United States
Environmental Protection
Agency

Office of
Solid Waste &
Emergency Response

EPA/530-SW-84-009
June 1984

Solid Waste

EPA

The Hydrologic Evaluation of Landfill Performance (HELP) Model

Do not remove. This document should be retained in the EPA Region 5 Library Collection.

Volume I. User's Guide for Version I

Technical Resource Document for Public Comment

THE HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE (HELP) MODEL

Volume I. User's Guide for Version 1

by

P. R. Schroeder, J. M. Morgan, T. M. Walski, and A. C. Gibson
U.S. Army Engineer Waterways Experiment Station
Vicksburg, MS 39180

Interagency Agreement Number AD-96-F-2-A140

Project Officer

D. C. Ammon
Solid and Hazardous Waste Research Division
Municipal Environmental Research Laboratory
Cincinnati, OH 45268

MUNICIPAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OH 45268

OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

U.S. Environmental Protection Agency
Region 5, Library (PL-12J)
77 West Jackson Boulevard, 12th Floor
Chicago, IL 60604-3590

DISCLAIMER

This report was prepared by P. R. Schroeder, J. M. Morgan, T. M. Walski, and A. C. Gibson of the U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi under Interagency Agreement AD-96-F-2-A140. The EPA Project Officer was D. C. Ammon of the Municipal Environmental Research Laboratory, Cincinnati, Ohio.

This is a draft report that is being released by EPA for public comment on the accuracy and usefulness of the information in it. The report has received extensive technical review but the Agency's peer and adminstrative review process has not yet been completed. Therefore it does not necessarily reflect the views or policies of the Agency. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

FOREWORD

The Environmental Protection Agency was created because of increasing public and governmental concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of the environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is the first necessary step in problem solution; it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems to prevent, treat, and manage wastewater and the solid and hazardous waste pollutant discharges from municipal and community sources; to preserve and treat public drinking water supplies; and to minimize the adverse economic, social, health and aesthetic effects of pollution. This publication is one of the products of that research--a vital communications link between the researcher and the user community.

The Hydrologic Evaluation of Landfill Performance (HELP) program was developed to facilitate rapid, economical estimations of the water movement across, into, through, and out of landfills. The program is applicable for evaluation of open, partially closed, and fully closed sites by both designers and permit writers.

FRANCIS T. MAYO
Director
Municipal Environmental Research Laboratory

PREFACE

Subtitle C of the Resource Conservation and Recovery Act (RCRA) requires the Environmental Protection Agency (EPA) to establish a Federal hazardous waste management program. This program must ensure that hazardous wastes are handled safely from generation until final disposition. EPA issued a series of hazardous waste regulations under Subtitle C of RCRA that is published in 40 Code of Federal Regulations (CFR) 260 through 265 and 122 through 124.

Parts 264 and 265 of 40 CFR contain standards applicable to owners and operators of all facilities that treat, store, or dispose of hazardous wastes. Wastes are identified or listed as hazardous under 40 CFR Part 261. The Part 264 standards are implemented through permits issued by authorized states or the EPA in accordance with 40 CFR Part 122 and Part 124 regulations. Land treatment, storage, and disposal (LTSD) regulations in 40 CFR Part 264 issued on July 26, 1982, establish performance standards for hazardous waste landfills, surface impoundments, land treatment units, and waste piles.

The Environmental Protection Agency is developing three types of documents for preparers and reviewers of permit applications for hazardous waste LTSD facilities. These types include RCRA Technical Guidance Documents, Permit Guidance Manuals, and Technical Resource Documents (TRD's). The RCRA Technical Guidance Documents present design and operating specifications or design evaluation techniques that generally comply with or demonstrate compliance with the Design and Operating Requirements and the Closure and Post-Closure Requirements of Part 264. The Permit Guidance Manuals are being developed to describe the permit application information the Agency seeks and to provide guidance to applicants and permit writers in addressing the information requirements. These manuals will include a discussion of each step in the permitting process, and a description of each set of specifications that must be considered for inclusion in the permit.

The Technical Resource Documents present state-of-the-art summaries of technologies and evaluation techniques determined by the Agency to constitute good engineering designs, practices, and procedures. They support the RCRA Technical Guidance Documents and Permit Guidance Manuals in certain areas (i.e., liners, leachate management, closure covers, water balance) by describing current technologies and methods for designing hazardous waste facilities or for evaluating the performance of a facility design. Although emphasis is given to hazardous waste facilities, the information presented in these TRD's may be used in designing and operating non-hazardous waste LTSD facilities as well. Whereas the RCRA Technical Guidance Documents and Permit Guidance Manuals are directly related to the regulations, the information in these

TRD's covers a broader perspective and should not be used to interpret the requirements of the regulations.

This document is a first edition draft being made available for public review and comment. It has undergone review by recognized experts in the technical areas covered, but Agency peer review processing has not been completed yet. Public comment is desired on the accuracy and usefulness of the information presented in this manual. Comments received will be evaluated, before publication of the second edition. Communications should be addressed to Docket Clerk, Room S-212, Office of Solid Waste (WH-562), U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, D.C., 20460. The document under discussion should be identified by title (e.g., "The Hydrologic Evaluation of Landfill Performance (HELP) Model").

ABSTRACT

The Hydrologic Evaluation of Landfill Performance (HELP) program was developed to facilitate rapid, economical estimation of the amounts of surface runoff, subsurface drainage, and leachate that may be expected to result from the operation of a wide variety of possible landfill designs. The program models the effects of hydrologic processes including precipitation, surface storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage using a quasi-two-dimensional approach. In this document, some basic elements of the model are briefly described, input/output options are discussed in detail, and instructions for running the program on the National Computer Center IBM Computer System are given.

This report was submitted in partial fulfillment of Interagency Agreement Number AD-96-F-2-A140 between the U.S. Environmental Protection Agency and the U.S. Army Engineer Waterways Experiment Station. This report covers a period from April 1982 to August 1983, and work was completed as of August 1983.

CONTENTS

FIGURES

TABLES

ACKNOWLEDGMENTS

The authors would like to express their sincere appreciation to Mrs. Cheryl Lloyd and Mr. Thomas E. Schaefer, Jr. of the Environmental Engineering Division, U.S. Army Engineer Waterways Experiment Station, for their many contributions to the development of this user's guide.

SECTION 1

INTRODUCTION

The Hydrologic Evaluation of Landfill Performance (HELP) computer program is a quasi-two-dimensional hydrologic model of water movement across, into, through, and out of landfills. The model accepts climatologic, soil, and design data and utilizes a solution technique that accounts for the effects of surface storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage. Landfill systems including various combinations of vegetation, cover soils, waste cells, special drainage layers, and relatively impermeable barrier soils, as well as synthetic membrane covers and liners, may be modeled. The program was developed to facilitate rapid estimation of the amounts of runoff, drainage, and leachate that may be expected to result from the operation of a wide variety of landfill designs. The model, applicable to open, partially closed, and fully closed sites, is a tool for both designers and permit writers.

BACKGROUND

The HELP program was developed by the U.S. Army Corps of Engineers Waterways Experiment Station (WES), Vicksburg, MS, for the U.S. Environmental Protection Agency (EPA) Municipal Environmental Research Laboratory, Cincinnati, OH, in response to needs identified by the EPA Office of Solid Waste, Washington, DC.

HELP represents a major advance beyond the Hydrologic Simulation on Solid Waste Disposal Sites (HSSWDS) program (1, 2) which was also developed at WES. For example, the HSSWDS model did not allow for lateral flow through drainage layers, handled saturated vertical flow only in a very rudimentary manner, and included infiltration, percolation, and evapotranspiration routines almost identical to those used in the Chemical, Runoff, and Erosion from Agricultural Management Systems (CREAMS) model which was developed by the U.S. Department of Agriculture (3). The HELP model is much improved (in terms of applicability to landfills) with respect to these components; however, the infiltration routine still relies heavily on the Hydrology Section of the National Engineering Handbook (4), as do both HSSWDS and CREAMS.

The HELP model is applicable to most landfill applications, but was developed specifically to perform hazardous waste disposal landfill evaluations as required by the Resource Conservation and Recovery Act. Hazardous waste disposal landfills generally should have a liner to prevent migration of waste out of the landfill, a final cover to minimize the production of leachate following closure, careful controls of runon and runoff, and limits on the buildup of leachate head over the liner to no more than one foot. The HELP model is useful for predicting the amounts of runoff, drainage, and leachate expected for reasonable design as well as the build-up of leachate above the liner. However, the model should not be expected to produce credible results from input unrepresentative of landfills.

OVERVIEW

The principal purpose of this user's guide is to provide the basic information needed to use the computer program. Thus, while some attention must be given to definitions, descriptions of variables, and interpretation of results, only a minimal amount of such information is provided. However, detailed documentation providing in-depth coverage of the theory and assumptions on which the model is based, as well as the internal logic of the program, is also available (5). Potential HELP users are strongly encouraged to read through the documentation and this user's guide before attempting to use the program to evaluate a landfill design.

Assistance in running the program can be provided by the developers at WES. They can be reached by commercial telephone at (601) 634-3710 or via the FTS system at 542-3710.

The outline of the remainder of this manual is presented below.

- Section 2 - Basic landfill design concepts
- Section 3 - Program definitions, options, and restrictions
- Section 4 - Program input
- Section 5 - Program output
- Section 6 - Examples
- Appendix A - Detailed explanation of how to execute the program on EPA's National Computer Center system
- Appendix B - Listing of information needed to access the National Computer Center system
- Appendix C - Cost analysis for executing HELP on the National Computer Center system

SECTION 2

BASIC LANDFILL DESIGN CONCEPTS

BACKGROUND

Over the past 30 to 40 years the sanitary landfill has come to be widely recognized as an economical and effective means for disposal of municipal and industrial solid wastes. Today, modern methods of landfill construction and management are sufficiently developed to ensure that even large volumes of such materials can be handled and disposed of in such a way as to protect public health, minimize adverse effects on the environment, and, in many cases, ultimately enhance land values.

More recently, public attention has been focused on a special class of materials commonly referred to as hazardous wastes. The chemical and physical diversity, environmental persistence, and acute and long-term detrimental effects on human, plant, and animal health of many of these substances are such that great care must be exercised in disposing of them. Hazardous wastes are produced in such large quantities and are so diverse that universally acceptable disposal methods have yet to be devised. However, it appears that, for the present, disposal (or, often more precisely, storage) in secure landfills is the prudent approach in many instances. The current state-of-the-art calls for what may be thought of simply as an extension of sanitary landfill technology utilizing very conservative design criteria. Some important basic principles and concepts of landfill design are summarized below. Specific emphasis is given to disposal of hazardous materials, but the discussion is applicable to ordinary sanitary landfills as well.

LEACHATE PRODUCTION

Storage of any waste material in a landfill poses several potential problems. Among these is the possible contamination of soil and ground and surface waters that may occur as leachate produced by water or liquid wastes moving into, through, and out of the landfill migrates into adjacent areas. This problem is especially important when hazardous wastes are involved since many of these substances are quite resistant to biological or chemical degradation and, thus, may be expected to persist in their original form for many years, perhaps even for centuries. Given this possibility it is desirable for hazardous waste landfills to be designed to prevent any waste or leachate from ever moving into adjacent areas. This objective is beyond the capability of current technology, but does represent a goal in the design and operation of today's landfills. The Hydrologic Evaluation of Landfill Performance (HELP) model has been developed specifically as a tool that may be used by designers and regulatory reviewers to choose designs that minimize potential contamination problems, but yet are practical given the state-of-the-art.

In the context of a landfill, leachate may be described as liquid that has percolated through the layers of waste material. Thus, leachate may be composed of liquids that originate from a number of sources including reactions associated with decomposition of waste materials, precipitation, surface drainage, and groundwater. The chemical quality of leachate varies widely depending upon a number of factors including the quantity produced, the original nature of the buried waste materials, and the various chemical and biochemical reactions that may occur as the waste materials decompose. In the absence of evidence to the contrary, most regulatory agencies prefer to assume that any leachate produced will be contaminated to such an extent that entry into either ground or surface waters is undesirable. Considered in the light of the potential water quality impact of leachate contamination, this approach appears reasonable.

The quantity of leachate produced is affected to some extent by decomposition reactions, but is largely governed by the amount of external water entering the landfill. Thus, a key first step in controlling leachate contamination is to limit production by preventing, to the extent feasible, the entry of external water into the waste layers. A second, though equally important, step is to collect any leachate that is produced for subsequent treatment and disposal. Techniques are currently available to limit the amount of leachate that migrates into adjoining areas to a virtually immeasurable volume so long as the integrity of the landfill structure and leachate control system is maintained.

DESIGN FOR LEACHATE CONTROL

A schematic profile view of a typical hazardous waste landfill is shown in Figure 1. The bottom layer of soil may be hauled in, placed, and compacted to specifications following excavation to a suitable subgrade, or may be naturally existing material. In either case, the base of the landfill should act as a barrier layer having some minimum thickness and a very low hydraulic conductivity (or permeability). Chemical treatment may be used either with or without compaction to reduce permeability to an acceptable level. As an added factor of safety, an impermeable synthetic membrane may be carefully bedded in granular material and placed at the top of the barrier soil layer. The combination of low permeability barrier soil and optional membrane is often referred to as the landfill liner.

Immediately above the liner is a drainage layer consisting of sand with suitably spaced perforated or open joint drain pipe embedded at the base. The drainage layer is typically at least one foot thick and serves to collect any leachate that may percolate through the waste layers. The top of the liner is sloped in such a way as to prevent ponding by encouraging leachate to flow toward the drains. The net effect is such that very little leachate should percolate through the liner system to the natural formations below. Taken as

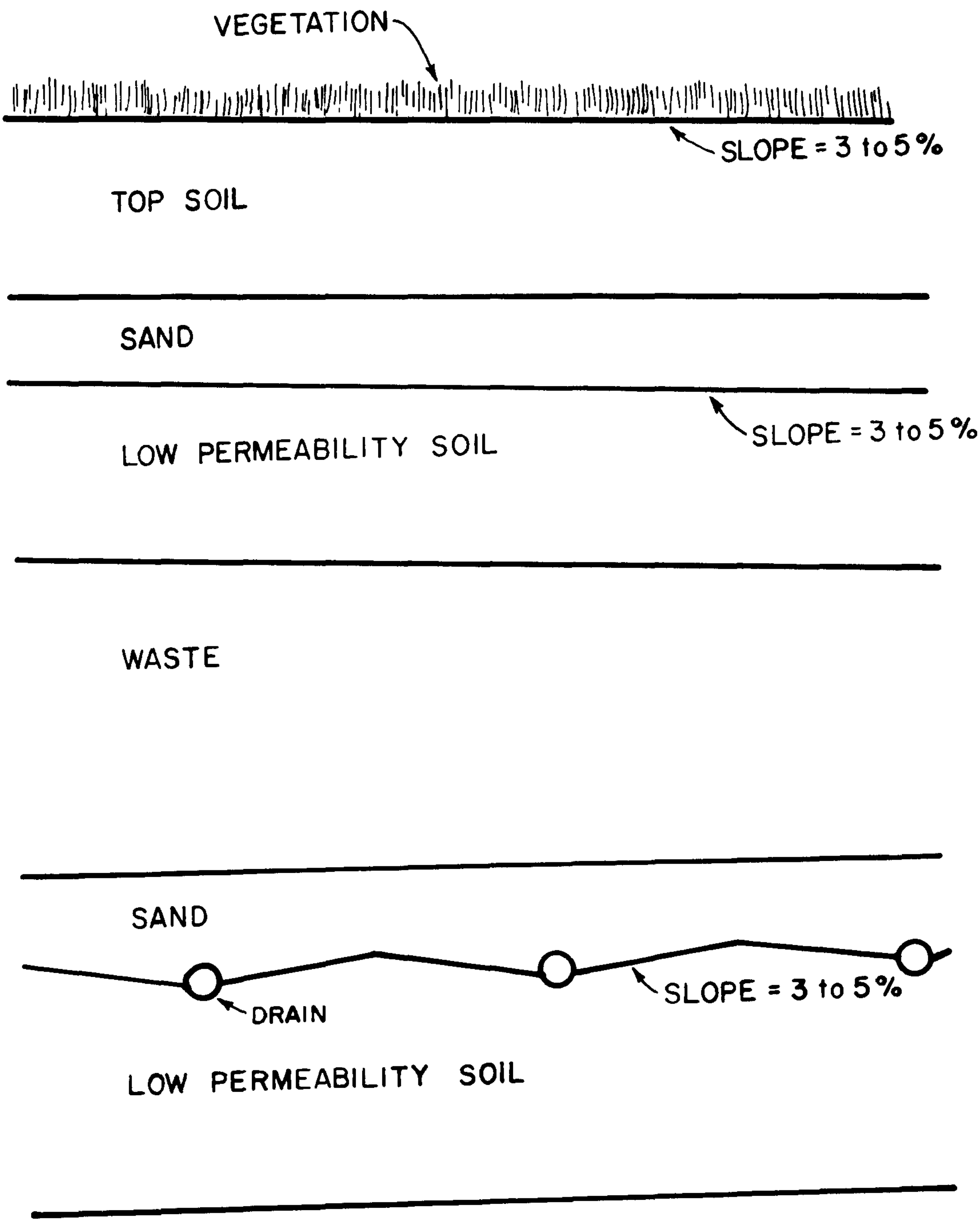

Figure 1. Typical hazardous waste landfill profile (not to scale).

a whole the drainage layer, optional membrane, and barrier soil may be referred to as the drainage/liner system.

After the landfill is closed, the drainage/liner system serves basically in a back-up capacity. However, while the landfill is open and waste is being added, these components are the principal defense against contamination of adjacent areas. Thus, care must be given to their design and construction.

Day-to-day operation of a modern sanitary landfill calls for wastes to be placed in relatively thin lifts, compacted, and covered with compacted soil each day. Thus, wastes should not be left exposed more than a few hours. While the daily soil cover serves effectively to hide the wastes and limit the access of nuisance insects and potential disease vectors, it is of limited value for preventing the formation of leachate. Thus, even though a similar procedure may be utilized for hazardous wastes, it is imperative that the drainage/liner system function well throughout the active life of the landfill and beyond.

When the capacity of the landfill is reached, the waste cells may be covered with a cap, or final cover, typically composed of three distinct layers as shown in Figure 1. At the base of the cap, or cover, is a drainage layer and barrier soil layer similar to that used at the base of the landfill. Again, an impermeable synthetic membrane may be used if needed. The top of the barrier soil layer is graded so that water percolating into the drainage layer will tend to move horizontally toward some removal system located at the edge of the landfill or subunit thereof.

A layer of soil suitable for the support of vegetative growth is placed on top of the upper drainage layer to complete the landfill. A two-foot thick layer of soil having a high loam content serves this purpose nicely. The upper surface is graded so that runon is minimized and as much precipitation as possible is converted to runoff, without causing excessive erosion of the cap. The vegetation used should be selected to grow readily, provide a good cover even during the winter when it is dormant, and have a root system that will not penetrate into the upper barrier layer. Grasses are usually best for this purpose.

The combination of site selection, surface grading, transpiration from vegetation, soil evaporation, drainage through the sand, and the low hydraulic conductivity of the barrier soil serves effectively to minimize leachate production from external water. Added effectiveness is gained by the use of impermeable synthetic membranes in the cap and liner. However, it is important that the cap be no more permeable than the liner; otherwise, the landfill could gradually fill with liquid and ultimately overflow into adjacent areas. This phenomenon is sometimes referred to as the "bathtub" effect.

The HELP model is designed to perform water budget calculations for landfills having as many as nine layers by modeling each of the hydrologic processes that occur. Thus, it is possible to design a landfill to achieve specific goals, or evaluate the performance of a given landfill design, with the aid of the model. A description of the program is presented in the following section.

SECTION 3

PROGRAM DEFINITIONS, OPTIONS AND RESTRICTIONS

INTRODUCTION

The Hydrologic Evaluation of Landfill Performance (HELP) program was developed to assist landfill designers and regulators by providing a tool to allow rapid, economical screening of alternative designs. Specifically, the program may be used to estimate the magnitudes of various components of the water budget, including the volume of leachate produced and the thickness of water saturated soil (head) above barrier layers. The results may be used to compare the leachate production potential of alternative designs, select and size appropriate drainage and collection systems, and size leachate treatment facilities.

The model uses climatologic, soil, and design data to produce daily estimates of water movement across, into, through, and out of landfills. To accomplish this, daily precipitation is partitioned into surface storage (snow), runoff, infiltration, surface evaporation, evapotranspiration, percolation, stored soil moisture, and subsurface lateral drainage to maintain a water budget. Surface runon and subsurface lateral inflow are not considered.

In this chapter emphasis is placed on data requirements, nomenclature, important assumptions, program limitations, and other fundamental information needed by all users to facilitate running the program. Readers desiring detailed explanations of the solution techniques employed are directed to the program documentation (5).

HYDROLOGIC PROCESSES

As noted above, the HELP program models a number of hydrologic processes. Runoff is computed using the Soil Conservation Service Runoff Curve Number method. When the program is run for a closed landfill using the default soil data option, a default runoff curve number is selected automatically. However, the program gives the user an opportunity to override the default value. When soil data are entered manually, and when an open landfill is being modeled, the user must estimate an appropriate runoff curve number. A complete discussion of the curve number technique is available from the Soil Conservation Service (4).

Factors such as surface slope and roughness are not considered directly in estimating runoff, and hence infiltration. However, they may be taken into account in the manual selection of a curve number. This approach to runoff estimation is made possible by considering only daily precipitation totals, and not the intensity, duration and distribution of individual rainfall events (storms).

Percolation and vertical water routing are modeled using Darcy's Law for saturated flow with modifications for unsaturated conditions. Lateral drainage is computed analytically from a linearized Boussinesq equation corrected to agree with numerical solutions of the nonlinearized form for the range of design specifications used in hazardous waste landfills. Evapotranspiration is estimated by a modified Penman method adjusted for limiting soil moisture conditions. Detailed solution methods for all hydrologic processes are presented in the program documentation (5).

DATA REQUIREMENTS

The HELP program requires climatologic, soil, and design data. However, sufficient default climatologic and soil data are internally available to satisfy the needs of many users. Although the model contains default climatologic and soil data, these data should not be used unless they have been examined and verified to be representative of the site under study. In all cases, the user should attempt to acquire data specific to the site and use these available data before supplementing with default data. The basic data requirements and input options are briefly discussed below. Step-by-step instructions for entering data into the program are given in Section 4, and complete input/output listings for three examples are presented in Section 6.

Climatologic Data

Climatologic data, including daily precipitation in inches, mean monthly temperatures in °F, mean monthly insolation (solar radiation) in langleys, leaf area indices, and winter cover factors, may be entered manually or selected from built-in default data files. Default climatologic data are available for only 102 cities; therefore, none of these cities may be representative of the study site. The precipitation data base is also limited to only five years of daily records which may not be representative since the period of record could have been unusually wet or dry. It is also highly recommended to run the simulation for more than five years to examine the design under the range of possible climatologic conditions.

Default Data Option--

Default climatologic data consisting of five years (usually 1974-78) of observed daily precipitation and one set of values for mean monthly temperature, mean monthly insolation, and leaf area index for each of the cities listed in Table 1 are built into the program. These data may be accessed and used simply by giving the appropriate responses to straightforward program queries as described in Section 4.

It is important to understand that, while the program requires daily precipitation, temperature, and insolation data, it interpolates for average daily temperature and insolation from mean monthly data. Therefore, even

TABLE 1. LISTING OF DEFAULT CITIES AND STATES

- Alaska
  - Annette
  - Bethel
  - Fairbanks
- Arizona
  - Flagstaff
  - Phoenix
  - Tucson
- Arkansas
  - Little Rock
- California
  - Fresno
  - Los Angeles
  - Sacramento
  - San Diego
  - Santa Maria
- Colorado
  - Denver
  - Grand Junction
- Connecticut
  - Bridgeport
  - Hartford
  - New Haven
- Florida
  - Jacksonville
  - Miami
  - Orlando
  - Tallahassee
  - Tampa
  - W. Palm Beach
- Georgia
  - Atlanta
  - Watkinsville
- Hawaii
  - Honolulu
- Idaho
  - Boise
  - Pocatello
- Illinois
  - Chicago
  - E. St. Louis
- Indiana
  - Indianapolis
- Iowa
  - Des Moines
- Kansas
  - Dodge City
  - Topeka
- Kentucky
  - Lexington
- Louisiana
  - Lake Charles
  - New Orleans
  - Shreveport
- Maine
  - Augusta
  - Bangor
  - Caribou
  - Portland
- Massachusetts
  - Boston
  - Plainfield
  - Worcester
- Michigan
  - E. Lansing
  - Sault Ste. Marie
- Minnesota
  - St. Cloud
- Missouri
  - Columbia
- Montana
  - Glasgow
  - Great Falls
- Nebraska
  - Grand Island
  - North Omaha
- Nevada
  - Ely
  - Las Vegas
- New Hampshire
  - Concord
  - Nashua
- New Jersey
  - Edison
  - Seabrook
- New Mexico
  - Albuquerque
- New York
  - Central Park
  - Ithaca
  - New York City
  - Schenectady
  - Syracuse
- North Carolina
  - Greensboro
- North Dakota
  - Bismarck
- Ohio
  - Cincinnati
  - Cleveland
  - Columbus
  - Put-in-Bay
- Oklahoma
  - Oklahoma City
  - Tulsa
- Oregon
  - Astoria
  - Medford
  - Portland
- Pennsylvania
  - Philadelphia
  - Pittsburgh
- Rhode Island
  - Providence
- South Carolina
  - Charleston
- South Dakota
  - Rapid City
- Tennessee
  - Knoxville
  - Nashville
- Texas
  - Brownsville
  - Dallas
  - El Paso
  - Midland
  - San Antonio
- Utah
  - Cedar City
  - Salt Lake City
- Vermont
  - Burlington
  - Montpelier
  - Rutland
- Virginia
  - Lynchburg
  - Norfolk
- Washington
  - Pullman
  - Seattle
  - Yakima
- Wisconsin
  - Madison
- Wyoming
  - Cheyenne
  - Lander
- Puerto Rico
  - San Juan

though the default data set contains actual historical observations of precipitation, no attempt is made to model the exact weather conditions existing on any given day.

