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Recharge at the Hanford Site: Status Report

G. W. Gee

November 1987

Prepared for the U.S. Department of Energy
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Pacific Northwest Laboratory
Richland, Washington 99352

EXECUTIVE SUMMARY

A variety of field programs designed to evaluate recharge and other water balance components (e.g., precipitation, infiltration, evaporation, and water storage changes) have been carried out at the Hanford Site since 1970. Data from these programs have indicated that a wide range of recharge rates can occur depending upon specific site conditions. Present evidence suggests that minimum recharge occurs where soils are fine-textured and surfaces are vegetated with deep-rooted plants. Maximum recharge occurs where coarse soils or gravels exist at the surface and soils are kept bare. Recharge can occur in areas where shallow-rooted plants dominate the surface, particularly where soils are coarse-textured. Recharge was estimated to be near zero during a 14-year period in a lysimeter located on the 200 Area plateau. In agreement with these results, moisture profiles from another site on the 200 Area plateau, where deep-rooted plants (sagebrush, hopsage, etc.) have been growing on fine soil, indicated that the soil has dried (likely as a result of water extraction by roots) to depths up to 8 m; these results strongly suggest that recharge is less than 0.1 cm/yr under these conditions. In contrast, data from drainage lysimeters located near the 300 Area indicate significant drainage has occurred during the past several years. Since 1985, 12 bare-surface lysimeters in the 300 Area have exhibited drainage rates of 10 cm/yr or more while an adjacent vegetated (cheatgrass-covered) lysimeter drained at an average rate of about 6 cm/yr. Neutron probe data at a grass-covered field site near the 300 Area also suggest that water is draining below the root zone under conditions of coarse soil and shallow-rooted vegetation.

Recharge estimates have been made for the site using simulation models. A U.S. Geological Survey model that attempts to account for climate variability, soil storage parameters, and plant factors has calculated recharge values ranging from near zero to an average of about 1 cm/yr for the Hanford Site. Other models such as the Morton or the Thornthwaite-Mather Model also tend to predict very low recharge rates. These estimates apparently do not account for site-specific soil conditions and plant cover types (e.g., bare soils or shallow-rooted plant cover); hence they do not predict observed high

recharge rates (more than 50% of the total annual precipitation). Furthermore, none of the simplified codes that have been used to date have been calibrated specifically for Hanford Site conditions.

UNSAT-H, a deterministic model developed for the site, appears to be the best code available for estimating recharge on a site-specific basis. Verification of this code has been completed (Fayer, Gee and Jones 1986), and calibration of the code to site-specific data is under way. The continuation of field monitoring of soil and plant parameters under a range of variable climatic conditions is designed to provide model input data for code calibration purposes.

Lysimeters have provided the first direct evidence of recharge for the Hanford Site. However, no waste storage sites at Hanford have been directly monitored for recharge. In areas where gravels cover the surface, such as tank farms, much of the annual precipitation can be expected to drain through the gravel and be available for recharge. The significance of gravel cover over waste sites needs to be assessed.

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1.0 INTRODUCTION

Ground-water recharge is the process whereby the surplus of infiltration over evaporation (and transpiration) results in water draining through the vadose (unsaturated) zone to the water table, where it is added to the ground-water reservoir (unconfined aquifer). At Hanford, water from either artificial (recharge basins; i.e., ponds, cribs, trenches) or natural (rainfall, snowmelt) sources moves downward through a relatively thick (10 to 100 m or more) mantle of relatively coarse sediments to the water table, where in response to hydrostatic pressure-head differences it moves laterally toward and eventually intercepts the Columbia River. The amount of artificial recharge at Hanford is estimated to be 5.5×10^7 liters/day (DOE 1986). For a given seepage pond or crib, artificial recharge represents a major input to ground water on a unit-area basis (i.e., as much as several hundred times the 16-cm annual precipitation).

The exact quantity of natural recharge (i.e., from rainfall and snowmelt) in waste storage areas at Hanford is of considerable interest because it represents a mechanism for leaching of contaminants from waste materials and transporting them to the ground water. Locations and quantities of shallow-buried wastes, particularly those located on the 200 Area plateau, have been documented (DOE 1986). Recharge (from natural sources) at these and other waste sites needs to be estimated as accurately as possible to predict the consequence of leaving the waste in place for time periods that may exceed thousands of years.

The purpose of the study that has produced the data documented by this report is to quantify natural recharge at Hanford, particulary for those conditions that exist at or near waste burial sites. Previous reports (Gee and Heller 1985; Gee and Jones 1985) have documented much of the background information that was used before 1985 to estimate recharge. This report provides continuity by describing work done since that time. Water balance data from four areas are provided. Two areas, the Buried Waste Test Facility (BWTF) and the 300 Area Grass Site, are located a few kilometers northwest of the 300 Area. The 200 Area deep lysimeter is located just south of the 200-East Area in the central part of the Hanford Site; the fourth area, the McGee Ranch

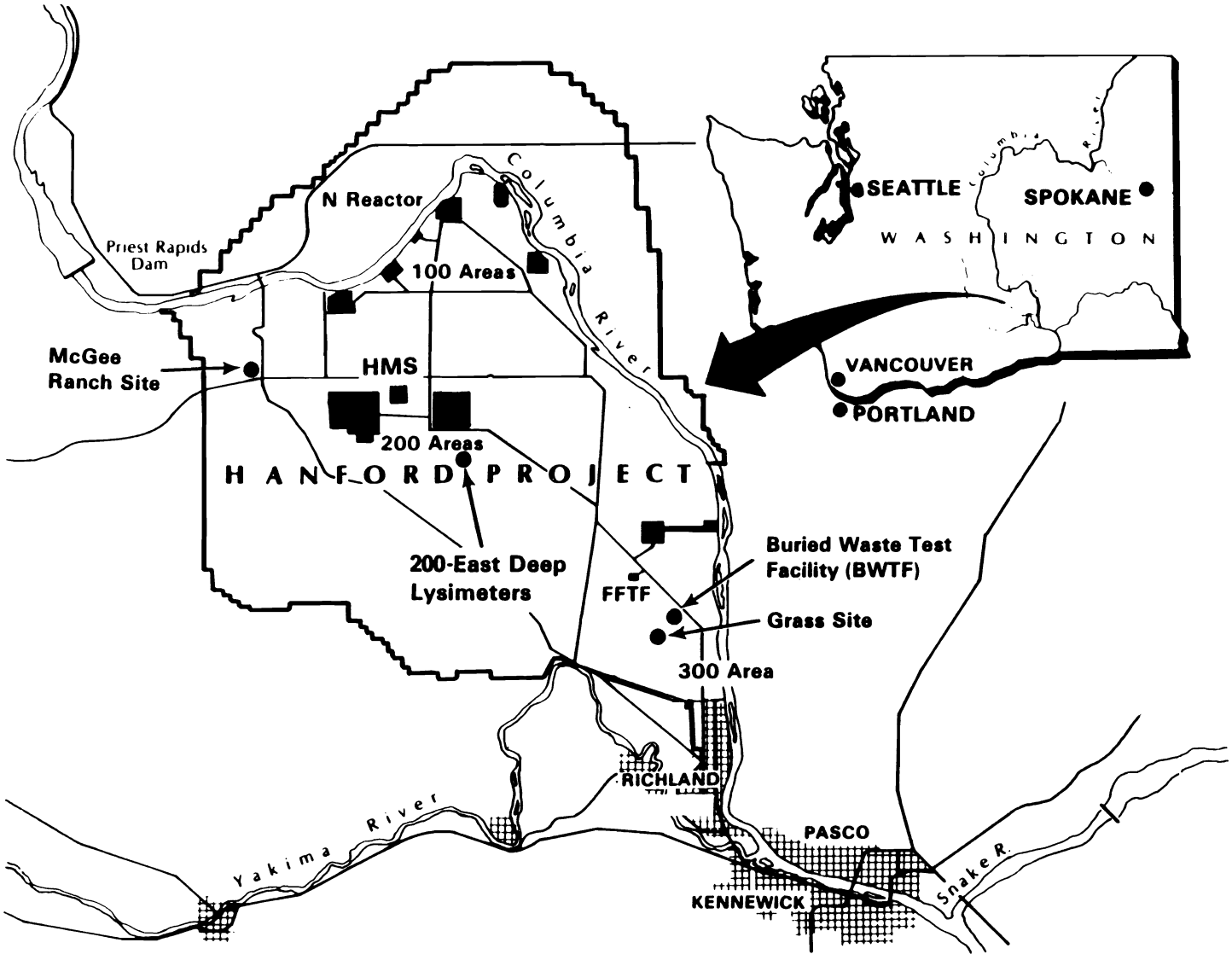

FIGURE 1.1. Location of Recharge Measurement Sites at the Hanford Site

site, is located northwest of the 200 Areas (Figure 1.1). Water storage data from neutron probe or gravimetric water contents are provided for each site. For the BWTF site, drainage lysimeter and tensiometer data are also presented. These locations provide a relatively wide range of surface soil and plant cover conditions that exist at the Hanford Site and hence should provide a range of recharge rates.

In the following four sections of this report, Section 2.0 provides general considerations of recharge at arid sites, specific considerations regarding recharge at Hanford provided by a recent workshop on this topic, and previous modeling estimates of recharge at Hanford; Section 3.0 provides updated information on the lysimeters used at Hanford to estimate recharge and an analysis of water storage data from lysimeters in the 200 Area compared to measured drainage in the 300 Area; Section 4.0 provides comparisons of water balance data from the 300 Area Grass Site and the McGee Ranch, and a discussion of effects of plant cover and soil type on recharge; and Section 5.0 presents a summary and conclusions from observations of present recharge rates, and states implications for current and future waste management practices at Hanford. An appendix of key data is also provided.

2.0 GENERAL CONSIDERATIONS

2.1 RECHARGE PROCESSES AT ARID SITES

Recharge at arid sites is generally low but for specific locations can vary from zero to a large fraction of the annual precipitation. Such variations have been observed at Hanford and will be described in subsequent sections.

Recharge depends on a variety of factors, including rainfall distribution and intensity, topographic and surface conditions, and soil texture and layering. Variation in precipitation input is a major contributor to the wide range of recharge that can occur. The temporal and spatial variability of precipitation at arid sites is difficult to quantify, and extreme events can have major consequences on recharge. In addition, the profound effect of precipitation on plant cover as well as on surface soil moisture and other physical features creates significant variations in water loss by evapotranspiration (ET), which can alter the recharge and other water balance components of the site. Recharge estimates thus require a thorough knowledge of the expected variations of the key factors (i.e., precipitation, soil type, and plant cover) and their interactions with the individual components of the site water balance. Utilizing models that do not account for these variations may be misleading and often underestimate the recharge that occurs.

Direct measurements of recharge at arid sites such as Hanford are difficult and often impossible; because water tables are deep and surface streams are ephemeral, discharge data are nonexistent. For arid sites one must rely on indirect measurements such as changes in water table depth, lysimeter drainage data, changes in water storage in a given soil profile, evapotranspiration (ET) measurements and subsequent calculations of water balance, thermal profile estimates, and tracer tests. All these methods are fraught with difficulty, but some are more useful than others, depending on the level of accuracy required and the use to which the recharge data will be applied.

Studies of waste management at arid sites often require very precise knowledge about the existence and extent of recharge. An external peer-reviewed Recharge Workshop that was held in 1985 has provided the focus for much of the recharge research conducted at Hanford during the past 2 years. A summary of that workshop is presented in this section. In subsequent sections, recharge

predictions that have been made for Hanford, the type of data that have been required for these models, and their relative merits for use in waste management considerations for the site are discussed.

2.1.1 Recharge Workshop Summary

Key issues related to recharge at Hanford were reviewed in a "Recharge Workshop" held October 14-15, 1985, in Richland, Washington. A panel of five experts in hydrology, with specific interests in unsaturated water flow in porous media, were invited to review past work, to respond to specific questions, and to recommend directions for future work related to recharge at Hanford. The panel consisted of Dr. Gaylon S. Campbell, Washington State University, Pullman, Washington; Dr. Daniel Hillel, University of Massachusetts, Amherst, Massachusetts; Dr. Arthur W. Warrick, University of Arizona, Tucson, Arizona; Dr. Edwin P. Weeks, U.S. Geological Survey, Denver, Colorado; and Dr. Stephen Whitaker, University of California, Davis, California. The panel prepared a report that was made available to the workshop participants from the U.S. Department of Energy (DOE), Pacific Northwest Laboratory (PNL), and Rockwell Hanford Operations personnel. Several key points made by the panel regarding recharge measurements are included here for background information and to provide a rationale for the ongoing work on Hanford Site recharge. Excerpts from their comments on recharge follow:

> Notwithstanding the general aridity of the climate at the Hanford Site and the absence of deep percolation in 'normal' years, it is entirely possible that some recharge of groundwater may indeed occur following episodes of unusually high precipitation. Such occurrences are particularly likely under topographic depressions where surface water might accumulate, in places underlain by very coarse and highly permeable deposits, and when the land is denuded of vegetation (as by fire, by overgrazing, or by mechanical clearing).
>
> The amounts and timing of downward percolation from the soil toward the water-table are highly dependent on the vegetation and on the temporal distribution of precipitation. With deep-rooted perennial vegetation, downward liquid fluxes may be almost balanced by upward distillation due to the geothermal temperature gradient. The net water flux may therefore be close to zero most of the time, and be either positive or negative part of the time. At the other extreme, unvegetated surfaces with pebble or cobble pavement will tend to retard evaporation and cause the accumulation within the soil of some

50% to 75% of the precipitation they receive. The eventual recharge under such surfaces may therefore amount to several centimeters per year.

As mentioned above, a key issue in determining long-term recharge is the occurrence of extreme rainfall or vegetation fluctuations. While deep-rooted vegetation may use nearly all of the available water in normal years, such vegetation will generally not increase water use sufficiently in extremely wet years to prevent the downward percolation of the excess of infiltration over evapotranspiration. The sandy and gravelly soils and subsoils of the Hanford area retain little water, so the amount draining out of the root zone is likely to find its way, sooner or later, to the water-table. Once water percolates below the root zone, significant upward movement in the liquid phase is unlikely. Fires which destroy perennial vegetation often result in the growth of shallow-rooted annuals, and consequently increase the likelihood that some water will move down beyond the depth to which soil moisture can be extracted by plants and returned to the atmosphere.

Knowing the magnitude of recharge is the key to calculating travel time in the event of a leakage or containment failure. The magnitude of recharge and the travel time are important not only in themselves, but also insofar as they influence the mechanisms and time periods for solute interactions. Diffusion, adsorption, reaction kinetics and flow rates must all be taken into account in assessing the transport of waterborne contaminants within the soil.

The panel was asked to specify what the annual recharge was at Hanford and to predict what it would be in 10,000 years. The panel did not answer these questions directly but indicated some of the difficulties in obtaining recharge estimates. They stated that evaluation of the downward percolation rates at Hanford is made particularly difficult by the following facts:

1. The recharge rates are of the same order of magnitude as the measurement errors of flux at the surface boundary (in some cases the recharge rates are smaller). Even though water movement below the root zone is slow, its cumulative amount cannot be neglected when projections extend over long periods.

2. The biological system is difficult to quantify. Root activity and plant growth impact the amount and timing of water uptake, and this in turn, influences the percolation rate. Effects such as range fires, nutrient interactions, or changes in the ecological system can become dominant at any particular time.

3. Point measurements and observations are difficult to project over large areas. The effect of local depressions, on a scale of a few square meters, could dominate infiltration, as well as plant growth, evapotranspiration, and the moisture regime below the root zone. Subsurface strata are important in determining the flow pattern in the unsaturated zone. Of great interest is the possible existence of preferred paths, especially such that might connect the soil's surface zone directly to the water table.

4. The data base pertaining to precipitation is too short in duration for determining the likelihood of extreme events with confidence, and insufficient for extending to very long periods (say, beyond 50 to 100 years). Although at first glance the records from the early 1900's would appear to be sufficient for any conceivable purpose, on close examination a precise probability figure for a 100-year precipitation event, or a cluster of extreme events, cannot be defined. This is due to the extremely skewed rainfall variation from year to year. Significant recharge may well result from only a few years out of many (i.e., from unusual episodes). Long-term climatic trends are yet undiscernible, so future changes cannot be predicted.

The recharge workshop panel further recommended that a suite of measurements be made in subsequent years to better define the site characteristics that influence recharge. Their recommendations included: evaluation of soil hydraulic properties; measurements of plant cover type, rooting patterns, water use variations, and phenology; additional lysimeter tests that include comparisons of vegetated to bare surfaces and are designed to measure drainage as well as other water balance components; and tracer tests at hydrologically representative sites.

2.2 RECHARGE PREDICTIONS AND MODELING

Several studies have used numerical models to estimate recharge at Hanford. Some of these models have been relatively simplistic, relying on a few key climatic parameters such as humidity and precipitation, while others have been more complex, requiring an estimate of topography, soil type, and plant cover as well as climatic data. A brief review of these models and their application to the Hanford Site follows.

2.2.1 Morton Model

Wallace (1978) used a model developed by Morton (1975, 1976) to estimate evapotranspiration for the Hanford Site and then calculated recharge from water balance considerations. The Morton model utilizes climatic data exclusively. It is based on the assumption that interactions between evaporating surfaces and overpassing air alter temperature and humidity of the air in a unique way. This results in a "feedback loop" which in turn modifies the surface evaporation. A complementary relationship between changes in potential and actual evapotranspiration is used to calculate the actual evapotranspiration. The potential evapotranspiration (PET) is defined as the computed water loss from the surface under a given climate (i.e., dependent on temperature, humidity, wind speed, radiation), assuming that the surface was a well-watered, short crop such as grass. The areal or actual evapotranspiration (AET) is defined as the surface water loss from an area so large that the effects of evapotranspiration on the temperature and humidity of the overpassing air are fully developed. Details of the equations used to calculate both PET and AET are provided by Wallace (1978).

The Morton model requires, as input, latitude, annual average atmospheric pressure, and weekly or monthly mean values of precipitation, air temperature, dew point temperature, and the ratio of the observed to the maximum possible sunshine duration for each time period. Data from the Hanford Meteorological Station provided long-term monthly averages for temperature, precipitation, relative humidity, dew point, sky cover, barometric pressure, wind speed, and solar radiation, which allowed Wallace to compare the Morton model with those of Penman (1948) and Thornthwaite and Mather (1955). The long-term records varied in length of time: from 1912 to 1970 for temperature and precipitation and from 1953 to 1970 for solar radiation.

Potential evapotranspiration (PET) was computed for all three methods. For the long-term (1912-1970) climate record, the computed PET values were 74.7, 79.5, and 139.2 cm/yr for the Thornthwaite-Mather, Penman, and Morton methods, respectively. This compares with the long-term average precipitation value of 15.9 cm/yr. On the basis of the difference of precipitation and potential evapotranspiration alone, all three models would predict that there would not be recharge at Hanford. Calculations similar to these have been

made for the Hanford Site in the past (ERDA 1975) and have led to erroneous assumptions about the potential for recharge. This method suggests that no recharge could ever occur at Hanford under present climate conditions. As discussed previously and pointed out by Thornthwaite and Mather (1955) and Morton (1975, 1976), actual evapotranspiration is generally just a small fraction of potential evapotranspiration for an arid site.

Actual evapotranspiration (AET) values were computed for the Thornthwaite-Mather and the Morton models. By making the assumptions that no runoff occurs (which appears to be reasonable for most of the waste storage areas at Hanford) and that the annual storage changes are zero (that is, the initial and final water storage are the same each year), the annual recharge was calculated as the excess of precipitation over actual evaportranspiration. Table 2.1 shows the calculated recharge for the Morton and the Thornthwaite-Mather methods. Only the Morton method produced results indicating that recharge would occur. Wallace suggested that of the models tested, the Morton model was preferred because its development and calibration included arid sites (although it was not calibrated specifically to the Hanford Site).

Wallace (1978) also computed recharge for two short-term data sets (1966-1970 and 1971-1975) using the Morton model. These time periods have average precipitation values of 14.1 and 17.1 cm/yr, respectively. The corresponding AET values were computed to be 3.0 and 0 cm/yr, respectively (Table 2.1). It is interesting to note that increasing the precipitation values increases the computed evapotranspiration, since the higher average rainfall years produce higher AET values. The calculated recharge was therefore less in the wetter years. This result is opposite that normally expected, and suggests that changes in climate that cause changes in precipitation are sufficiently complex that estimating recharge as some fraction of the annual precipitation is not appropriate. These calculations suggest that methods for estimating recharge from climate data alone can produce significantly different recharge results. Because site-specific recharge is known to be a function of more parameters than climate, and because relatively small changes in climate parameters can have a substantial influence on predicted evapotranspiration and subsequently

TABLE 2.1. Recharge Estimates at the Hanford Site Using Climate Models[a]

Time Period	Precipitation (cm/yr)	PET (cm/yr)	AET (cm/yr)		Recharge (cm/yr)	
			Morton	Thornthwaite	Morton	Thornthwaite
1966-1970	14.1	141.6	11.1	n.d.	3.0	n.d.[b]
1971-1975	17.1	142.4	17.3	n.d.	0.0	n.d.
Long-term averages	15.9	139.2	14.7	15.9	1.2	0

(a) After Wallace (1978).
(b) n.d. = not determined.

on recharge estimates, methods that rely on climate alone should not be used for predictions of recharge at Hanford. For this reason, the Morton method is not recommended.

2.2.2 Thornthwaite-Mather Model

In addition to Wallace (1978,) Gutknecht et al. (1980) and Whelan et al. 1987) used the Thornthwaite-Mather (T-M) model, or modifications of it, to assess recharge at Hanford. The T-M model was developed to calculate average potential evapotranspiration from mean monthly temperature data. The basic formula requires only temperature input and is an empirical index of evaporation from well-watered surfaces. It is based largely on evaporation and plant water-use data from central and eastern United States. In addition to temperature, estimates of rooting depth and soil water storage are required. In the T-M formulation, no consideration is given for temporal changes in vegetation type (such as might be created by fires or other disturbances), so this limitation must be accounted for empirically by altering the rooting depth or water storage factors. The plant rooting depths themselves are empirically derived parameters and have little to do with measured rooting depths, particularly for desert plants. Soil moisture retention tables based on soil texture properties are used to obtain the amount of water stored in the "root zone." From a knowledge of the root zone water capacity, the amount of soil moisture retained in the soil can be calculated and related to a given amount of evapotranspiration.

In the T-M model the actual evapotranspiration (AET) is computed as a linear function of PET and the soil water status (SWS) such that AET = (SWS/AW) (PET), where SWS is the actual soil water status (i.e., the actual water stored expressed in inches or centimeters) in the root zone and AW is the total available water capacity (determined from a textural estimate of the difference between the "field capacity" and the "wilting-point" water content). A detailed discussion of this methodology is provided by Gutknecht et al. (1980; see their Appendix B) and Whelan et al. (1987). The model treats the soil as a box or storage bin of finite capacity. When the soil water is depleted (i.e., the soil water is at the wilting point), the bin is empty and AET is zero. The analysis is typically done on a monthly basis, and tabular data are provided for all the water balance components (e.g., precipitation, runoff, moisture storage, and drainage). Gutknecht et al. (1980) estimated both PET and AET for the Pasco Basin (which includes Hanford) using Hanford Meteorological Station data and data from 39 other weather stations. Soils data used included Soil Conservation Service county maps, a Hanford Site soil survey (Hajek 1966), and Columbia Basin irrigation guidelines (USDA 1973). They estimated that the effective root zones for sagebrush and cheatgrass were 1.3 and 0.5 m, respectively. The computed AET was nearly equal to the precipitation for almost all of the Hanford Site. Although not presented in their report, values of recharge at the Hanford Site computed from their analysis ranged from 0 to about 0.25 cm/yr for the waste site locations on the 200 Area plateau (Dove et al. 1982; Wukelic et al. 1981; Foote et al.1980).

