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CALCULATION OF GROUNDWATER RECHARGE AT THE OLD SRP BURIAL GROUND USING THE CREAMS MODEL (1961-1986)

by

J. E. Hubbard and M. Englehardt

Faculty and Student Research Participants, respectively, Summer 1987.
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INTRODUCTION AND SUMMARY

The CREAMS[1] computer simulation model was used to calculated a water balance for the old SRP burial ground (643-G) for the period 1961-1986. Daily rainfall records from F-Area Separations were used in the simulation; soils, vegetation, and climatic characteristics of the burial ground site were used for the hydrologic parameters in the model.

Average annual recharge is 14.7 inches as calculated by CREAMS, about the same as the normal recharge for the site estimated by Hubbard and Emslie[2] and by others, and slightly less than one-third the normal rainfall. The extremes are 32 inches in 1964 and 4 inches in 1968, and 8.7 inches of recharge in the recent "drought" year 1986. CREAMS results confirm that most recharge occurs in winter and spring months; however, in some years large amounts of recharge have occurred in summer months.

BACKGROUND

The old SRP Low-Level Radioactive Waste Burial Ground (643-G) is located as shown in Figure 1. A simple water balance involves accounting for precipitation, runoff, evapotranspiration (ET), soil water storage, and deep percolation.

The CREAMS model was developed by the U. S. Department of Agriculture Research Service for the Environmental Protection Agency under the Clean Water Act, to give "reasonable estimates" of the water balance used to calculate diffuse pollution transported with surface runoff in small, cropped agricultural areas. Because deep percolation (groundwater recharge) is important to the understanding of contaminant transport below burial sites, CREAMS water balance calculations were used to estimate its variability with time.

The use of CREAMS at SRP followed instructions provided by Lane[3] who calculated a surface water balance for shallow land burial systems at Los Alamos, NM and Rock Valley, NV. The hydrologic parameters developed for the burial ground[4] were used in these CREAMS simulations in the format presented in Appendix A. Daily records of rainfall at F-Area Separations, provided by the SRL Meteorological Center, were converted to a correct format such that a PC version of CREAMS performed the calculations.

RESULTS AND DISCUSSION

Annual totals of the rainfall, recharge, runoff, and ET calculated by CREAMS are shown in Table 1. Recharge, which is also shown in Figure 2, varied considerably year-to-year from its "normal" 14.7 inches, and generally, as expected, was greatest in years with high rainfall. However, 1984 and 1985 results show that recharge may differ by as much as 6 inches between years

with similar totals, but differing distribution of the timing and amount of rain.

Runoff averaged slightly more than 1 inch, generally occurring only with large rainfall events and relatively moist soils. ET varied little, but this is partly explained by the model's use of monthly "normals" rather than actual measured solar radiation and temperature records for each month in this study.

Monthly recharge for the period 1980-1986, shown in Figure 3, included the recent dry periods in 1984 and 1986. In recent years the greatest amounts of recharge have occurred in February, March, and May, and in some months of summer and autumn there was no recharge. However, over the 26-year period of records, very large amounts of rainfall and recharge have occurred with tropical storms in summer months.

Monthly averages of rainfall, runoff, recharge, and ET for 1961-1986 are shown in Figure 4. Rainfall is distributed throughout the year, with the driest months in autumn. Rainfall exceeds ET by 1/2 inch or more except in June and July.

CREAMS calculations of ET were compared with figures based on field measurements made by K. Denehy and P. McMahon of the U. S. Geological Survey in a report submitted to the Journal of Hydrology. Comparison of the CREAMS ET estimates with their measurements at the Barnwell, SC radioactive waste site in 1983 and 1984 indicates that the annual results generally agree, but that CREAMS overestimates ET in winter and underestimates ET in summer.

The CREAMS water balance method is being used in other hydrologic models, such as the Environmental Protection Agency's HELP Model of water movement at

landfill sites and the Department of Agriculture's GLEAMS Model for pesticide transport in subsurface water. PC versions of these are available from J. R. Cook of the Interim Waste Technology Division, SRL.

CREAMS was designed primarily for application to small field-size agricultural areas. A version for forested areas has been written and tested to a limited extent. However, a PC version, sent to us for testing, has been withdrawn, as there seems to be several "bugs" in that version of the program, and it is being revised.