The default climatologic data base includes values for two variables that relate to the effects of vegetation on evapotranspiration; leaf area index (LAI) and winter cover factor. LAI is defined as the dimensionless ratio of the leaf area of actively transpiring vegetation to the nominal surface area of land on which the vegetation is growing. The HELP program assumes that LAI may vary from a minimum value of 0 to a maximum value of 3. The former is representative of no actively growing vegetation (i.e., bare ground or dormant vegetation) and the latter represents the most dense stand of actively growing vegetation considered. Default LAI data sets consist of thirteen Julian dates (spaced throughout the entire year) and corresponding maximum LAI values for a good row crop and an excellent stand of grass. A different set of LAI data is provided for each of the 102 cities listed in Table 1. The program adjusts these maximum values downward if necessary, depending upon the vegetative cover specified, and interpolates for daily values in order to model evapotranspiration during the growing season. For the remainder of the year, transpiration is assumed not to occur. However, even dormant vegetation can serve to insulate the soil and, thus, affect evaporation. Winter cover factors, which vary from 0 for row crops to 1.8 for an excellent stand of grass, are used to account for this effect.

Manual Data Option--

When the manual climatologic data input option is utilized, the user must provide daily precipitation data for each year of interest. The maximum allowable period of record is 20 years and the minimum is 2 years. A separate set of temperature, insolation, LAI, and winter cover factor data may be entered for each year, or a single set of data may be used for all years. The information needed to enter climatologic data using the manual input option is presented in Section 4.

For most locations, observed precipitation and temperature data are readily available. Possible sources include local weather stations, libraries, universities, agricultural and climatologic research facilities, and the National Climatic Center, NOAA, Federal Building, Ashville, North Carolina 28801. Insolation data may be more difficult to obtain; however, average values are commonly reported in architectural publications, solar heating handbooks, and general reference works. A general discussion pertaining to LAI values for different types of vegetation is presented in the program documentation (5).

Vegetative Cover Data

If the default climatologic or soil data options are used, the user must specify one of seven types of vegetative cover. Acceptable default types of vegetation are bare ground (i.e., no vegetation); excellent, good, fair and poor stands of grass; and good and fair stands of row crops. The default LAI data sets for a good row crop and an excellent stand of grass are modified for lesser stands of vegetation when these types are specified by the user. The values for a good row crop are multiplied by 0.5 for a fair row crop and the values for an excellent stand of grass are multiplied by 0.17, 0.33, and 0.67 for poor, fair and good stands of grass, respectively. Similarly, the hydraulic conductivity of the top soil layer is corrected for the effects of roots when the user specifies one of the 21 default soil types for the top layer. The hydraulic conductivity of soil without vegetation is multiplied by 5.0, 4.2, 3.0, 1.8, 1.9 and 1.5 for excellent, good, fair and poor stands of grass, and good and fair row crops, respectively.

The user must also specify an evaporative zone depth as one of the climatologic variables. The evaporative zone depth may be thought of simply as the maximum depth from which water may be removed from the landfill by evapotranspiration. Thus, where vegetation is present, the evaporative depth should at least equal the expected average depth of root penetration. In actual fact, the influence of plant roots generally extends well beyond the depth of root penetration because of capillary suction created as water is extracted from the soil. However, limiting the evaporative depth to the expected average depth of root penetration may be justified as a conservative approach to landfill evaluation since this results in reduced estimates of evapotranspiration and increased estimates of lateral drainage and percolation. Evaporation will, of course, occur even if no vegetation is present. Thus, it is reasonable that some evaporative depth be specified even for the bare ground (no vegetation) condition. Suggested conservative values of evaporative depth range from 4 inches for bare ground, to 10 inches for a fair stand of grass, to 18 inches for an excellent stand of grass. The program does not permit the evaporative depth to be greater than the depth to the top of the topmost barrier soil layer.

Design and Soil Data

The user must specify data describing the various materials contained in the landfill (e.g., top soil, clay, sand, waste) and the physical layout (design) of the landfill (e.g., size, thickness of various layers, slopes, etc.). Either the default or manual input options may be utilized for soil data; however, design data must be entered manually.

Landfill Profile--

The HELP program may be used to model landfills composed of up to nine distinct layers. However, there are some limitations on the order in which the layers may be arranged which must be observed if meaningful results are to be obtained. Also, each layer must be identified as either a vertical percolation, lateral drainage, waste, or barrier soil layer. This identification is very important because the program models water flow through the various types of layers in different ways. However, in all cases, the program assumes that each layer is homogeneous with respect to hydraulic conductivity, transmissivity, wilting point, porosity, and field capacity. A typical closed landfill profile is shown on Figure 2. The circled numbers indicate the layer identification system used by the program.

Vertical percolation layers (e.g., layer 1 on Figure 2) are assumed to have great enough hydraulic conductivity that vertical flow in the downward direction (i.e., percolation) is not significantly restricted. Lateral drainage is not permitted, but water can move upward and be lost to evapotranspiration if the layer is within the specified evaporative zone. Percolation is

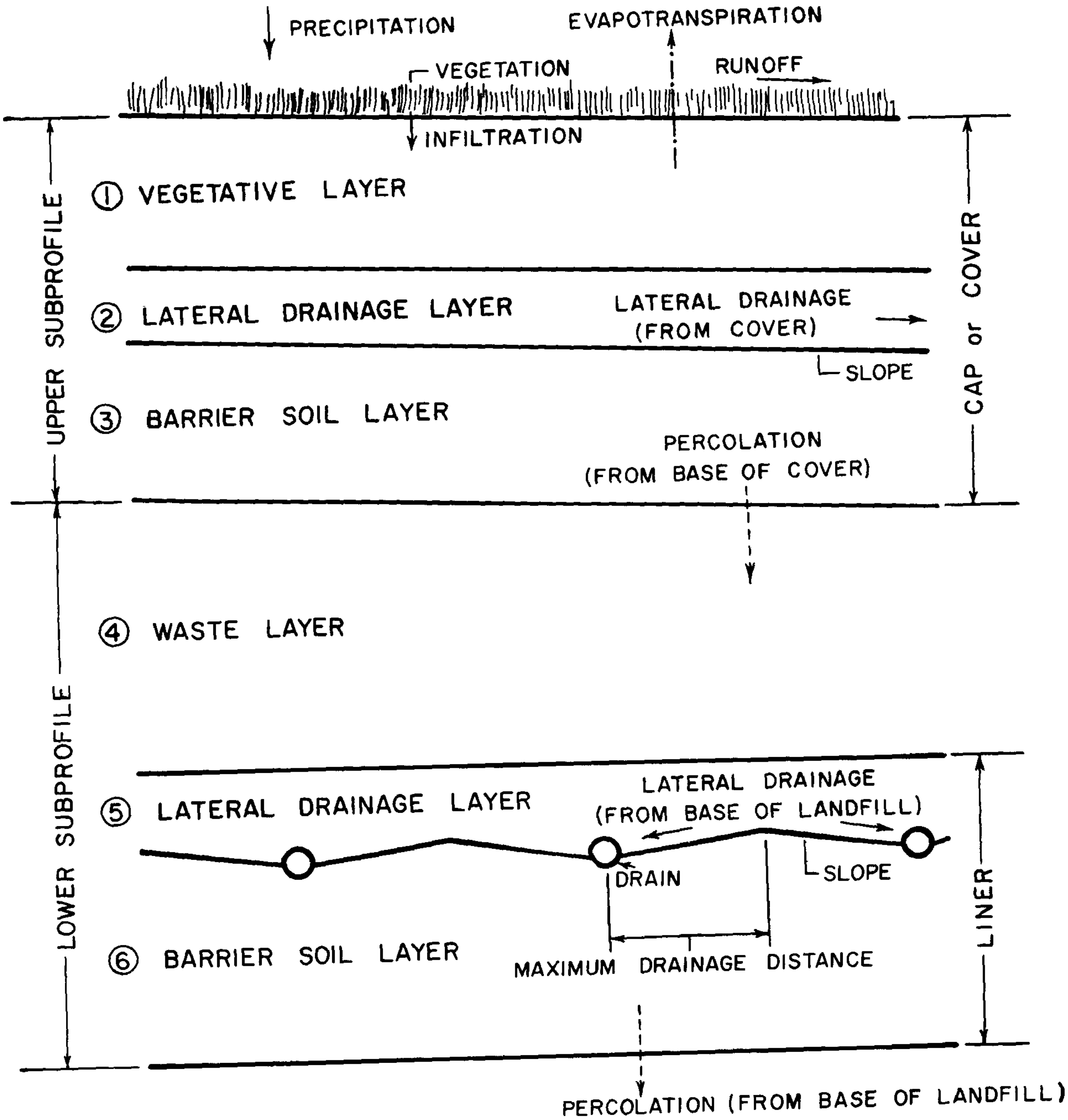

Figure 2. Typical landfill profile.

modeled as being independent of the depth of water saturated soil (i.e., the head) above the layer. Layers designed to support vegetation should generally be designated as vertical percolation layers.

Lateral drainage layers are assumed to have hydraulic conductivity high enough that little resistance to flow is offered. Therefore, the hydraulic conductivity of a drainage layer should be equal to or greater than that of the overlying layer. Vertical flow is modeled in the same manner as for a vertical percolation layer; however, lateral outflow is allowed. This lateral drainage is considered to be a function of the slope of the bottom of the layer, the maximum horizontal distance that water must traverse to drain from the layer, and the depth of water saturated soil above the top of the underlying barrier soil layer. (Note: a lateral drainage layer may be underlain by only another lateral drainage layer or a barrier soil layer.) The lateral drainage submodel has been calibrated for drainage slopes between 0 and 10 percent and for maximum drainage distances between 25 and 200 feet. Layers 2 and 5 on Figure 2 are lateral drainage layers.

Barrier soil layers restrict vertical flow. Thus, such layers should have hydraulic conductivity substantially lower than for vertical percolation, lateral drainage, or waste layers. The program only allows downward flow in barrier soil layers. Thus, any water moving into a barrier layer will eventually percolate through it. Percolation is modeled as a function of the depth of water saturated soil (head) above the base of the layer. The program recognizes two types of barrier layers; those composed of soil alone, and those composed of soil overlain by an impermeable synthetic membrane. In the latter case, the user must specify some membrane leakage fraction. This factor may be thought of simply as the fraction (range 0 to 1) of the maximum daily potential percolation (i.e., the percolation that would occur, in response to some given head, in the absence of the membrane) through the layer that is expected to actually occur on a day when the membrane is in place, assuming the barrier layer is subjected to the same head. The net effect of specifying the presence of a membrane is to reduce the effective hydraulic conductivity of the layer. The factor may also be considered as the fraction of the area that drains into the barrier soil layer through leaks in the membrane liner. The program does not model aging of the membrane. Layers 3 and 6 shown on Figure 2 are barrier layers.

Water movement through a waste layer is modeled in the same manner as for a vertical percolation layer. However, identifying a layer as a waste layer indicates to the program which layers should be considered part of the landfill cap or cover (see Figures 1 and 2), and which layers should be considered as part of the liner/drainage system. Layer 4 shown on Figure 2 is a waste layer.

If the topmost layer of a landfill profile is identified as a waste layer, the program assumes that the landfill is open. In this case the user must specify a runoff curve number (discussed above) and the fraction (a factor that may vary from 0 to 1) of the potential surface runoff that is actually collected and removed from the landfill surface.

The HELP program can model up to nine layers in the landfill profile. As many as three layers may be identified as barrier soil layers. While the program is quite flexible, there are some basic rules that must be followed relative to the order in which the layers are arranged in the profile. First, a vertical percolation layer or a waste layer may not be placed directly below a lateral drainage layer. Second, a barrier soil layer may not be placed directly below another barrier soil layer. Third, when a barrier soil is not placed directly below the lowest drainage layer all drainage layers in the lowest subprofile are treated as vertical percolation layers. Thus, no lateral drainage is allowed in this subprofile. Fourth, the top layer may not be a barrier soil layer.

Important nomenclature used by the program is indicated on Figure 2. For computational purposes the soil profile is partitioned into subprofiles which are defined in relation to the location of the barrier soil layers. For example, the upper subprofile shown on Figure 2 extends from the surface to the bottom of the upper barrier soil layer (layer 3), while the lower subprofile extends from the top of the waste layer to the base of the lower barrier soil layer. If an intermediate barrier soil layer had been specified, a third (intermediate) subprofile would have been defined. Since there can be no more than three barrier soil layers there can be no more than three subprofiles. The program models the flow of water through one subprofile at a time with the percolation from one subprofile serving as the inflow to the underlying subprofile, and so on through the complete profile.

Soil Data--

The type of soil present in each layer must be specified by the user. This can be accomplished using either the default or manual data input options. Characteristics for 21 default soil types are presented in Table 2. The first three columns represent soil texture designations used by the HELP program, and two standard classification systems--the U.S. Department of Agriculture system and the Unified Soil Classification System. The numerical entries represent typical values corresponding to the various soil types and are used by the HELP program, as needed, for computational purposes. These values were obtained mainly from agricultural soils which may be less dense and more aerated than typical soils placed in landfills (6, 7, 8). Clays and silts in landfills would generally be compacted except for a well managed vegetative layer which may be tilled to promote vegetative growth. Untilled vegetative layers would generally be more compacted than the loams listed in Table 2. Soil texture type 19 is representative of typical municipal solid waste that has been compacted. Soil texture types 20 and 21 denote very well compacted clay soils that might be used for barrier layers. Default soil data may be accessed and used simply by entering the appropriate soil texture number in response to a straightforward command from the program.

The user may also enter soil characteristics manually. In this instance, the program will require that numerical values be entered for porosity, field capacity, wilting point, hydraulic conductivity (i.e., saturated hydraulic conductivity) in inches per hour, and evaporation coefficient in millimeters per square root of day. (Note: porosity, field capacity, and wilting point are all dimensionless.) In some cases these data may not be actually used by the program. Specifically, the porosity, wilting point, and evaporation

TABLE 2. DEFAULT SOIL CHARACTERISTICS

Soil Texture Class			MIR[d]	Porosity	Field Capacity	Wilting Point	Hydraulic Conductivity	CON[e]
HELP[a]	USDA[b]	USCS[c]	In/hr	Vol/Vol	Vol/Vol	Vol/Vol	in/hr	$mm/day^{0.5}$
1	CoS	GS	0.500	0.351	0.174	0.107	11.95	3.3
2	CoSL	GP	0.450	0.376	0.218	0.131	7.090	3.3
3	S	SW	0.400	0.389	0.199	0.066	6.620	3.3
4	FS	SM	0.390	0.371	0.172	0.050	5.400	3.3
5	LS	SM	0.380	0.430	0.16	0.060	2.780	3.4
6	LFS	SM	0.340	0.401	0.129	0.075	1.000	3.3
7	LVFS	SM	0.320	0.421	0.176	0.090	0.910	3.4
8	SL	SM	0.300	0.442	0.256	0.133	0.670	3.8
9	FSL	SM	0.250	0.458	0.223	0.092	0.550	4.5
10	VFSL	MH	0.250	0.511	0.301	0.184	0.330	5.0
11	L	ML	0.200	0.521	0.377	0.221	0.210	4.5
12	SIL	ML	0.170	0.535	0.421	0.222	0.110	5.0
13	SCL	SC	0.110	0.453	0.319	0.200	0.084	4.7
14	CL	CL	0.090	0.582	0.452	0.325	0.065	3.9
15	SICL	CL	0.070	0.588	0.504	0.355	0.041	4.2
16	SC	CH	0.060	0.572	0.456	0.378	0.065	3.6
17	SIC	CH	0.020	0.592	0.501	0.378	0.033	3.8
18	C	CH	0.010	0.680	0.607	0.492	0.022	3.5
19	Waste		0.230	0.520	0.320	0.190	0.283	3.3
20	Barrier Soil		0.002	0.520	0.450	0.360	0.000142	3.1
21	Barrier Soil		0.001	0.520	0.480	0.400	0.0000142	3.1

[a] Soil classification system used in the HELP model (see discussion in text).

[b] Soil classification system used by the U.S. Department of Agriculture.

[c] The Unified Soil Classification System.

[d] MIR = Minimum Infiltration Rate.

[e] CON = Evaporation Coefficient (Transmissivity).

coefficient are not used for barrier soils, and the wilting point and evaporation coefficient are not used for any layer below the effective evaporative zone. Brief definitions for some terms used to describe soil moisture content, and the movement of water through soil, are presented below.

Porosity--the ratio of the volume of voids to the total volume occupied by a soil.

Field capacity--the ratio of the volume of water that a soil retains after gravity drainage ceases to the total volume occupied by a soil.

Wilting point--the ratio of the volume of water that a soil retains after plants can no longer extract water (thus, the plants remain wilted) to the total volume occupied by a soil.

Available (or plant available) water capacity--the difference between the soil water content at field capacity and at the wilting point.

Hydraulic conductivity--the rate at which water moves through soil in response to gravitational forces.

Evaporation coefficient--(also called transmissivity) an indicator of the relative ease by which water is transmitted through soil in response to capillary suction.

Users opting for manual soil data input should recognize that certain logical relationships must exist among the soil characteristics of a given layer. The porosity, field capacity, and wilting point are all represented by dimensionless values varying between 0 and 1, but the porosity must be greater than the field capacity which must, in turn, be greater than the wilting point. The minimum permissible evaporation coefficient is 3.0 mm per square root of day.

The program is designed to accept a combination of default and manual soil data if such is desired. This is especially convenient for specifying characteristics of waste layers. To use this option the user simply specifies soil types 22 or 23. The program responds to these soil texture types by asking for the soil characteristics discussed above.

Soil Compaction--

Barrier soil layers and waste layers may be compacted to restrict the vertical flow of water. When using the default soil data option, the user may specify that any layer is to be considered compacted. For a layer so identified, the hydraulic conductivity is reduced by a factor of 20, and the drainable water (i.e., porosity minus field capacity) and plant available water (i.e., field capacity minus wilting point) are each reduced by 25 percent. When using the manual soil data option, the user simply enters soil data representative of compacted soil. Layers that support vegetation are not generally compacted.

Design Data--

The distinction between soil and design data is not always a clear cut one. However, in this section the term design data refers to those items discussed immediately below.

The user must enter the total surface area of the landfill to be modeled in square feet, and the thickness of each layer in inches. For drainage layers the slope of the bottom of the layer (in percent) and the maximum horizontal drainage distance (in feet) must also be supplied. The lateral drainage submodel has been calibrated for slopes between 0 and 10 percent and for maximum drainage distances between 25 to 200 feet. When drain tiles are to be used, the appropriate distance is one half the maximum spacing. When drains are not used, the appropriate distance is the maximum horizontal distance that water must travel to reach a free discharge. Depending upon the soil profile chosen and the input option selected, other data such as runoff curve number, membrane leakage fraction, and potential runoff fraction may be requested by the program. Each of these are discussed in the appropriate paragraphs above. Some general guidance for selection of runoff curve numbers is provided in Figure 3 (4, 9). Typical values for minimum infiltration rates are provided in Table 2.

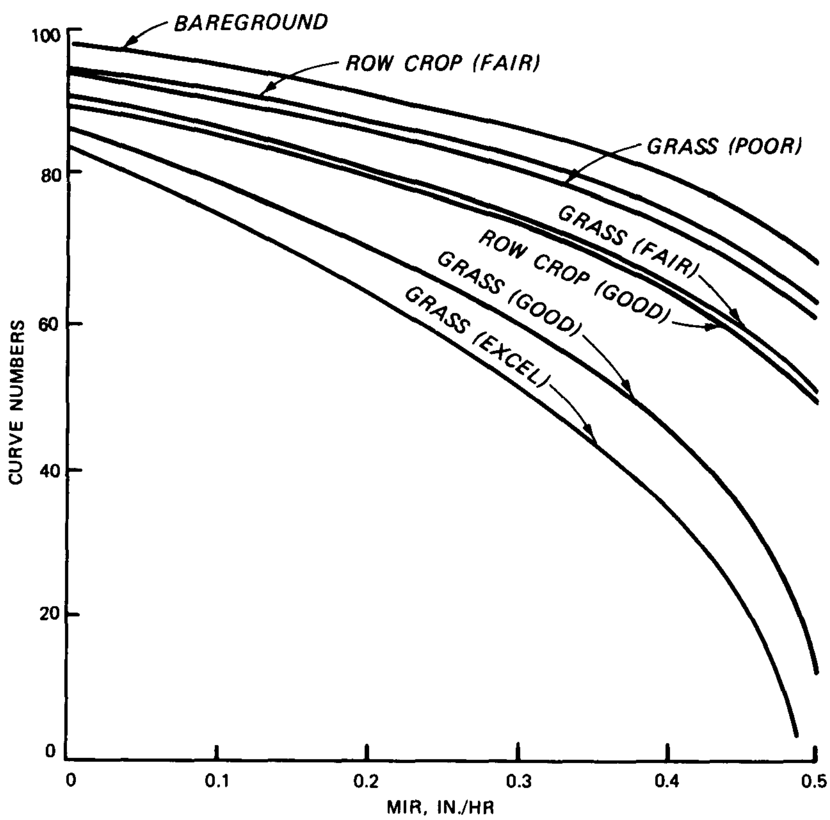

Figure 3. Relationship between SCS curve number and minimum infiltration rate (MIR) for various vegetative covers

SECTION 4

PROGRAM INPUT

INTRODUCTION

Once the program is started, it automatically solicits input from the user. This chapter describes the input commands given by the program, the questions the program asks, possible responses the user can provide, and the implications of these responses. For convenience, both input commands and questions are referred to as "questions" in this chapter. Obviously, the commands are really statements and not questions. For reference, each question has been assigned an identification number which will enable the user to find a description of the question in this chapter. A brief description of how to obtain and run the program on the National Computer Center IBM Computer System is given in Appendix A.

The ten types of data which the user can enter are listed below:

1. Overall Program Control (MAIN),
2. Default Climatologic Data (DCDATA),
3. Manual Rainfall Data (MCDATA),
4. Default Soil Data (DSDATA),
5. Manual Soil Data (MSDATA),
6. Site Description (SITE),
7. Characteristics of Open Sites (OPEN),
8. Manual Climatologic Data other than Rainfall (MTRLYR),
9. Edit of Rainfall Data (PRECHK),
10. Edit of Soil Data (SDCHK),
11. Simulation Output Control (SIMULA),

The names in parentheses are the subroutines in which the data are entered. The relationship between subroutines is shown schematically in Figure 4. MAIN is the main program.

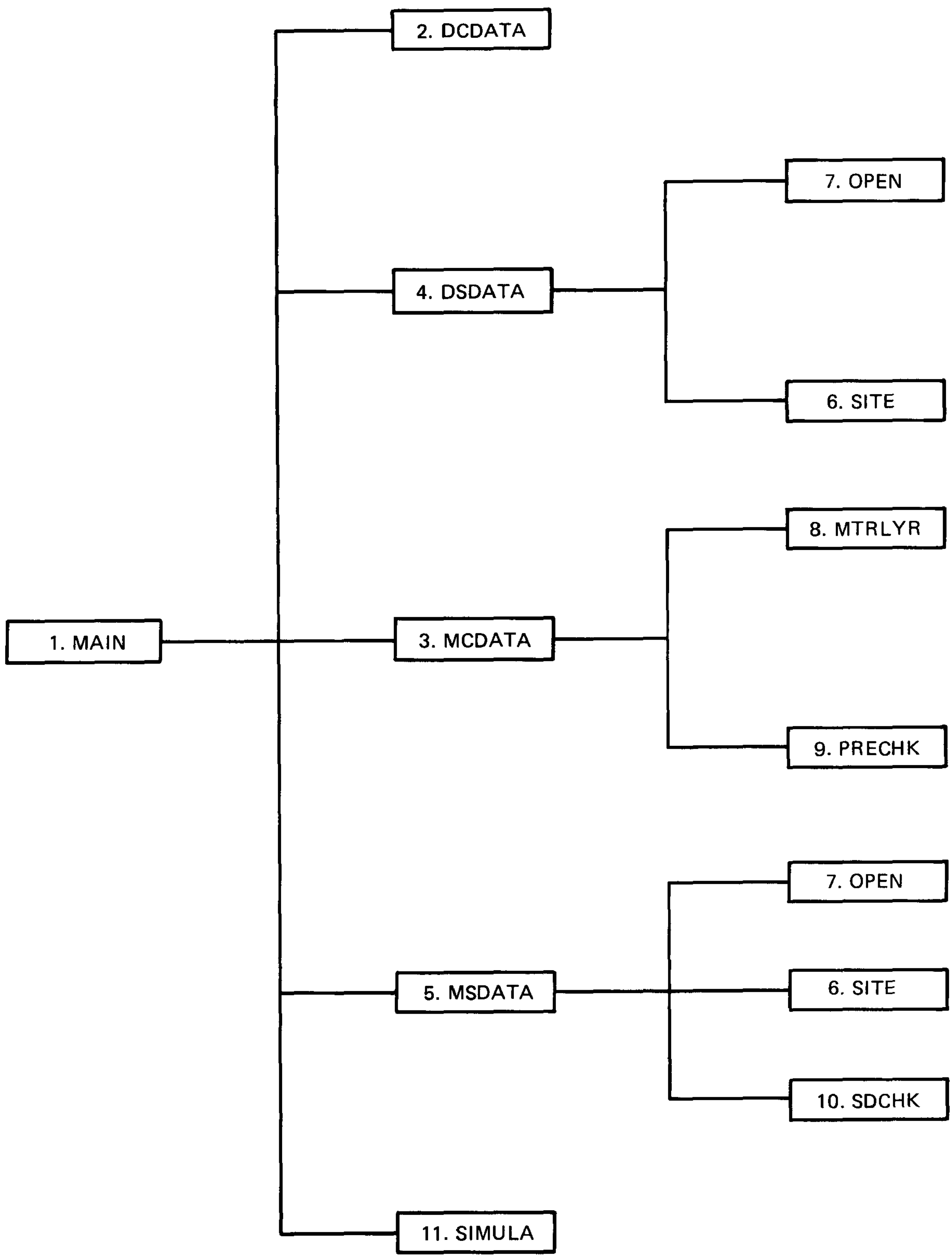

Figure 4. Relationship among types of input.