A water balance model that uses a modified version of the T-M approach has recently been proposed by Whelan et al. (1987) as part of a Remedial Action Priority System (RAPS). The major difference between the Whelan (RAPS) model and that used by Gutknecht et al. (1980) is that it accounts for variations in plant cover directly by partitioning the AET according to the percent cover and accounts for water storage as snow in the winter. The RAPS methodology is used primarily in comparing and ranking hazardous waste sites and would not be used directly in assessing recharge at Hanford. It has the capability of being calibrated to specific site conditions and providing initial estimates of the consequence of specific site management practices (i.e., placement of covers over a waste site compared to no cover placement). However, it relies on the T-M assumptions of monthly climate averages, and therefore it does not account

for daily variations (i.e., snowmelt events, thunderstorms, etc.) that may be important at Hanford. The use of RAPS methodology for estimating site-specific recharge at Hanford is not recommended.

2.2.3 USGS Model

The U.S. Geological Survey (USGS) has recently developed a regional groundwater model for the Columbia Plateau regional aquifer system. A component of this model was used to estimate recharge for the Hanford Site (Bauer and Vacarro 1986). Documentation of the deep drainage (recharge) model developed by the USGS is provided by Bauer and Vaccaro (1987). The recharge component of this model is similar to the T-M model but is more detailed in its accounting for daily fluctuations of weather and in its handling of topographic features and other key factors influencing recharge. As in the modeling effort of Gutknecht et al. (1980), the test area is divided into a grid network and water balance parameters are subsequently calculated for each grid element. The USGS used grid spacings that varied from 0.25 to 1.0 square miles. The following physical processes were simulated at each grid element: 1) snow accumulation and snowmelt; 2) interception of precipitation; 3) surface runoff; 4) evaporation from foliar cover; 5) evaporation from unshaded bare soil; and 6) plant transpiration. The model accounts for soil type, land use, plant growth, altitude, slope, and aspect, and each grid element is assigned individual values for each process. The model accounts for runoff using methods developed by the Agricultural Research Service (Wight and Neff 1983) and for surface evaporation using methods developed by Saxton, Johnson and Shaw (1974). Soils data were obtained from interpretations of soil survey maps, and plant cover data were obtained from aerial photography and Hanford Site reports.

The USGS model computes water balance on a daily basis. Simulations were made by Bauer and Vaccaro (1986) using historical climate data from the Hanford Site for a test period of 21 years (1957-1977). The model was run in two ways. First, the actual daily climate values were used to predict annual recharge, and the average recharge value for the 21-year period was computed for each grid element and for the entire site. Subsequently, the average daily values for the 21 years were used, and the model was run until the annual recharge obtained a constant value. Results tabulated from the first runs reflect the variable nature of the climate, with the recharge varying from near zero to

as much as 5.8 cm/yr during the 21-year test period with an average value of 1.2 cm/yr for the entire site. In contrast, taking the 21-year averages for each day and computing a steady-state recharge produced an average recharge value of 0.2 cm/yr for the entire site. The effect of averaging the data is clearly apparent. Table 2.2 shows the results for the two simulations. Bauer and Vacarro concluded that the variations in frequency and distribution of rainfall and other climate variables played such a major role in determining recharge that daily input, rather than monthly or yearly averages, would be required to accurately predict recharge for the Hanford Site.

Since the publication of the Bauer and Vacarro (1986) report, additional simulations run by the USGS have shown that the average recharge for the 21-year test period may be less than the 0.2 to 1.2 cm/yr values by a factor of about 30% (personal communication, H. Bauer, USGS, Seattle, Washington, June 1987). Slight changes in the rooting-depth algorithm plus an accounting for wintertime evaporation (sublimation) increased the predictions of evaporation, thus lowering the annual recharge estimates.

2.2.4 UNSAT-H Model

Fayer, Gee and Jones (1986) have documented a computer code used to predict unsaturated-zone water flow at Hanford. Versions of this code have been used to simulate typical climate, soil, and plant conditions that might exist

TABLE 2.2. Simulations of Recharge at the Hanford Site[a]

Recharge Based on Actual Daily Climate[b] (cm/yr)		Recharge Based on Average Daily Climate[b] (cm/yr)	
Maximum	5.8	Maximum	3.1
Minimum	0.05	Minimum	0
Average	1.2	Average	0.2

(a) From Bauer and Vacarro (1986).
(b) 21-year record.

if protective barriers were placed over selected waste sites at Hanford (Fayer et al. 1985; Fayer 1987). The model is deterministic in that it relies on specific climate, soil, and plant data as input and generates values for infiltration, evaporation, redistribution, and drainage from these input data. The UNSAT-H model is more fundamentally based than the T-M type models. Water retention characteristics of multiple soil horizons are incorporated directly into the model. Unlike any of the models previously described, UNSAT-H utilizes a water potential (head) formulation based on Richards' equation to calculate water flow (infiltration, redistribution, and drainage) in the soil and a vapor diffusion model to calculate the water vapor flow below the soil surface (Fayer, Gee and Jones 1986). Evapotranspiration is calculated utilizing site-specific plant and soil data (plant and soil hydrologic characteristics) as inputs. In its present form, this model can simulate transient (hourly or less) rainfall events that may influence recharge. It incorporates key features of the Hanford Site that are currently thought to affect recharge, including daily climate variations and site-specific plant and soil data. The UNSAT-H model has been validated using analytical solutions for infiltration (Fayer, Gee and Jones 1986), and is currently being calibrated to Hanford Site lysimeter data and tested against field data sets. Data from a suite of barrier tests that will be available during the next several years will provide a range of soil, plant, and climate conditions with which to test and validate the UNSAT-H model (Adams and Wing 1987).

3.0 LYSIMETER STUDIES

Several lysimeter studies have been conducted at Hanford during the past 15 years. Reviews of past work with lysimeters for recharge and water balance measurements have been reported previously (Gee and Heller 1985; Gee and Jones 1985). Presented here is an update of the lysimeter measurements that have been obtained to estimate recharge at the Hanford Site.

3.1 THE 200 AREA DEEP LYSIMETER

Figure 3.1 diagrams the 18.5-m-deep closed-bottom lysimeter that is located about 2 km south of the 200-East Area at the Hanford Site [see Gee and Heller (1985) for a summary of the studies conducted at this lysimeter and a companion open-bottom lysimeter]. The measurements of water balance (water content and water storage changes) at this lysimeter have been used to support the argument that recharge is virtually zero for the Hanford Site. Last, Easley and Brown (1976) state that the soil moisture data collected using neutron probes at the lysimeter site during the water years 1974-1975 and 1975-1976 "confirm the ability of the semiarid Hanford environment to prevent percolation of meteoric water down to the water table on the 200 Area plateau."

The National Academy of Sciences (1978), relying largely on reports related to these two lysimeters, stated that additional testing for recharge by lysimetry and related techniques is justified "since it furthers the end of finally resolving a general question of radioactive waste management: is a thick unsaturated zone in a semi-arid environment or arid region, as at Hanford, a dependable barrier against, or an open route for disposal of radionuclides into the biosphere? Evidence thus far available favors the barrier concept..."

The opinion that recharge is very low because Hanford is an arid site seemed to be supported by early data from the moisture profiles at the 200-East Area lysimeters. Jones (1978) was not as optimistic as other investigators that these lysimeters gave evidence of zero recharge. Rather than zero recharge, he reasoned that the observation of relatively uniform moisture profiles with depth indicated that there was a constant water potential

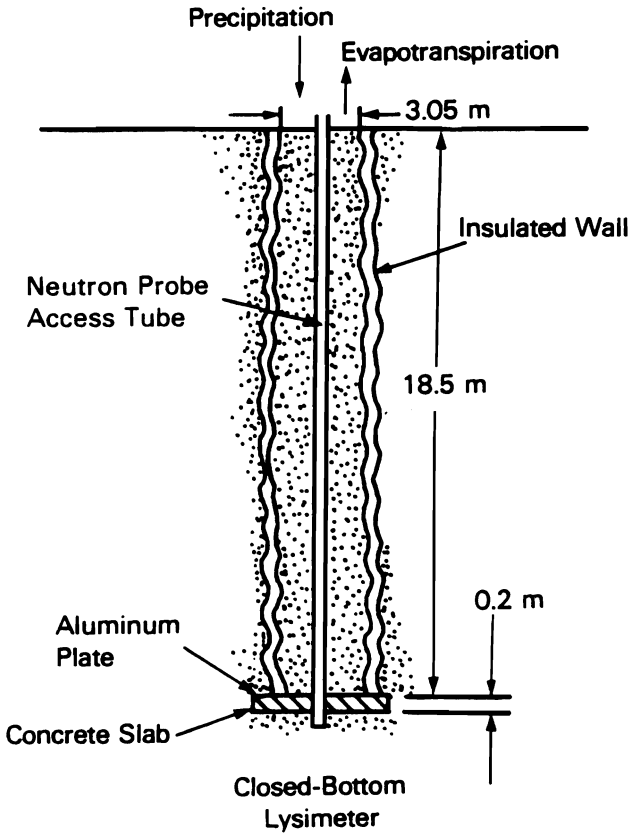

FIGURE 3.1. Schematic Diagram of the 200-East Area Closed-Bottom Lysimeter

and that, if this were the case, that water could be moving downward under a gravity gradient (i.e., the total head gradient was near unity). He concluded that one interpretation of the neutron probe data from the site was that a flux of at least 0.5 cm/yr could be moving steadily downward in the lysimeters.

Conflicting interpretations suggested that additional measurements over time were needed to determine the rate at which water is moving. If recharge had been occurring at a constant rate in the lysimeter, there should be an increase of water content detectable as a change in water storage. If a measurable amount of water infiltrated below the root zone, it also would be expected that a wetting front would move down into the soil profile, eventually resulting in an accumulation of moisture at the bottom of the lysimeter.

Neutron probe sampling during 1971 to 1978 gave indication of moisture accumulation in the lower depths of the closed-bottom lysimeter.

In early October 1985, the closed-bottom lysimeter was sampled for water content by coring the lysimeter. The data show that water contents at all depths had not changed by more than about 0.5 wt% during the 14-year period 1971 to 1985. In fact, there was an apparent loss of water storage during this time period. In Table 3.1, the measured water contents taken from a 10-cm borehole in October 1985 are compared directly with the moisture contents taken from the lysimeter when it was installed in 1971 (Hsieh, Brownell and Reisenauer 1973). The error in gravimetrically determined mass wetness (water content) is estimated to be less than 0.1 wt%. By directly comparing (water content) values for these two time periods, the problems inherent with neutron probe readings described by Jones (1978) and Gee and Heller (1985)

TABLE 3.1. Water Content Data from the Closed-Bottom Lysimeter in the 200-East Area

Soil Depth (m)	Percent Dry Weight		
	November 1971[a]	October 1985[b]	Difference
0 - 1.5	3.4	2.8	-0.6
1.5 - 3.0	3.5	2.6	-0.9
3.0 - 4.6	3.2	2.9	-0.3
4.6 - 6.1	3.3	2.9	-0.4
6.1 - 7.6	3.1	2.8	-0.3
7.6 - 9.1	2.8	2.8	0
9.1 - 10.7	3.1	3.0	-0.1
10.7 - 12.2	2.8	2.9	+0.1
12.2 - 13.7	2.4	2.9	+0.5
13.7 - 15.2	2.4	2.8	+0.4
15.2 - 16.8	2.5	2.8	+0.3
16.8 - 18.3	2.6	2.8	+0.2
Mean Water Content	2.9	2.8	-0.1
Mean Soil Suction (MPa)[c]	0.5	0.8	-0.3
Mean K(θ) (cm/yr)[d]	2.0×10^{-3}	7.0×10^{-4}	1.3×10^{-3}

(a) From Table 2 of Hsieh, Brownell and Reisenauer (1973).
(b) Appendix B of Fayer, Gee and Jones 1986, values represent the average of five 1-ft measurements.
(c) Estimated from Figure 6 of Hsieh, Brownell and Reisenauer (1973).
(d) Estimated from Figure 7 of Hsieh, Brownell and Reisenauer (1973).

are eliminated; the differences should reflect changes in moisture contents within the error of spatial sampling of a "homogeneous" soil column. The slight increase in water content with time in the lower profile suggests that there has been a redistribution of water (probably as a result of the downward pull of gravity). However, there has not been a significant accumulation of water and it appears that little, if any, surface water has infiltrated below the 4-m depth.

The observation that the total storage is less after almost 14 years indicates that some mechanism is responsible for preventing significant deep drainage in this lysimeter. The average initial soil suction (tension) (in November 1971) was 0.5 MPa, which apparently dried to 0.8 MPa in October 1985. These values are associated with low water contents (~3% wt%) for this lysimeter soil. The calculated water flow for this soil ranges from 20 x 10^{-4} to 0.7 x 10^{-4} cm/yr, utilizing the calculated unsaturated hydraulic conductivity (Hsieh, Brownell and Reisenauer 1973) and assuming a unit-gradient flow condition.

Gee and Heller (1985), Gee and Jones (1985), and Fayer, Gee and Jones (1986) speculated that plant water uptake was responsible for the lack of deep drainage in this lysimeter; plants were observed growing on the lysimeter. Fayer, Gee and Jones (1986; Appendix B) used computer models to simulate the water balance in this lysimeter. When no plants were included in the simulation, the water storage increased by about 17 cm during the 14-year test period. When plant cover was simulated, the water storage cycled during the test period and showed an apparent decrease in storage similar to the measured value.

These simulations do not prove that plant cover was entirely responsible for the lack of "drainage" at this lysimeter, but the results do support the argument that plant cover can greatly alter the water balance under these desert (arid) climate conditions. Because the lysimeter is not a drainage-type lysimeter, estimates of drainage from this lysimeter must be made indirectly from changes in water content of the sampled soil profile. Considering the information in Table 3.1, we can speculate that the soil in this lysimeter would have to become wetter throughout the profile before drainage would be expected. Based on the calculated hydraulic conductivity and water

retention characteristics (Hsieh, Brownell and Reisenauer 1973), no drainage would be estimated to occur until the water contents in the lower few meters of the lysimeter increased to more than 6 or 7 wt% (10 or 11 vol%) and the soil at the bottom of the lysimeter saturated. This observation suggests that an increase of storage in excess of 16 cm would be required before drainage would occur (i.e., standing water collected in the bottom of the lysimeter). If plants were removed from this lysimeter and the lysimeter were maintained without vegetation for several years, it would be possible to confirm the hypothesis that evapotranspiration has been responsible for the lack of drainage or recharge at this lysimeter and provide additional data that would be useful in calibrating models for recharge predictions.

3.2 LYSIMETERS AT THE BWTF

Three lysimeters located at the Buried Waste Test Facility (BWTF), about 6 km northwest of the 300 Area and adjacent to the 300-N Burial Ground (Figure 3.1), have been monitored for drainage during the past several years. The data collected from these lysimeters are in sharp contrast to the data obtained from the 200 Area closed-bottom lysimeter. The results from the BWTF lysimeter tests have shown that significant quantities of water drain from both bare soil surfaces and from surfaces that have been vegetated with shallow-rooted grasses. The differences between 200 Area and 300 Area data will be discussed in the following sections.

Figure 3.2 shows a schematic cross-section of the lysimeter arrangement at the BWTF. This facility was installed during a period of 9 months (May 1978 through February 1979). Details of the construction are provided by Phillips et al. (1979).

Drainage data from the South Caisson (SC), an 8.2-m-deep drainage lysimeter at the BWTF, have been collected since early 1981. Data collected through 1982 from this lysimeter have been reported previously (Jones, Gee and Campbell 1984; Gee and Jones 1985). From early March of 1983 through February of 1984, the South Caisson was not monitored for drainage, because of lack of funding. The data collection resumed in late February of 1984 and has continued without interruption since that time.

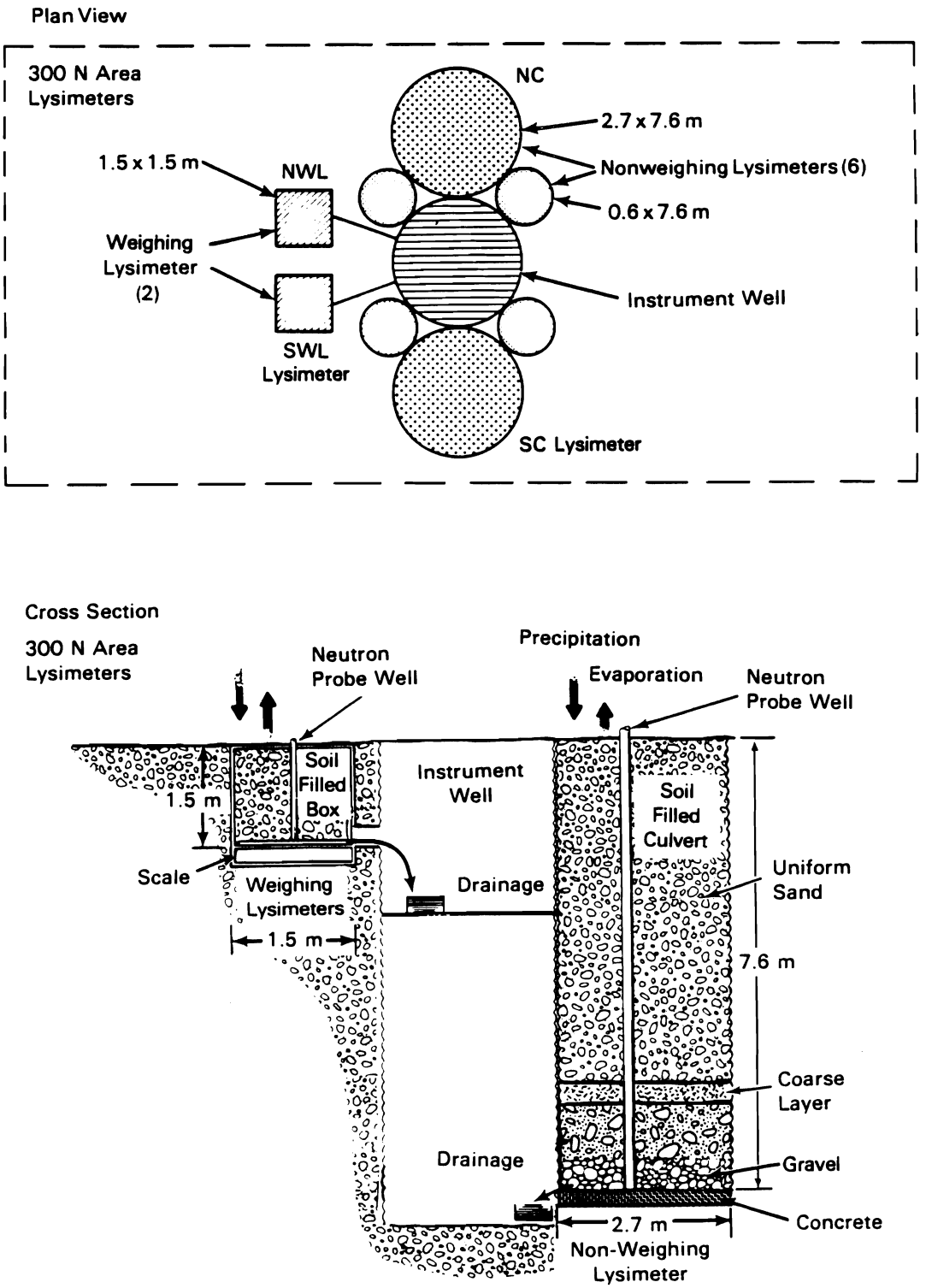

FIGURE 3.2. Schematic Diagram of the Lysimeters at the Buried Waste Test Facility Site (BWTF) in the 300 Area

Drainage values from the SC lysimeter for January 1984 through June 1987 are presented in Figure 3.3. The drainage was measured by collecting water from the bottom of the lysimeter (as shown in Figure 3.2) using 40 liter plastic carboys, which were brought back to the laboratory and weighed on a precision balance to ± 10 g. Based on an average of 26 (i.e., biweekly) weighings throughout the year, the resolution in annual drainage is ± 0.004 cm H_2O for the SC lysimeter. (Similar resolution was obtained in measuring drainage for the other lysimeters for which data are reported in this document.) The reported drainage numbers represent minimum drainage because leakage may have o ccurred from the lysimeters or water may have evaporated from the carboys. Drainage rates for the SC lysimeter have remained relatively constant for the past 3.5 years and have averaged about 10 cm/yr.

These data indicate that the recharge rate for bare, coarse-textured soils at the BWTF has been more than half of the annual precipitation during the past 3.5 years. Average precipitation at the BWTF for this period of time was 16.7 cm. This value is very close to the long-term (1912-1980) precipitation average of 16.0 cm/yr recorded for the Hanford Site (Stone et al. 1983). The precipitation at the BWTF site since 1979 has been comparable to the precipitation measured at the Hanford Meteorological Station for all but 2 years, 1982 and 1984. The 8.5-year (January 1979 to June 1987) average precipitation for the BWTF and the Hanford Meteorological Station is 19.7 and 18.9 cm/yr, respectively, or a difference of less than 5%. These data suggest that annual precipitation at the BWTF is similar to the precipitation on the 200 Area plateau (as measured at the Hanford Meteorological Station).

Water storage, measured using down-well neutron probes, has been determined during the past 9 years at the SC lysimeter (Figure 3.2) in the 300 Area. Figure 3.5 shows that water storage changes have been significant over the life of the lysimeter. The large increase in storage during 1983 is associated with drainage water accumulating in the bottom of the lysimeter during the period of time that the drainage was not monitored. After 1983, annual water storage changes have ranged from 6 to 10 cm/yr as a result of wintertime accumulation followed by surface evaporation and relatively constant drainage.