RECOMMENDATIONS

Recommendations are as follows:

- Validate the Forest version of CREAMS when it becomes available and simulate groundwater recharge in a homogeneous representative upland region at SRP as was done for the burial ground in this study. It would be best to designate a "research watershed" at SRP for the validation measurements and for other future hydrologic studies as required.
- Compute the spatial variability of groundwater recharge at SRP by using CREAMS on hydrologic parameters estimated from field measurements of and remote imagery of representative soils, vegetation, and landscapes.
- Investigate applications of GLEAMS and HELP to groundwater studies of the burial grounds and other shallow land burial and possible contamination sites.

REFERENCES

1. W. G. Knisel, "CREAMS, A Field Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems," U.S. Department of Agriculture, Conservation Research Report No. 26, Washington, DC, 1980.
2. J. E. Hubbard and R. H. Emslie, "Water Budget for SRP Burial Ground Area," DPST-83-742, March 9, 1984.
3. L. J. Lane, "Surface Water Management: A User's Guide to Calculate a Water Balance Using the CREAMS Model," Los Alamos Scientific Laboratory Report LA-10177-M, 1984.
4. J. E. Hubbard, "An Update on the SRP Burial Ground Area Water Balance and Hydrology," DPST-85-958, January 9, 1986.

APPENDIX A: HYDROLOGIC PARAMETERS FOR SRP BURIAL GROUND USED IN CREAMS

DAILY HYDROLOGY PARAMETERS - SRP BURIAL GROUND

BASE VALUES FROM GRUBER REPORT AND S = 0.002
1961-1986 RAINFALL, NORMAL TEMPERATURE & INSOLATION, RUN G

61001	1	0	1	0					
100.	0.20	0.50	0.45	3.50	0.45	0.10			
0.2	72.0	0.200	1.1	18.0					
0.18	0.90	1.08	1.08	1.08	1.08	1.08			
45.8	48.3	54.6	63.8	71.7	78.2	80.4	79.6	74.2	64.1
53.7	46.4								
235.0	302.0	384.0	500.0	542.0	563.0	526.0	504.0	410.0	341.0
277.0	218.0								
1.0									
1	0								
91	.02								
121	0.05								
152	0.20								
182	1.00								
213	1.00								
244	0.80								
274	0.20								
305	0.01								
366	0								
0	0	0							
0	0	0							
0	0	0							
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0	0	0							
0	0	0							
-1	0	0							