RULES

There are a few fundamental rules that a user must keep in mind when using the program. They are summarized below.

When the program requests a word response (e.g. YES or NO), the response must be left justified and the first four characters must be spelled correctly. For example _YES and NO_SIR are not acceptable. When entering numerical data, there must be no stray signs or decimals. If fewer values are entered on a line than are called for, the program assigns zeros to the remaining locations. For example, if 10 daily rainfall values are required on a line and the values are

    0.   0.9   0.   0.4 0.   0.   0.25   0.   0.   0.

the user can enter

    0 .9 0 .4 0 0 .25

But if the user entered

    0. . . .9 - 0 .4 0. 0. .25

the program would store

    0. 0. 0. .9 -0. 0. 0.4 0. 0. 0.25

The user should always enter at least one character on any line. Otherwise, since most computers regard a blank line as an end-of-file, the run may be prematurely terminated. For example, if the user is entering rainfall data for a 10 day period with no rain, it is permissible to enter

    0

but not to leave the entire line blank.

Trailing decimal points are not required on input as the program automatically knows whether to treat a value as an integer or floating point variable. For example, if a user wishes to enter the number nine, either 9, 9. or 9.00 are acceptable. The program decides whether to store the values as 9 or 9.000000.

If the program is expecting one of several responses to a question (e.g. 1, 2, 3, or 4) and the user does not enter such a response, the program warns the user and provides another opportunity to respond correctly. In most cases the entire question is not repeated.

The user is discouraged from terminating a run during input as some of the data may be lost. If necessary, though, the user can terminate input by hitting the "ESCAPE" or "INTERRUPT" key, depending on the type of terminal being used.

Each question (and input command) has been assigned an identifying code composed of two arabic numerals separated by a decimal point. The first number always refers to the appropriate subroutine, while the second indicates the order of the questions (and input commands) within the subroutine. These identifying codes assist the user in locating the portion of this chapter that may be of interest in interpreting the questions (and input commands).

OVERALL PROGRAM CONTROL (1. MAIN)

When the program starts, it first prints a heading introducing the HELP Model and then asks the following:

1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
2 FOR SOIL OR DESIGN DATA INPUT,
3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
4 TO STOP THE PROGRAM, AND
5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.

If the user enters 1, the program will expect the user to enter either the default or manual climatologic data, depending upon the answer to question 1.2. If the user enters 2, the program will expect the user to enter either default or manual soil data, depending upon the answer to question 1.3. If the user enters 3, the simulation will begin and detailed output including a summary will be produced, while if the user enters 4, the run will be halted. If the user enters 5, the simulation will begin and only a summary of the simulation results will be produced. If the user enters a value other than 1, 2, 3, 4, or 5, the question is repeated. The program returns to this question each time it completes a portion of the program. For example, after entering climatologic data, the user must instruct the program whether soil data will be entered, the simulation should begin, or the run should end.

If the user answered 1 to question 1.1, the program asks the user what type of climatologic data is to be used in the run.

1.2 DO YOU WANT TO USE DEFAULT CLIMATOLOGIC DATA?
ENTER YES OR NO.

The user answers YES if it is desired to build a new file of climatologic data from the default data tapes, and NO if it is desired to enter climatologic data manually. If it is desired to modify climatologic data that were previously entered, a NO answer should be given. A YES answer transfers control to subroutine 2. DCDATA (question 2.1) while a NO answer transfers control to subroutine 3. MCDATA (question 3.1).

If the user answers 2 to question 1.1, the program asks the following question:

1.3 DO YOU WANT TO USE DEFAULT SOIL DATA?
ENTER YES OR NO.

The user should enter YES if it is desired to build a new data file of soil data from the default soil texture data, and NO if it is desired to enter soil data manually during the run or edit previously entered soil or design data.

If the user answers 3 or 5 to question 1.1, the programs transfers controlls to subroutine 11. SIMULA (question 11.1).

If the user answers 4 to question 1.1, the run is halted and the following message is printed:

1.4 ENTER RUNHELP TO RERUN PROGRAM OR
ENTER LOGOFF TO LOGOFF COMPUTER SYSTEM.

DEFAULT CLIMATOLOGIC DATA (2. DCDATA)

If the user specified that default climatologic data would be used (a YES response to question 1.2), the program first asks if the user wants a list of cities for which default climatologic data are stored.

2.1 DO YOU WANT A LIST OF DEFAULT CITIES?
ENTER YES OR NO.

A YES response will result in the program printing a list (Table 1) of the 102 cities for which 5-year climatologic data sets are stored. Regardless of the answer to 2.1, the following question is printed:

2.2 ENTER NAME OF STATE OF INTEREST

The user need only enter the first four characters of the state name. Some states have no cities for which climatologic data are stored. For these, the program responds

2.3 THERE ARE NO DEFAULT VALUES FOR __________

and control is returned to question 2.1. In that case, the user must enter climatologic data manually or use the default data for a nearby city from a neighboring state.

Once the state name is entered, the user must enter the name of the city for which climatologic data are to be used in response to

2.4 ENTER NAME OF CITY OF INTEREST

The user can only select names from the 102 cities given in response to question 2.1. This table is reproduced in Section 3 as Table 1.

If the name of the city is not found in the default climatologic data base, the program responds with statement 2.3 and asks question 2.1. If the user wants a listing of the cities, the program produces a listing of the cities and returns to question 2.2; else, the program returns to question 2.4.

If the name of the city is in the list of cities but does not correspond with the user specified state, the program responds

2.5 PITTSBURGH LOUISIANA CANNOT BE FOUND ON DEFAULT
CLIMATOLOGIC DATA FILE.

and the program returns to question 2.1.

Once the program has read the default climatologic data from storage, it requests the user to specify the type of vegetative cover if the vegetative type had not been previously specified during this run when entering default soil data. If previously specified, control is passed to question 2.9; else, the program asks

```
2.6 SELECT THE TYPE OF VEGETATIVE COVER
ENTER NUMBER 1 FOR BARE GROUND
             2 FOR EXCELLENT GRASS
             3 FOR GOOD GRASS
             4 FOR FAIR GRASS
             5 FOR POOR GRASS
             6 FOR GOOD ROW CROPS
             7 FOR FAIR ROW CROPS
```

These values set default values for leaf area indices and winter cover factors which are used in evapotranspiration calculations. If the user enters a value other than a number between 1 and 7, the program responds

2.7 9 INAPPROPRIATE VALUE TRY AGAIN

and provides another opportunity to enter an appropriate response.

When default soil data are utilized, the vegetation type is also used in selecting the SCS runoff curve number for the site and to correct the hydraulic conductivity of the vegetative layer. If the value given in the default soil data input does not agree with the value specified in question 2.6, erroneous results may be obtained. Therefore, the program warns

2.8 IF YOU ARE USING DEFAULT SOIL DATA AND THIS VEGETATION
TYPE IS NOT THE SAME AS USED IN THE DEFAULT SOIL DATA INPUT,
YOU SHOULD ENTER THE SOIL DATA AGAIN OR CORRECT THE SCS
RUNOFF CURVE NUMBER.

The program then asks for the thickness of the evaporative zone as follows:

2.9 ENTER THE EVAPORATIVE ZONE DEPTH IN INCHES.

```
CONSERVATIVE VALUES ARE:
         4 IN. FOR BAREGROUND
        10 IN. FOR FAIR GRASS
        18 IN. FOR EXCELLENT GRASS
```

and the user must respond with an appropriate value.

MANUAL RAINFALL DATA (3. MCDATA)

If the user specified, in response to question 1.2, that default climatologic data would not be used, the program asks the user whether it is desired to build a climatologic data file from scratch or correct previously entered data. The question posed is

3.1 DO YOU WANT TO ENTER PRECIPITATION DATA?
ENTER YES OR NO.

If the user wishes to enter a completely new set of precipitation data or to add or replace years of precipitation data in the existing precipitation data file, the user should enter YES to question 3.1; otherwise, the user should enter NO. A NO answer passes control to subroutine 9. PRECHK (question 9.1) where the user is provided an opportunity to correct lines of the precipitation data. A YES answer prompts the program to produce instructions for entering precipitation data and ask question 3.2.

3.2 DO YOU WANT TO CORRECT OR ADD TO EXISTING PRECIPITATION DATA?
ENTER YES OR NO.

The user should enter YES to question 3.2 if the user wishes to add, replace, check or correct years of precipitation data in the existing precipitation data file. A YES answer passes control to question 3.8. An answer of NO indicates that the user wishes a completely new set of precipitation data and prompts the program to respond

3.3 YOU ARE ENTERING A COMPLETE NEW SET OF PRECIPITATION DATA.

and to instruct the user to

3.4 ENTER THE YEAR OF PRECIPITATION DATA TO BE ENTERED.
ENTER 0 (ZERO) TO END RAINFALL INPUT.

If the user enters 0 in response to instruction 3.4, precipitation input is stopped and control is passed to subroutine 9. PRECHK (question 9.1). If the user enters a year for which precipitation data have been previously entered, the program responds

3.5 ______ ALREADY EXISTS IN THE DATA.
DO YOU WANT TO REPLACE THE EXISTING DATA?
ENTER YES OR NO.

Otherwise, the program transfers control to question 3.6 where the user is requested to enter the precipitation data.

If the user answers NO to question 3.5, control is returned to question 3.4 and a new year must be specified. If the user answers YES, the program will replace the data for the specified year and requests the user to enter the precipitation data as follows:

3.6 ENTER TEN DAILY PRECIPITATION VALUES PER LINE
AND 37 LINES PER YEAR FOR __.

3.7 ENTER LINE 1.

The user should enter 10 values for daily rainfall in inches in accordance with the guidance presented previously in the part of this section titled "RULES". After each line is entered, the program repeats instruction 3.7 until all 37 lines of data are entered for the year. The program then returns control to question 3.4 until 20 years of data have been entered if the user is entering a completely new data file or to question 3.8 if the user is working on an existing data file.

If the user wanted to enter precipitation data in order to add more years of data to the existing data or to correct the existing data (i.e., the user answered YES to question 3.2), the program asks

3.8 DO YOU WANT TO ADD OR REPLACE ADDITIONAL YEARS OF
PRECIPITATION VALUES IN THE EXISTING DATA?
ENTER YES OR NO.

If the user answers NO to question 3.8, control is passed to subroutine 9. PRECHK (question 9.1) where the user has the opportunity to correct lines of data in the existing precipitation data file. If the user answers YES, the program lists the years for which precipitation data have been stored. If the user had previously entered data for 1974, 1975, 1976, 1977 and 1978, the program would respond

3.9 DATA EXIST FOR 5 YEARS: 1974 1975 1976 1977 1978

If less than 20 years of precipitation data are stored, the program passes control to question 3.4 to allow the user to enter the year of the data to be added or replaced. Data for a given year stored in the data file may be replaced with data for a different year only if 20 years of data are already stored; else, data can be replaced only with other data for the same year. If 20 years of data are already stored, the program responds

3.10 TWENTY YEARS OF PRECIPITATION DATA
HAVE ALREADY BEEN ENTERED.
DO YOU WISH TO REPLACE ANY YEARS OF DATA?
ENTER YES OR NO.

A NO answer to question 3.10 prompts the program to transfer control to subroutine 9. PRECHK (question 9.1) while a YES answer produces the following instruction:

3.11 ENTER THE YEAR TO BE REPLACED.

If the user responds with one of the years in the data file, control is passed to question 3.4. If data for the year specified by the user is not already stored, the program responds

3.12 ______ IS NOT IN THE EXISTING DATA.

and returns control to question 3.10. The user should consult message 3.9 to select a year for replacement that presently exists in the data file.

DEFAULT SOIL DATA (4. DSDATA)

If the user responds YES to question 1.3, the program issues some general instructions on entering soil data and then prints

4.1 ENTER TITLE ON LINE 1,
ENTER LOCATION OF SOLID WASTE SITE ON LINE 2,
AND ENTER TODAY'S DATE ON LINE 3.

The user enters this information on the following lines in any format desired since this information is only used for a heading. The program then responds

4.2 FOUR TYPES OF LAYERS MAY BE USED IN THE DESIGN:
VERTICAL PERCOLATION, LATERAL DRAINAGE, BARRIER SOIL, AND WASTE.

LATERAL DRAINAGE IS NOT PERMITTED FROM A VERTICAL PERCOLATION LAYER.
BOTH VERTICAL AND LATERAL DRAINAGE ARE PERMITTED FROM A LATERAL DRAINAGE LAYER.
A BARRIER SOIL LAYER SHOULD BE DESIGNED TO INHIBIT PERCOLATION.
AN IMPERMEABLE LINER MAY BE USED ON TOP OF ANY BARRIER SOIL LAYER.
THE WASTE LAYER SHOULD BE DESIGNED TO PERMIT RAPID DRAINAGE FROM THE WASTE LAYER.

RULES:

THE TOP LAYER CANNOT BE A BARRIER SOIL LAYER.
A BARRIER SOIL LAYER MAY NOT BE PLACED ADJACENT TO ANOTHER BARRIER SOIL LAYER.
ONLY A BARRIER SOIL LAYER OR ANOTHER LATERAL DRAINAGE LAYER MAY BE PLACED DIRECTLY BELOW A LATERAL DRAINAGE LAYER.
YOU MAY USE UP TO 9 LAYERS AND UP TO 3 BARRIER SOIL LAYERS.

ENTER THE NUMBER OF LAYERS IN YOUR DESIGN.

If the user enters a value between 2 and 9 for the number of layers (e.g., 5), the program responds

4.3 THE LAYERS ARE NUMBERED SUCH THAT
SOIL LAYER 1 IS THE TOP LAYER
AND SOIL LAYER 5 IS THE BOTTOM LAYER.

If the user entered 1, the program responds

4.4 SOIL LAYER 1 IS THE ONLY SOIL LAYER.

If the user entered a value which is less than 1 or greater than 9, the program responds

4.5 YOU MAY HAVE 1 TO 9 LAYERS.
ENTER THE NUMBER OF LAYERS IN YOUR DESIGN.

and the user must enter the number of layers again.

After the user has entered an acceptable number of layers, the program asks the following question:

4.6 IS THE TOP LAYER AN UNVEGETATED SAND OR GRAVEL LAYER?
ENTER YES OR NO.

The answer to this question affects the manner in which the program models percolation through the evaporative zone on days when infiltration occurs. If YES is answered, the model assumes that there is little capillary suction to draw water into lower layers and that percolation does not occur until the soil moisture in the evaporative zone exceeds the field capacity. These conditions are more typical of unvegetated or poorly vegetated sand or gravel layers occasionally used in semi-arid and arid climates. If NO is answered, the model assumes that water is drawn into the lower layers by capillary suction when infiltration occurs. This assumption is applicable for typical landfill designs where the top layer is a vegetated topsoil with a shallow water table or where the top layer is a clay or a loam.

After the user answers question 4.6, the program instructs the user to enter information describing the soil layers by repeating a loop of questions for each layer. The loop contains questions 4.7, 4.9, 4.15 and, in some cases, 4.23. The first instruction, given here for layer 1, is

4.7 ENTER THICKNESS OF SOIL LAYER _1_ IN INCHES.

If the user enters a value that is less than or equal to zero, the program warns

4.8 THICKNESS MUST BE GREATER THAN ZERO.

and returns control to question 4.7.

After question 4.7 is satisfactorily answered, the program instructs the user to

4.9 ENTER THE LAYER TYPE FOR LAYER _1_.

When data are being entered for the first layer, the program prints the following list of possible layer types which is not repeated for the other layers.

4.10 ENTER 1 FOR A VERTICAL PERCOLATION LAYER,
2 FOR A LATERAL DRAINAGE LAYER,
3 FOR A BARRIER SOIL LAYER,
4 FOR A WASTE LAYER, AND
5 FOR A BARRIER SOIL LAYER WITH
AN IMPERMEABLE LINER.

If the user enters a number other than 1 through 5 (e.g., 6), the program responds

4.11 6 INAPPROPRIATE VALUE--TRY AGAIN.

and returns control to question 4.9.

Several rules governing the order of layers in the landfill design were given in question 4.2. If these rules are not followed, the program prints an appropriate warning and returns control to question 4.9 to obtain an acceptable layer type. The warnings are

4.12 THE TOP LAYER MAY NOT BE A BARRIER SOIL LAYER.

4.13 EITHER A LATERAL DRAINAGE LAYER OR A BARRIER SOIL LAYER MUST FOLLOW A LATERAL DRAINAGE LAYER.--TRY AGAIN.

4.14 A BARRIER SOIL LAYER MAY NOT BE PLACED DIRECTLY BELOW ANOTHER BARRIER SOIL LAYER.

After an acceptable layer type is entered, the program requests the user to

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 1.

When data are being entered for the first layer, the program prints the following additional instructions:

4.16 ENTER A NUMBER (1 THROUGH 23) FOR TEXTURE CLASS OF SOIL MATERIAL.
CHECK USER'S GUIDE FOR NUMBER CORRESPONDING TO SOIL TYPE.

If the user enters a number other than 1 through 23 (e.g., 26), the program responds

4.17 26 INAPPROPRIATE SOIL TEXTURE NUMBER--TRY AGAIN.

and returns control to question 4.15.

Default soil data exist only for soil texture 1 through 21 as given in Table 2. Soil textures 22 and 23 are available to provide the user an opportunity to describe the soil characteristics of some layers manually while using default soil data for other layers. Therefore, if soil texture types 22 or 23 are specified, the program asks questions 4.18 through 4.22 to obtain the soil characteristics. The appropriate value must be entered in response to each of the following commands.

4.18 ENTER THE POROSITY OF THE LAYER IN VOL/VOL.

4.19 ENTER THE FIELD CAPACITY OF THE LAYER IN VOL/VOL.

4.20 ENTER THE WILTING POINT OF THE LAYER IN VOL/VOL.

4.21 ENTER THE HYDRAULIC CONDUCTIVITY OF THE LAYER IN INCHES/HR.

4.22 ENTER THE EVAPORATION COEFFICIENT OF THE LAYER IN MM/DAY**.5.

The default soil data for soil texture types 1 through 18 are typical values for uncompacted soils while default soil data for soil texture types 19, 20 and 21 are typical values for compacted municipal solid waste, and compacted clay barrier soils. Therefore, if soil textures 1 through 18 are specified, the program provides the user with an opportunity to correct the default soil data for compaction by asking (in this case for soil layer 2)

4.23 IS SOIL LAYER 2 COMPACTED?
ENTER YES OR NO.

If the layer under consideration is the top layer, the program also prints

4.24 THE VEGETATIVE SOIL LAYER IS GENERALLY NOT COMPACTED.

If the layer under consideration had been designated to be a barrier soil layer (either layer type 3 or 5), the program also prints

4.25 THE BARRIER SOIL LAYER IS GENERALLY COMPACTED.

If question 4.23 is answered YES, the hydraulic conductivity is reduced by a factor of 20, the porosity and plant available water capacity is reduced by 25 percent, and the evaporation coefficient is reduced to 3.1 $mm/day^{0.5}$. If NO is answered, the data from Table 2 are used.

After question 4.23 is answered, the loop of questions 4.7 through 4.23 is repeated for the rest of the layers. After data for all layers have been specified, the program checks the layer type of the bottom layer. If the bottom layer is a lateral drainage layer and less than 9 layers have been used in the design, the program provides the user with an opportunity to enter data for a barrier layer to be placed under the bottom lateral drainage layer by asking

4.26 A BARRIER LAYER SHOULD BE USED BELOW THE
BOTTOM LATERAL DRAINAGE LAYER.

DO YOU WANT TO ENTER DATA FOR A BARRIER LAYER?
ENTER YES OR NO.

IF NO IS ENTERED, THE MODEL ASSUMES THAT LATERAL
DRAINAGE DOES NOT OCCUR FROM THE BOTTOM LAYER.

If the bottom layer is a lateral drainage layer and 9 layers have already been used in the design, the program responds

4.27 A BARRIER LAYER SHOULD HAVE BEEN SPECIFIED.
THE MODEL ASSUMES THAT LATERAL DRAINAGE DOES NOT
OCCUR FROM THE BOTTOM LAYER.

A barrier soil layer must be placed below the bottom lateral drainage layers if the program is to estimate lateral drainage from the bottom subprofile. If a barrier soil layer was not used, the program models the lateral drainage layers in the bottom subprofile as if they were vertical percolation layers.

If the user answers YES to question 4.26, control is transferred to question 4.7 where the loop for entering data for a layer starts. If NO is answered, the program asks question 4.28 if a synthetic flexible membrane liner is used in the design.

4.28 WHAT FRACTION OF THE AREA DRAINS THROUGH LEAKS IN THE MEMBRANE
OR WHAT FRACTION OF THE DAILY POTENTIAL PERCOLATION THROUGH THE
BARRIER SOIL LAYER OCCURS ON THE GIVEN DAY?
ENTER BETWEEN 0 AND 1.

If the value entered for question 4.28 is less than 0 or greater than 1, the program responds

4.29 INAPPROPRIATE VALUE--TRY AGAIN.

and question 4.28 is repeated. If an acceptable value was entered, control for most cases is passed to question 4.30 where the user is requested to describe the vegetative cover. If a membrane liner was not used in a design and NO was answered to question 4.26, control is also passed to question 4.30 for most cases. Control is not passed to question 4.30 if the top layer was designated to be a waste layer. Specifying the top layer to be a waste layer indicates to the program that the landfill is open and unvegetated. Control in this case is passed to subroutine 7. OPEN (question 7.1). If default climatologic data have been entered during this run, question 4.30 is not asked since the vegetation was described when the climatologic data were entered.

The program requests a description of the vegetative cover as follows:

4.30 SELECT THE TYPE OF VEGETATIVE COVER.

ENTER NUMBER 1 FOR BARE GROUND
2 FOR EXCELLENT GRASS
3 FOR GOOD GRASS
4 FOR FAIR GRASS
5 FOR POOR GRASS
6 FOR GOOD ROW CROPS
7 FOR FAIR ROW CROPS

If the user enters a value that is less than 1 or greater than 7 (e.g., 9), the program responds

4.31 9 INAPPROPRIATE VALUE--TRY AGAIN.

and repeats question 4.30. Otherwise, the program warns

4.32 IF YOU ARE USING DEFAULT CLIMATOLOGIC DATA AND
THIS VEGETATION TYPE IS NOT THE SAME USED IN
THE CLIMATOLOGIC DATA INPUT, YOU SHOULD
ENTER THE CLIMATOLOGIC DATA AGAIN.

and passes control to question 4.33.

The program calculates the SCS runoff curve number based on the vegetation type and the soil texture of the top layer if one of the default soil textures were used for this layer (soil texture types 1 through 21). The equation used to calculate the curve numbers was developed for landfill with mild surface slopes (2 to 4 percent). The program provides the user with an opportunity to enter a curve number and override the default value as follows:

4.33 DO YOU WANT TO ENTER A RUNOFF CURVE
NUMBER AND OVERRIDE THE DEFAULT VALUE?
ENTER YES OR NO.

If NO is answered, control is transferred to subroutine 6. SITE (question 6.1) where the program requests more information describing the landfill site and design. If YES is answered or if the top layer has a soil texture number of 22 or 23 and is not a waste layer, the program asks the user to

4.34 ENTER SCS RUNOFF CURVE NUMBER (BETWEEN 15 AND 100).

Control is then transferred to subroutine 6. SITE (question 6.1).

MANUAL SOIL DATA (5. MSDATA)

If the user specified in response to question 1.3 that the default soil data is not to be used, then the program enters the manual soil data input subroutine (MSDATA). Many of the questions are the same in the default and manual soil data subroutines. The primary difference is that in entering manual soil data, the user must specify numerical values for soil porosity, field capacity, wilting point, hydraulic conductivity, and evaporation coefficient, while, in the default soil data subroutine, the user needs to merely specify a code number for the soil type.

The first question is

5.1 DO YOU WANT TO CORRECT OR CHECK
THE EXISTING DESIGN AND SOIL DATA?
ENTER YES OR NO.

If the user responds YES, the program assumes that soil data have already been entered and control is passed to subroutine 10. SDCHK (question 10.1) where the soil data may be corrected. If the user answers NO, the program prints a message and asks the user to begin building a data file.

5.2 YOU ARE ENTERING A COMPLETE NEW DATA SET.

```
*********************************************************************
              USE ONLY ENGLISH UNITS OF INCHES AND DAYS
                     UNLESS OTHERWISE INDICATED

#########################ANSWER ALL QUESTIONS#######################
*********************************************************************
            A VALUE **MUST** BE ENTERED FOR EACH COMMAND
                    EVEN WHEN THE VALUE IS ZERO.
*********************************************************************
```

ENTER TITLE ON LINE 1,
ENTER LOCATION OF SOLID WASTE SITE ON LINE 2
AND ENTER TODAY'S DATE ON LINE 3.

After the user enters the title, the program prints information on describing the layers in the landfill design and requests the user to enter the number of layers.

5.3 FOUR TYPES OF LAYERS MAY BE USED IN THE DESIGN:
VERTICAL PERCOLATION, LATERAL DRAINAGE, BARRIER SOIL, AND WASTE.

LATERAL DRAINAGE IS NOT PERMITTED FROM A VERTICAL PERCOLATION LAYER.
BOTH VERTICAL AND LATERAL DRAINAGE ARE PERMITTED FROM A LATERAL DRAINAGE LAYER.
A BARRIER SOIL LAYER SHOULD BE DESIGNED TO INHIBIT PERCOLATION.
AN IMPERMEABLE LINER MAY BE USED ON TOP OF ANY BARRIER SOIL LAYER.
THE WASTE LAYER SHOULD BE DESIGNED TO PERMIT RAPID DRAINAGE FROM THE WASTE LAYER.