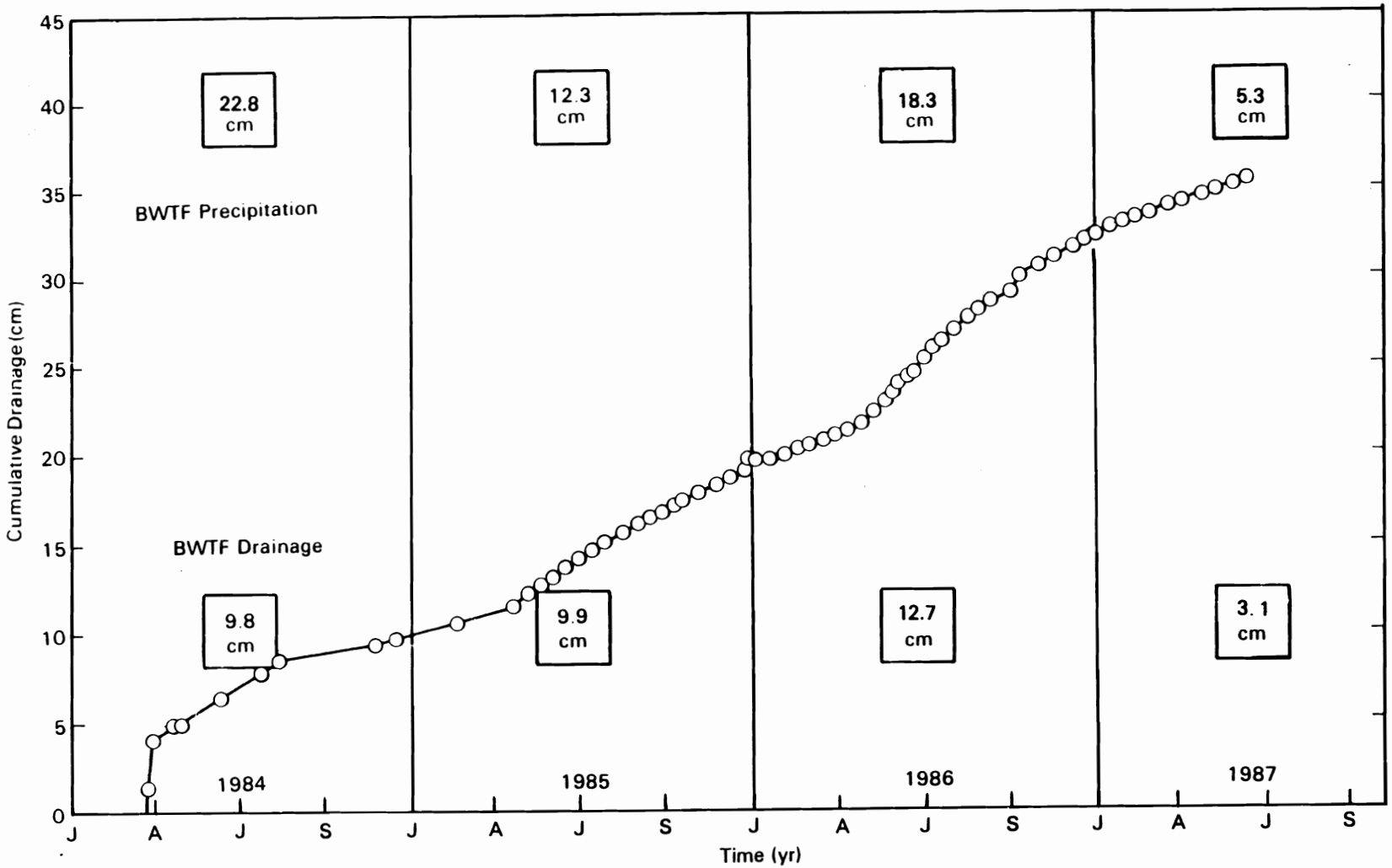

FIGURE 3.3. Drainage from the South Caisson (SC) Lysimeter at the Buried Waste Test Facility Site (BWTF) Near the 300 Area, January 1984 through June 1987

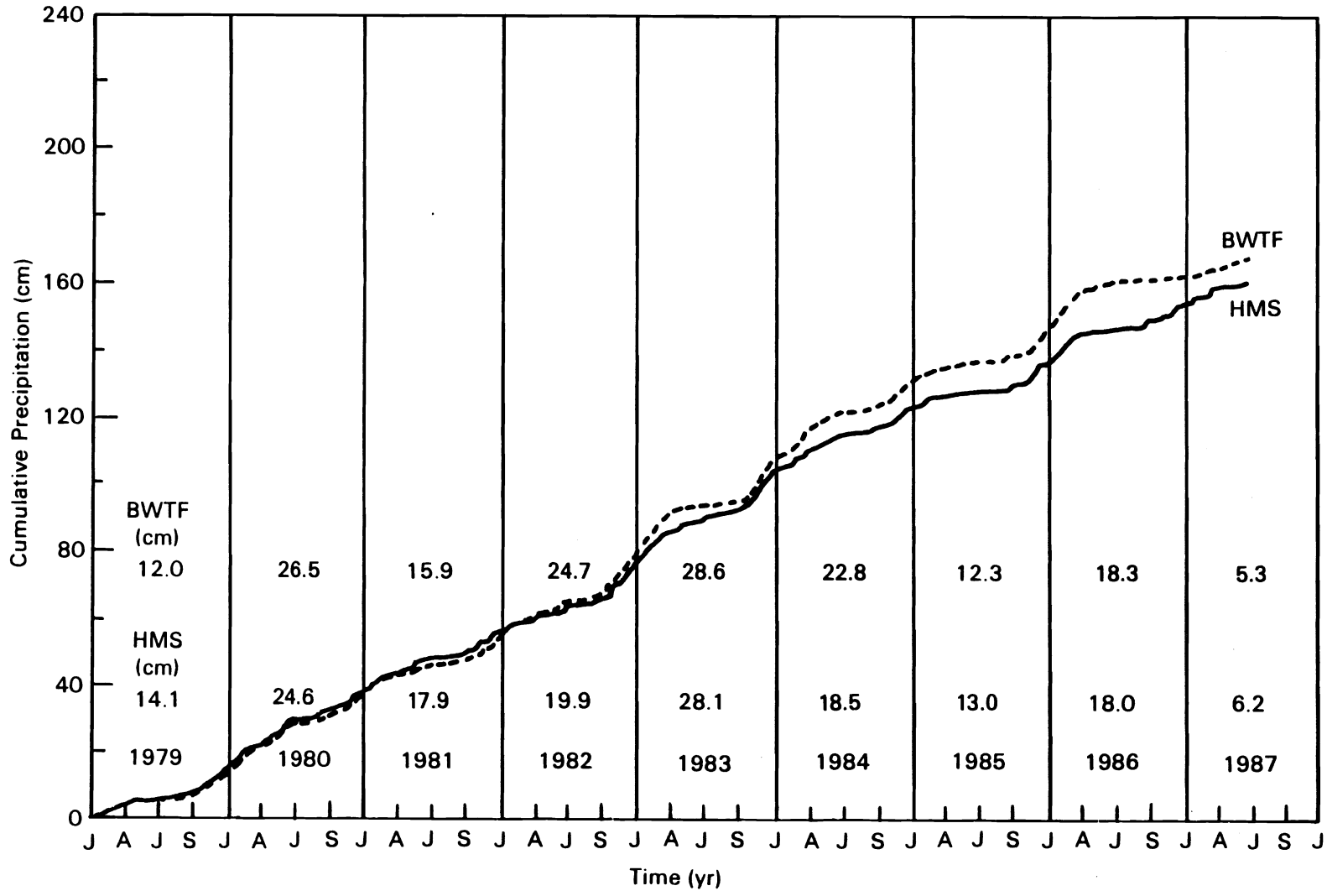

FIGURE 3.4. Comparison of the Buried Waste Test Facility Site (BWTF) and the Hanford Meteorological Station (HMS) Precipitation, January 1979 Through June 1987

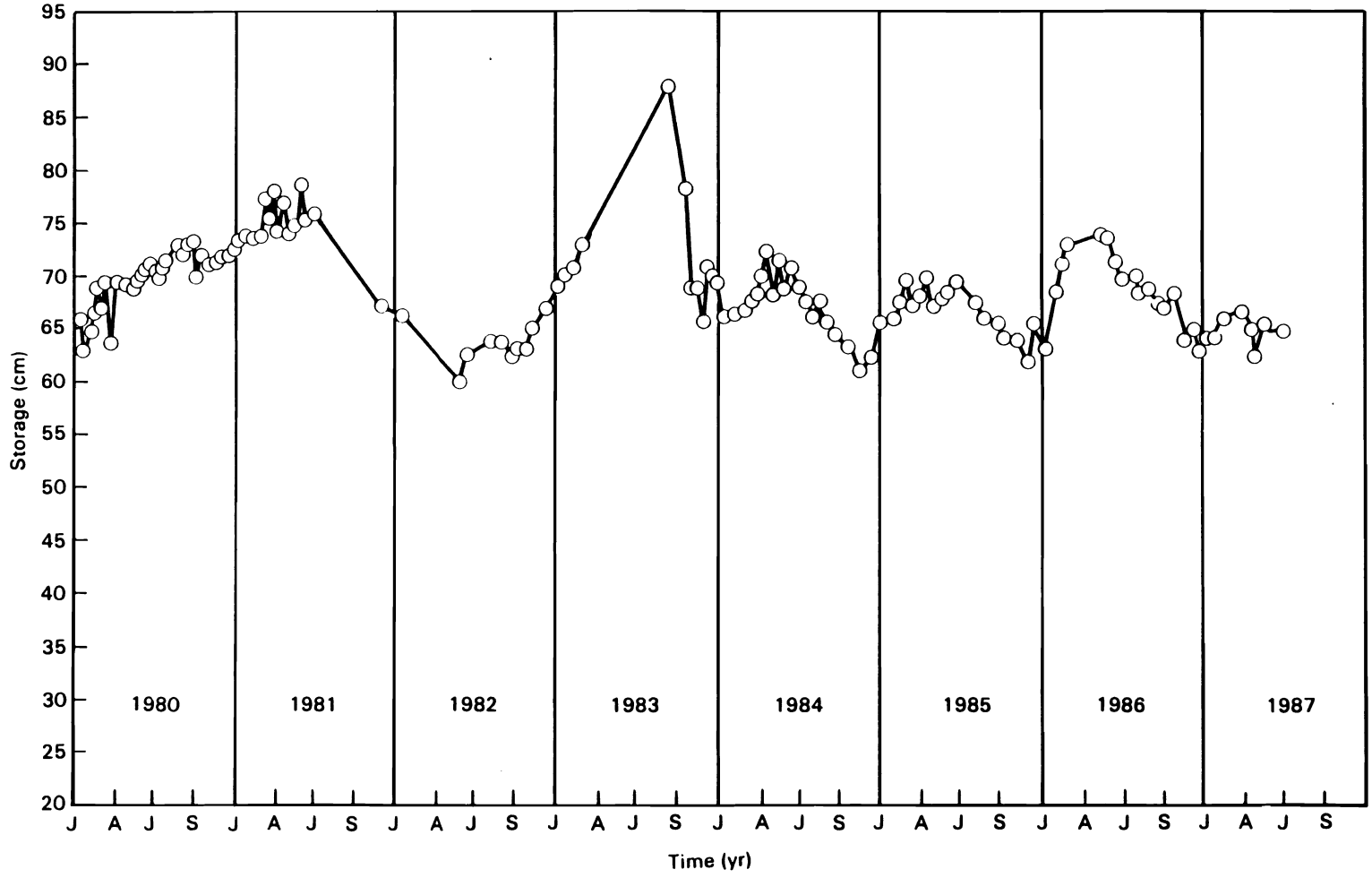

FIGURE 3.5. Water Storage Measured in the South Caisson (SC) Lysimeter Since 1980

In May of 1987, tensiometers were installed in side-access holes of the SC lysimeter. Figure 3.6 shows the computed total head (suction plus gravity) from the tensiometer and gravity data. The data confirm that unit-gradient conditions prevail in this lysimeter. During installation of the tensiometers, the soil was sampled gravimetrically. The gravimetric water contents for the entire profile averaged about 7 wt%, which was about twice that found in the 200 Area closed-bottom lysimeter.

The north (NWL) and south (SWL) weighing lysimeters (Figure 3.2) have somewhat different histories than the SC drainage lysimeter. The NWL was irrigated periodically from June 1979 through January 1981 with 85 cm of irrigation water. After January 1981, irrigation was discontinued on the NWL; the SWL and the SC lysimeter were not irrigated. During 1982 the NWL, SWL, and the SC lysimeter had measured drainage values of 5.3, 3.2, and 5.6 cm, respectively (Gee and Heller 1985). In March 1983, the SWL was revamped to evaluate the effects of vegetation on drainage. Soil was removed, the suction-candle drainage system was replaced, and the soil was repacked in the lysimeter. The surface of the SWL was then sodded with shallow-rooted cheatgrass (Bromus tectorum L.) and Sandberg's bluegrass (Poa secunda) taken from an adjacent area. Since that time, the surface of the SWL has remained vegetated. The NWL was excavated in August 1986, and new suction candles were installed. The soil in the NWL was replaced in January 1987, and monitoring of this lysimeter was resumed at that time.

Drainage values from the NWL and the SWL lysimeters are shown in Figure 3.7 and are tabulated in the Appendix. Water storage in the top 1.2 m of the NWL, SWL, and SC lysimeters is shown in Figure 3.8. Drainage was less in the SWL than in the NWL, and averaged about 6 cm/yr in the SWL for the past 3 years (1984-1986) compared to 10 cm/yr for the SC lysimeter. The lower drainage from the SWL is attributed to evapotranspiration (i.e., water loss from the vegetated surface).

The variable drainage rate of the SWL has resulted from a combination of precipitation variations and changes in plant cover. Table 3.2 lists the surface condition of the SWL since 1979. The large drainage observed at the SWL resulted from precipitation that infiltrated the soil during the winters of 1983-1984 and 1985-1986 and moved below the shallow root zone of the

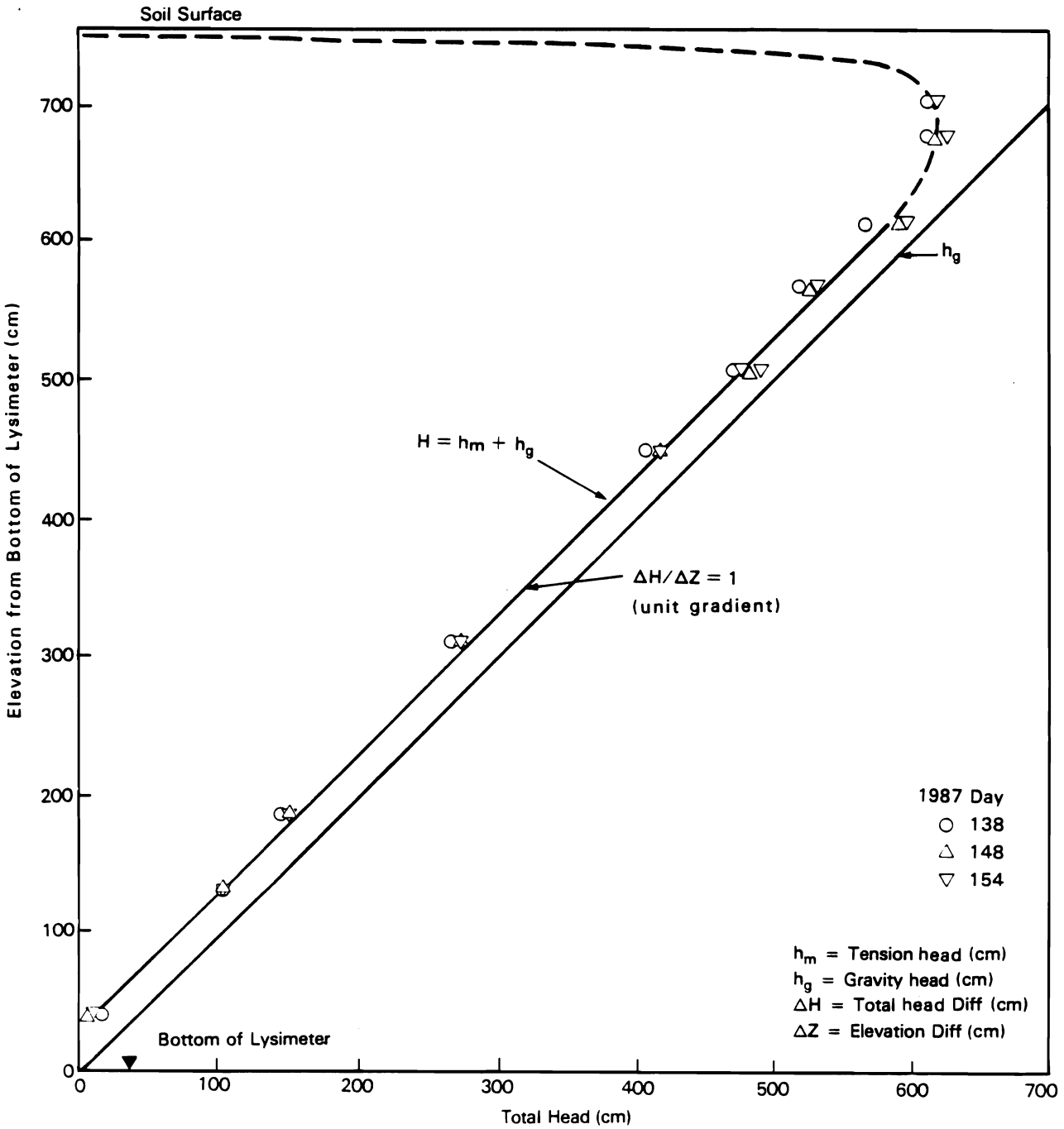

FIGURE 3.6. Total Head Values for the South Caisson (SC) Lysimeter at the Buried Waste Test Facility Site (BWTF) Near the 300 Area.

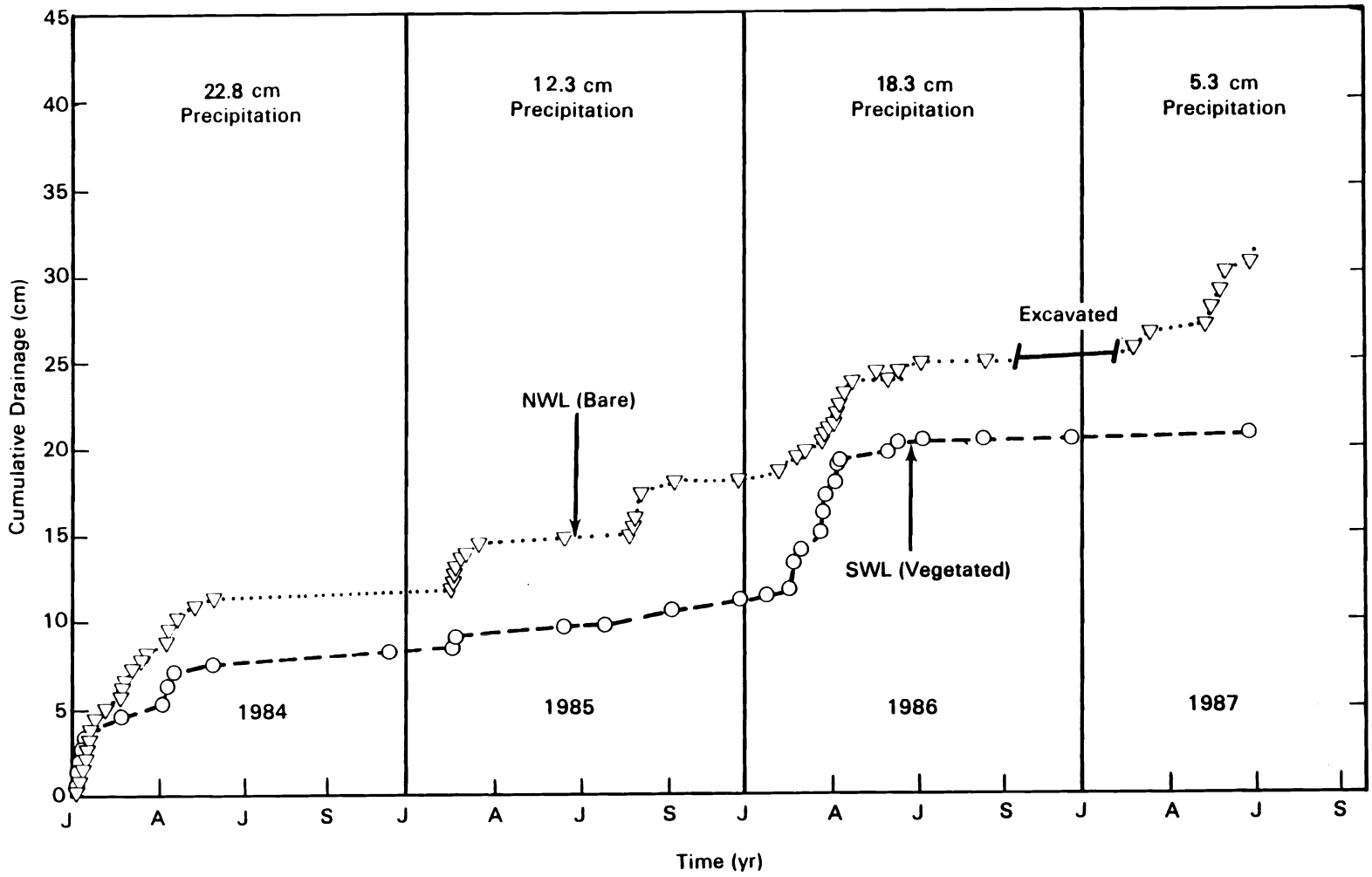

FIGURE 3.7. Drainage From the North Weighing Lysimeter (NWL) and South Weighing Lysimeter (SWL) at the Buried Waste Test Facility Site (BWTF) Near the 300 Area

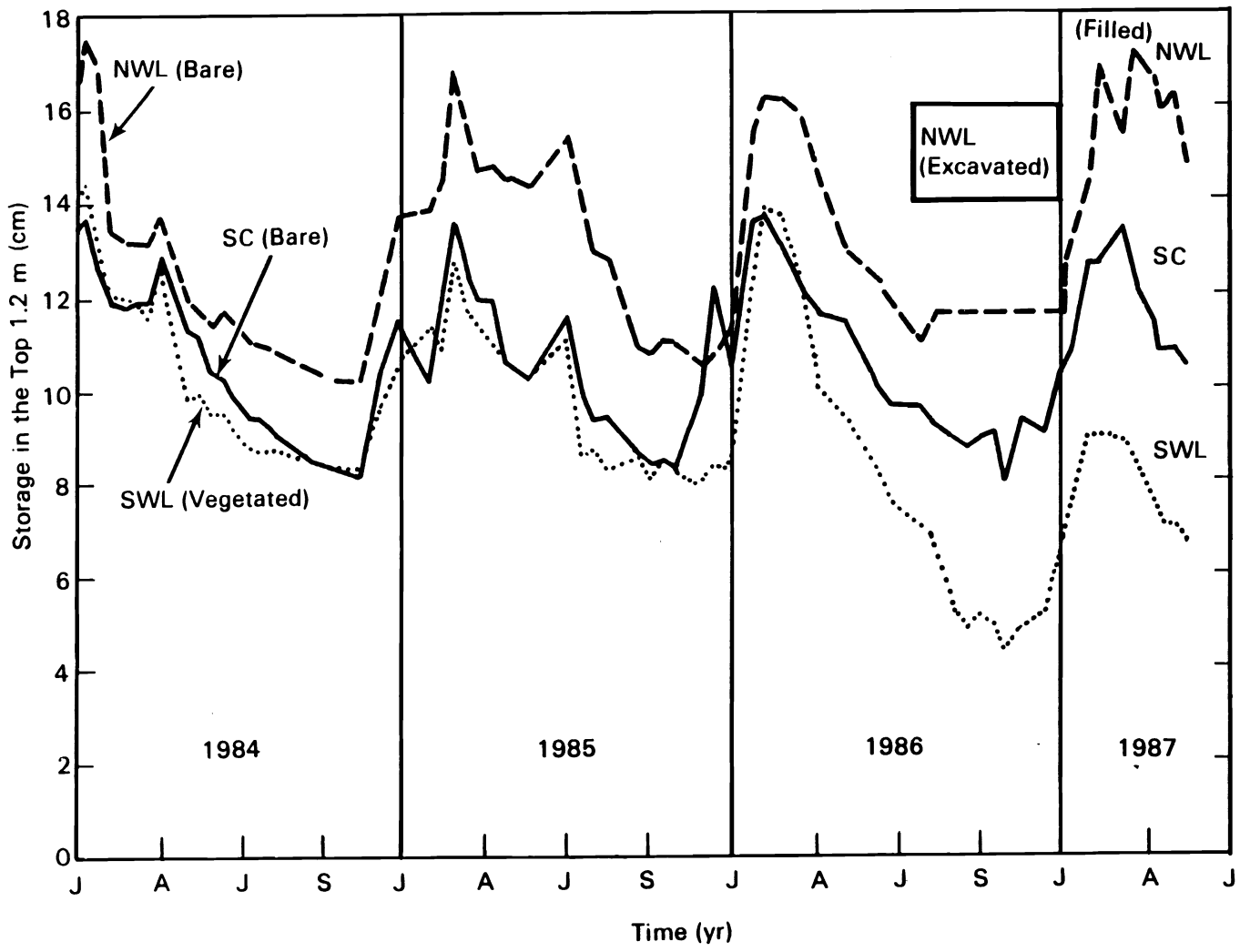

FIGURE 3.8. Comparison of Water Storage in the Buried Waste Test Facility Site (BWTF) Lysimeters, January 1984 Through June 1987

TABLE 3.2. Surface Cover of South Weighing Lysimeter (SWL) at the Buried Waste Test Facility Site (BWTF)

Year	Surface Condition
1979	Bare
1980	Bare
1981	Bare
1982	Bare
1983	Transplanted to cheatgrass and *Poa* (~40%) cover[a]
1984	Cheatgrass, *Poa* (50% cover)
1985	Cheatgrass, *Poa* (50% cover)
1986	Cheatgrass, *Poa*, Russian thistle (60% cover)
1987	Cheatgrass, *Poa*, mustard (75% cover)

(a) Plant cover on SWL:

Scientific Name	Common Name
Bromus tectorum L.	Cheatgrass
Poa sandbergii	Sandberg's bluegrass
Salsola kali	Russian thistle (tumbleweed)
Sisymbrium altissimum	Jim Hill mustard (tumble mustard)

grasses growing on the lysimeter. A single tumbleweed (*Salsola kali* L.) was allowed to grow on the lysimeter during the summer of 1986. Since that time there has been no measurable drainage from the SWL, and the water storage in this lysimeter has decreased significantly (Figure 3.8). The large change in water storage for the SWL during 1986 can be attributed to early spring drainage followed by a significant amount of water (>4 cm) extracted from the soil by transpiration from the tumbleweed during the summer months. Phenology (i.e., growth patterns of emergence, leaf elongation, seed production, senescence, etc.) of plant cover is important in determining water loss by desert plants. While the tumbleweed was actively growing and transpiring, the cheatgrass and bluegrass were dead and contributed little, if anything, to soil water removal. The model simulation described earlier, using UNSAT-H for the 200 Area closed-bottom lysimeter (Fayer, Gee and Jones 1986), demonstrates water storage effects similar to those observed in the SWL.

