

RECORDS ADMINISTRATION



R0061028

ACC# 248885
DP-MS-87-126

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.
Permanent Addresses:

Department of Earth Sciences, State University
of New York, College of Brockport, Brockport, NY 14420

and

Department of Geological Engineering, University of
Arizona, Tucson, AZ 85721

SRL
RECORD COPY

A paper prepared by Research Participants for the Savannah River Laboratory,
E. I. du Pont De Nemours and Company, Aiken, SC 29801

APPROVED for Release for
Unlimited (Release to Public)

This paper was prepared in connection with work done under Contract No. DE-AC09-76SR00001 with the U.S. Department of Energy. By acceptance of this paper, the publisher and/or recipient acknowledges the U.S. Government's right to retain a nonexclusive, royalty-free license in and to any copyright covering this paper, along with the right to reproduce and to authorize others to reproduce all or part of the copyrighted paper.

**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.
Permanent Addresses:

Department of Earth Sciences, State University
of New York, College of Brockport, Brockport, NY 14420

and

Department of Geological Engineering, University of
Arizona, Tucson, AZ 85721

INTRODUCTION AND SUMMARY

The CREAMS¹ computer simulation model was used to calculate 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 Emslie² 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 Lane³ 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 ground⁴ 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.

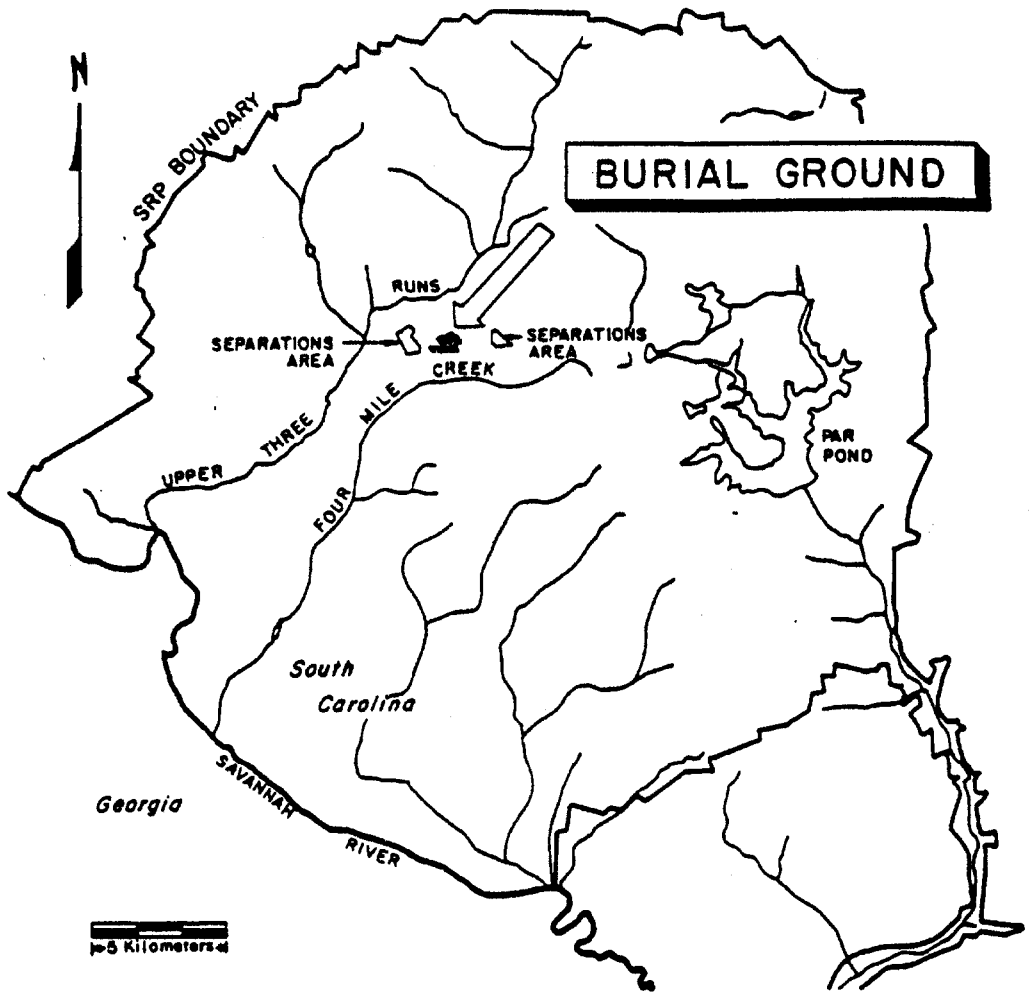


Figure 1. Burial Ground Location.