RULES:

THE TOP LAYER CANNOT BE A BARRIER SOIL LAYER.
A BARRIER SOIL LAYER MAY NOT BE PLACED ADJACENT TO ANOTHER BARRIER SOIL LAYER.
ONLY A BARRIER SOIL LAYER OR ANOTHER LATERAL DRAINAGE LAYER MAY BE PLACED DIRECTLY BELOW A LATERAL DRAINAGE LAYER.
YOU MAY USE UP TO 9 LAYERS AND UP TO 3 BARRIER SOIL LAYERS.

ENTER THE NUMBER OF LAYERS IN YOUR DESIGN.

If the user enters a value between 2 and 9 (e.g., 3), the program responds

5.4 THE LAYERS ARE NUMBERED SUCH THAT
SOIL LAYER 1 IS THE TOP LAYER
AND SOIL LAYER _3_ IS THE BOTTOM LAYER.

If the user entered 1, the program responds

5.5 SOIL LAYER 1 IS THE ONLY LAYER.

If the user entered a value that is less than 1 or greater than 9, the program responds

5.6 YOU MAY HAVE 1 TO 9 LAYERS.
ENTER THE NUMBER OF LAYERS IN YOUR DESIGN.

and the user must enter the number of layers again.

After the user has entered an acceptable number of layers, the program asks the following question:

5.7 IS THE TOP LAYER AN UNVEGETATED SAND OR GRAVEL LAYER?
ENTER YES OR NO.

The user should refer to the discussion for question 4.6 to understand the implication of this question.

After the user answers question 5.7, the program instructs the user to enter information describing the soil layers by repeating a loop of questions for each layer. The loop contains questions 5.8, 5.10, 5.11, 5.12, 5.13, 5.14, and 5.15. The first instruction, shown here for layer 1, is

5.8 ENTER THICKNESS OF SOIL LAYER _1_ IN INCHES.

If the user enters a value that is less than or equal to zero, the program warns

5.9 THICKNESS MUST BE GREATER THAN ZERO.

and returns control to question 5.8.

After question 5.8 is satisfactorily answered, the program asks the following questions. The program does not check the specified numerical values for their appropriateness.

5.10 ENTER THE POROSITY OF SOIL LAYER _1_ IN VOL/VOL.

5.11 ENTER THE FIELD CAPACITY OF SOIL LAYER _1_ IN VOL/VOL.

5.12 ENTER THE WILTING POINT OF SOIL LAYER _1_ IN VOL/VOL.

5.13 ENTER THE HYDRAULIC CONDUCTIVITY OF SOIL LAYER _1_ IN INCHES/HR.

5.14 ENTER THE EVAPORATION COEFFICIENT OF SOIL LAYER _1_
IN (MM)/(DAY**0.5).

After asking questions 5.10 through 5.14, the program instructs the user to

5.15 ENTER THE LAYER TYPE FOR LAYER 1.

When data are being entered for the first layer, the program prints the following list of possible layer types. This list is not repeated for the other layers.

5.16 ENTER 1 FOR A VERTICAL PERCOLATION LAYER,
2 FOR A LATERAL DRAINAGE LAYER,
3 FOR A BARRIER SOIL LAYER,
4 FOR A WASTE LAYER AND
5 FOR A BARRIER SOIL LAYER WITH
AN IMPERMEABLE LINER.

If the user enters a value other than 1 through 5 (e.g., 7), the program responds

5.17 7 INVALID VALUE--TRY AGAIN

and repeats question 5.15 until an acceptable response is given.

Several rules governing the ordering of layers in the landfill design were given in question 5.3. If these rules are not followed, the program prints an appropriate warning and returns control to question 5.15 to obtain an acceptable layer type. The warnings are

5.18 THE TOP LAYER MAY NOT BE A BARRIER SOIL LAYER.

5.19 EITHER A LATERAL DRAINAGE LAYER OR
A BARRIER SOIL LAYER MUST FOLLOW
A LATERAL DRAINAGE LAYER.--TRY AGAIN.

5.20 A BARRIER SOIL LAYER MAY NOT BE PLACED DIRECTLY BELOW
ANOTHER BARRIER SOIL LAYER.

After question 5.15 is answered, the loop of questions 5.8 through 5.15 is repeated for the rest of the layers. After data for all layers have been specified, the program checks the layer type of the bottom layer. If the bottom layer is a lateral drainage layer and less than 9 layers have been used in the design, the program provides the user with an opportunity to enter data for a barrier layer to be placed under the bottom lateral drainage layer by asking

5.21 A BARRIER LAYER SHOULD BE USED BELOW THE BOTTOM LATERAL
DRAINAGE LAYER.

DO YOU WANT TO ENTER DATA FOR A BARRIER LAYER?
ENTER YES OR NO.

IF NO IS ENTERED, THE MODEL ASSUMES THAT
LATERAL DRAINAGE DOES NOT OCCUR FROM THE BOTTOM LAYER.

If the bottom layer is a lateral drainage layer and 9 layers have already been used in the design, the program responds

5.22 A BARRIER LAYER SHOULD HAVE BEEN SPECIFIED.
THE MODEL ASSUMES THAT LATERAL DRAINAGE DOES NOT OCCUR
FROM THE BOTTOM LAYER.

A barrier soil layer must be used below the bottom lateral drainage layers if the program is to estimate lateral drainage from the bottom subprofile. If a barrier soil layer was not used, the program models the lateral drainage layers in the bottom subprofile as if they were vertical percolation layers.

If the user answers YES to question 5.21, control is transferred to question 5.8 where the loop for entering data for a layer starts. If NO is answered, the program asks question 5.23 if a synthetic flexible membrane liner is used in the design.

5.23 WHAT FRACTION OF THE AREA DRAINS THROUGH LEAKS IN THE MEMBRANE
OR WHAT FRACTION OF THE DAILY POTENTIAL PERCOLATION THROUGH THE
BARRIER SOIL LAYER OCCURS ON THE GIVEN DAY?
ENTER BETWEEN 0 AND 1.

If the value entered for question 5.23 is less than 0 or greater than 1, the program responds

5.24 INAPPROPRIATE VALUE--TRY AGAIN.

and question 5.23 is repeated. If an acceptable value was entered or if a membrane liner was not used in the design, question 5.25 is asked next unless the top layer in the design is a waste layer.

5.25 ENTER THE SCS RUNOFF CURVE NUMBER FOR THE DESIGN VEGETATIVE SOIL
AND VEGETATIVE COVER UNDER ANTECEDENT MOISTURE CONDITION II.
(BETWEEN 15 AND 100)

The user must enter an appropriate runoff curve number since the program does not check the numerical value.

If the top layer in the design is a waste layer, control is passed to subroutine 7. OPEN (question 7.1). Question 5.25 is not asked since the user will enter a runoff curve number in subroutine OPEN.

Control is passed to subroutine 6. SITE (question 6.1) after asking question 5.25 or the questions in subroutine OPEN. In subroutine SITE the program requests additional information describing the landfill design.

SITE DESCRIPTION (6. SITE)

After the user has completed soil data input, using either the default or manual options, the program asks the user for additional information on the site design. In order to compute estimates of the water budget components in volume units, the program needs the surface area of the landfill and inquires

6.1 ENTER THE TOTAL AREA OF THE SURFACE, IN SQUARE FEET.

The computation of lateral drainage estimates is a function of the slope of the surface of the barrier soil layer. Lateral drainage is also a function of the maximum drainage distance to the collector along the surface of the barrier soil layer. Therefore, the program asks for the slope and maximum drainage distance at the base of the bottom lateral drainage layer in each lateral drainage subprofile.

6.2 ENTER THE SLOPE AT THE BASE OF SOIL LAYER _1_, IN PERCENT.

6.3 ENTER THE MAXIMUM DRAINAGE DISTANCE ALONG THE SLOPE
TO THE COLLECTOR, IN FEET.

These two questions are repeated for each lateral drainage subprofile. After asking for the slope and drainage distance for each lateral drainage subprofile, the program passes control to question 1.1 if the default soil data input option was used and to subroutine SDCHK (question 10.1) to check the soil and design data if the manual soil data input option was used.

CHARACTERISTICS OF OPEN SITES (7. OPEN)

If the soil data subroutine detects that a landfill is to be simulated as being open (i.e., the top layer is a waste layer), the following questions are asked:

7.1 ENTER THE SCS RUNOFF CURVE NUMBER FOR THE SOIL TEXTURE AND AVERAGE
MOISTURE CONDITION OF THE TOP WASTE LAYER.
(BETWEEN 15 AND 100)

The user also has the option of specifying the fraction of the total potential runoff that actually drains from the surface of the waste layer. This is especially useful when the top of the waste cell is in a pit without provisions for drainage. The question is

7.2 WHAT FRACTION OF THE DAILY POTENTIAL RUNOFF DRAINS FROM THE
SURFACE OF THE WASTE LAYER?
ENTER BETWEEN 0 AND 1.

The user input is not checked. After this question is answered, control passes to subroutine 6. SITE (question 6.1) to request additional design information.

MANUAL CLIMATOLOGIC DATA EXCEPT RAINFALL (8. MTRLYR)

After the user manually enters precipitation data using subroutine MCDATA, the temperature, solar radiation, winter cover factor, evaporative zone depth and leaf area index data may be entered manually using this subroutine. The program asks

8.1 DO YOU WANT TO ENTER OR CORRECT
OTHER CLIMATOLOGIC DATA?
ENTER YES OR NO.

If the user answers NO, the program returns control to question 1.1 and assumes that the user will enter these data later or that the user wishes to use the climatologic data that was previously entered using either manual or default data input options. The program does not assign default values for these climatologic parameters when rainfall data was entered manually; therefore, the user should enter these data for the initial run to prevent unpredictable results. The user may enter default values for these parameters by using the default climatologic data input option, subroutine 2. DCDATA, and then manually replacing the precipitation data using the manual climatologic data input option for rainfall, subroutine 3. MCDATA.

If the user answers YES to question 8.1, the program asks

8.2 DO YOU WANT TO ENTER TEMPERATURE DATA?
ENTER YES OR NO.

If the user answers NO, control is passed to question 8.12. If YES is entered, the program asks

8.3 DO YOU WANT TO ENTER A DIFFERENT SET OF
MONTHLY TEMPERATURES FOR EACH YEAR?

ENTER YES OR NO.

(IF NO IS ENTERED, THE PROGRAM WILL USE THE
SAME SET OF MONTHLY TEMPERATURES FOR EACH
YEAR OF SIMULATION.)

If the user enters NO, control is transferred to question 8.10.

If YES is answered in response to question 8.3, the program asks a loop of questions (8.4 through 8.9) that is repeated for each year for which precipitation data were entered. The program first prompts

8.4 ENTER MONTHLY TEMPERATURES FOR 1970.

If 1970 is not the first year (i.e., it is not the first time through the loop), the program gives the user an opportunity to use the same values that were used during the previous time through the loop instead of entering new values. The program asks

8.5 DO YOU WANT TO USE THE SAME VALUES AS THE PREVIOUS YEAR?
ENTER YES OR NO.

If the user answers YES, the program returns to question 8.4 for the next year of values.

If question 8.5 is answered NO or if it is the first time through the loop of questions 8.4 through 8.9, the program instructs the user to

8.6 ENTER MONTHLY VALUES FOR JANUARY THROUGH JUNE 1970 IN DEGREES F.
ENTER ALL 6 VALUES IN THE SAME LINE.

If fewer than 6 values are entered, the remaining values are assumed to be zeros. After the user responds to question 8.6, the program asks

8.7 ENTER MONTHLY VALUES FOR JULY THROUGH DECEMBER 1970 IN DEGREES F.
ENTER ALL 6 VALUES IN THE SAME LINE.

After the user responds, the program lists the 12 values and then asks the user if the values need to be corrected. For example,

8.8 THESE ARE THE INPUT TEMPERATURE VALUES.

JAN.-JUNE	JULY-DEC.
24.5	68.2
26.7	66.1
31.2	53.9
45.3	49.9
54.2	41.8
67.2	35.0

8.9 DO YOU WANT TO CHANGE THEM?
ENTER YES OR NO.

If the user answers YES, control returns to question 8.6. If the user answers NO, the loop is completed and starts again at question 8.4 for the next year of data. If all years of temperature data have been entered, the program passes control to question 8.12.

If the user entered NO in response to question 8.3, the program would have responded

8.10 ENTER THE MONTHLY TEMPERATURES IN DEGREES F.
TO BE USED FOR ALL YEARS OF SIMULATION.

ENTER VALUES FOR JANUARY THROUGH JUNE.
ENTER ALL 6 VALUES IN THE SAME LINE.

After the user responds, the program prompts the user to

8.11 ENTER MONTHLY VALUES FOR JULY THROUGH DECEMBER IN DEGREES F.
ENTER ALL 6 VALUES IN THE SAME LINE.

The program then prints a list of the 12 values as in message 8.8 and ask the user if they need to be corrected (question 8.9). If the values need to be changed, control is returned to question 8.10; else, control is transferred to question 8.12.

After the temperature values have been entered, the program asks

8.12 DO YCU WANT TO ENTER SOLAR RADIATION DATA?
ENTER YES OR NO.

If the user answers NO, control is passed to question 8.20. If YES is entered, the program asks

8.13 DO YOU WANT TO ENTER A DIFFERENT SET OF
MONTHLY SOLAR RADIATION VALUES FOR EACH YEAR?
ENTER YES OR NO.

If the user enters NO, the program will use the same set of monthly solar radiation (insolation) values for each year of simulation and control is passed to question 8.18 for this input.

If YES is answered in response to question 8.13, the program asks a loop of questions (8.14 through 8.17 and 8.9) that is repeated for each year which precipitation data were entered. The program first prompts

8.14 ENTER MONTHLY SOLAR RADIATION VALUES FOR 1970.

If 1970 is not the first year of data, the program asks question 8.5 to give the user an opportunity to use the same values that were used during the last time through the loop instead of entering new values. If the user wishes to use the same values, the program returns to question 8.14 for the next year of values.

If the user wishes to enter new values or if it is the first time through the loop of questions 8.14 through 8.17, the program prompts the user to

8.15 ENTER MONTHLY SOLAR RADIATION VALUES FOR
JANUARY THROUGH JUNE 1970 IN LANGLEYS/DAY.
ENTER ALL 6 VALUES IN THE SAME LINE.

After the user responds, the program asks

8.16 ENTER MONTHLY SOLAR RADIATION VALUES FOR
JULY THROUGH DECEMBER 1970 IN LANGLEYS/DAY.
ENTER ALL 6 VALUES IN THE SAME LINE.

After the user responds, the program lists the 12 values as shown below and then asks question 8.9 to see if the values need to be corrected.

8.17 THESE ARE THE INPUT SOLAR RADIATION VALUES.

JAN.-JUNE	JULY-DEC.
220.0	450.0
250.0	420.0
285.0	395.0
330.0	350.0
420.0	290.0
448.0	230.0

If the values need to be changed, the program returns to question 8.15; otherwise, the loop of questions is completed and starts again at question 8.14 for the next year of data. If all years of solar radiation data have been entered, the program passes control to question 8.20.

If the user answered NO in response to question 8.13, the program would have responded

8.18 ENTER THE MONTHLY SOLAR RADIATION VALUES IN LANGLEYS/DAY
TO BE USED FOR ALL YEARS OF SIMULATION.
ENTER VALUES FOR JANUARY THROUGH JUNE.
ENTER ALL 6 VALUES IN THE SAME LINE.

After the user responds, the program instructs the user to

8.19 ENTER MONTHLY SOLAR RADIATION VALUES IN
LANGLEYS/DAY FOR JULY THROUGH DECEMBER.
ENTER ALL 6 VALUES IN THE SAME LINE.

The program then prints a list of the 12 values as in message 8.17 and asks the user if they need to be corrected (question 8.9). If the values need to be changed, control is returned to question 8.18; otherwise, control is transferred to question 8.20.

After the solar radiation values have been entered, the program asks

8.20 DO YOU WANT TO ENTER EVAPORATIVE ZONE DEPTHS?
ENTER YES OR NO.

If the user answers NO, control is transferred to question 8.23. If YES is entered, the program instructs the user to

8.21 ENTER THE EVAPORATIVE ZONE DEPTH IN INCHES
TO BE USED FOR ALL YEARS OF SIMULATION.

CONSERVATIVE VALUES ARE:
4 IN. FOR BAREGROUND
10 IN. FOR FAIR GRASS
18 IN. FOR EXCELLENT GRASS

Unlike the input for the other climatologic parameters, a different value for the evaporative zone depth may not be entered for each of the various years of simulation. The single evaporative zone depth entered in response to question 8.21 is used for each year of simulation. After the user answers this question, the program responds

8.22 THE EVAPORATIVE ZONE DEPTH IS 10.00.
DO YOU WANT TO CHANGE IT? ENTER YES OR NO.

If the user enters YES, the program repeats question 8.21. If NO is entered, the program passes control to question 8.23.

After the user has entered the evaporative zone depth, the program asks

8.23 DO YOU WANT TO ENTER WINTER COVER FACTORS?
ENTER YES OR NO.

If the user answers NO, control is passed to question 8.28. If YES is entered, the program asks

8.24 DO YOU WANT TO ENTER A DIFFERENT WINTER COVER
FACTOR FOR EACH YEAR?
ENTER YES OR NO.

If the user enters NO, the program will use the same winter cover factor for each year of simulation and control is passed to question 8.27 for this input.

If YES is answered in response to question 8.24, the program asks questions 8.25 and 8.26 for each year which precipitation data were entered. The program first instructs the user to

8.25 ENTER THE WINTER COVER FACTOR FOR 1970 (BETWEEN 0 AND 1.8).

After the user responds, the program lists the value and asks if the value needs to be corrected.

8.26 THE WINTER COVER FACTOR ENTERED IS 0.70.
DO YOU WANT TO CHANGE IT? ENTER YES OR NO.

If the user indicates that the value needs to be changed, question 8.25 is repeated; otherwise, question 8.25 is asked to obtain the winter cover factor for the following year of simulation. If all years of data have been entered, the program passes control to question 8.28.

If the user entered NO in response to question 8.24, the program would have responded

8.27 ENTER THE WINTER COVER FACTOR TO BE USED
FOR ALL YEARS OF SIMULATION.

After the user responds, the program, using message 8.27, lists the value and asks the user if the value needs to be corrected. If the value needs to be changed, question 8.27 is repeated; otherwise, control is transferred to question 8.28.

After the winter cover factors have been entered, the program asks

```
8.28 DO YOU WANT TO ENTER LEAF AREA INDEX DATA?
ENTER YES OR NO.
```

If the user enters NO, manual climatologic data input is concluded and control is passed to question 1.1. If YES is entered, the program responds

```
8.29 13 LEAF AREA INDICES MUST BE ENTERED FOR A
YEAR OF SIMULATION.
EACH INDEX IS COMPOSED OF THE DATE OF THE MEASUREMENT
AND THE LEAF AREA MEASUREMENT.
**REMEMBER TO START WITH DAY 1 AND END WITH DAY 366.**

DO YOU WANT TO ENTER A DIFFERENT SET OF
LEAF AREA INDICES FOR EACH YEAR?
ENTER YES OR NO.
```

If the user answers NO, the program will use the same set of leaf area indices for each year of simulation and control is passed to question 8.33 for this input.

If YES is answered in response to question 8.29, the program asks questions 8.30, 8.31, 8.32 and 8.9 that are repeated in a loop for each year which precipitation data were entered. The program first prompts

8.30 ENTER LEAF AREA INDICES FOR <u>1970</u>.

If 1970 is not the first year of data, the program asks question 8.5 to give the user an opportunity to use the same indices that were used during the last time through the loop instead of entering new values. If the user wishes to use the same indices, the program returns to question 8.30 for the next year of values.

If the user wishes to enter new values or if it is the first time through the loop of questions 8.30 through 8.32, the program instructs the user to

8.31 ENTER TWO VALUES PER LINE--THE JULIAN DATE
AND THE LEAF AREA MEASUREMENT FOR INDEX <u>1</u>.

The leaf area indices are not monthly average values as are the temperature and solar radiation data; instead, the user must select 13 dates of the year (including Julian dates 1 and 366) which describe the vegetative growth. The program interpolates the leaf area linearly between the specified dates. The Julian date for index 1 must be 1 and the Julian date for index 13 must be 366.

Question 8.31 is repeated until all 13 leaf area indices are entered. At that time, the program prints the leaf area indices (message 8.32) and asks the user (question 8.9) if the values need to be corrected.

8.32 THESE ARE THE INPUT DATES AND LAI VALUES FOR 1970.

DATE	LAI
1	0.0
31	0.10
66	0.20
99	0.60
130	1.00
160	1.40
190	1.70
222	1.60
255	1.20
280	0.80
310	0.30
340	0.10
366	0.0

If the values need to be changed, the program returns to question 8.31; otherwise, the loop of questions is completed and starts again at question 8.30 for the next year of indices. If all years of data have been entered, the manual climatologic data input is concluded and control is passed to question 1.1.

If the user answered NO in response to question 8.29, the program would have responded

8.33 ENTER THE LEAF AREA INDICES TO BE USED
FOR ALL YEARS OF SIMULATION.

and then asked question 8.31 until all 13 leaf area indices have been entered. The program would then list the leaf area indices as in message 8.32 and ask if these values need to be corrected. If the values need to be changed, control is returned to question 8.31; otherwise, the manual climatologic data input is concluded and control is transferred to question 1.1.

EDITING PRECIPITATION DATA (9. PRECHK)

This subroutine allows the user to edit lines of the precipitation data. The user may not enter new years of data in this subroutine. This subroutine is called when the user has completed entering precipitation data manually or when the user answers NO to questions 3.1 or 3.8. The program starts by asking

9.1 DO YOU WANT TO CHECK OR CORRECT THE PRECIPITATION VALUES ENTERED?
ENTER YES OR NO.

If the user answers NO, control is passed to subroutine 8. MTRLYR (question 8.1). If the user enters YES, the program prints a list of years for which precipitation data have been entered.

9.2 DATA EXIST FOR 5 YEARS: 74 75 76 77 78

The program then instructs the user to

9.3 ENTER YEAR TO BE CHECKED.

If the user enters a year other than those listed in message 9.2 (e.g., 82), the program responds

9.4 DATA FOR YEAR 82 ARE NOT IN THE DATA FILE.

and question 9.3 is repeated.

If the user enters a year that is in the precipitation data set, the program responds

9.5 THE DATA FOR 78 ARE:

```
78 0.01 0.0  0.11 0.0  0.0  0.0  0.05 0.40 1.85 0.0     1
78 0.0  0.0  0.77 0.0  0.0  0.0  0.25 0.01 1.44 0.01    2
78 0.0  0.0  0.01 0.46 4.60 2.13 0.0  0.01 0.06 0.0     3
78 0.70 0.27 0.53 0.30 0.0  0.0  0.0  0.0  0.0  0.02    4
```

and so on until the 37 lines of precipitation values are printed. The program then asks

9.6 DO YOU WANT TO CHANGE OR CORRECT ANY OF THESE VALUES?
ENTER YES OR NO.

If the user enters NO, the program passes control to question 9.11. If the user answers YES, the program instructs the user to

9.7 ENTER NUMBER OF LINE TO BE CHANGED.

If the user enters a number that is less than 1 or greater than 37 (i.e., the total number of lines per year), the program responds

9.8 LINE NUMBERS MUST RANGE FROM 1 TO 37.
TRY AGAIN.

and repeats question 9.7.

If a valid number is answered in response to question 9.7, the program responds

9.9 ENTER THE TEN DAILY PRECIPITATION VALUES.

The user must enter all values on the same line. The rules for entering precipitation data were described previously in the part of this section entitled "RULES". After the user enters the precipitation values, the program asks

9.10 DO YOU WANT TO CHANGE ANOTHER LINE OF THIS YEAR?
ENTER YES OR NO.

If the user answers YES, the program returns to question 9.7.

If the user enters NO in response to question 9.10, the program asks

9.11 DO YOU WANT TO CHECK OR CORRECT ANOTHER
YEAR OF PRECIPITATION VALUES?
ENTER YES OR NO.

If the user answers YES, control is passed to question 9.3. If NO is entered, the program passes control to subroutine 8. MTRLYR (question 8.1) where data for other climatologic parameters can be entered.

If precipitation data have not been entered and the user answers YES to question 9.1, the program responds

9.12 THE DATA FILE CONTAINS NO PRECIPITATION VALUES.

The user must enter precipitation data either by the manual or default climatologic data input options before the data can be edited. After message 9.12 is printed, control is passed to subroutine 8. MTRLYR (question 8.1).

EDITING SOIL AND DESIGN DATA (10. SDCHK)

When the user indicates that the manual soil data input option is to be used, the program gives the user the opportunity to edit the soil and design data in this subroutine. The program calls the subroutine after the last of the design data is entered manually (i.e., after question 6.3) and also when the user answers YES to question 5.1. The program first lists the design and soil data as follows:

10.1 THE DESIGN AND SOIL DATA ARE:

(THE LAST NUMBER OF EACH LINE OF DATA IS THE LINE NUMBER.)

```
TITLE:
DRAINFIL COMPARISON FOR OPEN LANDFILL

TITLE:
SEATTLE, WASHINGTON 1951-1975

TITLE:
AUGUST 31, 1983

# OF LAYERS, # OF LINERS, LINER LEAKAGE FRACTION, RUNOFF FRACTION
FOR OPEN SITES, AND CN-II:
 3 0    1.000000    0.0        20.000000      4

THICKNESSES:
 108.00  12.00  24.00   0.0    0.0    0.0    0.0    0.0    0.0     5

POROSITIES:
 0.5000 0.5000 0.5000 0.0    0.0    0.0    0.0    0.0    0.0      6
```

```
FIELD CAPACITIES:
 0.4500 0.3800 0.4900 0.0    0.0    0.0    0.0    0.0    0.0        7

WILTING POINTS:
 0.1500 0.1500 0.1500 0.0    0.0    0.0    0.0    0.0    0.0        8

EVAPORATION COEFFICIENTS:
  3.800  3.300  3.100  0.0    0.0    0.0    0.0    0.0    0.0       9

HYDRAULIC CONDUCTIVITIES:
   0.14169991  14.1699991    0.00014170   0.0          0.0         10
   0.0         0.0           0.0          0.0           11

SURFACE AREA:
      12000.     12

LAYER TYPES:
      4      2      3      0      0      0      0      0      0    13

LAYER SLOPES:
   0.0    2.00   0.0    0.0    0.0    0.0    0.0    0.0    0.0     14

LAYER DRAINAGE LENGTHS:
    0.0   25.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    15
```

The program then asks

10.2 DO YOU WANT TO CHANGE ANY LINES?
ENTER YES OR NO.

If this is the first time that this question is asked and the user answers NO (i.e., the user does not want to change any of the original data), the program returns control to question 1.1. If the user answers NO and had previously changed some lines, the program asks question 10.9.