That there has been no further drainage from the SWL in 1987 is attributed to the lack of sufficient winter precipitation to wet the soil above

the "field capacity" (i.e., the soil did not wet sufficiently to be drained by the 100-cm vacuum control imposed on the suction candles at the bottom of the lysimeter). The low water storage and an increased amount of vegetation cover (cheatgrass, bluegrass, and tumbleweed) during early 1987 (Table 3.2) were apparently sufficient to prevent water from percolating below the root zone. The increased grass cover is attributed to an unusually wet March (2.7 cm of precipitation, which was 267% of normal). The increased plant growth resulted in greater water loss by evapotranspiration, thus cycling water from the spring and summer rains back to the atmosphere rather than storing it in the soil.

These data illustrate the complex interactions between vegetation, soil, and climate that in combination may influence drainage rates at Hanford. The SWL data indicate that recharge can occur under conditions where shallow-rooted plants (grasses) dominate the cover of a coarse-textured soil. The data also demonstrate that recharge can be reduced when deep-rooted plants (tumbleweeds) are present. The data further illustrate the interactions between precipitation, plant growth, and evapotranspiration. Predicting when recharge will occur given these surface and soil conditions requires a detailed knowledge of plant response to soil and climate variables that is often lacking. A limited amount of information about water use by plant communities typical of the Hanford site is available (Cline, Ursek, and Rickard 1977). However, information about plant response (phenology, rooting depths, etc.) to Hanford Site climate conditions (e.g., precipitation, temperature, net radiation, etc.) is not yet sufficiently detailed to provide accurate predictions of seasonal or annual evapotranspiration (ET). Further information about plant phenology, soil hydraulic properties, and climate variations are needed to predict the magnitude of drainage, particularly when shallow-rooted plants are present.

Continued monitoring of the SWL (grass-covered) lysimeter is recommended. Weight changes, neutron probe water storage measurements, and detailed observations of the plant cover on the SWL during the next several years will help properly account for the ET component in the water balance. Comparison of lysimeter data from this site will provide estimates of surface water losses that occur with and without plants, and thus provide estimates

of both evaporation and transpiration for model calibration tests for UNSAT-H or other arid-site water balance codes.

3.3 OTHER 300 AREA LYSIMETERS

During the past 3 years, two additional lysimeter installations located adjacent to the BWTF have become operational and have provided data that are pertinent to the evaluation of recharge at the Hanford Site: the Commercial Waste Test Facility (CWTF) and the Grout Waste Test Facility (GWTF) (Gee and Jones 1985). Both these facilities contain drainage-type lysimeters that have no vegetation growing on the surfaces. The CWTF has 10 operational lysimeters, and the GWTF has 2 presently in use. Significant drainage or water storage increases have been observed in all 12 lysimeters.

Jones and Skaggs (1987) reported that during a 1-year test period (September 1985-August 1986) the 10 bare-surface lysimeters at the CWTF averaged 12.3 (± 1.2) cm/yr drainage. This is slightly more than the drainage obtained from the SC lysimeter at the BWTF during the same time period (Figure 3.3).

Unusual climatic events can have a significant impact on Hanford Site recharge. Observations on 3 of the 10 CWTF lysimeters indicated that snowmelt in March 1985 caused water from adjacent soil surfaces that were slightly elevated (about 1% slope) above the lysimeters to form a pond on the surface, infiltrate, and drain in a few days. The quantity of drainage was in excess of the annual precipitation. This observation illustrates the effects of rapid snowmelt and local topography in producing rapid drainage in Hanford soils. Waste site areas that have topographic relief such that run-on is possible may experience elevated recharge if soils are coarse textured and bare.

The Grout Waste Test Facility adjacent to the BWTF has two gravel-covered lysimeters, that are 8.0-m deep, on which no plants are growing. In this respect, their surfaces are analogous to the surfaces that exist at the Tank Farm sites located in the 200 Areas. Neutron probe monitoring of these lysimeters for water storage indicated that they have accumulated between 65% and 85% of the precipitation that has occurred at the site since they were installed. The soils that were placed in these lysimeters were

relatively dry, and they are just now beginning to drain. Drainage data and other information (water chemistry) from these lysimeters will be available from the Grout program during the next several years.

The drainage and water storage data from the CWTF and GWTF confirm that water infiltration into bare soils at the Hanford Site can be significant. With gravel surfaces tending to retard evaporation, much of the annual precipitation may infiltrate and eventually drain from the vadose zone into the ground water. Run-on in localized areas can cause drainage (recharge) that exceeds the annual precipitation. These observations provide insight into needs for good management of surfaces at waste burial sites at Hanford. Graveled and/or bare surfaces should be eliminated if reduction in onsite recharge is desired.

4.0 FIELD SITE DATA

4.1 300 AREA GRASS SITE

This site is located about 5 km northwest of the 300 Area and about 2 km southeast of the BWTF (Figure 1.1). This area has burned at least twice in the past 10 years, most recently in August 1984. The site is covered with cheatgrass and Sandberg's bluegrass; the deep-rooted sagebrush and rabbitbrush were burned off before 1983. Water content and water storage at this site have been monitored since January 1983. Water storage data through June 1984 from this site analyzed by Gee and Kirkham (1984), suggested that drainage was occurring below the root zone at this site. The unsaturated conductivity was previously measured at one location on the 300 Area Grass Site using an instantaneous profile method (Gee and Kirkham 1984). In addition, the water balance of this site was modeled using the water flow code, UNSAT1D (Gee and Kirkham 1984). The simulation results utilizing the measured unsaturated conductivity data indicate that 3 to 5 cm/yr could drain below the root zone at this site, depending on the climate and soil variations used in the model.

Figure 4.1 shows water storage data for the Grass Site since 1983, which indicate that storage changes have occurred below the 1-m depth every year. These storage changes suggest that water is moving below the root zone. While direct measurement of the amount of drainage by neutron probes is not possible, storage changes below the root zone do provide qualitative evidence that recharge is occurring. The largest changes occurred in 1983, which was the wettest winter of the test period. Storage changes have persisted every year; however, they are smaller than the maximum change in 1983 which was about 8 cm (Figure 4.1).

A drainage study was initiated in 1987 to further evaluate the hydraulic properties of the soil at the Grass Site. This study required installation of deep tensiometers (deeper than 1 m) and provided a nearly direct measure of the unsaturated conductivity by monitoring drainage using the combination of neutron probe and tensiometers. A report detailing the drainage measurements and the unsaturated hydraulic conductivity data obtained from these

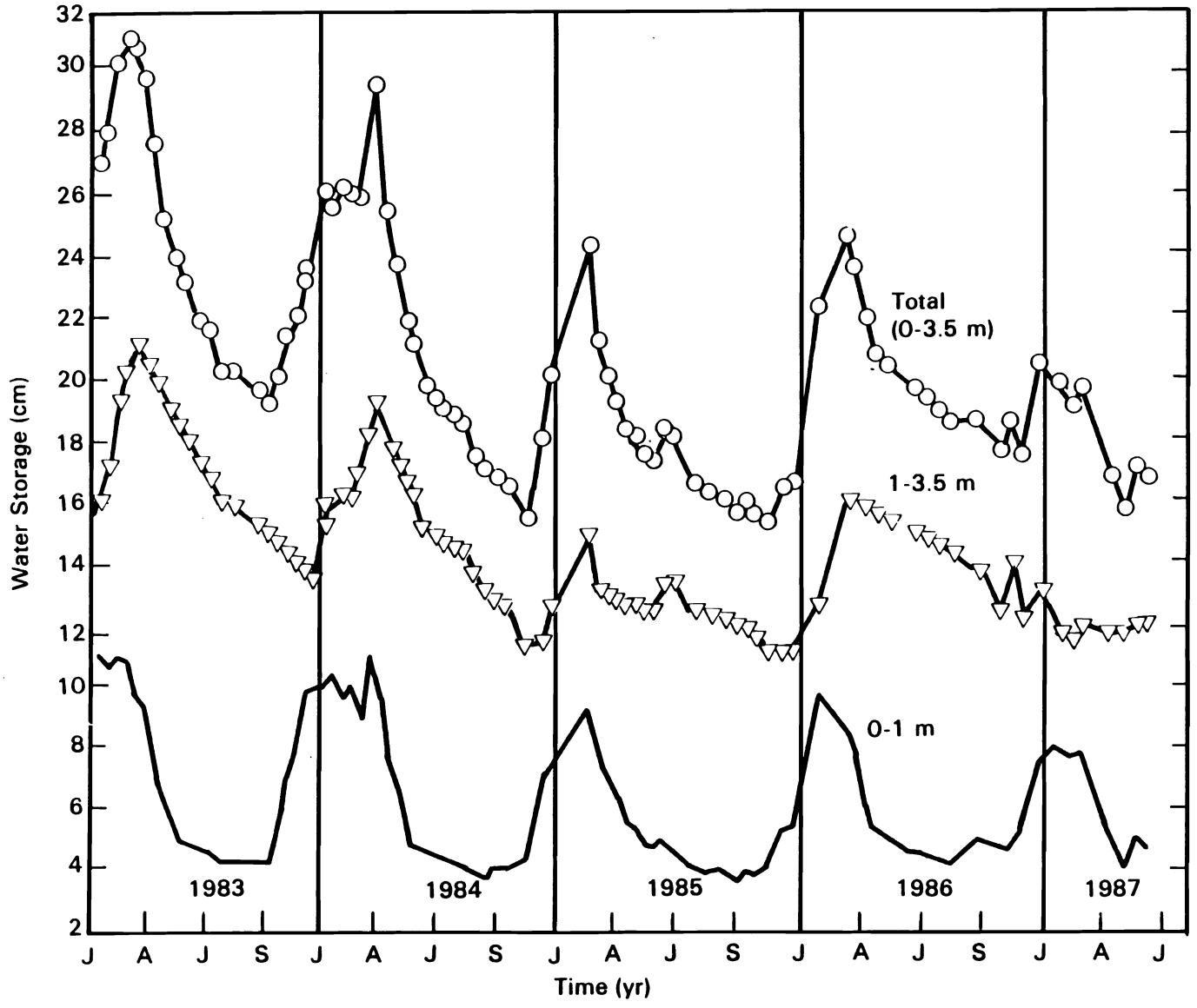

FIGURE 4.1. Water Storage Changes at the Grass Site Near the 300 Area, January 1983 Through June 1987

drainage measurements has been prepared and is to be published as part of the Comprehensive Data Base Task during the coming year. The results from the drainage tests suggest that water flow rates as great as 4 to 8 cm/yr could be occurring at this site.

Work planned at this site includes monitoring the water storage changes, evaluating the phenology of the plant community, and quantifying the variations in hydraulic conductivity that occur in the soil profile of the site. In addition, a small drainage lysimeter installed at this site could evaluate the drainage rates occurring in coarse soils covered with only shallow-rooted grasses. The amount of drainage occurring can be confirmed by using tensiometers, monitoring the head gradients below the root zone, and estimating the hydraulic conductivity from instantaneous profile data. Tensiometers should be installed at selected depths below the root zone (e.g., 1-2 m). Such instrumentation would provide information about the direction as well as the magnitude of the water flow below the root zone.

Data collected at this site suggest that drainage is occurring, but that the exact amount has not been quantified. Drainage appears to be variable, ranging from 4 to as much as 8 cm/yr. Further quantification of plant characteristics and variations in hydraulic properties is needed to define the drainage rate of the coarse-textured soil at this site. Installation of a drainage lysimeter at this site would allow quantification of the drainage rate.

4.2 MCGEE RANCH SITE

The McGee Ranch site is located just across Highway 240 from the Yakima Barricade west of the 200 Areas (Figure 1.1). The soils in this area have been classified as Esquatzel and Warden silt loams (Hajek 1966). A recent testing of the soil depths at the site indicated that the fine-grained soils range in depth from 3 to 10 m (Last et al. 1987). This site has been selected as the area from which fine-grained soil will be taken to be used as part of the Hanford Site Protective Barriers. A preliminary study of soil characteristics suitable for use as a barrier material revealed that the soils here have suitable water-holding characteristics, and are present in sufficient quantity to supply most, if not all, the material needed for

protective barriers at Hanford. Water storage and plant characteristics data from this site are being monitored to provide data critical to assessment of the adequacy of protective barriers.

Water content and water potential profiles were taken during the summer of 1986. Data from selected sites are shown in Tables 4.1 and 4.2. These data indicate that water contents and water potentials at the test plots are very low, suggesting that little if any water is draining from the root zone. Additional data from boreholes taken at this and other locations at the McGee Ranch, where deep-rooted plants (e.g., sagebrush, hopsage, etc.) are growing, indicate that the water potentials are so low in these soils that rates of flow are likely less than 0.1 cm/yr. This value is based on calculated hydraulic conductivity values for soil material of this type (Simmons and Gee 1981).

Actual measurements of water flow rates in these fine soils for dry conditions have not yet been obtained. However, measurements of drainage have

TABLE 4.1. Water Potential Data for McGee Ranch Site, July 1986

Depth (cm)	-MPa[a] Sagebrush Site	-MPa[a] Grass Site
15	15.9	40.3
30	2.1	2.1
45	1.1	1.4
90	0.6	0.6
135	3.1	1.0
180	3.6	1.2
240	3.8	1.4
270	4.0	2.1
300	4.5	0.9

(a) Soil samples were cored, bagged, sealed, and returned to the laboratory. Total water potential (in -MPa units) was measured using an SC-10 Thermocouple Psychrometer (Decagon Inc., Pullman, WA).

TABLE 4.2. Water Content in Soil Material Taken from Boreholes at the McGee Ranch Site

BOREHOLE	DEPTH (m)	WATER CONTENT (wt%)	WATER POTENTIAL (-MPa)
#33	0.61-0.71	6.66	1.0
	1.52-1.98	7.81	
	3.05-3.51	4.25	
	4.57-5.03	4.02	
	6.10-6.40	2.79	3.5
	7.01-7.32	2.12	
	7.32-7.47	4.32	
	8.08-8.23	3.45	2.0

BOREHOLE	DEPTH (m)	WATER CONTENT (wt%)	WATER POTENTIAL (-MPa)
#34	0.61-0.71	5.90	
	1.52-1.98	8.20	
	3.05-3.51	1.88	
	4.57-4.88	3.44	
	6.10-6.40	1.33	2.0
	6.40-6.55	4.72	
	7.62-7.77	2.89	
	7.77-8.08	4.64	
	9.14-9.30	2.19	

BOREHOLE	DEPTH (m)	WATER CONTENT (wt%)	WATER POTENTIAL (-MPa)
#35	0.61-0.71	6.68	
	1.52-1.58	5.21	
	1.58-1.83	3.69	
	3.05-3.51	3.12	1.5
	4.57-4.72	2.34	
	4.72-4.88	5.28	
	6.16-6.46	1.51	
	6.46-6.52	4.03	
	7.62-7.92	2.72	
	9.14-9.45	1.11	

BOREHOLE	DEPTH (m)	WATER CONTENT (wt%)	WATER POTENTIAL (-MPa)
#36	0.61-0.71	5.85	
	1.52-1.83	5.21	
	3.05-3.35	4.01	
	4.57-4.88	3.01	
	6.10-6.55	2.36	2.5
	7.62-7.77	1.51	
	7.77-8.08	3.16	
	8.23-8.38	2.97	

been initiated, and site-specific, field-saturated hydraulic conductivity values have been obtained at selected locations near a borrow area for soils used in testing protective barrier designs (Adams and Wing 1987). Results of these measurements are included with Grass Site data in the forthcoming report (discussed in Section 4.1) on hydraulic properties for Hanford Site soils. These data will be most useful in predicting the water flow under conditions that may exist near the surface in winter and early spring. However, additional sampling is required to substantiate the dry soil conditions observed at the McGee Ranch site. Lysimeter data would provide such information if the soils were allowed sufficient time to equilibrate in the lysimeter. It should be noted that at these very low drainage rates relatively long times would ensue before equilibrium was reached; hence these rates of flow can be determined only indirectly over a time span of 3 to 5 years.

The fine soils at the McGee Ranch site are very dry at depth, which suggests that plants are effective in removing water from the soils. This cycling of the precipitation water, such that little if any water moves past the root zone for long periods of time, supports the concept that a "cyclic" barrier is feasible given Hanford soil and climate conditions. The engineered barrier is designed to prevent infiltration of water past the root zone and thus to provide a zone of zero recharge for extended periods of time (Adams and Wing 1987). Evidence of this condition at the McGee Ranch site is apparent. It would be very helpful if further quantification of the actual water flow in these fine-grained soils could be documented. The use of tracers such as ^{3}H and ^{36}Cl might provide this information .

In summary, the fine soils of the McGee Ranch area, where covered with deep-rooted plants, are dry at depths of 6 m or more. The flow rates at these low water contents are expected to be less than 0.1 cm/yr, but measurements are needed for confirmation. Drainage lysimeters or tracer tests may be the most appropriate method for determining flow rates in the dry soils at the McGee Ranch site.

5.0 OBSERVATIONS AND CONCLUSIONS

Based on the results of lysimeter and field tests to date, recharge rates for specific locations at the Hanford Site can vary from zero to more than the average annual precipitation depending on which of many factors, or combination of factors, operates to control the water balance at a given site. The 200 Area deep-lysimeter is not draining and has stayed "dry" during the same period of time that 15 lysimeters in the 300 Area have drained readily. The difference apparently is that the 200 Area lysimeter has been covered with vegetation, while those in the 300 Area, with one exception, have not. Bare soils have consistently drained in the 300 Area. The 300 Area Grass Site data suggest that recharge is occurring; in contrast, the site at McGee Ranch indicates that little water movement, if any, is occurring below the root zone.

The differences in drainage observed in the lysimeters largely result from differences in plant cover. Lysimeters with plant cover have less measured drainage than those that are bare (i.e., have no plant cover). The difference in recharge at undisturbed sites apparently results from a combination of finer soil texture and difference in vegetation (shallow-rooted plants at the Grass Site compared to deep-rooted plants at McGee Ranch). Figure 5.1 shows the water retention characteristics for soils at the 200 Area deep lysimeter, the 300 Area BWTF, and the McGee Ranch site. The data indicate that the water storage capacity of McGee Ranch soil is considerably greater than that of the 200 Area and 300 Area lysimeter soils. That the soil has dried out over time at McGee Ranch suggests that, with present climate conditions, the soil water is not draining at this site and the annual winter rains, which tend to drain through coarse surface soils, are being retained in the near surface where they are recycled by ET processes. The data further suggest that water uptake by deep roots has dried subsurface soils to the extent that little liquid water movement is occurring below the root zone in the fine soils. This suggestion supports the hypothesis currently being tested in the Protective Barriers Program (Adams and Wing 1987): Fine-textured soil placed at the surface of a waste site reduces the potential for drainage.

When gravel is placed on the surface, significant increase in water infiltration and storage occurs. Much of the annual precipitation may be captured

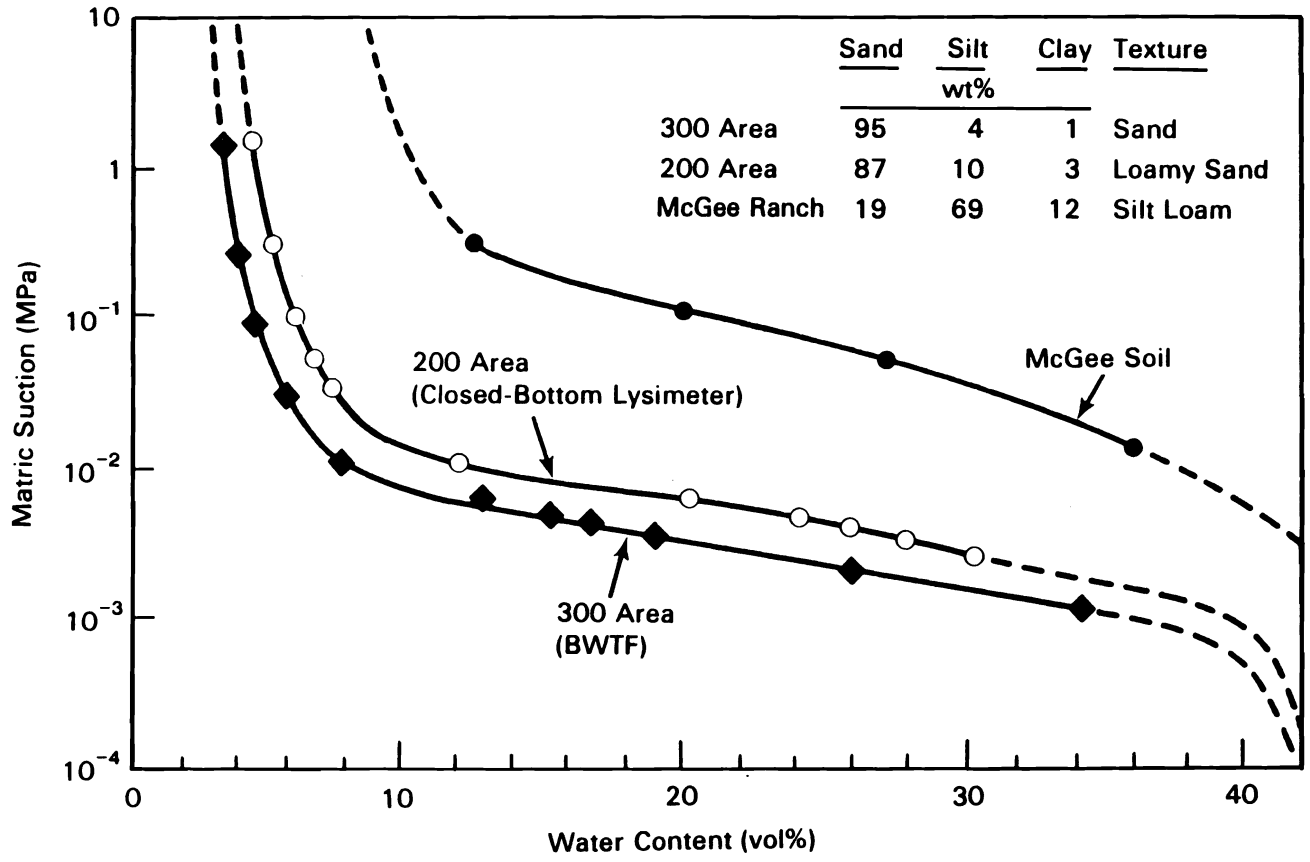

FIGURE 5.1. Water Retention and Textural Properties of Three Hanford Site Soils

by the rock-covered soil. The drainage observed at the Grout Waste Test Facility (discussed in Section 3.3) clearly is different than at the 200 Area lysimeter or at the McGee Ranch site. However, in areas where gravels cover the surface, such as at tank farm sites, most of the annual precipitation can be expected to drain through the gravel and be available for recharge.

