.94	24.97	1248.20	.18	1.34
238	0.61	0.18	26.31	16.05	1264.25	.11	1.46
239	0.30	0.08	8.20	2.46	1266.71	.03	1.48
240	0.30	0.07	8.23	2.47	1269.18	.02	1.50
241	0.46	0.18	10.53	4.84	1274.02	.08	1.59
242	0.46	0.20	18.44	8.48	1282.51	.09	1.68
243	0.30	0.29	21.54	6.46	1288.97	.09	1.76
244	0.30	0.27	18.59	5.58	1294.54	.08	1.84
245	0.30	0.22	22.02	6.61	1301.15	.07	1.91
246	0.30	0.29	30.65	9.19	1310.35	.09	2.00
247	0.30	0.32	20.68	6.20	1316.55	.10	2.10
248	0.30	0.36	33.94	10.18	1326.73	.11	2.20
249	0.30	0.38	32.00	9.60	1336.33	.11	2.32
250	0.30	0.35	20.08	6.02	1342.35	.10	2.42
251	0.30	0.42	26.72	8.02	1350.37	.13	2.55
252	0.30	0.38	33.10	9.93	1360.30	.11	2.66
253	0.30	0.42	23.95	7.19	1367.49	.13	2.79
254	0.30	0.32	18.01	5.40	1372.89	.10	2.89
255	0.46	0.31	27.37	12.59	1385.48	.14	3.03
256	0.46	0.34	18.25	8.40	1393.88	.15	3.18
257	0.30	0.43	15.32	4.60	1398.47	.13	3.31
258	0.30	0.41	11.04	3.31	1401.78	.12	3.43
259	0.30	0.48	11.43	3.43	1405.21	.14	3.58
260	0.30	0.55	9.37	2.81	1408.03	.16	3.74
261	0.30	0.59	16.55	4.96	1412.99	.18	3.92
262	0.30	0.50	16.07	4.82	1417.81	.15	4.07
263	0.30	0.28	7.26	2.18	1419.99	.08	4.15

Sample No.	Sample Interval Length (m)	Vol. Water Content (cu m/cu m)	Cl in Soil (g/cu m)	Cl in Soil (g/sq m)	Cum. Cl in Soil (g/sq m)	Vol. Water Cont. (m)	Cum. Vol. Wtr. Content (m)
264	0.30	0.35	9.25	2.78	1422.76	.10	4.26
265	0.30	0.52	15.34	4.60	1427.37	.16	4.41
266	0.30	0.46	10.85	3.25	1430.62	.14	4.55
267	0.30	0.57	23.83	7.15	1437.77	.17	4.72
268	0.30	0.24	5.88	1.76	1439.53	.07	4.79
269	0.30	0.25	4.68	1.40	1440.94	.08	4.87
270	0.15	0.20	4.30	0.65	1441.58	.03	4.90