DEEP PERCOLATION (RECHARGE) AT SRP BURIAL
GROUND 1961-1986

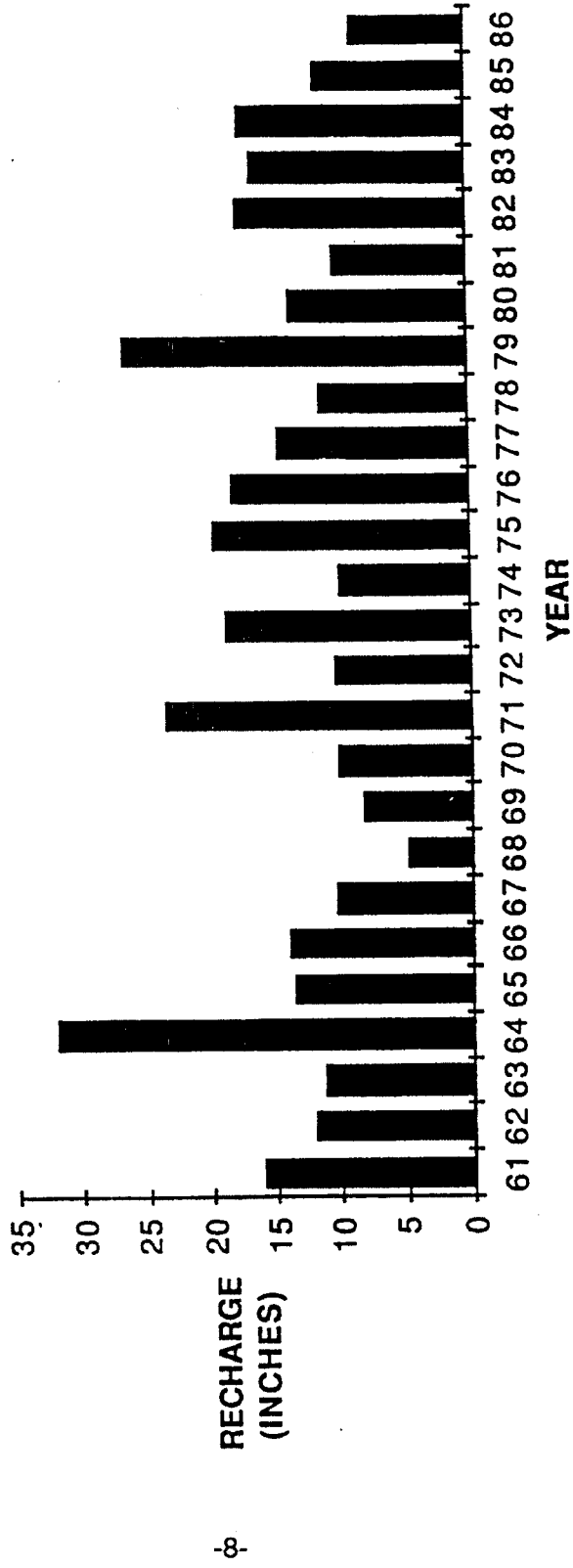


FIGURE 2

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

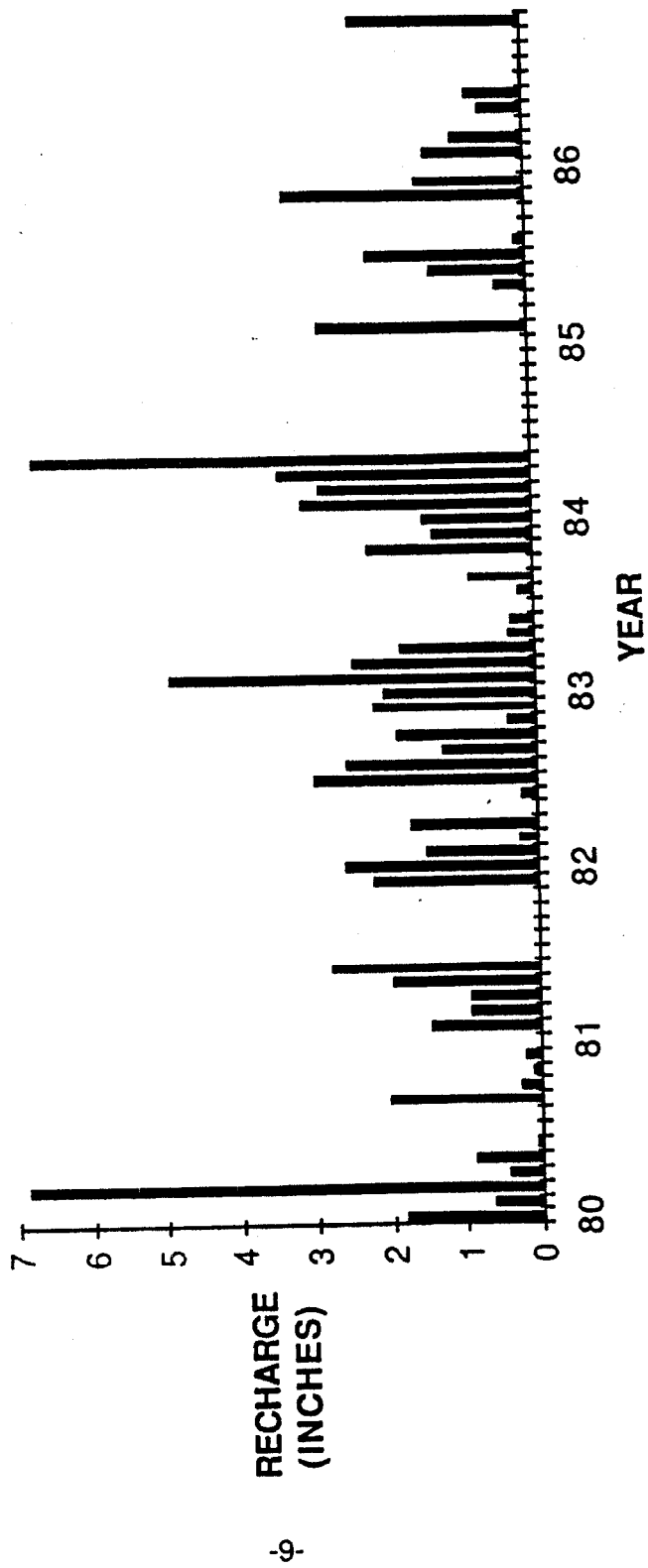


FIGURE 3

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

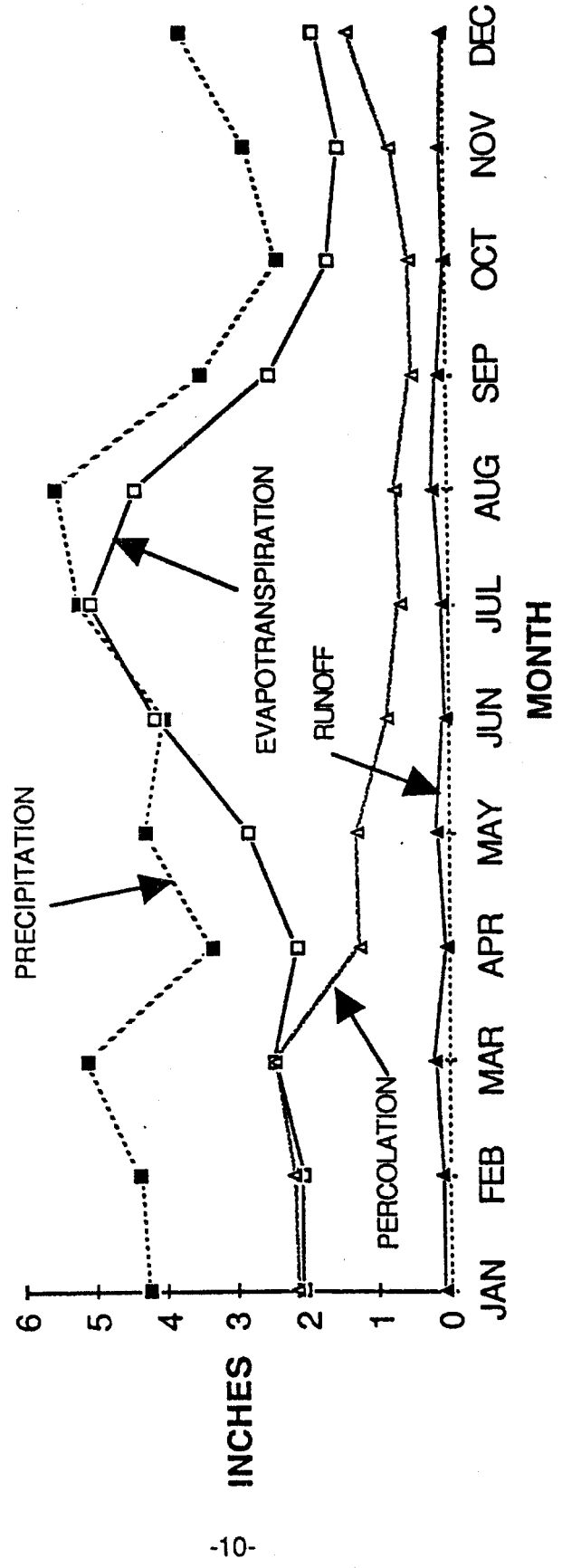


FIGURE 4

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



E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED

ATOMIC ENERGY DIVISION

SAVANNAH RIVER PLANT
AIKEN, SOUTH CAROLINA 29808-0001