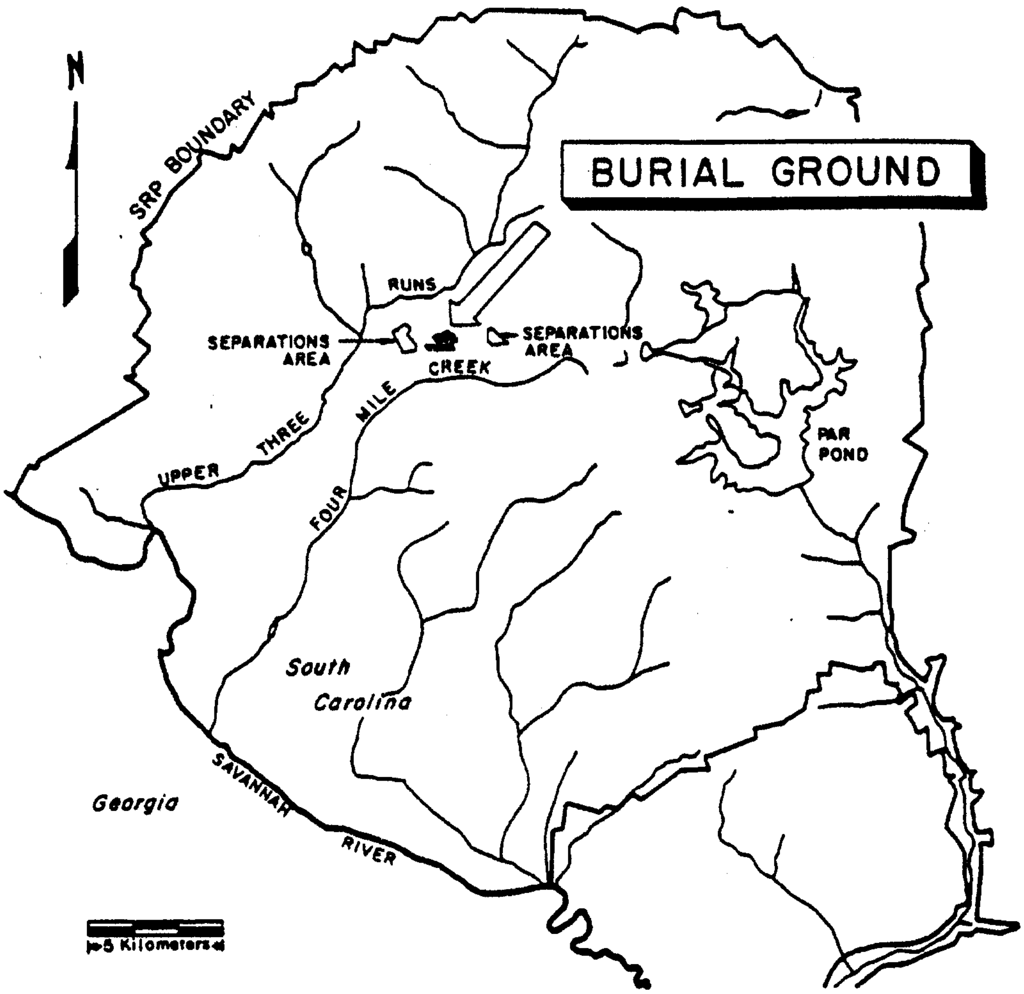

Figure 1. Burial Ground Location.

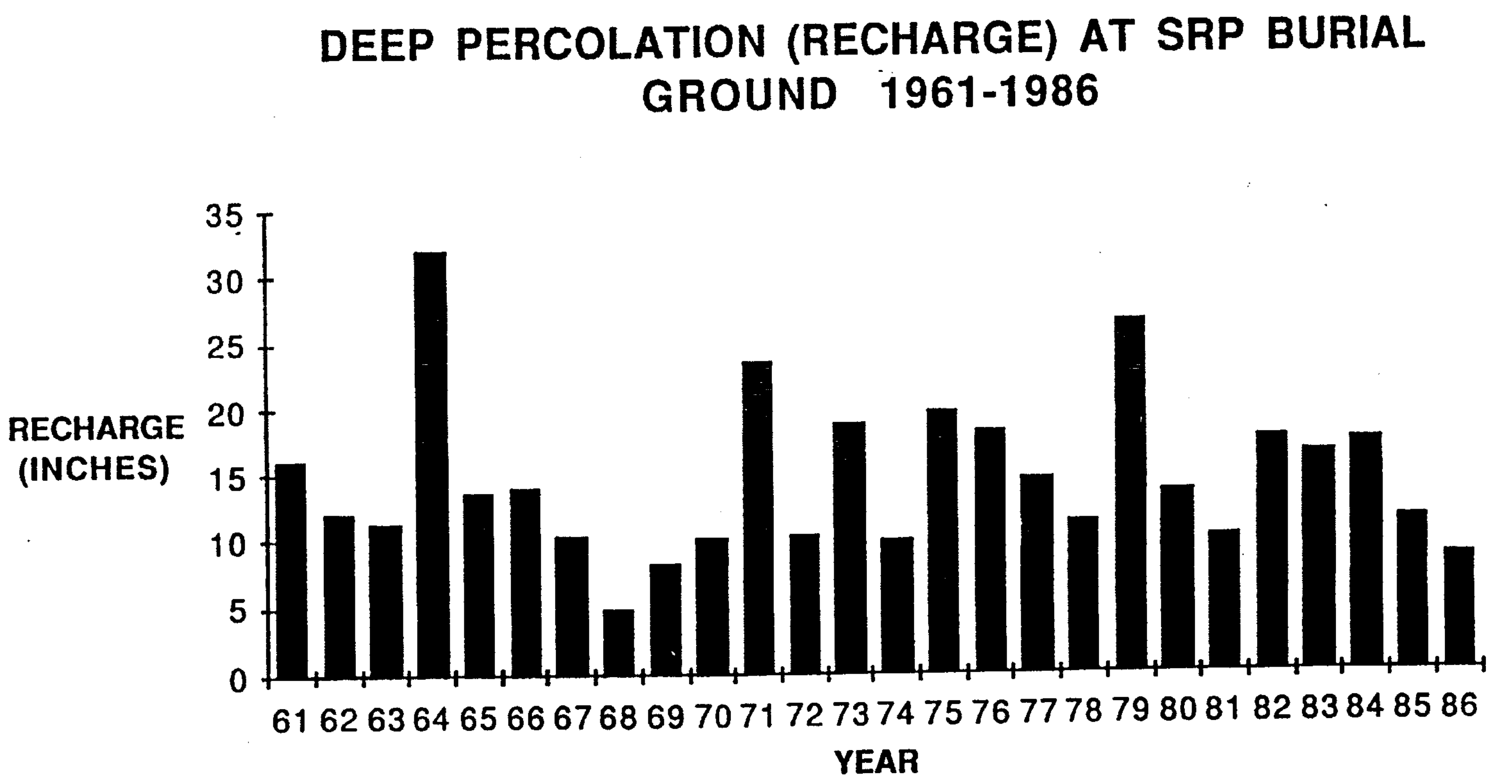
DEEP PERCOLATION (RECHARGE) AT SRP BURIAL GROUND 1961-1986
RECHARGE (INCHES)
35
30
25
20
15
10
5
0
61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
YEAR