Based on the data analyzed during the past 3 years, the following conclusions can be made:

1. Twelve drainage lysimeters located in the 300 Area have provided evidence that more than half of the annual precipitation could drain to the water table at this location when soils are coarse-textured and bare and when meteorological conditions are similar to those that existed when the lysimeters were tested.

2. Model-derived estimates of recharge for the Hanford Site should consider all factors affecting recharge. To date, detailed information gathered has been insufficient to predict recharge accurately for specific sites. Simplified models that require only climatic input or generalized soil and plant data and use monthly averages may underestimate the drainage. The UNSAT-H model is the best model currently available for predicting drainage at waste sites at Hanford. It is a deterministic code that calculates drainage as well as evaporation on an hourly or smaller time-step interval.

3. Hydraulic gradient measurements provide estimates of the direction of water flow. Hydraulic conductivity data provide qualitative information that is useful for scoping analyses, but order-of-magnitude calculations are probably the best that can be obtained from this of type analysis. At the SC lysimeter, a unit-gradient condition has been obtained, and the mean hydraulic conductivity at 11 vol% water content is about 10 cm/yr (3.2×10^{-7} cm/s).

4. An understanding of plant-water relations is needed to predict recharge. Current models use inadequate data for rooting depth and other plant characteristics that control water loss. Additional time will be required to obtain the appropriate data to quantify plant response to soil and climate variables at the Hanford Site. It is

a worthy goal, however, because plants have been shown to virtually control the fate of surface water. When deep-rooted plants are present, even relatively coarse soils show little evidence of downward drainage. When plants are absent, drainage occurs (as much as 10 cm/yr) for coarse-textured soils under present climate conditions (average of ~16 cm/yr precipitation).

5. Fine-textured soils tend to hold more water and are preferred for use as soil cover over waste sites rather than using coarse-textured soils or gravel. Gravel surfaces may trap water causing much of the annual precipitation to drain to the water table.

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APPENDIX

PRECIPITATION AND DRAINAGE DATA FOR THE BURIED WASTE TEST FACILITY (BWTF) AND HANFORD METEROLOGICAL STATION PRECIPITATION DATA

TABLE A.1. Precipitation Data for the Buried Waste Facility Site (BWTF) Near 300 Area, Hanford Site

PRECIPITATION DATA FOR THE BURIED WASTE TEST FACILITY
FROM 1979 TO JUNE 1987

DATE	DAYS SINCE 31-DEC-78	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
19-JAN-79	19	19	0.762	0.762	0.762
25-JAN-79	25	25	0.025	0.787	0.787
08-FEB-79	39	39	0.076	0.864	0.864
13-FEB-79	44	44	1.092	1.956	1.956
20-FEB-79	51	51	0.254	2.210	2.210
21-FEB-79	52	52	0.152	2.362	2.362
10-APR-79	100	100	0.025	2.388	2.388
25-APR-79	115	115	2.184	4.572	4.572
04-MAY-79	124	124	0.127	4.699	4.699
09-MAY-79	129	129	0.102	4.801	4.801
11-MAY-79	131	131	0.025	4.826	4.826
17-MAY-79	137	137	0.025	4.851	4.851
25-MAY-79	145	145	0.076	4.928	4.928
04-JUN-79	155	155	0.051	4.978	4.978
21-JUN-79	172	172	0.076	5.055	5.055
02-JUL-79	183	183	0.152	5.207	5.207
11-JUL-79	192	192	0.254	5.461	5.461
14-AUG-79	226	226	0.203	5.664	5.664
21-AUG-79	233	233	0.127	5.791	5.791
30-AUG-79	242	242	0.051	5.842	5.842
04-SEP-79	247	247	1.524	7.366	7.366
11-OCT-79	284	284	0.051	7.417	7.417
18-OCT-79	291	291	0.330	7.747	7.747
19-OCT-79	292	292	0.559	8.306	8.306
22-OCT-79	295	295	0.305	8.611	8.611
24-OCT-79	297	297	0.076	8.687	8.687
25-OCT-79	298	298	0.025	8.712	8.712
29-OCT-79	302	302	0.254	8.966	8.966
05-NOV-79	309	309	0.406	9.373	9.373
06-NOV-79	310	310	0.102	9.474	9.474
09-NOV-79	313	313	0.025	9.500	9.500
12-NOV-79	316	316	0.025	9.525	9.525
16-NOV-79	320	320	0.127	9.652	9.652
26-NOV-79	330	330	0.076	9.728	9.728
03-DEC-79	337	337	0.711	10.439	10.439
06-DEC-79	340	340	0.076	10.516	10.516
10-DEC-79	344	344	0.051	10.566	10.566
17-DEC-79	351	351	0.025	10.592	10.592
18-DEC-79	352	352	0.254	10.846	10.846
19-DEC-79	353	353	0.025	10.871	10.871
20-DEC-79	354	354	0.076	10.947	10.947
26-DEC-79	360	360	0.737	11.684	11.684
31-DEC-79	365	365	0.356	12.040	12.040
02-JAN-80	367	2	0.711	0.711	12.751
07-JAN-80	372	7	1.372	2.083	14.122
10-JAN-80	375	10	0.711	2.794	14.834
15-JAN-80	380	15	0.406	3.200	15.240
16-JAN-80	381	16	0.051	3.251	15.291
17-JAN-80	382	17	0.406	3.658	15.697
01-FEB-80	397	32	0.127	3.785	15.824
04-FEB-80	400	35	0.686	4.470	16.510
06-FEB-80	402	37	0.152	4.623	16.662
13-FEB-80	409	44	0.076	4.699	16.739

TABLE A.1. (cont'd)

PRECIPITATION DATA FOR THE BURIED WASTE TEST FACILITY
FROM 1979 TO JUNE 1987

DATE	DAYS SINCE 31-DEC-78	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
14-FEB-80	410	45	0.051	4.750	16.789
19-FEB-80	415	50	0.940	5.690	17.729
20-FEB-80	416	51	0.432	6.121	18.161
24-FEB-80	420	55	0.025	6.147	18.186
26-FEB-80	422	57	0.508	6.655	18.694
27-FEB-80	423	58	0.533	7.188	19.228
28-FEB-80	424	59	0.254	7.442	19.482
06-MAR-80	431	66	0.025	7.468	19.507
10-MAR-80	435	70	0.356	7.823	19.863
14-MAR-80	439	74	0.508	8.331	20.371
17-MAR-80	442	77	0.178	8.509	20.549
20-MAR-80	445	80	0.102	8.611	20.650
21-MAR-80	446	81	0.013	8.623	20.663
07-APR-80	463	98	0.051	8.674	20.714
09-APR-80	465	100	0.076	8.750	20.790
20-APR-80	476	111	1.295	10.046	22.085
30-APR-80	486	121	0.229	10.274	22.314
06-MAY-80	492	127	0.406	10.681	22.720
09-MAY-80	495	130	0.381	11.062	23.101
12-MAY-80	498	133	0.483	11.544	23.584
13-MAY-80	499	134	0.102	11.646	23.686
15-MAY-80	501	136	0.076	11.722	23.762
22-MAY-80	508	143	0.279	12.002	24.041
26-MAY-80	512	147	2.007	14.008	26.048
28-MAY-80	514	149	0.076	14.084	26.124
30-MAY-80	516	151	0.127	14.211	26.251
02-JUN-80	519	154	0.025	14.237	26.276
12-JUN-80	529	164	0.229	14.465	26.505
13-JUN-80	530	165	1.118	15.583	27.623
16-JUN-80	533	168	0.305	15.888	27.927
17-JUN-80	534	169	0.025	15.913	27.953
20-JUN-80	537	172	0.076	15.989	28.029
23-JUN-80	540	175	0.356	16.345	28.385
02-SEP-80	611	246	0.508	16.853	28.893
15-SEP-80	624	259	2.286	19.139	31.179
13-OCT-80	652	287	0.330	19.469	31.509
14-OCT-80	653	288	0.178	19.647	31.687
15-OCT-80	654	289	0.203	19.850	31.890
27-OCT-80	666	301	0.660	20.511	32.550
29-OCT-80	668	303	0.038	20.549	32.588
03-NOV-80	673	308	0.203	20.752	32.791
04-NOV-80	674	309	0.076	20.828	32.868
06-NOV-80	676	311	0.025	20.853	32.893
07-NOV-80	677	312	0.711	21.565	33.604
17-NOV-80	687	322	0.102	21.666	33.706
19-NOV-80	689	324	0.076	21.742	33.782
21-NOV-80	691	326	0.102	21.844	33.884
01-DEC-80	701	336	0.025	21.869	33.909
02-DEC-80	702	337	0.559	22.428	34.468
03-DEC-80	703	338	0.610	23.038	35.077
05-DEC-80	705	340	0.660	23.698	35.738
15-DEC-80	715	350	0.051	23.749	35.789
22-DEC-80	722	357	1.321	25.070	37.109

TABLE A.1. (cont'd)

PRECIPITATION DATA FOR THE BURIED WASTE TEST FACILITY
FROM 1979 TO JUNE 1987

DATE	DAYS SINCE 31-DEC-78	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
26-DEC-80	726	361	1.194	26.264	38.303
30-DEC-80	730	365	0.203	26.467	38.506
02-JAN-81	733	2	0.025	0.025	38.532
20-JAN-81	751	20	0.127	0.152	38.659
21-JAN-81	752	21	0.152	0.305	38.811
22-JAN-81	753	22	0.051	0.356	38.862
26-JAN-81	757	26	0.076	0.432	38.938
28-JAN-81	759	28	0.330	0.762	39.268
29-JAN-81	760	29	0.229	0.991	39.497
30-JAN-81	761	30	0.102	1.092	39.599
13-FEB-81	775	44	0.254	1.346	39.853
18-FEB-81	780	49	1.499	2.845	41.351
19-FEB-81	781	50	0.737	3.581	42.088
04-MAR-81	794	63	0.483	4.064	42.570
16-MAR-81	806	75	0.051	4.115	42.621
25-MAR-81	815	84	0.025	4.140	42.647
26-MAR-81	816	85	0.584	4.724	43.231
27-MAR-81	817	86	0.102	4.826	43.332
31-MAR-81	821	90	0.076	4.902	43.409
21-APR-81	842	111	0.025	4.928	43.434
22-APR-81	843	112	0.051	4.978	43.485
24-APR-81	845	114	0.025	5.004	43.510
28-APR-81	849	118	0.051	5.055	43.561
05-MAY-81	856	125	0.013	5.067	43.574
08-MAY-81	859	128	0.051	5.118	43.625
14-MAY-81	865	134	0.610	5.728	44.234
15-MAY-81	866	135	0.076	5.804	44.310
18-MAY-81	869	138	0.051	5.855	44.361
19-MAY-81	870	139	0.229	6.083	44.590
01-JUN-81	883	152	0.051	6.134	44.641
08-JUN-81	890	159	0.660	6.795	45.301
09-JUN-81	891	160	0.076	6.871	45.377
12-JUN-81	894	163	0.152	7.023	45.530
13-JUN-81	895	164	0.152	7.176	45.682
19-JUN-81	901	170	0.076	7.252	45.758
05-JUL-81	917	186	0.203	7.455	45.961
09-JUL-81	921	190	0.203	7.658	46.165
17-JUL-81	929	198	0.051	7.709	46.215
03-AUG-81	946	215	0.229	7.938	46.444
09-AUG-81	952	221	0.025	7.963	46.469
01-OCT-81	1005	274	1.194	9.157	47.663
05-OCT-81	1009	278	0.025	9.182	47.689
06-OCT-81	1010	279	0.152	9.335	47.841
08-OCT-81	1012	281	0.203	9.538	48.044
13-OCT-81	1017	286	0.076	9.614	48.120
26-OCT-81	1030	299	0.051	9.665	48.171
30-OCT-81	1034	303	0.457	10.122	48.628
12-NOV-81	1047	316	0.114	10.236	48.743
13-NOV-81	1048	317	0.749	10.986	49.492
17-NOV-81	1052	321	1.067	12.052	50.559
23-NOV-81	1058	327	0.152	12.205	50.711
30-NOV-81	1065	334	0.038	12.243	50.749
01-DEC-81	1066	335	0.203	12.446	50.952

TABLE A.1. (cont'd)

PRECIPITATION DATA FOR THE BURIED WASTE TEST FACILITY
FROM 1979 TO JUNE 1987

DATE	DAYS SINCE 31-DEC-78	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
05-DEC-81	1070	339	0.076	12.522	51.029
06-DEC-81	1071	340	0.089	12.611	51.118
09-DEC-81	1074	343	0.025	12.637	51.143
10-DEC-81	1075	344	0.254	12.891	51.397
14-DEC-81	1079	348	0.178	13.068	51.575
15-DEC-81	1080	349	0.864	13.932	52.438
18-DEC-81	1083	352	0.076	14.008	52.515
21-DEC-81	1086	355	1.016	15.024	53.531
22-DEC-81	1087	356	0.025	15.050	53.556
28-DEC-81	1093	362	0.787	15.837	54.343
29-DEC-81	1094	363	0.102	15.939	54.445
04-JAN-82	1100	4	0.533	0.533	54.978
07-JAN-82	1103	7	0.203	0.737	55.182
15-JAN-82	1111	15	0.013	0.749	55.194
21-JAN-82	1117	21	0.584	1.334	55.778
25-JAN-82	1121	25	0.838	2.172	56.617
28-JAN-82	1124	28	0.229	2.400	56.845
29-JAN-82	1125	29	0.013	2.413	56.858
19-FEB-82	1146	50	1.194	3.607	58.052
20-FEB-82	1147	51	0.229	3.835	58.280
01-MAR-82	1156	60	0.432	4.267	58.712
05-MAR-82	1160	64	0.127	4.394	58.839
09-MAR-82	1164	68	0.025	4.420	58.865
11-MAR-82	1166	70	0.203	4.623	59.068
15-MAR-82	1170	74	0.152	4.775	59.220
29-MAR-82	1184	88	0.356	5.131	59.576
30-MAR-82	1185	89	0.051	5.182	59.627
31-MAR-82	1186	90	0.102	5.283	59.728
02-APR-82	1188	92	0.102	5.385	59.830
05-APR-82	1191	95	0.483	5.867	60.312
09-APR-82	1195	99	0.025	5.893	60.338
12-APR-82	1198	102	0.864	6.756	61.201
13-APR-82	1199	103	0.127	6.883	61.328
14-APR-82	1200	104	0.178	7.061	61.506
28-APR-82	1214	118	0.356	7.417	61.862
10-MAY-82	1226	130	0.013	7.430	61.874
17-MAY-82	1233	137	0.279	7.709	62.154
28-MAY-82	1244	148	0.076	7.785	62.230
25-JUN-82	1272	176	0.025	7.811	62.255
28-JUN-82	1275	179	1.829	9.639	64.084
29-JUN-82	1276	180	0.889	10.528	64.973
30-JUL-82	1307	211	0.025	10.554	64.999
30-AUG-82	1338	242	0.051	10.605	65.049
09-SEP-82	1348	252	0.025	10.630	65.075
10-SEP-82	1349	253	0.635	11.265	65.710
13-SEP-82	1352	256	0.254	11.519	65.964
20-SEP-82	1359	263	0.584	12.103	66.548
27-SEP-82	1366	270	0.965	13.068	67.513
29-SEP-82	1368	272	0.711	13.780	68.224
04-OCT-82	1373	277	0.025	13.805	68.250
11-OCT-82	1380	284	0.025	13.830	68.275
22-OCT-82	1391	295	0.178	14.008	68.453
25-OCT-82	1394	298	1.067	15.075	69.520

TABLE A.1. (cont'd)

PRECIPITATION DATA FOR THE BURIED WASTE TEST FACILITY
FROM 1979 TO JUNE 1987

DATE	DAYS SINCE 31-DEC-78	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
26-OCT-82	1395	299	0.203	15.278	69.723
29-OCT-82	1398	302	2.515	17.793	72.238
01-NOV-82	1401	305	0.025	17.818	72.263
17-NOV-82	1417	321	0.711	18.529	72.974
18-NOV-82	1418	322	0.991	19.520	73.965
29-NOV-82	1429	333	0.813	20.333	74.778
02-DEC-82	1432	336	0.178	20.511	74.955
06-DEC-82	1436	340	1.422	21.933	76.378
15-DEC-82	1445	349	1.168	23.101	77.546
17-DEC-82	1447	351	0.686	23.787	78.232
27-DEC-82	1457	361	0.864	24.651	79.096
03-JAN-83	1464	3	0.229	0.229	79.324
04-JAN-83	1465	4	0.203	0.533	79.527
06-JAN-83	1467	6	1.219	0.737	80.747
07-JAN-83	1468	7	0.203	0.749	80.950
10-JAN-83	1471	10	0.305	1.334	81.255
17-JAN-83	1478	17	0.051	2.172	81.305
18-JAN-83	1479	18	1.168	2.400	82.474
19-JAN-83	1480	19	0.533	2.413	83.007
20-JAN-83	1481	20	0.381	3.607	83.388
21-JAN-83	1482	21	0.051	3.835	83.439
24-JAN-83	1485	24	0.254	4.267	83.693
26-JAN-83	1487	26	0.508	4.394	84.201
28-JAN-83	1489	28	0.051	4.420	84.252
31-JAN-83	1492	31	0.025	4.470	84.277
07-FEB-83	1499	38	0.178	4.496	84.455
08-FEB-83	1500	39	0.279	4.674	84.734
11-FEB-83	1503	42	0.279	4.953	85.014
14-FEB-83	1506	45	0.051	5.232	85.065
16-FEB-83	1508	47	0.635	5.283	85.700
17-FEB-83	1509	48	0.330	5.918	86.030
22-FEB-83	1514	53	0.432	6.248	86.462
23-FEB-83	1515	54	0.025	6.680	86.487
25-FEB-83	1517	56	0.051	6.706	86.538
27-FEB-83	1519	58	0.533	6.756	87.071
02-MAR-83	1522	61	0.858	7.614	87.929
10-MAR-83	1530	69	1.127	8.741	89.056
16-MAR-83	1536	75	0.637	9.378	89.693
23-MAR-83	1543	82	0.441	9.819	90.134
31-MAR-83	1551	90	1.789	11.608	91.923
08-APR-83	1559	98	0.294	11.902	92.217
25-APR-83	1576	115	0.686	12.588	92.903
09-MAY-83	1590	129	0.490	13.078	93.393
24-MAY-83	1605	144	0.000	13.078	93.393
13-JUN-83	1625	164	0.221	13.298	93.613
22-JUN-83	1634	173	0.049	13.347	93.662
30-JUN-83	1642	181	0.055	13.402	93.717
01-JUL-83	1643	182	0.083	13.485	93.800
02-JUL-83	1644	183	0.088	13.573	93.888
06-JUL-83	1648	187	0.005	13.578	93.893
07-JUL-83	1649	188	0.004	13.582	93.897
09-JUL-83	1651	190	0.004	13.586	93.901
10-JUL-83	1652	191	0.005	13.591	93.906

TABLE A.1. (cont'd)

PRECIPITATION DATA FOR THE BURIED WASTE TEST FACILITY
FROM 1979 TO JUNE 1987

DATE	DAYS SINCE 31-DEC-78	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
11-JUL-83	1653	192	0.007	13.599	93.913
13-JUL-83	1655	194	0.006	13.605	93.920
25-JUL-83	1667	206	0.600	14.205	94.520
27-JUL-83	1669	208	0.030	14.235	94.550
04-AUG-83	1677	216	0.004	14.239	94.554
07-AUG-83	1680	219	0.024	14.263	94.578
11-AUG-83	1684	223	0.032	14.295	94.610
29-AUG-83	1702	241	0.012	14.307	94.622
31-AUG-83	1704	243	0.017	14.324	94.639
01-SEP-83	1705	244	0.075	14.399	94.714
10-SEP-83	1714	253	0.125	14.525	94.839
18-SEP-83	1722	261	0.250	14.775	95.090
24-SEP-83	1728	267	0.006	14.781	95.096
26-SEP-83	1730	269	0.011	14.792	95.107
14-OCT-83	1748	287	0.014	14.807	95.122
17-OCT-83	1751	290	0.313	15.120	95.435
21-OCT-83	1755	294	0.006	15.126	95.441
22-OCT-83	1756	295	0.815	15.941	96.256
30-OCT-83	1764	303	0.890	16.831	97.146
01-NOV-83	1766	305	0.531	17.363	97.677
02-NOV-83	1767	306	0.078	17.440	97.755
03-NOV-83	1768	307	0.253	17.693	98.007
04-NOV-83	1769	308	0.117	17.809	98.124
05-NOV-83	1770	309	0.185	17.994	98.309
06-NOV-83	1771	310	0.123	18.117	98.432
09-NOV-83	1774	313	0.202	18.319	98.634
10-NOV-83	1775	314	1.254	19.573	99.888
14-NOV-83	1779	318	0.090	19.663	99.977
15-NOV-83	1780	319	0.141	19.803	100.118
16-NOV-83	1781	320	0.209	20.012	100.327
17-NOV-83	1782	321	0.305	20.317	100.632
19-NOV-83	1784	323	0.100	20.417	100.732
21-NOV-83	1786	325	0.191	20.609	100.923
23-NOV-83	1788	327	0.486	21.094	101.409
24-NOV-83	1789	328	0.413	21.508	101.822
28-NOV-83	1793	332	0.060	21.568	101.882
02-DEC-83	1797	336	0.158	21.726	102.040
04-DEC-83	1799	338	0.139	21.864	102.179
05-DEC-83	1800	339	1.113	22.977	103.292
07-DEC-83	1802	341	1.199	24.176	104.491
08-DEC-83	1803	342	0.018	24.194	104.509
09-DEC-83	1804	343	0.578	24.772	105.087
10-DEC-83	1805	344	0.200	24.972	105.287
12-DEC-83	1807	346	0.166	25.139	105.454
14-DEC-83	1809	348	0.013	25.152	105.467
18-DEC-83	1813	352	0.232	25.384	105.698
19-DEC-83	1814	353	0.123	25.507	105.822
24-DEC-83	1819	358	0.517	26.024	106.339
25-DEC-83	1820	359	0.481	26.505	106.820
26-DEC-83	1821	360	0.053	26.558	106.873
27-DEC-83	1822	361	0.286	26.843	107.158
28-DEC-83	1823	362	0.047	26.891	107.206
29-DEC-83	1824	363	1.674	28.565	108.880

TABLE A.1. (cont'd)