The first time that the user answers YES in response to question 10.2, the program responds

10.3 DO YOU WANT TO CHANGE THE TITLE?
ENTER YES OR NO.

If the user answers NO, the program asks question 10.5. If the user enters YES, the program instructs the user to

10.4 ENTER TITLE ON LINE 1,
ENTER LOCATION OF SOLID WASTE SITE ON LINE 2
AND ENTER TODAY'S DATE ON LINE 3.

and then repeats question 10.2.

If the user answers YES in response to question 10.2 and it is not the first time that question 10.2 was asked or if the user answers NO to question 10.3, the program responds

10.5 ENTER THE NUMBER OF THE LINE.

After the user enters the number of the line of data to be changed, the program responds

10.6 ENTER THE DATA VALUES FOR LINE 4.
DO NOT ENTER THE LINE NUMBER.

After the user enters the values, the program returns control to question 10.2, but the program first prints messages if the user changed lines 4 or 13. If the user changed line 4, the program warns

10.7 IT IS RECOMMENDED THAT YOU REENTER ALL SOIL DATA
IF YOU WANT TO CHANGE THE NUMBER OF LAYERS; OTHERWISE,
YOU MUST CHANGE LINES 5 THROUGH 11 AND 13 THROUGH 15.

If the user changed line 13, the program warns

10.8 YOU MAY ALSO NEED TO CHANGE LINES 4, 14 AND 15,
IF YOU CHANGE THIS LINE.

If the user has made some changes and then answers NO to question 10.2 indicating that all of the changes have been made, the program asks

10.9 DO YOU WANT TO CHECK THE DATA SET AGAIN?
ENTER YES OR NO.

If the user answers YES, control is returned to message 10.1. If the user answers NO, the program returns control to question 1.1.

SIMULATION OUTPUT CONTROL (11. SIMULA)

When the user answers 3 or 5 to question 1.1, the program runs the simulation and produces output. The program requires information on the length of simulation and the detail of output. The program first asks

11.1 HOW MANY YEARS OF OUTPUT DO YOU WANT?
(BETWEEN 2 AND 5 YEARS MAY BE USED.)

If the user answers 3 to question 1.1, the program also asks the next two questions.

11.2 DO YOU WANT DAILY OUTPUT?
ENTER YES OR NO.

If the user answers YES, daily results will be printed for each year. A response of NO suppresses this output. The program then asks

11.3 DO YOU WANT MONTHLY TOTALS?
ENTER YES OR NO.

If the user answers YES, monthly totals of the water budget components will be printed for each year. A response of NO suppresses this output.

If the user had entered 5 in response to question 1.1, questions 11.2 and 11.3 are not asked since daily and monthly output are not available for this output option.

The program starts the simulation after question 11.3. After the program produces all of the requested output, the program returns control to question 1.1.

LOADING PRECIPITATON DATA FROM OFF-LINE MEDIA

Building precipitation data files on-line can be time consuming, and hence quite expensive, especially when data for several years must be entered. Thus, it may be desirable to build files off-line (e.g., punch cards, magnetic tape, floppy disk, etc.) and then enter the entire file into the HELP program. Regardless of the off-line media used, each year of data must be represented by 37 records, each consisting of 12 variables. The first variable (format I10) should contain the year of the data right justified (e.g., 1976). The next 10 values (format F5.2) must contain the daily precipitation data. The last variable (format I10) is the number of the record (i.e., 1 to 37).

Once the file is built, the user may log on to the NCC system, read the file, and store it under the data set name TAPE4. Then, following the command RUNHELP, the user can answer "1" to question 1.1, "NO" to question 1.2, "NO" to question 3.1, "NO" to question 9.1, and "YES" to question 8.1. This sequence will allow the user to enter climatologic data (other than rainfall) manually. If it is desired to check the precipitation data, question 9.1 may be answered with a "YES".

A procedure similar to that described above for rainfall may also be used for other types of data, although ordinarily there is no compelling need since other data files are much less lengthy. Users wishing to load other data from off-line should contact Mr. Anthony Gibson of the U.S. Army Engineer Waterways Experiment Station for guidance. Mr. Gibson may be reached by telephone at (601) 634-3710 (commercial) or 542-3710 (FTS).

SAVING PRECIPITATION DATA FILES

The HELP program is written such that precipitation data are stored permanently. Thus, once a new precipitation data file is created and entered it automatically replaces any previously stored precipitation data. The following technique may be used to save old precipitation data files before entering new precipitation data.

For example, assume that the user has manually entered 20 years of precipitation data for Vicksburg, Mississippi. Also assume that the rest of the climatologic, soil, and design data have been entered and that output has been printed. At this point, the user may save the precipitation data stored on the file TAPE4 under another name by using the EDIT, SAVE, and END commands as follows after the user stops the HELP program and the computer system responds READY.

```
EDIT     TAPE4
SAVE     VICKS
END
```

The user may also perform the same task using the following command:

```
COPY     TAPE4     VICKS
```

The 20 years of precipitation for Vicksburg, Mississippi, are now stored on the permanent file named VICKS. The user can now run the model with another set of precipitation data, without losing data for Vicksburg. To retrieve the precipitation data file for Vicksburg (stored under the file name of VICKS), the user may enter the following commands:

```
EDIT     VICKS
SAVE     TAPE4
END
```

The user may also retrieve the precipitation data file using the following commands:

```
DELETE    TAPE4     SCRATCH
COPY     VICKS     TAPE4
```

This will cause the precipitation data for Vicksburg to replace the existing precipitation data, and the model may then be run using the Vicksburg precipitation data.

SECTION 5

PROGRAM OUTPUT

INTRODUCTION

The HELP program always produces output consisting of the identifying labels and input data (except daily precipitation) supplied by the user, and a summary of the simulation results. Daily, monthly and yearly output may be obtained at the option of the user. Information presented in this section describes the output data sufficiently to allow most users to understand and interpret results obtained from typical program runs. More detailed explanations are presented in the program documentation (5). Complete input/output listings for three example runs are presented in Section 6.

SUMMARY OUTPUT

Basic program output composed of all default and manual input information (including identifying labels) except daily precipitation data, and summary results are always reported. Input data have been described in Sections 3 and 4 and will not be discussed further herein since users should have no difficulty in interpreting this information. Summary output data are described below. Example output is presented in Section 6. Occasional reference to Figure 2 may be helpful in understanding some of the terminology used in describing program output.

Following the input data summary, the program produces a table of the daily results, a table of the monthly totals and a table of the annual totals for each year of simulation if these options are used. If a different set of climatologic data was used for each year of simulation, these input values other than precipitation data would be printed before the results of each year of simulation. After the results for all years are printed, the program produces a summary of the output. The summary includes average monthly totals, average annual totals and peak daily values for various simulation variables.

The program reports average monthly totals for precipitation, runoff, evapotranspiration (total of evaporation from the surface and soil, and plant transpiration), percolation through the base of each subprofile, and lateral drainage from each subprofile. These results are reported in inches. The output values indicate averages of the monthly totals for a particular month of all years of simulation. For example, if 5 years of simulation were run, the reported average monthly precipitation total for March would be the average of the 5 monthly totals for March precipitation.

The next table in the summary output is a listing of the average annual totals for the simulation period. Average annual values for precipitation, runoff, evapotranspiration, percolation through the base of each subprofile, and lateral drainage from each subprofile are reported in terms of inches, cubic feet and as a percent of the total average annual precipitation.

In the last summary table, peak daily values for precipitation, runoff, percolation through the base of each subprofile, and precipitation accumulation on the surface in the form of snow are reported in terms of inches and cubic feet. These values represent the maximum values that occurred on any day during the simulation period. The table also contains the maximum head on the barrier soil layer of each subprofile and the maximum and minimum soil moisture content of the evaporative zone. These variables are reported in inches.

The data reported in these summary tables are sufficient for rapidly screening alternative designs and roughly sizing drainage and leachate collection and treatment systems in most cases. However, more detailed information which shows trends and variability in the results may be obtained by requesting annual, monthly or daily output.

ANNUAL, MONTHLY AND DAILY OUTPUT

If the user requests detailed output, the program will print annual totals of precipitation, runoff, evapotranspiration, percolation through the base of each subprofile, and lateral drainage from each subprofile for each year of simulation. Each of these output variables are reported in terms of inches, cubic feet and as a percent of the total annual precipitation. The program also lists the soil moisture contents and snow accumulations at the start and end of the year in inches and cubic feet. Example annual output is shown in Test Cases 1 and 2 of Section 6.

If the user requests monthly output, the program produces tables which report monthly totals in inches for precipitation, runoff, evapotranspiration, percolation through the base of each subprofile, and lateral drainage from each subprofile for each year of simulation. Monthly output is shown in Test Case 2 of Section 6.

If daily output is requested, the program prints a table containing the Julian date, and the daily values of precipitation, runoff, evapotranspiration, head on the soil barrier layer at the base of the cover, percolation through the base of the cover, total lateral drainage from all subprofiles in the cover, head on the soil barrier layer at the base of the landfill, percolation through the base of the landfill, total lateral drainage from all subprofiles below the cover and the soil moisture content of the evaporative zone. Where applicable, the units of the variables are in inches, except for the soil moisture content which is reported in dimensionless form (volume of water/volume of soil). The program prints an asterisk after the Julian date for dates when the mean temperature is below freezing (32°F). Example daily output is shown below for the first 10 days of a year of simulation.

****

DAILY OUTPUT FOR 74

DAY	RAIN IN.	RUNOFF IN.	ET IN.	COVER HEAD IN.	COVER PERC. IN.	COVER DRAIN IN.	BASE HEAD IN.	DEEP PERC. IN.	BASE DRAIN IN.	SOIL WATER IN/IN
1	0.04	0.0	0.083	0.0	0.0	0.0	0.0	0.0	0.0	0.3172
2	0.0	0.0	0.067	0.0	0.0	0.0	0.0	0.0	0.0	0.3105
3	0.43	0.0	0.139	0.1	0.0028	0.000	0.0	0.0020	0.000	0.3349
4	0.0	0.0	0.021	0.3	0.0007	0.000	0.0	0.0001	0.000	0.3323
5	0.0	0.0	0.070	0.3	0.0027	0.001	0.0	0.0026	0.000	0.3253
6	0.04	0.0	0.091	0.2	0.0028	0.001	0.0	0.0025	0.000	0.3201
7	0.39	0.0	0.131	0.3	0.0040	0.002	0.0	0.0034	0.000	0.3416
8	0.0	0.0	0.026	0.5	0.0010	0.001	0.0	0.0012	0.000	0.3385
9	0.0	0.0	0.070	0.4	0.0026	0.002	0.0	0.0030	0.000	0.3315
10	0.0	0.0	0.070	0.4	0.0026	0.002	0.0	0.0024	0.000	0.3245

SECTION 6

EXAMPLES

In this section three complete examples (test cases) are presented. Test Case 1 represents a typical open landfill, Test Case 2 represents a typical cap or cover, and Test Case 3 represents a closed landfill composed of the waste/drainage/liner layers from Test Case 1 and the cover from Test Case 2. For each example the input data are summarized and the complete input/output listing is reproduced. Detailed output without the optional daily and monthly output is presented for Test Case 1. Detailed output with monthly totals is presented for Test Case 2 and only summary output is presented for Test Case 3.

TEST CASE 1

Test Case 1 represents an open landfill composed of a waste layer, a drainage layer, and a low-permeability (barrier) soil liner. No synthetic membrane liner was used. The characteristics of a coarse sand (default soil type 1) were used to model the behavior of the waste layer. Since this soil has a very high hydraulic conductivity (11.95 inches per hour), the net effect is to prevent the waste layer, as modeled, from inhibiting drainage. The input data and input/output listing are presented below. Monthly and daily output were not requested, but annual totals were requested by asking for detailed output.

<u>Data for Test Case 1</u>

Location: New Orleans, LA
Length of rainfall record used: 5 years (default data)
Vegetative cover: bare ground (i.e. no vegetation)
Evaporative zone depth: 6 inches
Fraction of area contributing to runoff: 0.8
SCS runoff curve number: 65
Area of site: 231,000 square feet
Number of layers: 3

Layer 1--
Layer type: 4 (waste material)
Soil type: 1 (coarse sand, default)
Layer thickness: 60 inches

Layer 2--

Layer type: 2 (lateral drainage)
Soil type: 1 (coarse sand, default)
Slope at bottom of layer: 2%
Drainage length: 25 feet
Layer thickness: 12 inches

Layer 3--

Layer type: 3 (barrier soil with no synthetic membrane)
Soil type: 20 (especially prepared low-permeability barrier soil, default)
Layer thickness: 24 inches

TEST CASE 2

Test Case 2 represents a typical landfill cover (cap) composed of a top layer of soil supporting a fair stand of grass, a drainage layer, and a low-permeability (barrier) soil liner. No synthetic membrane was used. Default data describing the growth of the grass, leaf area index, etc. for the New Orleans area were used. The input data and input/output listing are presented below. Monthly and annual output were requested.

Data for Test Case 2

Location: New Orleans, LA
Length of rainfall record used: 5 years (default data)
Vegetative cover: fair grass (default data)
Evaporative zone depth: 10 inches
Area of site: 231,000 square feet
Number of layers: 3

Layer 1--

Layer type: 1 (vertical percolation)
Soil type: 12 (silt/loam, default)
Layer thickness: 24 inches

Layer 2--

Layer type: 2 (lateral drainage)
Soil type: 1 (coarse sand, default)
Slope at bottom of layer: 3%
Drainage length: 175 feet
Layer thickness: 12 inches

Layer 3--

Layer type: 3 (barrier soil with no synthetic membrane)
Soil type: 20 (especially prepared low-permeability barrier soil, default)
Layer thickness: 24 inches

TEST CASE 3

Test Case 3 represents a closed landfill consisting of the cover (cap) used in Test Case 2 and the waste layer, lower drainage layer, and liner used in Test Case 1. No synthetic membrane was used in either the cover or the liner. The input data and input/output listing are presented below. Only summary output was requested.

Data for Test Case 3

Location: New Orleans, LA
Length of rainfall record used: 5 years (default data)
Vegetative cover: fair grass (default data)
Evaporative zone depth: 10 inches
Area of site: 231,000 square feet
Number of layers: 6

Layer 1--
Layer type: 1 (vertical percolation)
Soil type: 12 (silt/loam, default)
Layer thickness: 24 inches

Layer 2--
Layer type: 2 (lateral drainage)
Soil type: 1 (coarse sand, default)
Slope at bottom of layer: 3%
Drainage length: 175 feet
Layer thickness: 12 inches

Layer 3--
Layer type: 3 (barrier soil with no synthetic membrane)
Soil type: 20 (especially prepared low-permeability barrier soil, default)
Layer thickness: 24 inches

Layer 4--
Layer type: 4 (waste material)
Soil type: 1 (coarse sand, default)
Layer thickness: 60 inches

Layer 5--
Layer type: 2 (lateral drainage)
Soil type: 1 (coarse sand, default)
Slope at bottom of layer: 2%
Drainage length: 25 feet
Layer thickness: 12 inches

Layer 6--
Layer type: 3 (barrier soil with no synthetic membrane)
Soil type: 20 (especially prepared low-permeability barrier soil, default)
Layer thickness: 24 inches

Input/Output Listing for Test Case 1

```
*****************************************************************************
*****************************************************************************
*                                                                           *
*             HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                 *
*                          HELP VERSION 1                                   *
*                                                                           *
*                            WRITTEN BY                                     *
*                                                                           *
*                        PAUL R. SCHROEDER                                  *
*                          AUGUST, 1983                                     *
*                                                                           *
*                              OF THE                                       *
*                WATER RESOURCES ENGINEERING GROUP                          *
*                     ENVIRONMENTAL LABORATORY                              *
*                 USAE WATERWAYS EXPERIMENT STATION                         *
*                          P.O. BOX 631                                     *
*                       VICKSBURG, MS  39180                                *
*                                                                           *
*****************************************************************************
*                                                                           *
*                USER'S GUIDE AVAILABLE UPON REQUEST                        *
*                FOR CONSULTATION CONTACT AUTHORS AT                        *
*                 (601) 634-3709 OR (601) 634-3710                          *
*                                                                           *
*****************************************************************************
*****************************************************************************


1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
      2 FOR SOIL OR DESIGN DATA INPUT,
      3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
      4 TO STOP THE PROGRAM, AND
      5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.


1


1.2 DO YOU WANT TO USE DEFAULT CLIMATOLOGIC DATA?
ENTER YES OR NO.


    YES
```

2.1 DO YOU WANT A LIST OF DEFAULT CITIES?
ENTER YES OR NO.

YES

DEFAULT DATA ARE PROVIDED ONLY FOR THE FOLLOWING CITIES AND STATES

ALASKA
  ANNETTE
  BETHEL
  FAIRBANKS
ARIZONA
  FLAGSTAFF
  PHOENIX
  TUCSON
ARKANSAS
  LITTLE ROCK
CALIFORNIA
  FRESNO
  LOS ANGELES
  SACRAMENTO
  SAN DIEGO
  SANTA MARIA
COLORADO
  DENVER
  GRAND JUNCTION
CONNECTICUT
  BRIDGEPORT
  HARTFORD
  NEW HAVEN
FLORIDA
  JACKSONVILLE
  MIAMI
  ORLANDO
  TALLAHASSEE
  TAMPA
  W. PALM BEACH
GEORGIA
  ATLANTA
  WATKINSVILLE
HAWAII
  HONOLULU
IDAHO
  BOISE
  POCATELLO
ILLINOIS
  CHICAGO
  E. ST. LOUIS
INDIANA
  INDIANAPOLIS
IOWA
  DES MOINES
KANSAS
  DODGE CITY
  TOPEKA
KENTUCKY
  LEXINGTON
LOUISIANA
  LAKE CHARLES
  NEW ORLEANS
  SHREVEPORT
MAINE
  AUGUSTA
  BANGOR
  CARIBOU
  PORTLAND
MASSACHUSETTS
  BOSTON
  PLAINFIELD
  WORCESTER
MICHIGAN
  E. LANSING
  SAULT STE. MARIE
MINNESOTA
  ST. CLOUD
MISSOURI
  COLUMBIA
MONTANA
  GLASGOW
  GREAT FALLS
NEBRASKA
  GRAND ISLAND
  NORTH OMAHA
NEVADA
  ELY
  LAS VEGAS
NEW HAMPSHIRE
  CONCORD
  NASHUA
NEW JERSEY
  EDISON
  SEABROOK
NEW MEXICO
  ALBUQUERQUE
NEW YORK
  CENTRAL PARK
  ITHACA
  NEW YORK CITY
  SCHENECTADY
  SYRACUSE
NORTH CAROLINA
  GREENSBORO
NORTH DAKOTA
  BISMARCK
OHIO
  CINCINNATI
  CLEVELAND
  COLUMBUS
  PUT-IN-BAY
OKLAHOMA
  OKLAHOMA CITY
  TULSA
OREGON
  ASTORIA
  MEDFORD
  PORTLAND
PENNSYLVANIA
  PHILADELPHIA
  PITTSBURGH
RHODE ISLAND
  PROVIDENCE
SOUTH CAROLINA
  CHARLESTON
SOUTH DAKOTA
  RAPID CITY
TENNESSEE
  KNOXVILLE
  NASHVILLE
TEXAS
  BROWNSVILLE
  DALLAS
  EL PASO
  MIDLAND
  SAN ANTONIO
UTAH
  CEDAR CITY
  SALT LAKE CITY
VERMONT
  BURLINGTON
  MONTPELIER
  RUTLAND
VIRGINIA
  LYNCHBURG
  NORFOLK
WASHINGTON
  PULLMAN
  SEATTLE
  YAKIMA
WISCONSIN
  MADISON
WYOMING
  CHEYENNE
  LANDER
PUERTO RICO
  SAN JUAN

2.2 ENTER NAME OF STATE OF INTEREST

LOUISIANA

```
2.4 ENTER NAME OF CITY OF INTEREST


NEW ORLEANS


2.6 SELECT THE TYPE OF VEGETATIVE COVER

ENTER NUMBER 1 FOR BARE GROUND
             2 FOR EXCELLENT GRASS
             3 FOR GOOD GRASS
             4 FOR FAIR GRASS
             5 FOR POOR GRASS
             6 FOR GOOD ROW CROPS
             7 FOR FAIR ROW CROPS
1

2.8 IF YOU ARE USING DEFAULT SOIL DATA AND THIS VEGETATION
TYPE IS NOT THE SAME AS USED IN THE DEFAULT SOIL DATA INPUT,
YOU SHOULD ENTER THE SOIL DATA AGAIN OR CORRECT THE SCS
RUNOFF CURVE NUMBER.


2.9 ENTER THE EVAPORATIVE ZONE DEPTH IN INCHES.

CONSERVATIVE VALUES ARE:
          4 IN. FOR BAREGROUND
         10 IN. FOR FAIR GRASS
         18 IN. FOR EXCELLENT GRASS

4


1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
      2 FOR SOIL OR DESIGN DATA INPUT,
      3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
      4 TO STOP THE PROGRAM, AND
      5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.



2


1.3 DO YOU WANT TO USE DEFAULT SOIL DATA?
ENTER YES OR NO.


YES
```

```
              USE ONLY ENGLISH UNITS OF INCHES AND DAYS
                     UNLESS OTHERWISE INDICATED

##############################ANSWER ALL QUESTIONS############################
******************************************************************************
               A VALUE **MUST** BE ENTERED FOR EACH COMMAND
                    EVEN WHEN THE VALUE IS ZERO.
******************************************************************************



4.1 ENTER TITLE ON LINE 1,
ENTER LOCATION OF SOLID WASTE SITE ON LINE 2,
AND ENTER TODAY'S DATE ON LINE 3.



TEST CASE 1
NEW ORLEANS, LOUISIANA
AUGUST 26, 1983

4.2 FOUR TYPES OF LAYERS MAY BE USED IN THE DESIGN:
VERTICAL PERCOLATION, LATERAL DRAINAGE, BARRIER SOIL, AND WASTE.

LATERAL DRAINAGE IS NOT PERMITTED FROM A VERTICAL PERCOLATION
LAYER.
BOTH VERTICAL AND LATERAL DRAINAGE ARE PERMITTED FROM A LATERAL
DRAINAGE LAYER.
A BARRIER SOIL LAYER SHOULD BE DESIGNED TO INHIBIT PERCOLATION.
AN IMPERMEABLE LINER MAY BE USED ON TOP OF ANY BARRIER SOIL LAYER.
THE WASTE LAYER SHOULD BE DESIGNED TO PERMIT RAPID DRAINAGE
FROM THE WASTE LAYER.


RULES:

THE TOP LAYER CANNOT BE A BARRIER SOIL LAYER.
A BARRIER SOIL LAYER MAY NOT BE PLACED ADJACENT TO ANOTHER
BARRIER SOIL LAYER.
ONLY A BARRIER SOIL LAYER OR ANOTHER LATERAL DRAINAGE LAYER MAY BE
PLACED DIRECTLY BELOW A LATERAL DRAINAGE LAYER.
YOU MAY USE UP TO 9 LAYERS AND UP TO 3 BARRIER SOIL LAYERS.

ENTER THE NUMBER OF LAYERS IN YOUR DESIGN.

3
 4.3 THE LAYERS ARE NUMBERED SUCH THAT
 SOIL LAYER 1 IS THE TOP LAYER
 AND SOIL LAYER 3 IS THE BOTTOM LAYER.
```

```
4.6 IS THE TOP LAYER AN UNVEGETATED SAND OR GRAVEL LAYER?
ENTER YES OR NO.

NO

4.7 ENTER THICKNESS OF SOIL LAYER 1 IN INCHES.
60

4.9 ENTER THE LAYER TYPE FOR LAYER 1.

4.10 ENTER 1 FOR A VERTICAL PERCOLATION LAYER,
           2 FOR A LATERAL DRAINAGE LAYER,
           3 FOR A BARRIER SOIL LAYER,
           4 FOR A WASTE LAYER, AND
           5 FOR A BARRIER SOIL LAYER WITH
             AN IMPERMEABLE LINER.

4

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 1.

4.16 ENTER A NUMBER (1 THROUGH 23) FOR TEXTURE CLASS OF SOIL MATERIAL.

   **CHECK USER'S GUIDE FOR NUMBER CORRESPONDING TO SOIL TYPE.**


1

4.23 IS SOIL LAYER 1 COMPACTED?
ENTER YES OR NO.


4.24 THE VEGETATIVE SOIL LAYER IS GENERALLY NOT COMPACTED.


NO

4.7 ENTER THICKNESS OF SOIL LAYER 2 IN INCHES.
12

4.9 ENTER THE LAYER TYPE FOR LAYER 2.

2

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 2.
1

4.23 IS SOIL LAYER 2 COMPACTED?
ENTER YES OR NO.


NO
```

4.7 ENTER THICKNESS OF SOIL LAYER 3 IN INCHES.
24

4.9 ENTER THE LAYER TYPE FOR LAYER 3.

3

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 3.
20

7.1 ENTER THE SCS RUNOFF CURVE NUMBER FOR THE SOIL TEXTURE AND AVERAGE MOISTURE CONDITION OF THE TOP WASTE LAYER.
(BETWEEN 15 AND 100)

65

7.2 WHAT FRACTION OF THE DAILY POTENTIAL RUNOFF DRAINS FROM THE SURFACE OF THE WASTE LAYER?
ENTER BETWEEN 0 AND 1.

.8

6.1 ENTER THE TOTAL AREA OF THE SURFACE, IN SQUARE FEET.

231000

6.2 ENTER THE SLOPE AT THE BASE OF SOIL LAYER 2, IN PERCENT.

2

6.3 ENTER THE MAXIMUM DRAINAGE DISTANCE ALONG THE SLOPE TO THE COLLECTOR, IN FEET.

25

1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
      2 FOR SOIL OR DESIGN DATA INPUT,
      3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
      4 TO STOP THE PROGRAM, AND
      5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.