FIGURE 2

DEEP PERCOLATION (RECHARGE) AT SRP BURIAL GROUND 1980-1986

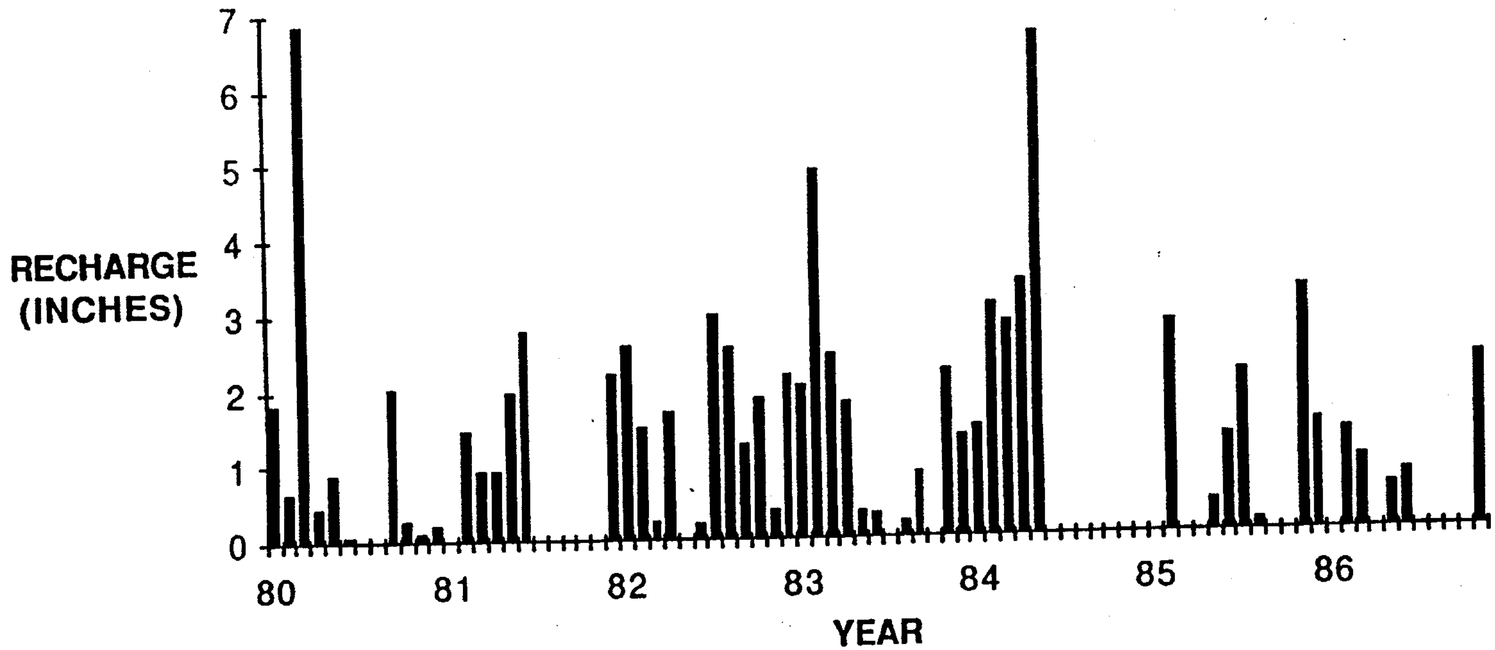

FIGURE 3

MONTHLY AVERAGES OF PRECIPITATION, RUNOFF, PERCOLATION AND EVAPOTRANSPIRATION, SAVANNAH RIVER PLANT BURIAL GROUNDS 1961-1986