PRECIPITATION DATA FOR THE BURIED WASTE TEST FACILITY
FROM 1979 TO JUNE 1987

DATE	DAYS SINCE 31-DEC-78	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
02-JAN-84	1828	2	0.073	0.073	108.953
03-JAN-84	1829	3	0.129	0.202	109.082
04-JAN-84	1830	4	0.588	0.790	109.670
05-JAN-84	1831	5	0.037	0.827	109.707
05-FEB-84	1862	36	0.018	0.845	109.725
09-FEB-84	1866	40	0.112	0.957	109.836
11-FEB-84	1868	42	0.064	1.021	109.900
12-FEB-84	1869	43	0.042	1.063	109.943
13-FEB-84	1870	44	0.191	1.254	110.134
15-FEB-84	1872	46	0.209	1.463	110.343
19-FEB-84	1876	50	0.056	1.519	110.399
20-FEB-84	1877	51	0.407	1.926	110.806
21-FEB-84	1878	52	0.554	2.480	111.359
23-FEB-84	1880	54	0.135	2.615	111.495
24-FEB-84	1881	55	0.127	2.742	111.622
25-FEB-84	1882	56	0.024	2.766	111.646
29-FEB-84	1886	60	0.058	2.824	111.704
10-MAR-84	1896	70	0.301	3.125	112.005
13-MAR-84	1899	73	0.702	3.827	112.706
14-MAR-84	1900	74	0.262	4.089	112.969
15-MAR-84	1901	75	0.055	4.144	113.024
16-MAR-84	1902	76	0.221	4.365	113.245
18-MAR-84	1904	78	0.035	4.401	113.280
19-MAR-84	1905	79	0.475	4.875	113.755
20-MAR-84	1906	80	0.992	5.867	114.747
21-MAR-84	1907	81	0.980	6.848	115.727
23-MAR-84	1909	83	0.019	6.866	115.746
25-MAR-84	1911	85	0.486	7.352	116.232
28-MAR-84	1914	88	0.327	7.679	116.559
01-APR-84	1918	92	0.149	7.828	116.707
02-APR-84	1919	93	0.047	7.874	116.754
04-APR-84	1921	95	0.148	8.023	116.902
05-APR-84	1922	96	0.074	8.097	116.977
07-APR-84	1924	98	0.673	8.770	117.650
09-APR-84	1926	100	0.131	8.901	117.781
10-APR-84	1927	101	0.097	8.999	117.878
14-APR-84	1931	105	0.015	9.013	117.893
15-APR-84	1932	106	0.036	9.049	117.929
16-APR-84	1933	107	0.110	9.159	118.039
18-APR-84	1935	109	0.094	9.253	118.132
20-APR-84	1937	111	0.021	9.273	118.153
22-APR-84	1939	113	0.013	9.287	118.167
24-APR-84	1941	115	0.033	9.320	118.200
27-APR-84	1944	118	0.026	9.346	118.226
28-APR-84	1945	119	0.019	9.365	118.244
30-APR-84	1947	121	0.414	9.778	118.658
01-MAY-84	1948	122	0.363	10.141	119.021
04-MAY-84	1951	125	0.012	10.154	119.033
05-MAY-84	1952	126	0.042	10.196	119.076
11-MAY-84	1958	132	0.065	10.261	119.141
12-MAY-84	1959	133	0.056	10.317	119.197
14-MAY-84	1961	135	0.035	10.352	119.232
15-MAY-84	1962	136	0.021	10.373	119.253

TABLE A.1. (cont'd)

PRECIPITATION DATA FOR THE BURIED WASTE TEST FACILITY
FROM 1979 TO JUNE 1987

DATE	DAYS SINCE 31-DEC-78	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
19-MAY-84	1966	140	0.239	10.612	119.491
22-MAY-84	1969	143	0.385	10.997	119.876
25-MAY-84	1972	146	0.145	11.141	120.021
26-MAY-84	1973	147	0.052	11.193	120.073
02-JUN-84	1980	154	0.036	11.230	120.109
04-JUN-84	1982	156	0.808	12.038	120.918
05-JUN-84	1983	157	0.025	12.063	120.942
07-JUN-84	1985	159	0.238	12.301	121.181
12-JUN-84	1990	164	0.031	12.332	121.212
20-JUN-84	1998	172	0.352	12.684	121.563
21-JUN-84	1999	173	0.039	12.723	121.603
26-JUN-84	2004	178	0.161	12.884	121.764
29-JUN-84	2007	181	0.229	13.114	121.993
29-JUL-84	2037	211	0.093	13.207	122.087
05-AUG-84	2044	218	0.050	13.256	122.136
27-AUG-84	2066	240	0.066	13.323	122.203
05-SEP-84	2075	249	0.060	13.383	122.263
20-SEP-84	2090	264	0.175	13.558	122.437
22-SEP-84	2092	266	0.809	14.367	123.247
23-SEP-84	2093	267	0.288	14.655	123.535
10-OCT-84	2110	284	0.155	14.811	123.690
11-OCT-84	2111	285	0.083	14.893	123.773
01-NOV-84	2132	306	0.390	15.283	124.163
02-NOV-84	2133	307	0.378	15.661	124.541
06-NOV-84	2137	311	0.020	15.681	124.561
10-NOV-84	2141	315	0.499	16.180	125.060
11-NOV-84	2142	316	0.243	16.423	125.303
12-NOV-84	2143	317	0.214	16.637	125.517
13-NOV-84	2144	318	0.208	16.845	125.725
16-NOV-84	2147	321	0.068	16.913	125.793
18-NOV-84	2149	323	0.198	17.112	125.991
20-NOV-84	2151	325	0.643	17.755	126.634
23-NOV-84	2154	328	0.827	18.581	127.461
24-NOV-84	2155	329	0.015	18.597	127.476
27-NOV-84	2158	332	1.177	19.774	128.654
28-NOV-84	2159	333	0.196	19.970	128.850
29-NOV-84	2160	334	0.124	20.095	128.974
08-DEC-84	2169	343	0.079	20.173	129.053
09-DEC-84	2170	344	0.948	21.121	130.001
10-DEC-84	2171	345	0.246	21.367	130.247
11-DEC-84	2172	346	0.113	21.480	130.360
12-DEC-84	2173	347	0.216	21.696	130.576
14-DEC-84	2175	349	0.028	21.724	130.604
17-DEC-84	2178	352	0.063	21.787	130.666
20-DEC-84	2181	355	0.090	21.876	130.756
21-DEC-84	2182	356	0.032	21.908	130.788
25-DEC-84	2186	360	0.026	21.934	130.814
28-DEC-84	2189	363	0.150	22.084	130.963
29-DEC-84	2190	364	0.692	22.776	131.656
30-DEC-84	2191	365	0.023	22.799	131.679
09-JAN-85	2201	9	0.025	0.025	131.704
12-JAN-85	2204	12	0.025	0.051	131.729
18-JAN-85	2210	18	0.025	0.076	131.755

TABLE A.1. (cont'd)

PRECIPITATION DATA FOR THE BURIED WASTE TEST FACILITY
FROM 1979 TO JUNE 1987

DATE	DAYS SINCE 31-DEC-78	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
20-JAN-85	2212	20	0.610	0.686	132.364
21-JAN-85	2213	21	0.356	1.041	132.720
22-JAN-85	2214	22	0.102	1.143	132.822
02-FEB-85	2225	33	0.076	1.219	132.898
03-FEB-85	2226	34	0.076	1.295	132.974
04-FEB-85	2227	35	0.025	1.321	132.999
05-FEB-85	2228	36	0.076	1.397	133.076
06-FEB-85	2229	37	0.076	1.473	133.152
07-FEB-85	2230	38	0.025	1.499	133.177
08-FEB-85	2231	39	0.533	2.032	133.711
09-FEB-85	2232	40	0.102	2.134	133.812
11-FEB-85	2234	42	0.203	2.337	134.015
12-FEB-85	2235	43	0.025	2.362	134.041
16-FEB-85	2239	47	0.025	2.388	134.066
19-FEB-85	2242	50	0.025	2.413	134.092
23-FEB-85	2246	54	0.025	2.438	134.117
01-MAR-85	2252	60	0.025	2.464	134.142
04-MAR-85	2255	63	0.762	3.226	134.904
20-MAR-85	2271	79	0.025	3.251	134.930
23-MAR-85	2274	82	0.076	3.327	135.006
26-MAR-85	2277	85	0.178	3.505	135.184
27-MAR-85	2278	86	0.051	3.556	135.235
30-MAR-85	2281	89	0.025	3.581	135.260
16-APR-85	2298	106	0.152	3.734	135.412
22-APR-85	2304	112	0.127	3.861	135.539
23-APR-85	2305	113	0.076	3.937	135.616
13-MAY-85	2325	133	0.178	4.115	135.793
23-MAY-85	2335	143	0.660	4.775	136.454
29-MAY-85	2341	149	0.279	5.055	136.733
06-JUN-85	2349	157	0.330	5.385	137.063
07-JUN-85	2350	158	0.025	5.410	137.089
31-JUL-85	2404	212	0.254	5.664	137.343
01-AUG-85	2405	213	0.025	5.690	137.368
02-AUG-85	2406	214	0.025	5.715	137.394
04-AUG-85	2408	216	0.051	5.766	137.444
08-SEP-85	2443	251	0.203	5.969	137.648
09-SEP-85	2444	252	0.025	5.994	137.673
10-SEP-85	2445	253	0.356	6.350	138.029
11-SEP-85	2446	254	0.381	6.731	138.410
12-SEP-85	2447	255	0.051	6.782	138.460
13-SEP-85	2448	256	0.025	6.807	138.486
16-SEP-85	2451	259	0.025	6.833	138.511
17-SEP-85	2452	260	0.051	6.883	138.562
10-OCT-85	2475	283	0.025	6.909	138.587
22-OCT-85	2487	295	0.025	6.934	138.613
24-OCT-85	2489	297	0.025	6.960	138.638
04-NOV-85	2500	308	0.076	7.036	138.714
09-NOV-85	2505	313	0.203	7.239	138.918
10-NOV-85	2506	314	0.102	7.341	139.019
15-NOV-85	2511	319	0.432	7.772	139.451
17-NOV-85	2513	321	0.279	8.052	139.730
19-NOV-85	2515	323	0.330	8.382	140.061
20-NOV-85	2516	324	0.127	8.509	140.188

TABLE A.1. (cont'd)

PRECIPITATION DATA FOR THE BURIED WASTE TEST FACILITY
FROM 1979 TO JUNE 1987

DATE	DAYS SINCE 31-DEC-78	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
21-NOV-85	2517	325	1.270	9.779	141.458
22-NOV-85	2518	326	0.051	9.830	141.508
25-NOV-85	2521	329	0.025	9.855	141.534
27-NOV-85	2523	331	0.203	10.058	141.737
29-NOV-85	2525	333	0.102	10.160	141.839
30-NOV-85	2526	334	0.051	10.211	141.889
01-DEC-85	2527	335	0.076	10.287	141.966
02-DEC-85	2528	336	0.864	11.151	142.829
06-DEC-85	2532	340	0.457	11.608	143.286
07-DEC-85	2533	341	0.711	12.319	143.998
24-DEC-85	2550	358	0.025	12.344	144.023
01-JAN-86	2558	1	0.406	0.406	144.429
03-JAN-86	2560	3	3.124	3.531	147.554
05-JAN-86	2562	5	0.406	3.937	147.960
08-JAN-86	2565	8	0.025	3.962	147.985
09-JAN-86	2566	9	0.051	4.013	148.036
15-JAN-86	2572	15	0.229	4.242	148.265
16-JAN-86	2573	16	0.356	4.597	148.620
17-JAN-86	2574	17	0.127	4.724	148.747
18-JAN-86	2575	18	0.025	4.750	148.773
19-JAN-86	2576	19	0.025	4.775	148.798
22-JAN-86	2579	22	0.559	5.334	149.357
23-JAN-86	2580	23	0.051	5.385	149.408
27-JAN-86	2584	27	0.330	5.715	149.738
28-JAN-86	2585	28	0.305	6.020	150.043
29-JAN-86	2586	29	0.584	6.604	150.627
30-JAN-86	2587	30	0.762	7.366	151.389
01-FEB-86	2589	32	0.025	7.391	151.414
02-FEB-86	2590	33	0.356	7.747	151.770
03-FEB-86	2591	34	0.051	7.798	151.821
04-FEB-86	2592	35	0.533	8.331	152.354
05-FEB-86	2593	36	0.025	8.357	152.380
12-FEB-86	2600	43	0.025	8.382	152.405
15-FEB-86	2603	46	0.508	8.890	152.913
21-FEB-86	2609	52	0.559	9.449	153.472
23-FEB-86	2611	54	0.940	10.389	154.412
07-MAR-86	2623	66	0.914	11.303	155.326
08-MAR-86	2624	67	0.381	11.684	155.707
09-MAR-86	2625	68	0.051	11.735	155.758
10-MAR-86	2626	69	0.102	11.836	155.859
12-MAR-86	2628	71	0.076	11.913	155.936
13-MAR-86	2629	72	0.457	12.370	156.393
14-MAR-86	2630	73	0.178	12.548	156.571
18-MAR-86	2634	77	0.025	12.573	156.596
23-MAR-86	2639	82	1.067	13.640	157.663
24-MAR-86	2640	83	0.279	13.919	157.942
26-MAR-86	2642	85	0.127	14.046	158.069
30-MAR-86	2646	89	0.381	14.427	158.450
12-APR-86	2659	102	0.051	14.478	158.501
13-APR-86	2660	103	0.025	14.503	158.526
26-APR-86	2673	116	0.051	14.554	158.577
02-MAY-86	2679	122	0.076	14.630	158.653
03-MAY-86	2680	123	0.051	14.681	158.704

TABLE A.1. (cont'd)

PRECIPITATION DATA FOR THE BURIED WASTE TEST FACILITY
FROM 1979 TO JUNE 1987

DATE	DAYS SINCE 31-DEC-78	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
05-MAY-86	2682	125	0.025	14.707	158.730
06-MAY-86	2683	126	0.381	15.088	159.111
09-MAY-86	2686	129	0.356	15.443	159.466
21-MAY-86	2698	141	0.559	16.002	160.025
28-JUN-86	2736	179	0.305	16.307	160.330
02-JUL-86	2740	183	0.305	16.612	160.635
03-JUL-86	2741	184	0.025	16.637	160.660
04-JUL-86	2742	185	0.381	17.018	161.041
16-JUL-86	2754	197	0.076	17.094	161.117
15-SEP-86	2815	258	0.076	17.170	161.193
16-SEP-86	2816	259	0.127	17.297	161.320
19-SEP-86	2819	262	0.127	17.424	161.447
23-SEP-86	2823	266	0.127	17.551	161.574
29-SEP-86	2829	272	0.025	17.577	161.600
26-OCT-86	2856	299	0.152	17.729	161.752
29-OCT-86	2859	302	0.051	17.780	161.803
23-NOV-86	2884	327	0.025	17.805	161.828
24-NOV-86	2885	328	0.025	17.831	161.854
26-NOV-86	2887	330	0.051	17.882	161.905
27-NOV-86	2888	331	0.051	17.932	161.955
28-NOV-86	2889	332	0.051	17.983	162.006
05-DEC-86	2896	339	0.051	18.034	162.057
13-DEC-86	2904	347	0.051	18.085	162.108
14-DEC-86	2905	348	0.051	18.136	162.159
17-DEC-86	2908	351	0.051	18.186	162.209
18-DEC-86	2909	352	0.025	18.212	162.235
19-DEC-86	2910	353	0.051	18.263	162.286
01-JAN-87	2923	1	0.025	0.229	162.311
13-JAN-87	2935	13	0.076	0.305	162.387
14-JAN-87	2936	14	0.102	0.406	162.489
15-JAN-87	2937	15	0.051	0.457	162.540
25-JAN-87	2947	25	0.051	0.508	162.590
26-JAN-87	2948	26	0.076	0.584	162.667
27-JAN-87	2949	27	0.152	0.737	162.819
01-FEB-87	2954	32	0.152	0.889	162.971
15-FEB-87	2968	46	0.025	0.914	162.997
17-FEB-87	2970	48	0.051	0.965	163.048
03-MAR-87	2984	62	0.152	1.118	163.200
04-MAR-87	2985	63	0.127	1.245	163.327
06-MAR-87	2987	65	0.051	1.295	163.378
07-MAR-87	2988	66	0.025	1.321	163.403
09-MAR-87	2990	68	0.025	1.346	163.429
10-MAR-87	2991	69	0.025	1.372	163.454
12-MAR-87	2993	71	0.102	1.473	163.556
13-MAR-87	2994	72	0.787	2.261	164.343
14-MAR-87	2995	73	0.025	2.286	164.368
15-MAR-87	2996	74	0.254	2.540	164.622
16-MAR-87	2997	75	0.254	2.794	164.876
18-MAR-87	2999	77	0.025	2.819	164.902
19-MAR-87	3000	78	0.025	2.845	164.927
11-APR-87	3023	101	0.229	3.073	165.156
18-APR-87	3030	108	0.381	3.454	165.537
29-APR-87	3041	119	0.356	3.810	165.892
13-MAY-87	3055	133	0.152	3.962	166.045
31-MAY-87	3073	151	1.194	5.156	167.239
09-JUN-87	3082	160	0.051	5.207	167.289
16-JUN-87	3089	167	0.051	5.258	167.340
22-JUN-87	3095	173	0.025	5.283	167.366

TABLE A.2. Precipitation Data for Hanford Meteorology Station

PRECIPITATION DATA FROM THE HANFORD METEOROLOGICAL STATION
1979 TO JUNE 1987

DATE	DAYS SINCE 01-JAN-79	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
10-JAN-79	10	10	0.508	0.508	0.508
11-JAN-79	11	11	0.406	0.914	0.914
14-JAN-79	14	14	0.279	1.194	1.194
23-JAN-79	23	23	0.051	1.245	1.245
24-JAN-79	24	24	0.102	1.346	1.346
30-JAN-79	30	30	0.025	1.372	1.372
11-FEB-79	42	42	0.025	1.397	1.397
12-FEB-79	43	43	0.203	1.600	1.600
16-FEB-79	47	47	0.076	1.676	1.676
20-FEB-79	51	51	0.076	1.753	1.753
21-FEB-79	52	52	0.025	1.778	1.778
25-FEB-79	56	56	0.025	1.803	1.803
03-MAR-79	62	62	0.076	1.880	1.880
04-MAR-79	63	63	0.178	2.057	2.057
06-MAR-79	65	65	0.051	2.108	2.108
27-MAR-79	86	86	1.067	3.175	3.175
02-APR-79	92	92	0.254	3.429	3.429
08-APR-79	98	98	0.025	3.454	3.454
11-APR-79	101	101	0.076	3.531	3.531
12-APR-79	102	102	0.025	3.556	3.556
16-APR-79	106	106	0.203	3.759	3.759
17-APR-79	107	107	0.432	4.191	4.191
24-APR-79	114	114	0.102	4.293	4.293
30-APR-79	120	120	0.203	4.496	4.496
01-MAY-79	121	121	0.203	4.699	4.699
04-MAY-79	124	124	0.025	4.724	4.724
05-MAY-79	125	125	0.025	4.750	4.750
06-JUL-79	187	187	0.051	4.801	4.801
08-JUL-79	189	189	0.025	4.826	4.826
10-JUL-79	191	191	0.051	4.877	4.877
11-JUL-79	192	192	0.102	4.978	4.978
13-AUG-79	225	225	0.102	5.080	5.080
14-AUG-79	226	226	0.229	5.309	5.309
19-AUG-79	231	231	0.127	5.436	5.436
20-AUG-79	232	232	0.051	5.486	5.486
21-AUG-79	233	233	0.152	5.639	5.639
29-AUG-79	241	241	0.025	5.664	5.664
30-AUG-79	242	242	0.279	5.944	5.944
01-SEP-79	244	244	0.152	6.096	6.096
02-SEP-79	245	245	0.025	6.121	6.121
03-SEP-79	246	246	0.330	6.452	6.452
18-OCT-79	291	291	0.711	7.163	7.163
19-OCT-79	292	292	0.305	7.468	7.468
20-OCT-79	293	293	0.152	7.620	7.620
24-OCT-79	297	297	0.279	7.899	7.899
25-OCT-79	298	298	0.178	8.077	8.077
27-OCT-79	300	300	0.076	8.153	8.153
02-NOV-79	306	306	0.152	8.306	8.306
04-NOV-79	308	308	0.229	8.534	8.534
05-NOV-79	309	309	0.178	8.712	8.712
06-NOV-79	310	310	0.152	8.865	8.865
16-NOV-79	320	320	1.067	9.931	9.931
22-NOV-79	326	326	0.762	10.693	10.693

TABLE A.2. (cont'd)

PRECIPITATION DATA FROM THE HANFORD METEOROLOGICAL STATION
1979 TO JUNE 1987

DATE	DAYS SINCE 01-JAN-79	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
24-NOV-79	328	328	0.787	11.481	11.481
26-NOV-79	330	330	0.127	11.608	11.608
01-DEC-79	335	335	0.178	11.786	11.786
02-DEC-79	336	336	0.051	11.836	11.836
03-DEC-79	337	337	0.076	11.913	11.913
05-DEC-79	339	339	0.102	12.014	12.014
15-DEC-79	349	349	0.076	12.090	12.090
17-DEC-79	351	351	0.102	12.192	12.192
18-DEC-79	352	352	0.127	12.319	12.319
23-DEC-79	357	357	0.686	13.005	13.005
24-DEC-79	358	358	0.127	13.132	13.132
25-DEC-79	359	359	0.076	13.208	13.208
28-DEC-79	362	362	0.051	13.259	13.259
29-DEC-79	363	363	0.178	13.437	13.437
30-DEC-79	364	364	0.381	13.818	13.818
31-DEC-79	365	365	0.305	14.122	14.122
01-JAN-80	366	1	0.279	0.279	14.401
04-JAN-80	369	4	0.229	0.508	14.630
07-JAN-80	372	7	0.127	0.635	14.757
08-JAN-80	373	8	0.559	1.193	15.316
09-JAN-80	374	9	0.508	1.701	15.824
11-JAN-80	376	11	0.432	2.133	16.256
12-JAN-80	377	12	0.025	2.159	16.281
13-JAN-80	378	13	0.838	2.997	17.119
14-JAN-80	379	14	0.152	3.149	17.272
16-JAN-80	381	16	0.127	3.276	17.399
31-JAN-80	396	31	0.076	3.352	17.475
01-FEB-80	397	32	0.178	3.530	17.653
02-FEB-80	398	33	0.305	3.835	17.957
06-FEB-80	402	37	0.025	3.860	17.983
13-FEB-80	409	44	0.432	4.292	18.415
14-FEB-80	410	45	0.076	4.368	18.491
15-FEB-80	411	46	0.051	4.419	18.542
16-FEB-80	412	47	0.025	4.445	18.567
17-FEB-80	413	48	0.711	5.156	19.278
18-FEB-80	414	49	0.025	5.181	19.304
19-FEB-80	415	50	0.178	5.359	19.481
20-FEB-80	416	51	0.025	5.384	19.507
25-FEB-80	421	56	0.051	5.435	19.558
26-FEB-80	422	57	0.508	5.943	20.066
27-FEB-80	423	58	0.610	6.553	20.675
28-FEB-80	424	59	0.102	6.654	20.777
05-MAR-80	430	65	0.102	6.756	20.878
10-MAR-80	435	70	0.152	6.908	21.031
13-MAR-80	438	73	0.127	7.035	21.158
14-MAR-80	439	74	0.152	7.188	21.310
17-MAR-80	442	77	0.051	7.239	21.361
20-MAR-80	445	80	0.152	7.391	21.513
29-MAR-80	454	89	0.025	7.416	21.539
04-APR-80	460	95	0.127	7.543	21.666
05-APR-80	461	96	0.051	7.594	21.717
06-APR-80	462	97	0.102	7.696	21.818
09-APR-80	465	100	0.305	8.001	22.123

TABLE A.2. (cont'd)