(TWX: 810-771-2670, TEL: 803-725-6211, WU: AUGUSTA, GA.)

CC: W. F. Perrin, DOE-SR (2)
J. S. Roberts, 703-A
J. A. Duschinski, 703-43A
R. J. Guschl-J. C. Corey, 773-A
D. E. Gordon, 773-42A
File: (DP-MS-87-126)



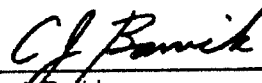
September 22, 1987

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

Dear Mr. Powell:

REQUEST FOR APPROVAL TO RELEASE SCIENTIFIC/TECHNICAL INFORMATION

The attached document is submitted for approval for external release. Please complete Part II of this letter and return the letter to the undersigned, by: ASAP Patent clearance is requested and received via direct communication between DOE Patent Counsel and AED Patent Reviewer. The document has ~~not~~ been reviewed for classification and UCNI. The document is classified/unclassified and contains no UCNI. (Strike words that do not apply.)



C. J. Barick AED Classification Officer

I. DETAILS OF REQUEST FOR RELEASE

DP-MS-87-126, "CALCULATION OF GROUNDWATER RECHARGE AT THE OLD SRP BURIAL GROUND USING THE CREAMS MODEL (1961-1986)", by J. E. Hubbard and M. Engelhardt.