3

11.1 HOW MANY YEARS OF OUTPUT DO YOU WANT?
(BETWEEN 2 AND 5 YEARS MAY BE USED.)
5

11.2 DO YOU WANT DAILY OUTPUT?
ENTER YES OR NO.

NO

11.3 DO YOU WANT MONTHLY TOTALS?
ENTER YES OR NO.

NO

****
****

TEST CASE 1
NEW ORLEANS, LOUISIANA
AUGUST 26, 1983

****
****

BARE GROUND

LAYER 1

WASTE LAYER		
THICKNESS	=	60.00 INCHES
EVAPORATION COEFFICIENT	=	3.00 MM/DAY**0.5
POROSITY	=	0.3510 VOL/VOL
FIELD CAPCITY	=	0.1740 VOL/VOL
WILTING POINT	=	0.1070 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	11.9499998 INCHES/HR

LAYER 2

LATERAL DRAINAGE LAYER		
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	25.0 FEET
THICKNESS	=	12.00 INCHES
EVAPORATION COEFFICIENT	=	3.300 MM/DAY**0.5
POROSITY	=	0.3510 VOL/VOL
FIELD CAPACITY	=	0.1740 VOL/VOL
WILTING POINT	=	0.1070 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	11.9499998 INCHES/HR

LAYER 3

BARRIER SOIL LAYER		
THICKNESS	=	24.00 INCHES
EVAPORATION COEFFICIENT	=	3.100 MM/DAY**0.5
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.4500 VOL/VOL
WILTING POINT	=	3.600 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	0.00014200 INCHES/HR

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	65.00
TOTAL AREA OF COVER	=	231000. SQ. FT
EVAPORATIVE ZONE DEPTH	=	4.00 INCHES
POTENTIAL RUNOFF FRACTION	=	0.800000
EFFECTIVE EVAPORATION COEFFICIENT	=	3.300 MM/DAY**0.5
UPPER LIMIT VEG. STORAGE	=	1.4040 INCHES
INITIAL VEG. STORAGE	=	0.5620 INCHES

CLIMATOLOGIC DATA FOR NEW ORLEANS LOUISIANA

MONTHLY MEAN TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
53.30	55.00	60.28	67.71	75.31	81.04
83.37	81.66	76.39	68.95	61.35	55.62

MONTHLY MEANS SOLAR RADIATION, LANGLEYS PER DAY

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
236.64	268.52	321.36	381.00	431.47	459.23
456.86	424.98	372.14	312.50	262.03	234.27

LEAF AREA INDEX TABLE

DATE	LAI
1	0.0
44	0.0
74	0.0
105	0.0
135	0.0
165	0.0
196	0.0
226	0.0
256	0.0
286	0.0
317	0.0
347	0.0
366	0.0

BARE GROUND

WINTER COVER FACTOR = 0.0

****

ANNUAL TOTALS FOR 74

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	72.79	1401194.	100.0

RUNOFF	0.372	7153.	0.51
EVAPOTRANSPIRATION	17.187	330844.	23.61
PERCOLATION FROM BASE OF LANDFILL	1.5299	29450.	2.10
DRAINAGE FROM BASE OF LANDFILL	53.621	1032197.	73.67
SOIL WATER AT START OF YEAR	23.19	446484.	73.67
SOIL WATER AT END OF YEAR	23.27	448002.	
SNOW WATER AT START OF YEAR	0.0	0.	
SNOW WATER AT END OF YEAR	0.0	0.	
ANNUAL WATER BUDGET BALANCE	0.00	33.	0.00

****

****

ANNUAL TOTALS FOR 75

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	80.50	1549610.	100.00
RUNOFF	2.175	41872.	2.70
EVAPOTRANSPIRATION	19.802	381196.	24.60
PERCOLATION FROM BASE OF LANDFILL	1.5465	29770.	1.92
DRAINAGE FROM BASE OF LANDFILL	56.052	1078996.	69.63
SOIL WATER AT START OF YEAR	23.27	448002.	

SOIL WATER AT END OF YEAR	24.19	465752.	
SNOW WATER AT START OF YEAR	0.0	0.	
SNOW WATER AT END OF YEAR	0.0	0.	
ANNUAL WATER BUDGET BALANCE	0.0	27.	0.00

****

****

ANNUAL TOTALS FOR 76

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	47.36	911673.	100.0
RUNOFF	0.0	0.	0.0
EVAPOTRANSPIRATION	13.500	259884.	28.51
PERCOLATION FROM BASE OF LANDFILL	1.4087	27117.	2.97
DRAINAGE FROM BASE OF LANDFILL	33.022	635672.	69.73
SOIL WATER AT START OF YEAR	24.19	465752.	
SOIL WATER AT END OF YEAR	23.62	454732.	
SNOW WATER AT START OF YEAR	0.0	0.	
SNOW WATER AT END OF YEAR	0.0	0.	
ANNUAL WATER BUDGET BALANCE	0.00	19.	0.00

****

****

ANNUAL TOTALS FOR 77

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	72.81	1401578.	100.0
RUNOFF	0.627	12078.	0.86
EVAPOTRANSPIRATION	18.912	364058.	25.97
PERCOLATION FROM BASE OF LANDFILL	1.5354	29557.	2.11
DRAINAGE FROM BASE OF LANDFILL	50.636	974736.	69.55
SOIL WATER AT START OF YEAR	23.62	454732.	
SOIL WATER AT END OF YEAR	24.72	475857.	
SNOW WATER AT START OF YEAR	0.0	0.	
SNOW WATER AT END OF YEAR	0.0	0.	
ANNUAL WATER BUDGET BALANCE	0.00	25.	0.00

****

****

ANNUAL TOTALS FOR 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	76.85	1479348.	100.0

RUNOFF	1.532	29492.	1.99
EVAPOTRANSPIRATION	16.446	316594.	21.40
PERCOLATION FROM BASE OF LANDFILL	1.4951	28781.	1.95
DRAINAGE FROM BASE OF LANDFILL	58.741	1130766.	76.44
SOIL WATER AT START OF YEAR	24.72	475857.	
SOIL WATER AT END OF YEAR	23.35	449539.	
SNOW WATER AT START OF YEAR	0.0	0.	
SNOW WATER AT END OF YEAR	0.0	0.	
ANNUAL WATER BUDGET BALANCE	0.00	32.	0.00

****

****

AVERAGE MONTHLY TOTALS FOR 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	6.54	3.66	4.37	4.55	7.01	5.95
	6.58	9.84	5.91	3.16	7.12	5.37
RUNOFF (INCHES)	0.060	0.025	0.047	0.033	0.165	0.0
	0.012	0.153	0.088	0.0	0.359	0.000
EVAPOTRANSPIRATION	1.098	0.730	1.062	0.873	1.595	2.188
(INCHES)	2.690	2.699	1.605	0.577	1.180	0.870

PERCOLATION FROM BASE	0.1324	0.1187	0.1228	0.1216	0.1257	0.1236
OF LANDFILL (INCHES)	0.1288	0.1339	0.1201	0.1197	0.1228	0.1331
DRAINAGE FROM BASE OF	5.315	3.302	3.010	3.407	5.003	3.332
LANDFILL (INCHES)	4.157	6.611	4.560	2.277	4.683	4.921

****

****

AVERAGE ANNUAL TOTAL FOR 74 THROUGH 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	70.06	1348681.	100.0
RUNOFF	0.941	18119.	1.34
EVAPOTRANSPIRATION	17.170	330515.	24.51
PERCOLATION FROM BASE OF LANDFILL	1.5031	28935.	2.15
DRAINAGE FROM BASE OF LANDFILL	50.414	970473.	71.96

****

****

PEAK DAILY VALUES FOR 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	8.52	164010.0
RUNOFF	1.793	34522.6
PERCOLATION FROM BASE OF LANDFILL	0.0072	139.5
DRAINAGE FROM BASE OF LANDFILL	1.997	38439.7
HEAD ON BASE OF LANDFILL	21.2	
SNOW WATER	0.0	0.0

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.1553

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1070

****
****

1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
2 FOR SOIL OR DESIGN DATA INPUT,
3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
4 TO STOP THE PROGRAM, AND
5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.

4

1.4 ENTER RUNHELP TO RERUN PROGRAM OR
ENTER LOGOFF TO LOGOFF COMPUTER SYSTEM

Input/Output Listing for Test Case 2

```
****************************************************************************
****************************************************************************
*                                                                          *
*              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               *
*                            HELP VERSION 1                                *
*                                                                          *
*                              WRITTEN BY                                  *
*                                                                          *
*                          PAUL R. SCHROEDER                               *
*                            AUGUST, 1983                                  *
*                                                                          *
*                               OF THE                                     *
*                  WATER RESOURCES ENGINEERING GROUP                       *
*                       ENVIRONMENTAL LABORATORY                           *
*                  USAE WATERWAYS EXPERIMENT STATION                       *
*                             P.O. BOX 631                                 *
*                         VICKSBURG, MS  39180                             *
*                                                                          *
****************************************************************************
*                                                                          *
*                  USER'S GUIDE AVAILABLE UPON REQUEST                     *
*                  FOR CONSULTATION CONTACT AUTHORS AT                     *
*                   (601) 634-3709 OR (601) 634-3710                       *
*                                                                          *
****************************************************************************
****************************************************************************
```

```
1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
      2 FOR SOIL OR DESIGN DATA INPUT,
      3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
      4 TO STOP THE PROGRAM, AND
      5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.


1


1.2 DO YOU WANT TO USE DEFAULT CLIMATOLOGIC DATA?
ENTER YES OR NO.


YES
```

```
2.1 DO YOU WANT A LIST OF DEFAULT CITIES?
ENTER YES OR NO.

NO

2.2 ENTER NAME OF STATE OF INTEREST


LOUISIANA

2.4 ENTER NAME OF CITY OF INTEREST


NEW ORLEANS


2.6 SELECT THE TYPE OF VEGETATIVE COVER

ENTER NUMBER 1 FOR BARE GROUND
             2 FOR EXCELLENT GRASS
             3 FOR GOOD GRASS
             4 FOR FAIR GRASS
             5 FOR POOR GRASS
             6 FOR GOOD ROW CROPS
             7 FOR FAIR ROW CROPS

4

2.8 IF YOU ARE USING DEFAULT SOIL DATA AND THIS VEGETATION
TYPE IS NOT THE SAME AS USED IN THE DEFAULT SOIL DATA INPUT,
YOU SHOULD ENTER THE SOIL DATA AGAIN OR CORRECT THE SCS
RUNOFF CURVE NUMBER.


2.9 ENTER THE EVAPORATIVE ZONE DEPTH IN INCHES.

CONSERVATIVE VALUES ARE:
          4 IN. FOR BAREGROUND
         10 IN. FOR FAIR GRASS
         18 IN. FOR EXCELLENT GRASS

10


1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
      2 FOR SOIL OR DESIGN DATA INPUT,
      3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
      4 TO STOP THE PROGRAM, AND
      5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.
```

2

1.3 DO YOU WANT TO USE DEFAULT SOIL DATA?
ENTER YES OR NO.

YES

USE ONLY ENGLISH UNITS OF INCHES AND DAYS
UNLESS OTHERWISE INDICATED

#############################ANSWER ALL QUESTIONS############################
****
A VALUE **MUST** BE ENTERED FOR EACH COMMAND
EVEN WHEN THE VALUE IS ZERO.
****

4.1 ENTER TITLE ON LINE 1,
ENTER LOCATION OF SOLID WASTE SITE ON LINE 2,
AND ENTER TODAY'S DATE ON LINE 3.

TEST CASE 2
NEW ORLEANS, LOUISIANA
AUGUST 26, 1983

4.2 FOUR TYPES OF LAYERS MAY BE USED IN THE DESIGN:
VERTICAL PERCOLATION, LATERAL DRAINAGE, BARRIER SOIL, AND WASTE.

LATERAL DRAINAGE IS NOT PERMITTED FROM A VERTICAL PERCOLATION
LAYER.
BOTH VERTICAL AND LATERAL DRAINAGE ARE PERMITTED FROM A LATERAL
DRAINAGE LAYER.
A BARRIER SOIL LAYER SHOULD BE DESIGNED TO INHIBIT PERCOLATION.
AN IMPERMEABLE LINER MAY BE USED ON TOP OF ANY BARRIER SOIL LAYER.
THE WASTE LAYER SHOULD BE DESIGNED TO PERMIT RAPID DRAINAGE
FROM THE WASTE LAYER.

RULES:

THE TOP LAYER CANNOT BE A BARRIER SOIL LAYER.
A BARRIER SOIL LAYER MAY NOT BE PLACED ADJACENT TO ANOTHER
BARRIER SOIL LAYER.

ONLY A BARRIER SOIL LAYER OR ANOTHER LATERAL DRAINAGE LAYER MAY BE PLACED DIRECTLY BELOW A LATERAL DRAINAGE LAYER.
YOU MAY USE UP TO 9 LAYERS AND UP TO 3 BARRIER SOIL LAYERS.

ENTER THE NUMBER OF LAYERS IN YOUR DESIGN.

3
4.3 THE LAYERS ARE NUMBERED SUCH THAT
SOIL LAYER 1 IS THE TOP LAYER
AND SOIL LAYER 3 IS THE BOTTOM LAYER.

4.6 IS THE TOP LAYER AN UNVEGETATED SAND OR GRAVEL LAYER?
ENTER YES OR NO.

NO

4.7 ENTER THICKNESS OF SOIL LAYER 1 IN INCHES.
24

4.9 ENTER THE LAYER TYPE FOR LAYER 1.

4.10 ENTER 1 FOR A VERTICAL PERCOLATION LAYER,
2 FOR A LATERAL DRAINAGE LAYER,
3 FOR A BARRIER SOIL LAYER,
4 FOR A WASTE LAYER, AND
5 FOR A BARRIER SOIL LAYER WITH
AN IMPERMEABLE LINER.

1

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 1.

4.16 ENTER A NUMBER (1 THROUGH 23) FOR TEXTURE CLASS OF SOIL MATERIAL.

CHECK USER'S GUIDE FOR NUMBER CORRESPONDING TO SOIL TYPE.

12

4.23 IS SOIL LAYER 1 COMPACTED?
ENTER YES OR NO.

4.24 THE VEGETATIVE SOIL LAYER IS GENERALLY NOT COMPACTED.

NO

4.7 ENTER THICKNESS OF SOIL LAYER 2 IN INCHES.
12

4.9 ENTER THE LAYER TYPE FOR LAYER 2.

2

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 2.
1

4.23 IS SOIL LAYER 2 COMPACTED?
ENTER YES OR NO.

NO

4.7 ENTER THICKNESS OF SOIL LAYER 3 IN INCHES.
24

4.9 ENTER THE LAYER TYPE FOR LAYER 3.

3

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 3.
20

4.30 SELECT THE TYPE OF VEGETATIVE COVER.

```
ENTER NUMBER 1 FOR BARE GROUND
        2 FOR EXCELLENT GRASS
        3 FOR GOOD GRASS
        4 FOR FAIR GRASS
        5 FOR POOR GRASS
        6 FOR GOOD ROW CROPS
        7 FOR FAIR ROW CROPS
```

4

4.32 IF YOU ARE USING DEFAULT CLIMATOLOGIC DATA AND
THIS VEGETATION TYPE IS NOT THE SAME USED IN
THE CLIMATOLOGIC DATA INPUT, YOU SHOULD
ENTER THE CLIMATOLOGIC DATA AGAIN.

4.33 DO YOU WANT TO ENTER A RUNOFF CURVE
NUMBER AND OVERRIDE THE DEFAULT VALUE?
ENTER YES OR NO.

NO

6.1 ENTER THE TOTAL AREA OF THE SURFACE, IN SQUARE FEET.

231000

6.2 ENTER THE SLOPE AT THE BASE OF SOIL LAYER 2, IN PERCENT.

3

6.3 ENTER THE MAXIMUM DRAINAGE DISTANCE ALONG THE SLOPE
TO THE COLLECTOR, IN FEET.

175

1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
      2 FOR SOIL OR DESIGN DATA INPUT,
      3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
      4 TO STOP THE PROGRAM, AND
      5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.

3

11.1 HOW MANY YEARS OF OUTPUT DO YOU WANT?
(BETWEEN 2 AND 5 YEARS MAY BE USED.)
5

11.2 DO YOU WANT DAILY OUTPUT?
ENTER YES OR NO.

NO

11.3 DO YOU WANT MONTHLY TOTALS?
ENTER YES OR NO.

YES

****
****

TEST CASE 2
NEW ORLEANS, LOUISIANA
AUGUST 26, 1983

****
****

FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER		
THICKNESS	=	24.00 INCHES
EVAPORATION COEFFICIENT	=	5.000 MM/DAY**0.5
POROSITY	=	0.5350 VOL/VOL
FIELD CAPACITY	=	0.4210 VOL/VOL
WILTING POINT	=	0.2220 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	0.33000004 INCHES/HR

LAYER 2

LATERAL DRAINAGE LAYER		
SLOPE	=	3.00 PERCENT
DRAINAGE LENGTH	=	175.0 FEET
THICKNESS	=	12.00 INCHES
EVAPORATION COEFFICIENT	=	3.300 MM/DAY**0.5
POROSITY	=	0.3510 VOL/VOL
FIELD CAPACITY	=	0.1740 VOL/VOL
WILTING POINT	=	0.1070 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	11.9499998 INCHES/HR

LAYER 3

BARRIER SOIL LAYER		
THICKNESS	=	24.00 INCHES
EVAPORATION COEFFICIENT	=	3.100 MM/DAY**0.5
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.4500 VOL/VOL
WILTING POINT	=	3.600 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	0.00014200 INCHES/HR

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	81.28
TOTAL AREA OF COVER	=	231000. SQ. FT
EVAPORATIVE ZONE DEPTH	=	10.00 INCHES
EFFECTIVE EVAPORATION COEFFICIENT	=	5.000 MM/DAY**0.5
UPPER LIMIT VEG. STORAGE	=	5.3500 INCHES
INITIAL VEG. STORAGE	=	3.2150 INCHES

CLIMATOLOGIC DATA FOR NEW ORLEANS LOUISIANA

MONTHLY MEAN TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
53.30	55.00	60.28	67.71	75.31	81.04
83.37	81.66	76.39	68.95	61.35	55.62

MONTHLY MEANS SOLAR RADIATION, LANGLEYS PER DAY

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
236.64	268.52	321.36	381.00	431.47	459.23
456.86	424.98	372.14	312.50	262.03	234.27

LEAF AREA INDEX TABLE

DATE	LAI
1	0.0
44	0.0
74	0.61

105	0.99
135	0.99
165	0.99
196	0.99
226	0.99
256	0.89
286	0.65
317	0.32
347	0.16
366	0.0

FAIR GRASS

WINTER COVER FACTOR = 0.60

****

MONTHLY TOTALS FOR 74

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	8.46	5.53	6.64	5.52	9.84	3.83
	5.66	6.70	7.58	2.26	5.88	4.89
RUNOFF (INCHES)	1.903	2.111	1.554	1.088	1.508	0.023
	0.005	0.135	0.809	0.003	0.345	0.648
EVAPOTRANSPIRATION	2.605	2.297	2.809	4.196	5.118	4.556
(INCHES)	5.328	5.602	4.891	1.730	3.323	2.497
PERCOLATION FROM BASE	0.1050	0.1801	0.1497	0.1620	0.1572	0.1518
OF COVER (INCHES)	0.1385	0.1299	0.1306	0.1375	0.1251	0.1611
DRAINAGE FROM BASE OF	0.590	2.239	1.439	1.953	1.677	1.408
COVER (INCHES)	0.634	0.406	0.783	0.543	0.425	1.868

****

****

ANNUAL TOTALS FOR 74

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	72.79	1401194.	100.0
RUNOFF	10.131	195030.	13.92
EVAPOTRANSPIRATION	44.950	865292.	61.75
PERCOLATION FROM BASE OF COVER	1.7283	33270.	2.37
DRAINAGE FROM BASE OF COVER	13.966	268840.	19.19
SOIL WATER AT START OF YEAR	22.00	423442.	
SOIL WATER AT END OF YEAR	24.01	462181.	
SNOW WATER AT START OF YEAR	0.0	0.	
SNOW WATER AT END OF YEAR	0.0	0.	
ANNUAL WATER BUDGET BALANCE	0.00	23.	0.00

****

****

MONTHLY TOTALS FOR 75

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	2.95	3.64	5.32	6.69	8.03	12.28
	8.35	10.11	3.97	4.00	11.35	3.81
RUNOFF (INCHES)	0.039	0.226	0.560	1.273	1.155	1.355
	0.644	3.138	0.089	0.844	4.980	0.027
EVAPOTRANSPIRATION (INCHES)	2.139	2.067	3.701	3.753	5.116	6.634
	6.240	5.485	3.926	1.912	2.640	2.413
PERCOLATION FROM BASE OF COVER (INCHES)	0.1530	0.1258	0.1532	0.1424	0.1371	0.1745
	0.2264	0.2149	0.1539	0.1454	0.1627	0.1424
DRAINAGE FROM BASE OF COVER (INCHES)	1.508	0.779	1.425	1.011	0.690	1.988
	2.689	2.575	1.670	0.901	1.843	1.071

****

****

ANNUAL TOTALS FOR 75

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	80.50	1549610.	100.00
RUNOFF	14.330	275858.	17.80
EVAPOTRANSPIRATION	46.024	885967.	57.17

PERCOLATION FROM BASE OF COVER	1.9313	37178.	2.40
DRAINAGE FROM BASE OF COVER	18.159	349561.	22.56
SOIL WATER AT START OF YEAR	24.01	462181.	
SOIL WATER AT END OF YEAR	24.06	463198.	
SNOW WATER AT START OF YEAR	0.0	0.	
SNOW WATER AT END OF YEAR	0.0	0.	
ANNUAL WATER BUDGET BALANCE	0.00	29.	0.00

****

****

MONTHLY TOTALS FOR 76

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	2.61	3.85	3.08	0.28	5.58	3.36
	5.67	1.69	1.57	5.08	5.80	8.79
RUNOFF (INCHES)	0.107	0.573	0.0	0.0	0.074	0.000
	0.0	0.028	0.0	0.415	0.712	2.150
EVAPOTRANSPIRATION	2.090	2.260	2.597	1.425	4.862	2.589
(INCHES)	5.171	2.260	1.502	2.191	2.738	2.535

PERCOLATION FROM BASE OF COVER (INCHES)	0.1436	0.1383	0.1379	0.1325	0.1246	0.1406
	0.1197	0.1309	0.0893	0.0722	0.1263	0.1974
DRAINAGE FROM BASE OF COVER (INCHES)	0.821	1.366	0.674	0.302	0.274	0.234
	0.195	0.164	0.010	0.054	0.685	2.388

****

****

ANNUAL TOTALS FOR 76

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	47.36	911673.	100.0
RUNOFF	4.059	78129.	8.57
EVAPOTRANSPIRATION	32.220	620229.	68.03
PERCOLATION FROM BASE OF COVER	1.5532	29900.	3.28
DRAINAGE FROM BASE OF COVER	7.165	137924.	15.13
SOIL WATER AT START OF YEAR	24.06	463198.	
SOIL WATER AT END OF YEAR	26.42	508669.	
SNOW WATER AT START OF YEAR	0.0	0.	
SNOW WATER AT END OF YEAR	0.0	0.	
ANNUAL WATER BUDGET BALANCE	0.00	20.	0.00

****

****

MONTHLY TOTALS FOR 77

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	5.31	3.08	3.54	6.80	1.87	2.46
	2.91	16.02	13.44	4.47	7.89	5.02
RUNOFF (INCHES)	0.281	0.185	0.106	1.803	0.033	0.0
	0.0	2.947	6.582	0.396	0.600	0.690
EVAPOTRANSPIRATION	2.439	1.925	3.475	3.180	2.272	2.323
(INCHES)	2.772	6.509	5.045	3.304	3.130	2.428
PERCOLATION FROM BASE	0.2362	0.1734	0.1604	0.1386	0.1479	0.1365
OF COVER (INCHES)	0.1493	0.1379	0.2400	0.1854	0.1562	0.1878
DRAINAGE FROM BASE OF	2.779	2.152	1.813	1.025	1.122	0.378
COVER (INCHES)	0.120	0.794	2.767	2.327	1.761	2.334

****

****

ANNUAL TOTALS FOR 77

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	72.81	1401578.	100.0
RUNOFF	13.623	262249.	18.71
EVAPOTRANSPIRATION	38.800	746894.	53.29
PERCOLATION FROM BASE OF COVER	2.0497	39457.	2.82
DRAINAGE FROM BASE OF COVER	19.371	372891.	26.61
SOIL WATER AT START OF YEAR	26.42	508669.	
SOIL WATER AT END OF YEAR	25.39	488730.	
SNOW WATER AT START OF YEAR	0.0	0.	
SNOW WATER AT END OF YEAR	0.0	0.	
ANNUAL WATER BUDGET BALANCE	0.00	27.	0.00

****

****

MONTHLY TOTALS FOR 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	13.37	2.18	3.29	3.44	9.71	7.83
	10.32	14.70	2.98	0.0	4.67	4.36

RUNOFF (INCHES)	5.843	0.468	0.113	0.625	3.193	0.801
	1.635	4.073	0.008	0.0	0.913	0.823
EVAPOTRANSPIRATION (INCHES)	2.565	2.289	3.036	2.744	5.010	4.544
	6.719	5.871	3.769	0.898	0.973	2.473
PERCOLATION FROM BASE OF COVER (INCHES)	0.2095	0.2058	0.1616	0.1419	0.1497	0.1388
	0.1492	0.1644	0.1796	0.1449	0.1324	0.1505
DRAINAGE FROM BASE OF COVER (INCHES)	2.555	2.445	1.851	0.888	1.131	0.504
	1.637	1.753	2.183	0.949	0.324	1.355

****

****

ANNUAL TOTALS FOR 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	76.85	1479348.	100.00
RUNOFF	18.495	356035.	24.07
EVAPOTRANSPIRATION	40.889	787115.	53.21
PERCOLATION FROM BASE OF COVER	1.9283	37120.	2.51
DRAINAGE FROM BASE OF COVER	17.575	338324.	22.87
SOIL WATER AT START OF YEAR	25.39	488730.	
SOIL WATER AT END OF YEAR	23.35	449458.	