PRECIPITATION DATA FROM THE HANFORD METEOROLOGICAL STATION
1979 TO JUNE 1987

DATE	DAYS SINCE 01-JAN-79	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
19-APR-80	475	110	0.051	8.051	22.174
20-APR-80	476	111	1.422	9.474	23.596
28-APR-80	484	119	0.025	9.499	23.622
30-APR-80	486	121	0.102	9.601	23.723
05-MAY-80	491	126	0.051	9.652	23.774
06-MAY-80	492	127	0.254	9.906	24.028
09-MAY-80	495	130	0.203	10.109	24.231
10-MAY-80	496	131	0.381	10.490	24.612
12-MAY-80	498	133	0.127	10.617	24.739
14-MAY-80	500	135	0.076	10.693	24.815
21-MAY-80	507	142	0.051	10.744	24.866
22-MAY-80	508	143	0.127	10.871	24.993
25-MAY-80	511	146	0.279	11.150	25.273
26-MAY-80	512	147	2.007	13.157	27.279
27-MAY-80	513	148	0.025	13.182	27.305
12-JUN-80	529	164	0.559	13.741	27.863
13-JUN-80	530	165	0.889	14.630	28.752
16-JUN-80	533	168	0.356	14.986	29.108
20-JUN-80	537	172	0.483	15.468	29.591
22-JUN-80	539	174	0.025	15.494	29.616
24-JUN-80	541	176	0.051	15.544	29.667
25-JUN-80	542	177	0.051	15.595	29.718
26-JUN-80	543	178	0.025	15.621	29.743
18-AUG-80	596	231	0.051	15.671	29.794
01-SEP-80	610	245	0.102	15.773	29.895
13-SEP-80	622	257	2.007	17.780	31.902
14-SEP-80	623	258	0.025	17.805	31.927
20-SEP-80	629	264	0.025	17.830	31.953
12-OCT-80	651	286	0.127	17.957	32.080
13-OCT-80	652	287	0.102	18.059	32.181
14-OCT-80	653	288	0.127	18.186	32.308
15-OCT-80	654	289	0.025	18.211	32.334
24-OCT-80	663	298	0.152	18.364	32.486
25-OCT-80	664	299	0.305	18.669	32.791
01-NOV-80	671	306	0.051	18.719	32.842
03-NOV-80	673	308	0.051	18.770	32.893
06-NOV-80	676	311	0.762	19.532	33.655
07-NOV-80	677	312	0.076	19.608	33.731
14-NOV-80	684	319	0.076	19.685	33.807
21-NOV-80	691	326	0.025	19.710	33.832
27-NOV-80	697	332	0.025	19.735	33.858
29-NOV-80	699	334	0.051	19.786	33.909
02-DEC-80	702	337	0.864	20.650	34.772
03-DEC-80	703	338	1.422	22.072	36.195
04-DEC-80	704	339	0.051	22.123	36.245
06-DEC-80	706	341	0.025	22.148	36.271
20-DEC-80	720	355	0.381	22.529	36.652
21-DEC-80	721	356	0.762	23.291	37.414
24-DEC-80	724	359	0.381	23.672	37.795
25-DEC-80	725	360	0.660	24.333	38.455
29-DEC-80	729	364	0.127	24.460	38.582
30-DEC-80	730	365	0.102	24.561	38.684
31-DEC-80	731	366	0.025	24.587	38.709

TABLE A.2. (cont'd)

PRECIPITATION DATA FROM THE HANFORD METEOROLOGICAL STATION
1979 TO JUNE 1987

DATE	DAYS SINCE 01-JAN-79	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
01-JAN-81	732	1	0.025	0.025	38.735
17-JAN-81	748	17	0.051	0.076	38.785
19-JAN-81	750	19	0.051	0.127	38.836
21-JAN-81	752	21	0.279	0.406	39.116
22-JAN-81	753	22	0.051	0.457	39.166
26-JAN-81	757	26	0.051	0.508	39.217
27-JAN-81	758	27	0.508	1.016	39.725
28-JAN-81	759	28	0.356	1.372	40.081
29-JAN-81	760	29	0.051	1.422	40.132
13-FEB-81	775	44	0.533	1.956	40.665
15-FEB-81	777	46	0.051	2.007	40.716
18-FEB-81	780	49	0.483	2.489	41.198
19-FEB-81	781	50	0.178	2.667	41.376
24-FEB-81	786	55	0.254	2.921	41.630
26-FEB-81	788	57	0.025	2.946	41.656
04-MAR-81	794	63	0.356	3.302	42.011
16-MAR-81	806	75	0.127	3.429	42.138
25-MAR-81	815	84	0.025	3.454	42.164
26-MAR-81	816	85	1.270	4.724	43.434
22-APR-81	843	112	0.051	4.775	43.484
14-MAY-81	865	134	0.127	4.902	43.611
17-MAY-81	868	137	0.051	4.953	43.662
18-MAY-81	869	138	0.330	5.283	43.992
19-MAY-81	870	139	0.127	5.410	44.119
25-MAY-81	876	145	1.880	7.290	45.999
02-JUN-81	884	153	0.051	7.341	46.050
05-JUN-81	887	156	0.356	7.696	46.405
07-JUN-81	889	158	0.152	7.849	46.558
08-JUN-81	890	159	0.533	8.382	47.091
05-JUL-81	917	186	0.483	8.865	47.574
19-AUG-81	962	231	0.051	8.915	47.625
20-AUG-81	963	232	0.025	8.941	47.650
26-SEP-81	1000	269	0.559	9.500	48.209
27-SEP-81	1001	270	0.965	10.465	49.174
06-OCT-81	1010	279	0.305	10.770	49.479
27-OCT-81	1031	300	0.051	10.820	49.530
28-OCT-81	1032	301	0.229	11.049	49.758
29-OCT-81	1033	302	0.406	11.455	50.165
11-NOV-81	1046	315	0.025	11.481	50.190
13-NOV-81	1048	317	1.194	12.675	51.384
14-NOV-81	1049	318	0.254	12.929	51.638
15-NOV-81	1050	319	0.330	13.259	51.968
16-NOV-81	1051	320	0.787	14.046	52.755
17-NOV-81	1052	321	0.076	14.122	52.832
21-NOV-81	1056	325	0.076	14.199	52.908
05-DEC-81	1070	339	0.051	14.249	52.959
06-DEC-81	1071	340	0.203	14.453	53.162
09-DEC-81	1074	343	0.102	14.554	53.263
13-DEC-81	1078	347	0.432	14.986	53.695
14-DEC-81	1079	348	0.584	15.570	54.279
15-DEC-81	1080	349	0.559	16.129	54.838
18-DEC-81	1083	352	0.559	16.688	55.397
19-DEC-81	1084	353	0.406	17.094	55.803

TABLE A.2. (cont'd)

PRECIPITATION DATA FROM THE HANFORD METEOROLOGICAL STATION
1979 TO JUNE 1987

DATE	DAYS SINCE 01-JAN-79	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
24-DEC-81	1089	358	0.356	17.450	56.159
26-DEC-81	1091	360	0.203	17.653	56.362
28-DEC-81	1093	362	0.102	17.755	56.464
31-DEC-81	1096	365	0.127	17.882	56.591
01-JAN-82	1097	1	0.127	0.127	56.718
02-JAN-82	1098	2	0.127	0.254	56.845
04-JAN-82	1100	4	0.102	0.356	56.946
16-JAN-82	1112	16	0.127	0.483	57.073
22-JAN-82	1118	22	0.203	0.686	57.277
23-JAN-82	1119	23	0.025	0.711	57.302
28-JAN-82	1124	28	0.127	0.838	57.429
13-FEB-82	1140	44	0.203	1.041	57.632
15-FEB-82	1142	46	0.508	1.549	58.140
17-FEB-82	1144	48	0.025	1.575	58.166
18-FEB-82	1145	49	0.102	1.676	58.267
19-FEB-82	1146	50	0.229	1.905	58.496
20-FEB-82	1147	51	0.127	2.032	58.623
26-FEB-82	1153	57	0.025	2.057	58.648
28-FEB-82	1155	59	0.229	2.286	58.877
01-MAR-82	1156	60	0.229	2.515	59.105
10-MAR-82	1165	69	0.051	2.565	59.156
28-MAR-82	1183	87	0.076	2.642	59.232
29-MAR-82	1184	88	0.025	2.667	59.258
30-MAR-82	1185	89	0.051	2.718	59.309
01-APR-82	1187	91	0.025	2.743	59.334
02-APR-82	1188	92	0.152	2.896	59.486
05-APR-82	1191	95	0.076	2.972	59.563
06-APR-82	1192	96	0.914	3.886	60.477
07-APR-82	1193	97	0.051	3.937	60.528
11-APR-82	1197	101	0.584	4.521	61.112
28-APR-82	1214	118	0.102	4.623	61.214
17-MAY-82	1233	137	0.330	4.953	61.544
27-MAY-82	1243	147	0.127	5.080	61.671
28-MAY-82	1244	148	0.254	5.334	61.925
13-JUN-82	1260	164	0.127	5.461	62.052
25-JUN-82	1272	176	0.025	5.486	62.077
26-JUN-82	1273	177	0.686	6.172	62.763
27-JUN-82	1274	178	0.787	6.960	63.550
28-JUN-82	1275	179	0.229	7.188	63.779
29-JUN-82	1276	180	0.051	7.239	63.830
07-JUL-82	1284	188	0.559	7.798	64.389
09-AUG-82	1317	221	0.254	8.052	64.643
13-AUG-82	1321	225	0.102	8.153	64.744
29-AUG-82	1337	241	0.152	8.306	64.897
03-SEP-82	1342	246	0.051	8.357	64.947
09-SEP-82	1348	252	0.076	8.433	65.024
11-SEP-82	1350	254	0.127	8.560	65.151
19-SEP-82	1358	262	0.432	8.992	65.582
24-SEP-82	1363	267	0.025	9.017	65.608
25-SEP-82	1364	268	0.635	9.652	66.243
28-SEP-82	1367	271	0.051	9.703	66.294
02-OCT-82	1371	275	0.076	9.779	66.370
21-OCT-82	1390	294	0.406	10.185	66.776

TABLE A.2. (cont'd)

PRECIPITATION DATA FROM THE HANFORD METEOROLOGICAL STATION
1979 TO JUNE 1987

DATE	DAYS SINCE 01-JAN-79	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
22-OCT-82	1391	295	0.381	10.566	67.157
25-OCT-82	1394	298	0.025	10.592	67.183
26-OCT-82	1395	299	0.025	10.617	67.208
28-OCT-82	1397	301	2.362	12.979	69.570
29-OCT-82	1398	302	0.102	13.081	69.672
15-NOV-82	1415	319	0.051	13.132	69.723
16-NOV-82	1416	320	0.051	13.183	69.773
17-NOV-82	1417	321	0.279	13.462	70.053
18-NOV-82	1418	322	1.168	14.630	71.221
26-NOV-82	1426	330	0.102	14.732	71.323
27-NOV-82	1427	331	0.127	14.859	71.450
28-NOV-82	1428	332	0.178	15.037	71.628
29-NOV-82	1429	333	0.356	15.392	71.983
02-DEC-82	1432	336	0.457	15.850	72.440
05-DEC-82	1435	339	0.533	16.383	72.974
06-DEC-82	1436	340	0.254	16.637	73.228
12-DEC-82	1442	346	0.737	17.374	73.964
14-DEC-82	1444	348	0.432	17.805	74.396
15-DEC-82	1445	349	0.279	18.085	74.676
16-DEC-82	1446	350	0.229	18.313	74.904
19-DEC-82	1449	353	0.102	18.415	75.006
20-DEC-82	1450	354	0.838	19.253	75.844
21-DEC-82	1451	355	0.686	19.939	76.530
02-JAN-83	1463	2	0.432	0.431	76.962
03-JAN-83	1464	3	0.203	0.634	77.165
06-JAN-83	1467	6	1.270	1.904	78.435
16-JAN-83	1477	16	0.127	2.031	78.562
18-JAN-83	1479	18	0.279	2.311	78.841
19-JAN-83	1480	19	0.305	2.615	79.146
24-JAN-83	1485	24	0.330	2.946	79.476
25-JAN-83	1486	25	0.051	2.996	79.527
26-JAN-83	1487	26	0.508	3.504	80.035
27-JAN-83	1488	27	0.152	3.657	80.187
06-FEB-83	1498	37	0.406	4.063	80.594
09-FEB-83	1501	40	0.356	4.419	80.949
10-FEB-83	1502	41	0.229	4.647	81.178
11-FEB-83	1503	42	0.025	4.673	81.203
12-FEB-83	1504	43	0.025	4.698	81.229
13-FEB-83	1505	44	0.051	4.749	81.280
14-FEB-83	1506	45	0.178	4.927	81.457
15-FEB-83	1507	46	0.279	5.206	81.737
17-FEB-83	1509	48	0.178	5.384	81.915
18-FEB-83	1510	49	0.864	6.248	82.778
21-FEB-83	1513	52	0.178	6.425	82.956
23-FEB-83	1515	54	0.025	6.451	82.981
24-FEB-83	1516	55	0.025	6.476	83.007
25-FEB-83	1517	56	0.559	7.035	83.566
27-FEB-83	1519	58	0.076	7.111	83.642
04-MAR-83	1524	63	0.025	7.136	83.667
05-MAR-83	1525	64	0.051	7.187	83.718
06-MAR-83	1526	65	0.051	7.238	83.769
08-MAR-83	1528	67	0.254	7.492	84.023
09-MAR-83	1529	68	0.660	8.152	84.683

TABLE A.2. (cont'd)

PRECIPITATION DATA FROM THE HANFORD METEOROLOGICAL STATION
1979 TO JUNE 1987

DATE	DAYS SINCE 01-JAN-79	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
10-MAR-83	1530	69	0.051	8.203	84.734
12-MAR-83	1532	71	0.051	8.254	84.785
13-MAR-83	1533	72	0.889	9.143	85.674
27-MAR-83	1547	86	0.127	9.270	85.801
29-MAR-83	1549	88	0.381	9.651	86.182
01-APR-83	1552	91	0.457	10.108	86.639
02-APR-83	1553	92	0.229	10.337	86.868
23-APR-83	1574	113	0.330	10.667	87.198
30-APR-83	1581	120	0.051	10.718	87.249
05-MAY-83	1586	125	0.076	10.794	87.325
07-MAY-83	1588	127	0.991	11.785	88.316
08-MAY-83	1589	128	0.254	12.039	88.570
10-JUN-83	1622	161	0.203	12.242	88.773
14-JUN-83	1626	165	0.102	12.344	88.875
18-JUN-83	1630	169	0.178	12.522	89.053
19-JUN-83	1631	170	0.025	12.547	89.078
22-JUN-83	1634	173	0.051	12.598	89.129
23-JUN-83	1635	174	0.025	12.623	89.154
27-JUN-83	1639	178	0.940	13.563	90.094
29-JUN-83	1641	180	0.203	13.766	90.297
01-JUL-83	1643	182	0.076	13.842	90.373
23-JUL-83	1665	204	0.051	13.893	90.424
24-JUL-83	1666	205	0.025	13.918	90.449
25-JUL-83	1667	206	0.584	14.502	91.033
27-JUL-83	1669	208	0.051	14.553	91.084
11-AUG-83	1684	223	0.025	14.578	91.109
26-AUG-83	1699	238	0.051	14.629	91.160
27-AUG-83	1700	239	0.051	14.680	91.211
28-AUG-83	1701	240	0.076	14.756	91.287
29-AUG-83	1702	241	0.102	14.858	91.389
01-SEP-83	1705	244	0.610	15.468	91.999
18-SEP-83	1722	261	0.559	16.027	92.558
17-OCT-83	1751	290	0.196	16.223	92.754
22-OCT-83	1756	295	0.490	16.713	93.244
30-OCT-83	1764	303	0.563	17.276	93.807
31-OCT-83	1765	304	0.024	17.300	93.831
01-NOV-83	1766	305	0.381	17.681	94.212
02-NOV-83	1767	306	0.127	17.808	94.339
03-NOV-83	1768	307	0.102	17.910	94.440
05-NOV-83	1770	309	0.102	18.011	94.542
06-NOV-83	1771	310	0.102	18.113	94.644
09-NOV-83	1774	313	0.178	18.291	94.821
10-NOV-83	1775	314	1.676	19.967	96.498
12-NOV-83	1777	316	0.025	19.993	96.523
13-NOV-83	1778	317	0.051	20.043	96.574
14-NOV-83	1779	318	0.203	20.247	96.777
15-NOV-83	1780	319	0.025	20.272	96.803
16-NOV-83	1781	320	0.203	20.475	97.006
17-NOV-83	1782	321	0.229	20.704	97.234
19-NOV-83	1784	323	0.203	20.907	97.438
21-NOV-83	1786	325	0.127	21.034	97.565
23-NOV-83	1788	327	1.067	22.101	98.631
24-NOV-83	1789	328	0.508	22.609	99.139

TABLE A.2. (cont'd)

PRECIPITATION DATA FROM THE HANFORD METEOROLOGICAL STATION
1979 TO JUNE 1987

DATE	DAYS SINCE 01-JAN-79	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
28-NOV-83	1793	332	0.152	22.761	99.292
02-DEC-83	1797	336	0.076	22.837	99.368
04-DEC-83	1799	338	0.127	22.964	99.495
05-DEC-83	1800	339	0.813	23.777	100.308
07-DEC-83	1802	341	0.813	24.590	101.121
09-DEC-83	1804	343	1.041	25.631	102.162
10-DEC-83	1805	344	0.152	25.784	102.314
12-DEC-83	1807	346	0.076	25.860	102.391
14-DEC-83	1809	348	0.025	25.885	102.416
16-DEC-83	1811	350	0.025	25.911	102.441
18-DEC-83	1813	352	0.051	25.962	102.492
19-DEC-83	1814	353	0.102	26.063	102.594
24-DEC-83	1819	358	0.152	26.216	102.746
25-DEC-83	1820	359	0.305	26.520	103.051
27-DEC-83	1822	361	0.229	26.749	103.280
29-DEC-83	1824	363	1.397	28.146	104.677
02-JAN-84	1828	2	0.051	0.051	104.727
03-JAN-84	1829	3	0.102	0.152	104.829
10-JAN-84	1836	10	0.051	0.203	104.880
21-JAN-84	1847	21	0.381	0.584	105.261
05-FEB-84	1862	36	0.025	0.610	105.286
08-FEB-84	1865	39	0.152	0.762	105.439
09-FEB-84	1866	40	0.102	0.864	105.540
11-FEB-84	1868	42	0.025	0.889	105.566
12-FEB-84	1869	43	0.076	0.965	105.642
13-FEB-84	1870	44	0.457	1.422	106.099
15-FEB-84	1872	46	0.330	1.753	106.429
19-FEB-84	1876	50	0.051	1.803	106.480
20-FEB-84	1877	51	0.457	2.261	106.937
21-FEB-84	1878	52	0.051	2.311	106.988
23-FEB-84	1880	54	0.203	2.515	107.191
24-FEB-84	1881	55	0.203	2.718	107.394
25-FEB-84	1882	56	0.152	2.870	107.547
29-FEB-84	1886	60	0.102	2.972	107.648
01-MAR-84	1887	61	0.076	3.048	107.725
10-MAR-84	1896	70	0.025	3.073	107.750
13-MAR-84	1899	73	0.356	3.429	108.106
15-MAR-84	1901	75	0.076	3.505	108.182
16-MAR-84	1902	76	0.076	3.581	108.258
18-MAR-84	1904	78	0.051	3.632	108.309
19-MAR-84	1905	79	0.279	3.912	108.588
20-MAR-84	1906	80	1.092	5.004	109.680
21-MAR-84	1907	81	0.254	5.258	109.934
25-MAR-84	1911	85	0.076	5.334	110.011
26-MAR-84	1912	86	0.025	5.359	110.036
28-MAR-84	1914	88	0.178	5.537	110.214
04-APR-84	1921	95	0.330	5.867	110.544
07-APR-84	1924	98	0.559	6.426	111.103
12-APR-84	1929	103	0.025	6.452	111.128
18-APR-84	1935	109	0.305	6.756	111.433
30-APR-84	1947	121	0.305	7.061	111.738
01-MAY-84	1948	122	0.483	7.544	112.220
11-MAY-84	1958	132	0.102	7.645	112.322

TABLE A.2. (cont'd)

PRECIPITATION DATA FROM THE HANFORD METEOROLOGICAL STATION
1979 TO JUNE 1987

DATE	DAYS SINCE 01-JAN-79	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
13-MAY-84	1960	134	0.127	7.772	112.449
14-MAY-84	1961	135	0.178	7.950	112.627
19-MAY-84	1966	140	0.076	8.026	112.703
22-MAY-84	1969	143	0.305	8.331	113.008
25-MAY-84	1972	146	0.127	8.458	113.135
04-JUN-84	1982	156	0.635	9.093	113.770
07-JUN-84	1985	159	0.178	9.271	113.948
12-JUN-84	1990	164	0.025	9.296	113.973
20-JUN-84	1998	172	0.610	9.906	114.583
21-JUN-84	1999	173	0.076	9.982	114.659
28-JUN-84	2006	180	0.584	10.566	115.243
29-JUN-84	2007	181	0.406	10.973	115.649
28-JUL-84	2036	210	0.152	11.125	115.802
05-SEP-84	2075	249	0.076	11.201	115.878
06-SEP-84	2076	250	0.025	11.227	115.903
20-SEP-84	2090	264	0.279	11.506	116.183
22-SEP-84	2092	266	0.508	12.014	116.691
23-SEP-84	2093	267	0.178	12.192	116.869
12-OCT-84	2112	286	0.076	12.268	116.945
23-OCT-84	2123	297	0.051	12.319	116.996
26-OCT-84	2126	300	0.051	12.370	117.046
01-NOV-84	2132	306	0.076	12.446	117.123
02-NOV-84	2133	307	0.635	13.081	117.758
03-NOV-84	2134	308	0.025	13.106	117.783
10-NOV-84	2141	315	0.305	13.411	118.088
11-NOV-84	2142	316	0.356	13.767	118.443
12-NOV-84	2143	317	0.152	13.919	118.596
13-NOV-84	2144	318	0.127	14.046	118.723
17-NOV-84	2148	322	0.254	14.300	118.977
18-NOV-84	2149	323	0.127	14.427	119.104
19-NOV-84	2150	324	0.025	14.453	119.129
20-NOV-84	2151	325	0.660	15.113	119.790
23-NOV-84	2154	328	0.508	15.621	120.298
24-NOV-84	2155	329	0.076	15.697	120.374
27-NOV-84	2158	332	1.245	16.942	121.618
28-NOV-84	2159	333	0.025	16.967	121.644
29-NOV-84	2160	334	0.051	17.018	121.695
09-DEC-84	2170	344	0.356	17.374	122.050
11-DEC-84	2172	346	0.127	17.501	122.177
12-DEC-84	2173	347	0.127	17.628	122.304
17-DEC-84	2178	352	0.457	18.085	122.761
20-DEC-84	2181	355	0.051	18.136	122.812
29-DEC-84	2190	364	0.330	18.466	123.142
19-JAN-85	2211	19	0.178	0.177	123.320
20-JAN-85	2212	20	0.660	0.837	123.981
22-JAN-85	2214	22	0.025	0.863	124.006
01-FEB-85	2224	32	0.660	1.523	124.666
05-FEB-85	2228	36	0.025	1.549	124.692
06-FEB-85	2229	37	0.076	1.625	124.768
07-FEB-85	2230	38	0.686	2.311	125.454
08-FEB-85	2231	39	0.305	2.615	125.759
09-FEB-85	2232	40	0.178	2.793	125.936
11-FEB-85	2234	42	0.152	2.946	126.089

TABLE A.2. (cont'd)