Technical questions pertaining to the contents of the document should be addressed to the author(s) or

J. C. Corey, Research Manager
Environmental Science
Savannah River Laboratory

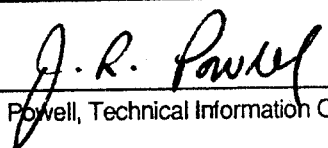
Questions concerning processing of this document should be addressed to the AED Classification Officer & Patent Reviewer at Extension 5-2606.

II. DOE-SR ACTION

DATE RECEIVED BY TIO 9-23-87

Approved as written
 Remarks

Not approved as written, revise and resubmit to DOE
 Approved upon completion of changes marked on document



J. R. Powell, Technical Information Officer, DOE-SR

Date 10/1/87

SAVANNAH RIVER DOCUMENT APPROVAL SHEET

(See SRP Procedures Manual Item 101)

Document Number DP-MS-87-126
UC or C Number _____

1. DESCRIPTION OF DOCUMENT (to be completed by author)

TITLE Calculation of Groundwater Recharge at the Old SRP Burial Ground Using the
AUTHOR(S) CREAMS Model (1969-1986) by J.E. Hubbard PHONE NO. _____

TYPE: INTERNAL DOCUMENT EXTERNAL DOCUMENT
by J.E. Hubbard and M. Engelhardt
 DP Report
 Paper (see below)
 Other _____

Additional Information for External Papers

PAPER FOR: Presentation Only _____ Publication Only _____ Both _____

MEETING NAME SC Water Resources Commission

CITY _____ DATES _____

CHAIRMAN & ADDRESS _____

JOURNAL NAME _____

DEADLINES FOR PUBLICATION: Abstract _____ No. of Copies _____
Paper _____ No. of Copies _____

I understand that for the information in this paper for external distribution:
A. Approvals by both Du Pont and DOE-SR managements are required.
B. Distribution verbally, or by publication, must be in accordance with policies set forth in DOE-SR orders.
C. Content of the external distribution must be limited to that actually approved by DOE-SR.

AUTHOR'S SIGNATURE _____

2. APPROVAL BY AUTHOR'S ORGANIZATION (required for all technical documents)

SRP/SRL ORGANIZATION D.E. Gordon

DERIVATIVE CLASSIFIER _____

Classification _____ Topic _____

DISTRIBUTION _____ Limit to List Attached. Reason: _____

_____ Limit to SRP & SRL. Reason: _____

_____ Limit to DOE-SR & Du Pont Contractual Family. Reason: _____

_____ Site-Specific Procedure, Data Sheet, TA, etc.

Unlimited To General Public

APPROVED BY RESEARCH MANAGER/SUPERINTENDENT J.C. Gray DATE 9/18/87

3. CLASSIFICATION & PATENT INFORMATION (to be completed by Patent & Classification Reviewer)

CLASSIFICATION (circle one for each)

Overall S C UCNI
Abstract S C UCNI
Title S C UCNI
Cover Letter S C UCNI U

CLASSIFICATION GUIDE TOPICS

CG-DAR-1
Topic 2.2

PATENT CONSIDERATIONS

Possible Novel Features NA

Closest Prior Art _____

APPROVED BY AED PATENT & CLASSIFICATION OFFICER C. J. Baird DATE 9/18/87

4. PUBLICATIONS DIVISION PROCESSING

DATE RECEIVED 9/21/87 PUBLICATIONS SUPERVISOR J.B. Barnes

EDITOR Jack Duschinski DATE ASSIGNED 9/21/87

DATE COPIES SUBMITTED FOR RELEASE _____

DOE-SR RELEASE DATES: Patent Branch _____ Tech. Info. Office _____

DATE COMPLETED _____ DATE SUBMITTED TO OSTI _____