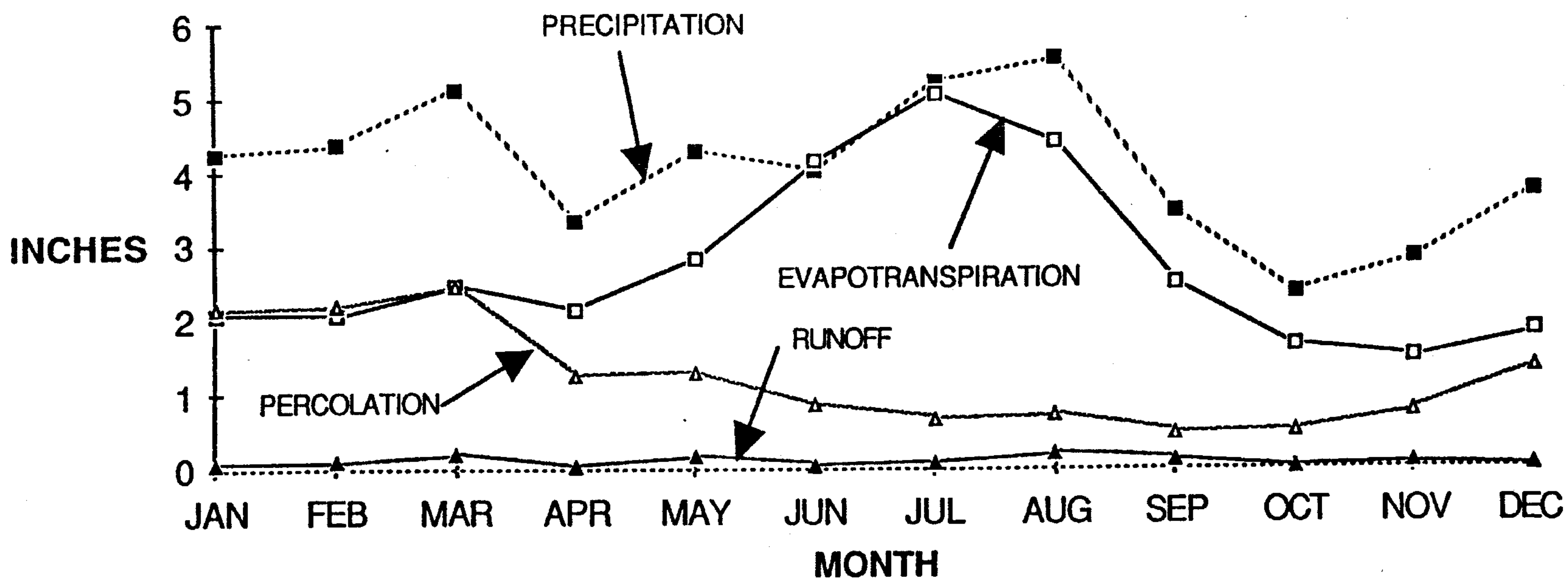

FIGURE 4

TABLE 1

SRP BURIAL GROUND HYDROLOGIC ESTIMATES FROM CREAMS MODEL				
YEAR	RAINFALL (INCHES)	RECHARGE (INCHES)	RUNOFF (INCHES)	EVAPOTRANSPIRATION (INCHES)
1961	49.29	16.18	1.87	31.24
1962	42.45	12.04	0.75	29.81
1963	41.38	11.27	0.77	29.18
1964	71.88	32.14	4.12	35.92
1965	48.32	13.62	1.73	33.46
1966	48.11	14.12	0.72	32.49
1967	42.52	10.32	1.59	31.12
1968	34.67	4.97	0.13	29.06
1969	39.46	8.34	0.35	31.12
1970	40.90	10.26	1.01	29.18
1971	59.79	23.62	1.97	34.97
1972	43.58	10.49	1.10	31.80
1973	55.11	18.76	1.09	34.86
1974	44.21	9.95	0.50	33.88
1985	57.88	19.78	1.06	36.91
1976	54.27	18.12	2.42	34.12
1977	51.05	14.54	0.55	35.66
1978	39.60	11.32	0.79	27.84
1979	66.28	26.57	3.07	36.20
1980	44.64	13.56	1.21	29.98
1981	42.91	10.30	0.85	31.74
1982	54.84	17.62	0.63	36.55
1983	52.36	16.56	0.73	35.25
1984	48.09	17.49	1.12	32.11
1985	47.24	11.62	1.17	32.18
1986	40.45	8.70	0.19	31.01
AVERAGE	48.51	14.70	1.21	32.60
STANDARD DEVIATION	8.73	6.04	0.90	2.64

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September 22, 1987

Mr. J. R. Powell, Technical Information Officer
U. S. Department of Energy
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Aiken, SC 29801

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J. C. Corey, Research Manager
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UC or C Number

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AUTHOR(S) ~~...~~ CREAMS Model (1969-1986) by ~~J.E. ...~~ PHONE NO.

TYPE: ☐ INTERNAL DOCUMENT ☒ EXTERNAL DOCUMENT

by J.E. Hubbard and M. Engelhardt

☐ DP Report

☐ Paper (see below)

☐ Other

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