PRECIPITATION DATA FROM THE HANFORD METEOROLOGICAL STATION
1979 TO JUNE 1987

DATE	DAYS SINCE 01-JAN-79	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
04-MAR-85	2255	63	0.406	3.352	126.495
23-MAR-85	2274	82	0.203	3.555	126.698
26-MAR-85	2277	85	0.229	3.784	126.927
29-MAR-85	2280	88	0.051	3.835	126.978
30-MAR-85	2281	89	0.025	3.860	127.003
22-APR-85	2304	112	0.025	3.885	127.029
04-MAY-85	2316	124	0.036	3.921	127.064
13-MAY-85	2325	133	0.279	4.200	127.344
06-JUN-85	2349	157	0.356	4.556	127.699
07-JUN-85	2350	158	0.025	4.581	127.725
31-JUL-85	2404	212	0.305	4.886	128.029
04-AUG-85	2408	216	0.025	4.912	128.055
01-SEP-85	2436	244	0.051	4.962	128.106
08-SEP-85	2443	251	0.254	5.216	128.360
09-SEP-85	2444	252	0.178	5.394	128.537
10-SEP-85	2445	253	0.152	5.547	128.690
11-SEP-85	2446	254	0.102	5.648	128.791
13-SEP-85	2448	256	0.279	5.928	129.071
14-SEP-85	2449	257	0.102	6.029	129.172
16-SEP-85	2451	259	0.076	6.105	129.249
17-SEP-85	2452	260	0.406	6.512	129.655
06-OCT-85	2471	279	0.305	6.817	129.960
07-OCT-85	2472	280	0.635	7.452	130.595
10-OCT-85	2475	283	0.229	7.680	130.823
04-NOV-85	2500	308	0.102	7.782	130.925
08-NOV-85	2504	312	0.076	7.858	131.001
10-NOV-85	2506	314	0.102	7.960	131.103
15-NOV-85	2511	319	0.432	8.391	131.535
17-NOV-85	2513	321	0.279	8.671	131.814
19-NOV-85	2515	323	0.330	9.001	132.144
20-NOV-85	2516	324	0.127	9.128	132.271
21-NOV-85	2517	325	1.270	10.398	133.541
22-NOV-85	2518	326	0.051	10.449	133.592
25-NOV-85	2521	329	0.025	10.474	133.617
27-NOV-85	2523	331	0.203	10.677	133.821
29-NOV-85	2525	333	0.102	10.779	133.922
30-NOV-85	2526	334	0.051	10.830	133.973
01-DEC-85	2527	335	0.076	10.906	134.049
02-DEC-85	2528	336	0.864	11.770	134.913
06-DEC-85	2532	340	0.457	12.227	135.370
07-DEC-85	2533	341	0.711	12.938	136.081
24-DEC-85	2550	358	0.025	12.963	136.107
01-JAN-86	2558	1	0.025	0.025	136.122
02-JAN-86	2559	3	0.102	0.127	136.223
04-JAN-86	2561	5	0.025	0.152	136.249
05-JAN-86	2562	6	0.483	0.635	136.731
09-JAN-86	2566	10	0.279	0.914	137.011
15-JAN-86	2572	16	0.152	1.067	137.163
16-JAN-86	2573	17	0.508	1.575	137.671
17-JAN-86	2574	18	0.229	1.803	137.900
18-JAN-86	2575	18	0.178	1.981	138.078
22-JAN-86	2579	23	0.787	2.769	138.865
23-JAN-86	2580	23	0.152	2.921	139.018

TABLE A.2. (cont'd)

PRECIPITATION DATA FROM THE HANFORD METEOROLOGICAL STATION
1979 TO JUNE 1987

DATE	DAYS SINCE 01-JAN-79	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
27-JAN-86	2584	27	0.203	3.124	139.221
28-JAN-86	2585	29	0.381	3.505	139.602
29-JAN-86	2586	30	0.559	4.064	140.161
30-JAN-86	2587	31	0.381	4.445	140.542
01-FEB-86	2589	32	0.076	4.521	140.618
02-FEB-86	2590	33	0.127	4.648	140.745
04-FEB-86	2592	36	0.559	5.207	141.304
12-FEB-86	2600	43	0.533	5.740	141.837
14-FEB-86	2602	46	0.940	6.680	142.777
15-FEB-86	2603	46	0.356	7.036	143.132
21-FEB-86	2609	53	0.508	7.544	143.640
23-FEB-86	2611	54	0.406	7.950	144.047
07-MAR-86	2623	66	0.533	8.484	144.580
08-MAR-86	2624	68	0.330	8.814	144.910
10-MAR-86	2626	69	0.051	8.865	144.961
12-MAR-86	2628	71	0.229	9.093	145.190
13-MAR-86	2629	73	0.076	9.169	145.266
18-MAR-86	2634	78	0.025	9.195	145.291
23-MAR-86	2639	83	0.406	9.601	145.698
24-MAR-86	2640	83	0.254	9.855	145.952
25-MAR-86	2641	85	0.025	9.881	145.977
02-MAY-86	2679	123	0.025	9.906	146.003
03-MAY-86	2680	123	0.025	9.931	146.028
06-MAY-86	2683	126	0.533	10.465	146.561
21-MAY-86	2698	141	0.102	10.566	146.663
26-MAY-86	2703	147	0.076	10.643	146.739
02-JUL-86	2740	184	0.178	10.820	146.917
04-JUL-86	2742	185	0.330	11.151	147.247
08-JUL-86	2746	189	0.025	11.176	147.273
29-AUG-86	2798	241	0.051	11.227	147.323
13-SEP-86	2813	257	0.076	11.303	147.400
15-SEP-86	2815	259	0.889	12.192	148.289
16-SEP-86	2816	259	0.483	12.675	148.771
17-SEP-86	2817	261	0.152	12.827	148.924
19-SEP-86	2819	263	0.102	12.929	149.025
23-SEP-86	2823	267	0.533	13.462	149.559
27-SEP-86	2827	271	0.025	13.487	149.584
29-SEP-86	2829	272	0.178	13.665	149.762
25-OCT-86	2855	299	0.076	13.741	149.838
26-OCT-86	2856	300	0.203	13.945	150.041
29-OCT-86	2859	303	0.457	14.402	150.498
05-NOV-86	2866	310	0.051	14.453	150.549
07-NOV-86	2868	311	0.127	14.580	150.676
24-NOV-86	2885	328	0.432	15.011	151.108
26-NOV-86	2887	331	0.279	15.291	151.387
27-NOV-86	2888	332	0.178	15.469	151.565
28-NOV-86	2889	333	0.584	16.053	152.149
04-DEC-86	2895	339	0.203	16.256	152.353
05-DEC-86	2896	340	0.559	16.815	152.911
13-DEC-86	2904	348	0.305	17.120	153.216
17-DEC-86	2908	351	0.025	17.145	153.242
18-DEC-86	2909	353	0.203	17.348	153.445
19-DEC-86	2910	353	0.102	17.450	153.546

TABLE A.2. (cont'd)

PRECIPITATION DATA FROM THE HANFORD METEOROLOGICAL STATION
1979 TO JUNE 1987

DATE	DAYS SINCE 01-JAN-79	DAY OF YEAR	PRECIP (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE TOTAL CM
22-DEC-86	2913	357	0.076	17.526	153.623
24-DEC-86	2915	358	0.076	17.602	153.699
25-DEC-86	2916	360	0.051	17.653	153.750
26-DEC-86	2917	360	0.254	17.907	154.004
27-DEC-86	2918	362	0.025	17.932	154.029
28-DEC-86	2919	363	0.076	18.009	154.105
01-JAN-87	2923	1	0.508	0.508	154.613
13-JAN-87	2935	13	0.305	0.813	154.918
14-JAN-87	2936	14	0.051	0.864	154.969
23-JAN-87	2945	23	0.025	0.889	154.994
24-JAN-87	2946	24	0.152	1.041	155.147
25-JAN-87	2947	25	0.406	1.448	155.553
26-JAN-87	2948	26	0.203	1.651	155.756
27-JAN-87	2949	27	0.051	1.702	155.807
31-JAN-87	2953	31	0.330	2.032	156.137
11-FEB-87	2964	42	0.076	2.108	156.213
12-FEB-87	2965	43	0.025	2.134	156.239
13-FEB-87	2966	44	0.279	2.413	156.518
22-FEB-87	2975	53	0.102	2.515	156.620
03-MAR-87	2984	62	0.203	2.718	156.823
05-MAR-87	2986	64	0.051	2.769	156.874
06-MAR-87	2987	65	0.051	2.819	156.925
08-MAR-87	2989	67	0.102	2.921	157.026
10-MAR-87	2991	69	0.025	2.946	157.052
11-MAR-87	2992	70	0.127	3.073	157.179
12-MAR-87	2993	71	1.067	4.140	158.245
14-MAR-87	2995	73	0.279	4.420	158.525
15-MAR-87	2996	74	0.457	4.877	158.982
19-MAR-87	3000	78	0.305	5.182	159.287
17-APR-87	3029	107	0.305	5.486	159.592
30-APR-87	3042	120	0.051	5.537	159.642
20-MAY-87	3062	140	0.076	5.613	159.719
30-MAY-87	3072	150	0.356	5.969	160.074
08-JUN-87	3081	159	0.025	5.994	160.100
14-JUN-87	3087	165	0.025	6.020	160.125
15-JUN-87	3088	166	0.076	6.096	160.201
20-JUN-87	3093	171	0.076	6.172	160.277
21-JUN-87	3094	172	0.076	6.248	160.354

TABLE A.3. Drainage from the South Caisson

SOUTH CASSION DRAINAGE

NOTE 1/2/86	DATE	DAY OF YEAR	DAYS SINCE 01-JAN-81	DRAINAGE (g)	EQUIVALENT WATER (CM)	CUMULATIVE CM ANNUAL DRAINAGE	CUMULATIVE DRAINAGE (cm)
	15-JUN-81	166	166	1200	0.020	0.020	0.020
	10-NOV-81	314	314	140	0.002	0.022	0.022
	03-DEC-81	337	337	64090	1.060	1.082	1.082
	05-JAN-82	5	370	58459	0.967	0.967	2.048
	24-FEB-82	55	420	21467	0.355	1.322	2.403
	26-FEB-82	57	422	36727	0.607	1.929	3.011
	03-MAR-82	62	427	16007	0.265	2.194	3.275
	05-MAR-82	64	429	2871	0.047	2.241	3.323
	08-MAR-82	67	432	6610	0.109	2.350	3.432
	15-MAR-82	74	439	6636	0.110	2.460	3.542
	16-MAR-82	75	440	7124	0.118	2.578	3.660
	17-MAR-82	76	441	3748	0.062	2.640	3.722
	19-MAR-82	78	443	2027	0.034	2.673	3.755
	13-APR-82	103	468	2591	0.043	2.716	3.798
	20-APR-82	110	475	4240	0.070	2.786	3.868
	21-APR-82	111	476	19392	0.321	3.107	4.189
	26-APR-82	116	481	4129	0.068	3.175	4.257
	27-APR-82	117	482	2384	0.039	3.215	4.296
	06-MAY-82	126	491	7163	0.118	3.333	4.415
	10-MAY-82	130	495	4682	0.077	3.410	4.492
	17-MAY-82	137	502	6387	0.106	3.516	4.598
	19-MAY-82	139	504	2492	0.041	3.557	4.639
	10-JUN-82	161	526	11430	0.189	3.746	4.828
	15-JUN-82	166	531	5314	0.088	3.834	4.916
	16-JUN-82	167	532	3437	0.057	3.891	4.973
	21-JUN-82	172	537	3998	0.066	3.957	5.039
	07-JUL-82	188	553	6444	0.107	4.064	5.145
	21-JUL-82	202	567	10430	0.172	4.236	5.318
	22-JUL-82	203	568	3049	0.050	4.286	5.368
	26-JUL-82	207	572	3965	0.066	4.352	5.434
	30-JUL-82	211	576	3571	0.059	4.411	5.493
	11-AUG-82	223	588	5819	0.096	4.507	5.589
	12-AUG-82	224	589	2981	0.049	4.557	5.638
	16-AUG-82	228	593	2971	0.049	4.606	5.688
	17-AUG-82	229	594	1201	0.020	4.626	5.707
	19-AUG-82	231	596	1946	0.032	4.658	5.740
	15-SEP-82	258	623	11870	0.196	4.854	5.936
	21-SEP-82	264	629	6011	0.099	4.953	6.035
	29-SEP-82	272	637	6060	0.100	5.054	6.136
	12-OCT-82	285	650	7643	0.126	5.180	6.262
	19-OCT-82	292	657	7665	0.127	5.307	6.389
	21-OCT-82	294	659	3532	0.058	5.365	6.447
	27-OCT-82	300	665	4561	0.075	5.441	6.522
	04-JAN-83	4	734	18158	0.300	0.300	6.823
	11-JAN-83	11	741	9326	0.154	0.454	6.977
	24-JAN-83	24	754	9898	0.164	0.618	7.141
	31-JAN-83	31	761	7146	0.118	0.736	7.259
	02-FEB-83	33	763	6575	0.109	0.845	7.367
	19-MAR-84	79	1174	79516	1.315	1.315	8.682
	23-MAR-84	83	1178	173708	2.872	4.187	11.554
	16-APR-84	107	1202	43590	0.721	4.908	12.275
	24-APR-84	115	1210	7785	0.129	5.037	12.404
	04-JUN-84	156	1251	82476	1.364	6.400	13.768

THE COLUMN AREA IS 60478 SQUARE CM.

TABLE A.3. (contd)

SOUTH CASSION DRAINAGE

NOTE 1/2/86	DATE	DAY OF YEAR	DAYS SINCE 01-JAN-81	DRAINAGE (g)	EQUIVALENT WATER (CM)	CUMULATIVE CM ANNUAL DRAINAGE	CUMULATIVE DRAINAGE (cm)
	17-JUL-84	199	1294	81210	1.343	7.743	15.110
	06-AUG-84	219	1314	52252	0.864	8.607	15.974
	19-NOV-84	324	1419	48745	0.806	9.413	16.780
	12-DEC-84	347	1442	22767	0.376	9.789	17.157
	15-FEB-85	46	1507	51567	0.853	0.853	18.010
	18-APR-85	108	1569	56593	0.936	1.788	18.945
	03-MAY-85	123	1584	43000	0.711	2.499	19.656
	16-MAY-85	136	1597	31123	0.515	3.014	20.171
	30-MAY-85	150	1611	28963	0.479	3.493	20.650
	11-JUN-85	162	1623	27226	0.450	3.943	21.100
	27-JUN-85	178	1639	32877	0.544	4.487	21.644
	09-JUL-85	190	1651	26505	0.438	4.925	22.082
	23-JUL-85	204	1665	24995	0.413	5.338	22.495
	13-AUG-85	225	1686	31300	0.518	5.856	23.013
	29-AUG-85	241	1702	30073	0.497	6.353	23.510
	09-SEP-85	252	1713	22790	0.377	6.730	23.887
	23-SEP-85	266	1727	20651	0.341	7.071	24.228
	07-OCT-85	280	1741	21365	0.353	7.425	24.582
	14-OCT-85	287	1748	12954	0.214	7.639	24.796
	01-NOV-85	305	1766	27161	0.449	8.088	25.245
	20-NOV-85	324	1785	27998	0.463	8.551	25.708
	03-DEC-85	337	1798	22203	0.367	8.918	26.075
	20-DEC-85	354	1815	22880	0.378	9.296	26.453
	26-DEC-85	360	1821	33940	0.561	9.858	27.014
	30-DEC-85	364	1825	0	0.000	9.858	27.014
	15-JAN-86	15	1841	5800	0.096	0.096	27.110
	28-JAN-86	28	1854	12180	0.201	0.297	27.312
	13-FEB-86	44	1870	20634	0.341	0.638	27.653
	26-FEB-86	57	1883	16150	0.267	0.906	27.920
	14-MAR-86	73	1899	17940	0.297	1.202	28.217
	25-MAR-86	84	1910	12420	0.205	1.408	28.422
	07-APR-86	97	1923	20260	0.335	1.743	28.757
	24-APR-86	114	1940	26940	0.445	2.188	29.202
	06-MAY-86	126	1952	33680	0.557	2.745	29.759
	21-MAY-86	141	1967	41230	0.682	3.427	30.441
	28-MAY-86	148	1974	30830	0.510	3.936	30.951
	02-JUN-86	153	1979	28780	0.476	4.412	31.427
	11-JUN-86	162	1988	14748	0.244	4.656	31.671
	17-JUN-86	168	1994	12763	0.211	4.867	31.882
	30-JUN-86	181	2007	56600	0.936	5.803	32.817
	10-JUL-86	191	2017	36260	0.600	6.403	33.417
	18-JUL-86	199	2025	21705	0.359	6.761	33.776
	30-JUL-86	211	2037	38800	0.642	7.403	34.417
	13-AUG-86	225	2051	34955	0.578	7.981	34.995
	25-AUG-86	237	2063	31270	0.517	8.498	35.513
	09-SEP-86	252	2078	34300	0.567	9.065	36.080
	03-OCT-86	276	2102	34770	0.575	9.640	36.655
	10-OCT-86	283	2109	41211	0.681	10.322	37.336
	29-OCT-86	302	2128	40104	0.663	10.985	37.999
	13-NOV-86	317	2143	33975	0.562	11.546	38.561
	04-DEC-86	338	2164	30890	0.511	12.057	39.072
	16-DEC-86	350	2176	23674	0.391	12.449	39.463
	29-DEC-86	363	2189	15107	0.250	12.698	39.713

THE COLUMN AREA IS 60478 SQUARE CM.

TABLE A.3. (contd)

SOUTH CASSION DRAINAGE

NOTE 1/2/86	DATE	DAY OF YEAR	DAYS SINCE 01-JAN-81	DRAINAGE (g)	EQUIVALENT WATER (CM)	CUMULATIVE CM ANNUAL DRAINAGE	CUMULATIVE DRAINAGE (cm)
	13-JAN-87	13	2204	15468	0.256	0.256	39.969
	30-JAN-87	30	2221	21705	0.359	0.615	40.328
	11-FEB-87	42	2233	15510	0.256	0.871	40.584
	24-FEB-87	55	2246	18637	0.308	1.179	40.892
	18-MAR-87	77	2268	20901	0.346	1.525	41.238
	31-MAR-87	90	2281	19860	0.328	1.853	41.566
	20-APR-87	110	2301	22810	0.377	2.230	41.943
	05-MAY-87	125	2316	17516	0.290	2.520	42.233
	26-MAY-87	146	2337	18450	0.305	2.825	42.538
	17-JUN-87	158	2349	19300	0.319	3.144	42.857

THE COLUMN AREA IS 60478 SQUARE CM.

TABLE A.4. Drainage from the North Weighing Lysimeter

DRAINAGE FROM THE NORTH WEIGHING LYSIMETER SINCE 1984

DATE	DAY OF YEAR	DAYS SINCE 01-JAN-81	DRAINAGE WATER (g)	EQUIVALENT WATER (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE CM TOTAL
06-JAN-84	6	1100	7261	0.314	0.314	44.290
11-JAN-84	11	1105	16736	0.724	1.039	45.014
13-JAN-84	13	1107	23932	1.036	2.074	46.050
16-JAN-84	16	1110	11058	0.479	2.553	46.528
17-JAN-84	17	1111	14506	0.628	3.181	47.156
26-JAN-84	26	1120	18663	0.808	3.989	47.964
27-JAN-84	27	1121	8388	0.363	4.352	48.327
03-FEB-84	34	1128	12963	0.561	4.913	48.888
23-FEB-84	54	1148	15206	0.658	5.571	49.546
24-FEB-84	55	1149	11204	0.485	6.056	50.031
27-FEB-84	58	1152	11586	0.501	6.557	50.533
07-MAR-84	67	1161	17667	0.765	7.322	51.297
14-MAR-84	74	1168	8612	0.373	7.695	51.670
19-MAR-84	79	1173	8391	0.363	8.058	52.033
09-APR-84	100	1194	17313	0.749	8.807	52.783
10-APR-84	101	1195	15977	0.692	9.499	53.474
23-APR-84	114	1208	10174	0.440	9.939	53.915
24-APR-84	115	1209	3723	0.161	10.100	54.076
11-MAY-84	132	1226	15434	0.668	10.768	54.744
01-JUN-84	153	1247	12898	0.558	11.327	55.302
19-FEB-85	50	1510	10382	0.449	0.449	55.751
20-FEB-85	51	1511	11468	0.496	0.946	56.248
21-FEB-85	52	1512	18195	0.788	1.733	57.035
27-FEB-85	58	1518	8145	0.353	2.086	57.388
04-MAR-85	63	1523	10725	0.464	2.550	57.852
19-MAR-85	78	1538	12081	0.523	3.073	58.375
20-JUN-85	171	1631	5567	0.241	3.314	58.616
28-AUG-85	240	1700	7945	0.344	3.658	58.960
29-AUG-85	241	1701	6900	0.299	3.956	59.258
03-SEP-85	246	1706	6857	0.297	4.253	59.555
09-SEP-85	252	1712	37670	1.630	5.884	61.186
14-OCT-85	287	1747	19156	0.829	6.713	62.015
26-DEC-85	360	1820	375	0.016	6.729	62.031
06-FEB-86	37	1862	12678	0.549	0.549	62.580
24-FEB-86	55	1880	18893	0.818	1.366	63.397
04-MAR-86	63	1888	7850	0.340	1.706	63.737
24-MAR-86	83	1908	11015	0.477	2.183	64.214
25-MAR-86	84	1909	7351	0.318	2.501	64.532
26-MAR-86	85	1910	8847	0.383	2.884	64.915
27-MAR-86	86	1911	2294	0.099	2.983	65.014
08-APR-86	98	1923	5566	0.241	3.224	65.255
10-APR-86	100	1925	17902	0.775	3.999	66.030
11-APR-86	101	1926	4781	0.207	4.206	66.237
16-APR-86	106	1931	17693	0.766	4.972	67.003
17-APR-86	107	1932	2812	0.122	5.094	67.124
25-APR-86	115	1940	12604	0.546	5.639	67.670
05-JUN-86	156	1981	4742	0.205	5.844	67.875
13-JUN-86	164	1989	11433	0.495	6.339	68.370
09-JUL-86	190	2015	9835	0.426	6.765	68.796
15-SEP-86	258	2083	0	0.000	6.765	68.796
24-FEB-87	55	2245	20349	0.881	0.881	69.677
11-MAR-87	70	2260	19418	0.840	1.721	70.517
14-MAY-87	134	2324	12830	0.555	2.277	71.072
19-MAY-87	139	2329	23720	1.027	3.303	72.099
26-MAY-87	146	2336	19258	0.834	4.137	72.933
01-JUN-87	152	2342	25330	1.096	5.233	74.029
30-JUN-87	181	2371	14130	0.612	5.845	74.640

TABLE A.5. Drainage from the South Weighing Lysimeter

DRAINAGE FROM THE SOUTH WEIGHING LYSIMETER SINCE 1984

DATE	DAY OF YEAR	DAYS SINCE 01-JAN-81	WATER RE MOVED (g)	EQUIVALENT WATER (CM)	CUMULATIVE ANNUAL CM	CUMULATIVE CM TOTAL
06-JAN-84	6	1100	14650	0.634	0.634	10.054
09-JAN-84	9	1103	13887	0.601	1.235	10.655
10-JAN-84	10	1104	18163	0.786	2.021	11.441
11-JAN-84	11	1105	16733	0.724	2.746	12.165
12-JAN-84	12	1106	14464	0.626	3.372	12.791
23-FEB-84	54	1148	28504	1.234	4.605	14.025
10-APR-84	101	1195	18493	0.800	5.406	14.826
12-APR-84	103	1197	18831	0.815	6.221	15.641
18-APR-84	109	1203	18558	0.803	7.024	16.444
01-JUN-84	153	1247	11986	0.519	7.543	16.963
12-DEC-84	347	1441	14910	0.645	8.188	17.608
20-FEB-85	51	1511	5602	0.242	0.242	17.850
21-FEB-85	52	1512	17058	0.738	0.981	18.589
20-JUN-85	171	1631	11290	0.489	1.469	19.077
02-AUG-85	214	1674	1867	0.081	1.550	19.158
14-OCT-85	287	1747	18650	0.807	2.357	19.965
26-DEC-85	360	1820	14712	0.637	2.994	20.602
24-JAN-86	24	1849	3332	0.144	0.144	20.746
18-FEB-86	49	1874	9573	0.414	0.559	21.161
24-FEB-86	55	1880	35363	1.531	2.089	22.691
04-MAR-86	63	1888	15550	0.673	2.762	23.364
25-MAR-86	84	1909	24866	1.076	3.838	24.441
26-MAR-86	85	1910	28314	1.226	5.064	25.666
27-MAR-86	86	1911	23008	0.996	6.060	26.662
08-APR-86	98	1923	13220	0.572	6.632	27.234
10-APR-86	100	1925	27091	1.173	7.805	28.407
16-APR-86	106	1931	4082	0.177	7.981	28.583
05-JUN-86	156	1981	11017	0.477	8.458	29.060
13-JUN-86	164	1989	12500	0.541	8.999	29.601
09-JUL-86	190	2015	4528	0.196	9.195	29.797
15-SEP-86	258	2083	0	0.000	9.195	29.797
19-DEC-86	353	2178	0	0.000	9.195	29.797

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