SNOW WATER AT START OF YEAR	0.0	0.	
SNOW WATER AT END OF YEAR	0.0	0.	
ANNUAL WATER BUDGET BALANCE	0.00	28.	0.00

****

****

AVERAGE MONTHLY TOTALS FOR 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	6.54 6.58	3.66 9.84	4.37 5.91	4.55 3.16	7.01 7.12	5.95 5.37
RUNOFF (INCHES)	1.635 0.457	0.712 2.064	0.467 1.498	0.958 0.332	1.193 1.510	0.436 0.868
EVAPOTRANSPIRATION (INCHES)	2.368 5.246	2.168 5.145	3.124 3.826	3.060 2.007	4.476 2.561	4.129 2.469
PERCOLATION FROM BASE OF COVER (INCHES)	0.1695 0.1566	0.1647 0.1556	0.1526 0.1587	0.1435 0.1371	0.1433 0.1405	0.1484 0.1678
DRAINAGE FROM BASE OF COVER (INCHES)	1.651 1.055	1.796 1.138	1.440 1.482	1.036 0.955	0.979 1.008	0.905 1.803

****

****

AVERAGE ANNUAL TOTALS FOR 74 THROUGH 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	70.06	1348681.	100.00
RUNOFF	12.128	233460.	17.31
EVAPOTRANSPIRATION	40.577	781099.	57.92
PERCOLATION FROM BASE OF COVER	1.8382	35385.	2.62
DRAINAGE FROM BASE OF COVER	15.247	293508.	21.76

****

****

PEAK DAILY VALUES FOR 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	8.52	164010.0
RUNOFF	4.818	92753.7
PERCOLATION FROM BASE OF COVER	0.0122	234.6
DRAINAGE FROM BASE OF COVER	0.144	2772.9
HEAD ON BASE OF COVER	36.0	
SNOW WATER	0.0	0.0

```
  MAXIMUM VEG. SOIL WATER (VOL/VOL)                          0.5350

  MINIMUM VEG. SOIL WATER (VOL/VOL)                          0.2220
******************************************************************************
******************************************************************************
```

```
1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
      2 FOR SOIL OR DESIGN DATA INPUT,
      3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
      4 TO STOP THE PROGRAM, AND
      5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.


4


1.4 ENTER RUNHELP TO RERUN PROGRAM OR
ENTER LOGOFF TO LOGOFF COMPUTER SYSTEM
```

Input/Output Listing for Test Case 3

```
****************************************************************************
****************************************************************************
*                                                                          *
*              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               *
*                             HELP VERSION 1                               *
*                                                                          *
*                               WRITTEN BY                                 *
*                                                                          *
*                           PAUL R. SCHROEDER                              *
*                             AUGUST, 1983                                 *
*                                                                          *
*                                OF THE                                    *
*                   WATER RESOURCES ENGINEERING GROUP                      *
*                       ENVIRONMENTAL LABORATORY                           *
*                   USAE WATERWAYS EXPERIMENT STATION                      *
*                              P.O. BOX 631                                *
*                          VICKSBURG, MS  39180                            *
*                                                                          *
****************************************************************************
*                                                                          *
*                  USER'S GUIDE AVAILABLE UPON REQUEST                     *
*                  FOR CONSULTATION CONTACT AUTHORS AT                     *
*                   (601) 634-3709 OR (601) 634-3710                       *
*                                                                          *
****************************************************************************
****************************************************************************
```

1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
      2 FOR SOIL OR DESIGN DATA INPUT,
      3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
      4 TO STOP THE PROGRAM, AND
      5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.

1

1.2 DO YOU WANT TO USE DEFAULT CLIMATOLOGIC DATA?
ENTER YES OR NO.

YES

```
2.1 DO YOU WANT A LIST OF DEFAULT CITIES?
ENTER YES OR NO.

NO

2.2 ENTER NAME OF STATE OF INTEREST


LOUISIANA

2.4 ENTER NAME OF CITY OF INTEREST


NEW ORLEANS

2.6 SELECT THE TYPE OF VEGETATIVE COVER

ENTER NUMBER 1 FOR BARE GROUND
             2 FOR EXCELLENT GRASS
             3 FOR GOOD GRASS
             4 FOR FAIR GRASS
             5 FOR POOR GRASS
             6 FOR GOOD ROW CROPS
             7 FOR FAIR ROW CROPS

4

2.8 IF YOU ARE USING DEFAULT SOIL DATA AND THIS VEGETATION
TYPE IS NOT THE SAME AS USED IN THE DEFAULT SOIL DATA INPUT,
YOU SHOULD ENTER THE SOIL DATA AGAIN OR CORRECT THE SCS
RUNOFF CURVE NUMBER.


2.9 ENTER THE EVAPORATIVE ZONE DEPTH IN INCHES.

CONSERVATIVE VALUES ARE:
           4 IN. FOR BAREGROUND
          10 IN. FOR FAIR GRASS
          18 IN. FOR EXCELLENT GRASS

10


1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
      2 FOR SOIL OR DESIGN DATA INPUT,
      3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
      4 TO STOP THE PROGRAM, AND
      5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.
```

2

1.3 DO YOU WANT TO USE DEFAULT SOIL DATA?
ENTER YES OR NO.

YES

USE ONLY ENGLISH UNITS OF INCHES AND DAYS
UNLESS OTHERWISE INDICATED

############################ANSWER ALL QUESTIONS############################
****
A VALUE **MUST** BE ENTERED FOR EACH COMMAND
EVEN WHEN THE VALUE IS ZERO.
****

4.1 ENTER TITLE ON LINE 1,
ENTER LOCATION OF SOLID WASTE SITE ON LINE 2,
AND ENTER TODAY'S DATE ON LINE 3.

TEST CASE 3
NEW ORLEANS, LOUISIANA
AUGUST 26, 1983

4.2 FOUR TYPES OF LAYERS MAY BE USED IN THE DESIGN:
VERTICAL PERCOLATION, LATERAL DRAINAGE, BARRIER SOIL, AND WASTE.

LATERAL DRAINAGE IS NOT PERMITTED FROM A VERTICAL PERCOLATION
LAYER.
BOTH VERTICAL AND LATERAL DRAINAGE ARE PERMITTED FROM A LATERAL
DRAINAGE LAYER.
A BARRIER SOIL LAYER SHOULD BE DESIGNED TO INHIBIT PERCOLATION.
AN IMPERMEABLE LINER MAY BE USED ON TOP OF ANY BARRIER SOIL LAYER.
THE WASTE LAYER SHOULD BE DESIGNED TO PERMIT RAPID DRAINAGE
FROM THE WASTE LAYER.

RULES:

THE TOP LAYER CANNOT BE A BARRIER SOIL LAYER.
A BARRIER SOIL LAYER MAY NOT BE PLACED ADJACENT TO ANOTHER
BARRIER SOIL LAYER.

ONLY A BARRIER SOIL LAYER OR ANOTHER LATERAL DRAINAGE LAYER MAY BE PLACED DIRECTLY BELOW A LATERAL DRAINAGE LAYER.
YOU MAY USE UP TO 9 LAYERS AND UP TO 3 BARRIER SOIL LAYERS.

ENTER THE NUMBER OF LAYERS IN YOUR DESIGN.

6
4.3 THE LAYERS ARE NUMBERED SUCH THAT
SOIL LAYER 1 IS THE TOP LAYER
AND SOIL LAYER 6 IS THE BOTTOM LAYER.

4.6 IS THE TOP LAYER AN UNVEGETATED SAND OR GRAVEL LAYER?
ENTER YES OR NO.

NO

4.7 ENTER THICKNESS OF SOIL LAYER 1 IN INCHES.
24

4.9 ENTER THE LAYER TYPE FOR LAYER 1.

4.10 ENTER 1 FOR A VERTICAL PERCOLATION LAYER,
2 FOR A LATERAL DRAINAGE LAYER,
3 FOR A BARRIER SOIL LAYER,
4 FOR A WASTE LAYER, AND
5 FOR A BARRIER SOIL LAYER WITH
AN IMPERMEABLE LINER.

1

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 1.

4.16 ENTER A NUMBER (1 THROUGH 23) FOR TEXTURE CLASS OF SOIL MATERIAL.

CHECK USER'S GUIDE FOR NUMBER CORRESPONDING TO SOIL TYPE.

12

4.23 IS SOIL LAYER 1 COMPACTED?
ENTER YES OR NO.

4.24 THE VEGETATIVE SOIL LAYER IS GENERALLY NOT COMPACTED.

NO

4.7 ENTER THICKNESS OF SOIL LAYER 2 IN INCHES.
12

4.9 ENTER THE LAYER TYPE FOR LAYER 2.

2

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 2.
1

4.23 IS SOIL LAYER 2 COMPACTED?
ENTER YES OR NO.

NO

4.7 ENTER THICKNESS OF SOIL LAYER 3 IN INCHES.
24

4.9 ENTER THE LAYER TYPE FOR LAYER 3.

3

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 3.
20

4.7 ENTER THICKNESS OF SOIL LAYER 4 IN INCHES.
60

4.9 ENTER THE LAYER TYPE FOR LAYER 4.

4

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 4.
1

4.23 IS SOIL LAYER 4 COMPACTED?
ENTER YES OR NO.

NO

4.7 ENTER THICKNESS OF SOIL LAYER 5 IN INCHES.
12

4.9 ENTER THE LAYER TYPE FOR LAYER 5.

2

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 5.
1

4.23 IS SOIL LAYER 5 COMPACTED?
ENTER YES OR NO.

NO

4.7 ENTER THICKNESS OF SOIL LAYER 6 IN INCHES.
24

4.9 ENTER THE LAYER TYPE FOR LAYER 6.

3

4.15 ENTER SOIL TEXTURE OF SOIL LAYER 6.
20

4.33 DO YOU WANT TO ENTER A RUNOFF CURVE
NUMBER AND OVERRIDE THE DEFAULT VALUE?
ENTER YES OR NO.

NO

6.1 ENTER THE TOTAL AREA OF THE SURFACE, IN SQUARE FEET.

231000

6.2 ENTER THE SLOPE AT THE BASE OF SOIL LAYER 2, IN PERCENT.

3

6.3 ENTER THE MAXIMUM DRAINAGE DISTANCE ALONG THE SLOPE
TO THE COLLECTOR, IN FEET.

175

6.2 ENTER THE SLOPE AT THE BASE OF SOIL LAYER 5, IN PERCENT.

2

6.3 ENTER THE MAXIMUM DRAINAGE DISTANCE ALONG THE SLOPE
TO THE COLLECTOR, IN FEET.

25

1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
2 FOR SOIL OR DESIGN DATA INPUT,
3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
4 TO STOP THE PROGRAM, AND
5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.

5

11.1 HOW MANY YEARS OF OUTPUT DO YOU WANT?
(BETWEEN 2 AND 5 YEARS MAY BE USED.)
5

****
****

TEST CASE 3
NEW ORLEANS, LOUISIANA
AUGUST 26, 1983

****
****

FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER		
THICKNESS	=	24.00 INCHES
EVAPORATION COEFFICIENT	=	5.000 MM/DAY**0.5
POROSITY	=	0.5350 VOL/VOL
FIELD CAPACITY	=	0.4210 VOL/VOL
WILTING POINT	=	0.2220 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	0.33000004 INCHES/HR

LAYER 2

LATERAL DRAINAGE LAYER		
SLOPE	=	3.00 PERCENT
DRAINAGE LENGTH	=	175.0 FEET
THICKNESS	=	12.00 INCHES
EVAPORATION COEFFICIENT	=	3.300 MM/DAY**0.5
POROSITY	=	0.3510 VOL/VOL
FIELD CAPACITY	=	0.1740 VOL/VOL
WILTING POINT	=	0.1070 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	11.9499998 INCHES/HR

LAYER 3

BARRIER SOIL LAYER		
THICKNESS	=	24.00 INCHES
EVAPORATION COEFFICIENT	=	3.100 MM/DAY**0.5
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.4500 VOL/VOL
WILTING POINT	=	3.600 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	0.00014200 INCHES/HR

LAYER 4

WASTE LAYER		
THICKNESS	=	60.00 INCHES
EVAPORATION COEFFICIENT	=	3.300 MM/DAY**0.5
POROSITY	=	0.3510 VOL/VOL
FIELD CAPACITY	=	0.1740 VOL/VOL
WILTING POINT	=	0.1070 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	11.9499998 INCHES/HR

LAYER 5

LATERAL DRAINAGE LAYER		
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	25.00 FEET
THICKNESS	=	12.00 INCHES
EVAPORATION COEFFICIENT	=	3.300 MM/DAY**0.5
POROSITY	=	0.3510 VOL/VOL
FIELD CAPACITY	=	0.1740 VOL/VOL
WILTING POINT	=	0.1070 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	11.9499998 INCHES/HR

LAYER 6

BARRIER SOIL LAYER		
THICKNESS	=	24.00 INCHES
EVAPORATION COEFFICIENT	=	3.100 MM/DAY**0.5
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.4500 VOL/VOL
WILTING POINT	=	0.3600 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	0.00014200 INCHES/HR

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	81.28
TOTAL AREA OF COVER	=	231000. SQ. FT
EVAPORATIVE ZONE DEPTH	=	10.00 INCHES
EFFECTIVE EVAPORATION COEFFICIENT	=	5.000 MM/DAY**0.5
UPPER LIMIT VEG. STORAGE	=	5.3500 INCHES
INITIAL VEG. STORAGE	=	3.2150 INCHES

CLIMATOLOGIC DATA FOR NEW ORLEANS LOUISIANA

MONTHLY MEAN TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
53.30	55.00	60.28	67.71	75.31	81.04
83.37	81.66	76.39	68.95	61.35	55.62

MONTHLY MEANS SOLAR RADIATION, LANGLEYS PER DAY

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
236.64	268.52	321.36	381.00	431.47	459.23
456.86	424.98	372.14	312.50	262.03	234.27

LEAF AREA INDEX TABLE

DATE	LAI
1	0.0
44	0.0
74	0.61
105	0.99
135	0.99
165	0.99
196	0.99
226	0.99
256	0.89
286	0.65
317	0.32
347	0.16
366	0.0

FAIR GRASS

WINTER COVER FACTOR = 0.60

****

AVERAGE MONTHLY TOTALS FOR 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	6.54	3.66	4.37	4.55	7.01	5.95
	6.58	9.84	5.91	3.16	7.12	5.37

RUNOFF (INCHES)	1.680	0.651	0.467	0.958	1.193	0.436
	0.457	2.065	1.500	0.332	1.510	0.868
EVAPOTRANSPIRATION	2.367	2.174	3.123	3.060	4.476	4.129
(INCHES)	5.246	5.146	3.828	2.007	2.561	2.469
PERCOLATION FROM BASE	0.1686	0.1625	0.1533	0.1436	0.1434	0.1467
OF COVER (INCHES)	0.1545	0.1550	0.1598	0.1360	0.1407	0.1669
PERCOLATION FROM BASE	0.1445	0.1418	0.1471	0.1376	0.1377	0.1382
OF LANDFILL (INCHES)	0.1392	0.1408	0.1417	0.1287	0.1337	0.1537
DRAINAGE FROM BASE OF	1.642	1.768	1.474	1.053	0.988	0.901
COVER (INCHES)	1.043	1.136	1.479	0.959	1.021	1.795
DRAINAGE FROM BASE OF	0.021	0.024	0.008	0.006	0.006	0.008
LANDFILL (INCHES)	0.014	0.014	0.018	0.010	0.006	0.011

****

****

AVERAGE ANNUAL TOTALS FOR 74 THROUGH 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	70.06	1348681.	100.00
RUNOFF	12.115	233208.	17.29
EVAPOTRANSPIRATION	40.585	781255.	57.93

PERCOLATION FROM BASE OF COVER	1.8311	35248.	2.61
PERCOLATION FROM BASE OF LANDFILL	1.6848	32433.	2.40
DRAINAGE FROM BASE OF COVER	15.259	293735.	21.78
DRAINAGE FROM BASE OF LANDFILL	0.146	2807.	0.21

****

****

PEAK DAILY VALUES FOR 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	8.52	164010.0
RUNOFF	4.818	92750.3
PERCOLATION FROM BASE OF COVER	0.0120	230.1
PERCOLATION FROM BASE OF LANDFILL	0.0082	158.0
DRAINAGE FROM BASE OF COVER	0.141	2716.1
DRAINAGE FROM BASE OF LANDFILL	0.003	58.5
HEAD ON BASE OF COVER	35.8	
HEAD ON BASE OF LANDFILL	0.1	
SNOW WATER	0.0	0.0

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.5350
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2220

****
****

```
1.1 DO YOU WANT TO ENTER OR CHECK DATA OR TO OBTAIN OUTPUT?

ENTER 1 FOR CLIMATOLOGIC INPUT,
      2 FOR SOIL OR DESIGN DATA INPUT,
      3 TO RUN THE SIMULATION AND OBTAIN DETAILED OUTPUT,
      4 TO STOP THE PROGRAM, AND
      5 TO RUN THE SIMULATION AND OBTAIN ONLY SUMMARY OUTPUT.


4


1.4 ENTER RUNHELP TO RERUN PROGRAM OR
ENTER LOGOFF TO LOGOFF COMPUTER SYSTEM
```

REFERENCES

1. Perrier, E. R., and A. C. Gibson. Hydrologic Simulation on Solid Waste Disposal Sites. EPA-SW-868, U.S. Environmental Protection Agency, Cincinnati, OH, 1980. 111 pp.

2. Schroeder, P. R., and A. C. Gibson. Supporting Documentation for the Hydrologic Simulation Model for Estimating Percolation at Solid Waste Disposal Sites (HSSWDS). Draft Report, U.S. Environmental Protection Agency, Cincinnati, OH, 1982. 153 pp.

3. Knisel, W. J., Jr., Editor. CREAMS, A Field Scale Model for Chemical Runoff and Erosion from Agricultural Management Systems. Vols. I, II, and III, Draft Copy, USDA-SEA, AR, Cons. Res. Report 24, 1980. 643 pp.

4. USDA, Soil Conservation Service. National Engineering Handbook, Section 4, Hydrology. U.S. Government Printing Office, Washington, C.C., 1972.

5. Schroeder, P. R., A. C. Gibson, and M. D. Smolen. Hydrologic Evaluation of Landfill Performance (HELP) Model: Volume II. Documentation for Version 1. Draft Report, Municipal Environmental Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, OH, 1983.

6. Lutton, R. J., G. L. Regan, and L. W. Jones. Design and Construction of Covers for Solid Waste Landfills. PB 80-100381, EPA-600/2-79-165, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1979.

7. England, C. B. Land Capability: A Hydrologic Response Unit in Agricultural Watersheds. ARS 41-172, Agricultural Research Service, USDA, 1970.

8. Breazeale, E., and W. T. McGeorge. A New Technic for Determining Wilting Percentage of Soil. Soil Science, Vol. 68, pp. 371-374, 1949.

9. Li, E. A. A Model to Define Hydrologic Response Units Based on Characteristics of the Soil-Vegetative Complex Within a Drainage Basin. M.S. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, VA, 1975. 124 pp.

APPENDIX A

STEPS TO LOG ON AND OFF NCC

The HELP program is maintained on the National Computer Center (NCC)* IBM Computer System. In order to run HELP on this system, the user must contact National Technical Information Services (NTIS) to open an account, be assigned a user identification number and password, and obtain permission to use the timesharing option (TSO). The individual to contact at NTIS is Mr. Walley Finch. Mr. Finch may be reached by telephone at (703) 487-4807. Once these arrangements have been made, the user should contact Mr. Anthony Gibson of the U.S. Army Engineer Waterways Experiment Station to have the HELP program established on the assigned account. Mr. Gibson may be reached by telephone at (601) 634-3710 (commercial) or 542-3710 (FTS).

Step-by-step procedures to log on and off the NCC System are presented below.

To log on:

1. Turn on the data terminal.

2. Dial the appropriate telephone number given in Appendix B.

3. Put the telephone handle in the handset muff (or depress the telephone data button).

4. The computer system will then respond if the user did not use the toll-free telephone number (1-800-334-1079) as follows:
   PLEASE TYPE YOUR TERMINAL IDENTIFIER**
   The user should type† his terminal identifier (see Appendix B).
   For example, <u>A</u>.

---

* To obtain cost information for the NCC Computer System, see Appendix C.

** If the BAUD rate for the user's computer terminal is 1200, the computer system will type a line of random characters. The user should enter the appropriate terminal identifier and continue.

† To correct typing errors, use the backspace key for character deletion or press the BREAK key for line deletion.

5. The computer system will then respond:
   -3625-ØØ4-PLEASE LOG IN
   The user should type:
   IBMEPA1;NCC (RETURN)

4A. If the user used the toll-free number (1-800-334-1079), the user should press the RETURN key as soon as the computer system is on-line.

5A. The computer system will then respond:
   ENTER IBM FOR IBM
   UNI FOR SPERRY
   The user should then type:
   IBM (Return)
   The computer system will then respond:
   CONNECTED
   The user should then press the RETURN key.

6. The computer system will then respond:
   IBM3 IS ON LINE
   The user should type:
   TSO (RETURN)

7. The computer system will then respond:
   ENTER LOGON
   The user should type:
   LOGON (RETURN)

8. The computer system will then respond:
   IKJ567ØØA ENTER USER ID -
   The user should type:
   User identification/password (RETURN)

9. The computer system will then respond:
   ENTER FIMAS ID -
   The user should type:
   HSSWP*** (RETURN)

10. The computer system will then respond:
   READY
   The user should type:
   RUNHELP (RETURN)

   The program will start functioning according to the instructions in Chapter 4 of the User's Guide.

*** HSSW is the utilization identifier and P is the mode character for the facility impact monitor analysis system (FIMAS).

11. When the program is finished, the user should type:
LOGOFF (RETURN)

APPENDIX B

NCC ACCESS NUMBERS AND TERMINAL IDENTIFIERS

The following list contains current NCC access numbers for 300 or 1200 BAUD rates. These numbers are to be used to access the TSO computer in Research Triangle Park, NC. A user should locate his city of interest on the list and dial the appropriate number for access to TSO. Users who fail to find their city of interest on the list should dial the toll free number 800-334-1079 for the 300 or 1200 BAUD rate.

TABLE B-1. ACCESS TELEPHONE NUMBERS

CITY	STATE	PHONE NUMBERS
ANNISTON	ALABAMA	205/236-2655
BIRMINGHAM	ALABAMA	205/942-4141
HUNTSVILLE	ALABAMA	205/882-3003
MOBILE	ALABAMA	205/343-8414
MONTGOMERY	ALABAMA	205/265-4570
TUSCALOOSA	ALABAMA	205/345-1420
PHOENIX	ARIZONA	602/254-5811
TUCSON	ARIZONA	602/790-0764
FT. SMITH	ARKANSAS	501/782-3210
HOT SPRINGS	ARKANSAS	501-321-9741
JONESBORO	ARKANSAS	501/932-6886
LITTLE ROCK	ARKANSAS	501/666-6886
SPRINGDALE	ARKANSAS	501/756-2201
ALHAMBRA	CALIFORNIA	818/308-1800
ANTIOCH	CALIFORNIA	415/778-3420
ARCADIA	CALIFORNIA	818/308-1800
BAKERSFIELD	CALIFORNIA	805/325-8366
BEVERLEY HILLS	CALIFORNIA	818/789-9002
BURBANK	CALIFORNIA	818/841-7890
BURLINGAME	CALIFORNIA	415/952-4757
CANOGA PARK	CALIFORNIA	818/789-9002
CHICO	CALIFORNIA	916/893-1876
CORONA	CALIFORNIA	714/371-2291

TABLE B-1. (CONTINUED)

CITY	STATE	PHONE NUMBERS
DAVIS/WOODLAND	CALIFORNIA	916/753-3722
DIAMOND BAR	CALIFORNIA	714/594-4567
EL SEGUNDO	CALIFORNIA	213/640-1281
ESCONDIDO	CALIFORNIA	619/480-0881
EUREKA	CALIFORNIA	707/445-3281
FREMONT	CALIFORNIA	415/490-7366
FRESNO	CALIFORNIA	209/442-4328
HAYWARD	CALIFORNIA	415/785-3431
LANCASTER	CALIFORNIA	805/945-7841
LONG BEACH	CALIFORNIA	213/435-0900
LOS ANGELES	CALIFORNIA	213/626-2400
LOS ANGELES	CALIFORNIA	213/623-8500
LOS ANGELES	CALIFORNIA	213/629-3001
MAR VISTA	CALIFORNIA	213/821-2257
MARINA DEL REY	CALIFORNIA	213/821-2257
MISSION HILLS	CALIFORNIA	818/789-9002
MODESTO	CALIFORNIA	209/577-5602
MOUNTAIN VIEW	CALIFORNIA	408/980-8100
NAPA	CALIFORNIA	707/257-2656
NEWPORT BEACH	CALIFORNIA	714/966-0313
NORTHRIDGE	CALIFORNIA	818/789-9002
NORWALK	CALIFORNIA	213/435-0900
OAKLAND	CALIFORNIA	415/836-8700
PALM SPRINGS	CALIFORNIA	619/320-0772
PALO ALTO	CALIFORNIA	415/966-8550
PASADENA	CALIFORNIA	818/308-1800
PLEASANT HILL	CALIFORNIA	415/798-2093
PLEASANTON	CALIFORNIA	415/462-8900
RANCHO BERNARDO	CALIFORNIA	619/485-1990
REDDING	CALIFORNIA	916/223-0449
RIVERSIDE/COLTON	CALIFORNIA	714/370-1200
SACRAMENTO	CALIFORNIA	916/448-4300
SALINAS	CALIFORNIA	408/443-4333
SAN CLEMENTE	CALIFORNIA	714/498-9504
SAN DIEGO	CALIFORNIA	619/296-3370
SAN FRANCISCO	CALIFORNIA	415/974-1300
SAN FRANCISCO	CALIFORNIA	415/543-0691
SAN JOSE/CUPERTINO	CALIFORNIA	408/980-8100
SAN LOUIS OBISPO	CALIFORNIA	805/546-8541
SAN PEDRO	CALIFORNIA	213/435-0900
SANTA ANA	CALIFORNIA	714/966-0313
SANTA BARBARA	CALIFORNIA	805/963-9241
SANTA BARBARA	CALIFORNIA	805/963-9251
SANTA CRUZ	CALIFORNIA	408/475-0981
SANTA MONICA	CALIFORNIA	213/306-4728
SANTA ROSA	CALIFORNIA	707/575-6180
SHERMAN OAKS	CALIFORNIA	818/789-9002

TABLE B-1. (CONTINUED)

CITY	STATE	PHONE NUMBERS
STOCKTON	CALIFORNIA	209/467-0601
THOUSAND OAKS	CALIFORNIA	805/496-3473
VALLEJO	CALIFORNIA	707/557-0333
VAN NUYS	CALIFORNIA	818/789-9002
VENTURA/OXNARD	CALIFORNIA	805/486-4811
VISTA	CALIFORNIA	619/727-6011
WALNUT CREEK	CALIFORNIA	415/932-0116
WEST COVINA	CALIFORNIA	818/331-3954
WEST COVINA	CALIFORNIA	818/915-5702
COLORADO SPRINGS	COLORADO	303/590-1003
DENVER	COLORADO	303/830-9210
GREELEY	COLORADO	303/356-0425
PUEBLO	COLORADO	303/543-3313
BLOOMFIELD	CONNECTICUT	203/242-7140
BRIDGEPORT	CONNECTICUT	203/367-6021
DANBURY	CONNECTICUT	203/797-9539
DARIEN	CONNECTICUT	203/965-0000
HARTFORD	CONNECTICUT	203/242-7140
MERIDEN	CONNECTICUT	203/235-5180
NEW HAVEN	CONNECTICUT	203/773-0082
NEW LONDON	CONNECTICUT	203/444-1709
STAMFORD	CONNECTICUT	203/965-0000
WATERBURY	CONNECTICUT	203/755-5994
WESTPORT	CONNECTICUT	203/226-5250
WASHINGTON	D.C.	703/691-8200
WASHINGTON	D.C.	703/691-8390
DOVER	DELAWARE	302/678-0449
WILMINGTON	DELAWARE	302/429-0112
BOCA RATON	FLORIDA	305/395-7330
DAYTONA BEACH	FLORIDA	904/255-4783
FORT MYERS	FLORIDA	813/936-4221
FT. PIERCE	FLORIDA	305/466-0661
FT. LAUDERDALE	FLORIDA	305/463-0882
GAINESVILLE	FLORIDA	904/376-0939
JACKSONVILLE	FLORIDA	904/721-8100
LAKELAND	FLORIDA	813/688-5776
MELBOURNE	FLORIDA	305/676-4336
MERRITT ISLE	FLORIDA	305/459-0671
MIAMI	FLORIDA	305/624-7900
OCALA	FLORIDA	904/351-0070
ORLANDO	FLORIDA	305/841-0020
PENSACOLA	FLORIDA	904/477-3344
SARASOTA	FLORIDA	813/365-3526

TABLE B-1. (CONTINUED)

CITY	STATE	PHONE NUMBERS
SARASOTA	FLORIDA	813/365-6980
ST. PETERSBURG	FLORIDA	813/441-9671
ST. PETERSBURG	FLORIDA	813/443-1533
TALLAHASSEE	FLORIDA	904/878-6929
TAMPA	FLORIDA	813/977-2400
TAMPA	FLORIDA	813/932-7070
W. PALM BEACH	FLORIDA	305/471-9310
ATHENS	GEORGIA	404/546-0167
ATLANTA/NORCROSS	GEORGIA	404/446-0270
AUGUSTA	GEORGIA	404/722-7967
COLUMBUS	GEORGIA	404/327-0396
MACON	GEORGIA	912/744-0605
MARIETTA	GEORGIA	404/424-0025
ROME	GEORGIA	404/291-1000
SAVANNAH	GEORGIA	912/232-6751
HONOLULU	HAWAII	808/528-4450
BOISE	IDAHO	208/343-0404
IDAHO FALLS	IDAHO	208/523-2964
POCATELLO	IDAHO	208/233-2501
AURORA	ILLINOIS	312/859-1143
BELLEVILLE	ILLINOIS	618/233-2230
CHAMPAIGN	ILLINOIS	217/356-7552
CHICAGO	ILLINOIS	312/922-4601
CHICAGO	ILLINOIS	312/922-6571
DECATUR	ILLINOIS	217/422-0612
FOREST PARK	ILLINOIS	312/771-9667
FREEPORT	ILLINOIS	815/233-5585
GLEN ELLYN/WHEATON	ILLINOIS	312/790-4400
JOLIET	ILLINOIS	815/727-1019
LAKE ZURICH	ILLINOIS	312/438-3771
LIBERTYVILLE	ILLINOIS	312/362-0820
PEORIA	ILLINOIS	309/637-5961
ROCK ISLAND	ILLINOIS	309/794-0731
ROCKFORD	ILLINOIS	815/398-6090
SPRINGFIELD	ILLINOIS	217/753-7905
ST. CHARLES	ILLINOIS	312/859-1143
URBANA	ILLINOIS	217/356-7552
EVANSVILLE	INDIANA	812/464-8181
FT. WAYNE	INDIANA	219/423-9686
HIGHLAND	INDIANA	219/838-6353
INDIANAPOLIS	INDIANA	317/257-3461

TABLE B-1. (CONTINUED)

CITY	STATE	PHONE NUMBERS
KOKOMO	INDIANA	317/457-7257
LAFAYETTE	INDIANA	317/742-0189
MARION	INDIANA	317/662-0091
MUNCIE/ANDERSON	INDIANA	317/288-2477
SOUTH BEND	INDIANA	219/234-5005
TERRE HAUTE	INDIANA	812/232-3605
CEDAR RAPIDS	IOWA	319/363-7514
DES MOINES	IOWA	515/277-7752
DUBUQUE	IOWA	319/556-8263
IOWA CITY	IOWA	319/354-7371
MARSHALLTOWN	IOWA	515/753-0667
SIOUX CITY	IOWA	712/252-1681
WATERLOO	IOWA	319/233-9227
LAWRENCE	KANSAS	913/749-0271
LEAVENWORTH	KANSAS	913/682-2660
MANHATTEN	KANSAS	913/776-5189
SALINA	KANSAS	913/823-7186
SHAWNEE MISSION	KANSAS	913/384-1544
TOPEKA	KANSAS	913/233-1682
WICHITA	KANSAS	316/265-1241
BOWLING GREEN	KENTUCKY	502/782-0436
LEXINGTON	KENTUCKY	606/253-3463
LOUISVILLE	KENTUCKY	502/499-7110
ALEXANDRIA	LOUISIANA	318/443-9544
BATON ROUGE	LOUISIANA	504/291-2650
LAFAYETTE	LOUISIANA	318/237-9500
LAKE CHARLES	LOUISIANA	318/436-1633
MONROE	LOUISIANA	318/322-4109
NEW ORLEANS	LOUISIANA	504/524-4371
SHREVEPORT	LOUISIANA	318/688-5840
AUBURN	MAINE	207/782-4101
LEWISTON	MAINE	207/782-4101
PORTLAND	MAINE	207/774-2654
ABERDEEN	MARYLAND	301/272-3800
BALTIMORE	MARYLAND	301/547-8100
FREDRICK	MARYLAND	301/293-1072
HAGERSTOWN	MARYLAND	301/293-1072
ROCKVILLE	MARYLAND	301/770-1680
ATTLEBORO	MASSACHUSETTS	617/226-4471

TABLE B-1. (CONTINUED)

CITY	STATE	PHONE NUMBERS
BOSTON	MASSACHUSETTS	617/292-1900
BROCKTON	MASSACHUSETTS	617/584-6873
PITTSFIELD	MASSACHUSETTS	413/442-6965
SPRINGFIELD	MASSACHUSETTS	413/781-6830
TAUNTON	MASSACHUSETTS	617/822-7799
WOBURN	MASSACHUSETTS	617/935-2057
WORCESTER	MASSACHUSETTS	617/791-9000
ANN ARBOR	MICHIGAN	313/662-8282
BATTLE CREEK	MICHIGAN	616/962-1851
CADILLAC	MICHIGAN	616/775-3429
DETROIT	MICHIGAN	313/963-3388
DETROIT	MICHIGAN	313/963-8880
DETROIT	MICHIGAN	313/963-2353
FLINT	MICHIGAN	313/732-7303
GRAND RAPIDS	MICHIGAN	616/459-2304
JACKSON	MICHIGAN	517/787-9461
KALAMAZOO	MICHIGAN	616/388-2130
LANSING	MICHIGAN	517/484-6602
MANISTEE	MICHIGAN	616/723-6573
MIDLAND	MICHIGAN	517/631-4721
MUSKOGEN	MICHIGAN	616/725-8136
PLYMOUTH	MICHIGAN	313/459-8900
PORT HURON	MICHIGAN	313/985-6005
SAGINAW	MICHIGAN	517/753-9921
SOUTHFIELD	MICHIGAN	313/569-8350
ST. JOSEPH	MICHIGAN	616/429-0813
TRAVERSE CITY	MICHIGAN	616/946-3026
MANKATO	MINNESOTA	507/625-9481
MINNEAPOLIS	MINNESOTA	612/339-5200
MINNEAPOLIS	MINNESOTA	612/339-2415
ROCHESTER	MINNESOTA	507/282-3741
JACKSON	MISSISSIPPI	601/355-9741
JACKSON	MISSISSIPPI	601/944-0860
MERIDIAN	MISSISSIPPI	601/693-8216
PASCAGOULA	MISSISSIPPI	601/769-6502
PASCAGOULA	MISSISSIPPI	601/769-6673
VICKSBURG	MISSISSIPPI	601/634-6670
BRIDGETON	MISSOURI	314/731-2304
COLUMBIA	MISSOURI	314/875-1290
JEFFERSON CITY	MISSOURI	314/634-3273
JOPLIN	MISSOURI	417/782-3037
KANSAS CITY	MISSOURI	913/384-1544
ROLLA	MISSOURI	314/364-3486

TABLE B-1. (CONTINUED)

CITY	STATE	PHONE NUMBERS
SPRINGFIELD	MISSOURI	417/831-5044
ST. JOSEPH	MISSOURI	816/232-1897
BOZEMAN	MONTANA	406/586-7638
BUTTE	MONTANA	406/494-6615
GREAT FALLS	MONTANA	406/727-0100
MISSOULA	MONTANA	406/728-2415
LINCOLN	NEBRASKA	402/475-8659
OMAHA	NEBRASKA	402/397-0414
LAS VEGAS	NEVADA	702/293-0300
RENO/CARSON CITY	NEVADA	702/885-8411
MANCHESTER	NEW HAMPSHIRE	603/623-0409
NASHUA	NEW HAMPSHIRE	603/882-0435
SALEM	NEW HAMPSHIRE	603/893-6200
ATLANTIC CITY	NEW JERSEY	609/345-6888
CHERRY HILL	NEW JERSEY	609/665-5600
EATONTOWN	NEW JERSEY	201/542-2180
ENGLEWOOD CLIFFS	NEW JERSEY	201/894-8250
JERSEY CITY	NEW JERSEY	201/432-4907
LYNDHURST	NEW JERSEY	201/460-0100
LYNDHURST	NEW JERSEY	201/460-0180
MOORESTOWN	NEW JERSEY	609/665-5600
MORRISTOWN	NEW JERSEY	201/539-1222
NEWARK/UNION	NEW JERSEY	201/483-5937
NEWARK/UNION	NEW JERSEY	201/483-4878
PENNSAUKIN	NEW JERSEY	609/665-5600
PISCATAWAY	NEW JERSEY	201/981-1900
PRINCETON	NEW JERSEY	609/452-1018
RIDGEWOOD	NEW JERSEY	201/445-8346
WAYNE	NEW JERSEY	201/785-4480
ALBUQUERQUE	NEW MEXICO	505/242-8344
LAS CRUCES	NEW MEXICO	505/524-1944
SANTA FE	NEW MEXICO	505/988-5953
ALBANY	NEW YORK	518/458-8300
BINGHAMTON	NEW YORK	607/772-1153
BUFFALO	NEW YORK	716/845-6610
CORNING	NEW YORK	607/962-4481
ELMIRA	NEW YORK	607/737-9010
HEMPSTEAD	NEW YORK	516/485-7422
HUNTINGTON	NEW YORK	516/420-1221
ITHACA	NEW YORK	607/257-6601

TABLE B-1. (CONTINUED)

CITY	STATE	PHONE NUMBERS
MELVILLE	NEW YORK	516/420-1221
MINEOLA	NEW YORK	516/294-3120
NEW YORK	NEW YORK	212/269-6985
NEW YORK	NEW YORK	212/785-5400
NEW YORK	NEW YORK	212/689-8850
NEW YORK	NEW YORK	212/509-5400
NIAGARA FALLS	NEW YORK	716/285-2561
POUGHKEEPSIE	NEW YORK	914/473-0401
ROCHESTER	NEW YORK	716/248-8000
SYRACUSE	NEW YORK	315/437-7111
UTICA	NEW YORK	315/735-2291
WHITE PLAINS	NEW YORK	914/684-6075
ASHEVILLE	NORTH CAROLINA	704/253-3873
CHARLOTTE	NORTH CAROLINA	704/376-2545
CHARLOTTE	NORTH CAROLINA	704/376-2544
DURHAM	NORTH CAROLINA	919/549-8952
FAYETTEVILLE	NORTH CAROLINA	919/323-4202
GREENSBORO	NORTH CAROLINA	919/273-0332
GREENVILLE	NORTH CAROLINA	919/758-7854
HIGH POINT	NORTH CAROLINA	919/882-6858
RALEIGH	NORTH CAROLINA	919/829-0536
WILMINGTON	NORTH CAROLINA	919/343-0770
WINSTON-SALEM	NORTH CAROLINA	919/761-1103
BISMARK	NORTH DAKOTA	701/223-9422
FARGO	NORTH DAKOTA	701/280-3000
GRAND FORKS	NORTH DAKOTA	701/772-7162
MINOT	NORTH DAKOTA	701/852-6871
AKRON	OHIO	216/535-1861
CINCINNATI	OHIO	513/489-2100
CLEVELAND	OHIO	216/781-7050
COLUMBUS	OHIO	614/221-1862
DAYTON	OHIO	513/223-3847
LIMA	OHIO	419/224-2998
MANSFIELD	OHIO	419/526-6067
MARYSVILLE	OHIO	513/644-0096
TOLEDO	OHIO	419/255-7790
WARREN	OHIO	216/394-6529
YOUNGSTOWN	OHIO	216/744-5326
ARDMORE	OKLAHOMA	405/223-1552
ENID	OKLAHOMA	405/233-7903
LAWTON	OKLAHOMA	405/355-0745
OKLAHOMA CITY	OKLAHOMA	405/947-6387
TULSA	OKLAHOMA	918/582-4433

TABLE B-1. (CONTINUED)

CITY	STATE	PHONE NUMBERS
EUGENE	OREGON	503/485-0027
MEDFORD	OREGON	503/773-1257
PORTLAND	OREGON	503/226-0627
SALEM	OREGON	503/399-14
DOWNINGTON	PENNSYLVANIA	215/873-0300
ERIE	PENNSYLVANIA	814/456-8501
GREENSBURG	PENNSYLVANIA	412/837-3800
HARRISBURG	PENNSYLVANIA	717/763-6481
KING OF PRUSSIA	PENNSYLVANIA	215/337-9900
LANCASTER	PENNSYLVANIA	717/397-7731
NEW CASTLE	PENNSYLVANIA	412/652-4223
PHILADELPHIA	PENNSYLVANIA	215/561-6120
PITTSBURGH	PENNSYLVANIA	412/765-1320
READING	PENNSYLVANIA	215/372-4473
SCRANTON	PENNSYLVANIA	717/346-4516
STATE COLLEGE	PENNSYLVANIA	814/237-6408
VALLEY FORGE	PENNSYLVANIA	215/666-9190
WILKES BARRE	PENNSYLVANIA	717/822-1272
YORK	PENNSYLVANIA	717/846-3900
MAYAGUEZ	PUERTO RICO	809/833-4535
PONCE	PUERTO RICO	809/840-9110
SAN JUAN	PUERTO RICO	809/792-5900
NEWPORT	RHODE ISLAND	401/847-0502
PROVIDENCE	RHODE ISLAND	401/273-0200
WOONSOCKET	RHODE ISLAND	401/765-2400
CHARLESTON	SOUTH CAROLINA	803/577-2179
COLUMBIA	SOUTH CAROLINA	803/254-7563
GREENVILLE	SOUTH CAROLINA	803/271-9213
SPARTANBURG	SOUTH CAROLINA	803/582-7924
RAPID CITY	SOUTH DAKOTA	605/341-5337
SIOUX FALLS	SOUTH DAKOTA	605/335-0780
CHATTANOOGA	TENNESSEE	615/265-1020
JACKSON	TENNESSEE	901/423-0075
KNOXVILLE	TENNESSEE	615/690-1543
MEMPHIS	TENNESSEE	901/529-0183
NASHVILLE	TENNESSEE	615/367-9382
OAKRIDGE	TENNESSEE	615/482-9080
AMARILLO	TEXAS	806/383-0304
AUSTIN	TEXAS	512/444-3280
BAYTOWN	TEXAS	713/427-5856

TABLE B-1. (CONTINUED)

CITY	STATE	PHONE NUMBERS
BROWNSVILLE	TEXAS	512/541-2251
BRYAN/COLLEGE STA.	TEXAS	409/770-0184
CORPUS CHRISTI	TEXAS	512/883-8050
DALLAS	TEXAS	214/638-8888
FT. WORTH	TEXAS	817/877-3630
HOUSTON	TEXAS	713/556-6700
KILLEEN	TEXAS	817/634-2810
LONGVIEW	TEXAS	214/236-4041
LUBBOCK	TEXAS	806/762-0136
MCALLEN	TEXAS	512/631-0020
MIDLAND	TEXAS	915/683-5645
NEDERLAND/PT. ARTHUR	TEXAS	409/724-0726
ODESSA	TEXAS	915/563-3745
SAN ANTONIO	TEXAS	512/225-8002
TYLER	TEXAS	214/592-1372
WACO	TEXAS	817/752-1642
WICHITA FALLS	TEXAS	817/761-1315
OGDEN	UTAH	801/627-2022
PROVO/OREM	UTAH	801/375-0645
SALT LAKE CITY	UTAH	801/364-0780
BURLINGTON	VERMONT	802/658-2123
MONTPELIER	VERMONT	802/223-3519
CHARLOTTESVILLE	VIRGINIA	804/971-1001
FAIRFAX	VIRGINIA	703/691-8200
FAIRFAX	VIRGINIA	703/691-8390
LYNCHBURG	VIRGINIA	804/528-1903
MIDLOTHIAN	VIRGINIA	804/744-4860
NEWPORT NEWS	VIRGINIA	804/596-7608
NORFOLK	VIRGINIA	804/855-7751
PETERSBURG	VIRGINIA	804/862-4700
RICHMOND	VIRGINIA	804/744-4860
ROANOKE	VIRGINIA	703/344-2762
WILLIAMSBURG	VIRGINIA	804/872-9592
ENUMCLAW	WASHINGTON	206/825-7720
OLYMPIA	WASHINGTON	206/438-2772
RICHLAND	WASHINGTON	509/375-3367
SEATTLE	WASHINGTON	206/285-0109
SPOKANE	WASHINGTON	509/747-4105
TACOMA	WASHINGTON	206/272-1503
VANCOUVER	WASHINGTON	206/693-0371
YAKIMA	WASHINGTON	509/453-1591
CHARLESTON	WEST VIRGINIA	304/345-9575

TABLE B-1. (CONCLUDED)

CITY	STATE	PHONE NUMBERS
HUNTINGTON	WEST VIRGINIA	304/525-4406
MORGANTOWN	WEST VIRGINIA	304/292-2175
PARKERSBURG	WEST VIRGINIA	304/428-8511
APPLETON	WISCONSIN	414/722-5580
GREEN BAY	WISCONSIN	414/432-3064
LA CROSSE	WISCONSIN	608/785-1450
MADISON	WISCONSIN	608/221-4211
MADISON	WISCONSIN	608/221-0891
MILWAUKEE	WISCONSIN	414/785-1614
NEENAH	WISCONSIN	414/722-5580
OSHKOSH	WISCONSIN	414/235-1082
RACINE	WISCONSIN	414/632-3006
WEST BEND	WISCONSIN	414/334-1240
CASPER	WYOMING	307/235-0164

NCC TERMINAL IDENTIFIERS

The NCC terminal identifiers (Table B-2) are user-entered characters that identify terminal speeds, carriage-return delay times, and codes to NCC.

If you are in doubt as to which NCC terminal identifier to use, contact Anthony Gibson at (601) 634-3710 (FTS 542-3710) or the NCC User Support Service at 800-334-2405.

TABLE B-2. IDENTIFIERS, BY TERMINAL MAKE AND MODEL

TERMINAL	ID*	TERMINAL	ID*
ADDS		General Electric	
580, 620, 680, 880, 980	A	Terminet	
Anderson Jacobson		300, 1200	G
330	#	Gen-Com	
830, 832	A	300	A
630	E	Hazeltine	
860	A	1200, 2000	A
Ann Arbor Terminals		Hewlett-Packard	
Design III, 200	A	2615, 2616, 262X Series, 263X Series, 264X Series, 7220A†	A
Beehive Medical Electronics		Hydra	
Mini Bee 1, 2, 4	A	Model B	I
Super Bee 2, 3	A	IBM	
I-211, M-501, R-211	A	2741	P #
Bell System		Interdata	
Dataspeed 40/2		Carousel 300	E
KD	A	Incoterm	
KDP	G	SPD 10/20, 20/20, 900	A
Computer Devices		Infoton	
1030	E	Vistar	A
1132, 1201, 1202, 1203 1204, 1205, 1206	A	ITT	
Computek		3501 Asciscope	A
200, 300	A	Lear Siegler	
Conrac		7700, ADM-1, ADM-2, ADM-3, ADM-31	A
401, 480	A	LogAbax Informatique	
Control Data		LX180	I
713	A	LX1010†	A
Computer Transceiver Systems		MI	
Execuport	E	2400	I
DEC		Megadata	A
GT40, LA34, LA36, LA38, LA120 , LS120†, VT05, VT50, VT100, VT132	A	Memorex	A
Datamedia		1240	G
1500, 2000, 2100, 2500	A	NCR	
Datapoint		260	E
1100, 3000, 3300	A	796	A
Delta Data		Omron	
5000, 5100, 5200	A	8525	A
Digi-Log		Ontel	
33, 209, 300	A	4000	A

* The symbol # represents a carriage return.

† During log in, enter Control R immediately before typing your user name.

TABLE B-2. (CONCLUDED)

TERMINAL	ID*	TERMINAL	ID*
Perkin-Elmer		Texas Instruments	
1200, 1250	A	720, 725, 733, 735	E
Research		743, 745, 763, 765, 771†,	
Teleray 3300, 3311, 3712	A	820†	A
Raytheon		Texas Scientific	
PTS-100	A	Entelkon 10	A
Singer		Typagraph	
30	E	DP-30	C
Scientific Measurement		Tymshare	
Systems		100, 110, 212, 213	E
1440	A	200	D
Tally		310, 311	C
1612†	A	125, 126, 225, 315, 316	
Tec		325, 350†, 420, 425†, 430,	
400 Series, 1440	A	440W, 444†, 470†,	
Tektronix		550†, 1100†	A
4012, 4012, 4014, 4023		Wang Laboratories	
4025	A	220 OB	A
Teletype		Westinghouse	
33, 35	D	1600, 1620	A
38	B	Xerox	
43	A	BC100, BC200	A

* The symbol # represents a carriage return.
† During log in, enter Control R immediately before typing your user name.

APPENDIX C

COST ANALYSIS FOR THE NATIONAL COMPUTER CENTER

TIMESHARING OPERATION

1. Costs associated with use of the National Computer System (NCC) timesharing operation (TSO) may be categorized as storage charges, central computer processing costs, input/output costs and connection costs.

2. The public online disk storage charge is $.025 per track per week.

3. NCC TSO charges other than storage are computed by the following algorithm.

TSO Costs = PRF (CPU Costs + I/O Costs) + Connection Costs

where

PRF = Priority Rate Factor, a multiplier of 2.5
CPU = Central Prossessing Unit Cost
= (TCB + SPB) * $425.00/hr
TCB = Task Control Block (hours)
SRB = System Resource Block (hours)
I/O = Terminal Input/Output Unit Cost
= $0.74/1000 lines
Connection Unit Cost = $6.00/hr

The above costs are current as of October 1983 and are subject to change.

*U.S. GOVERNMENT PRINTING OFFICE : 1984 0-421-545/11814