New Mexico Recycling Solid Waste Conference

NMRC

SWANA

HELP 4.0

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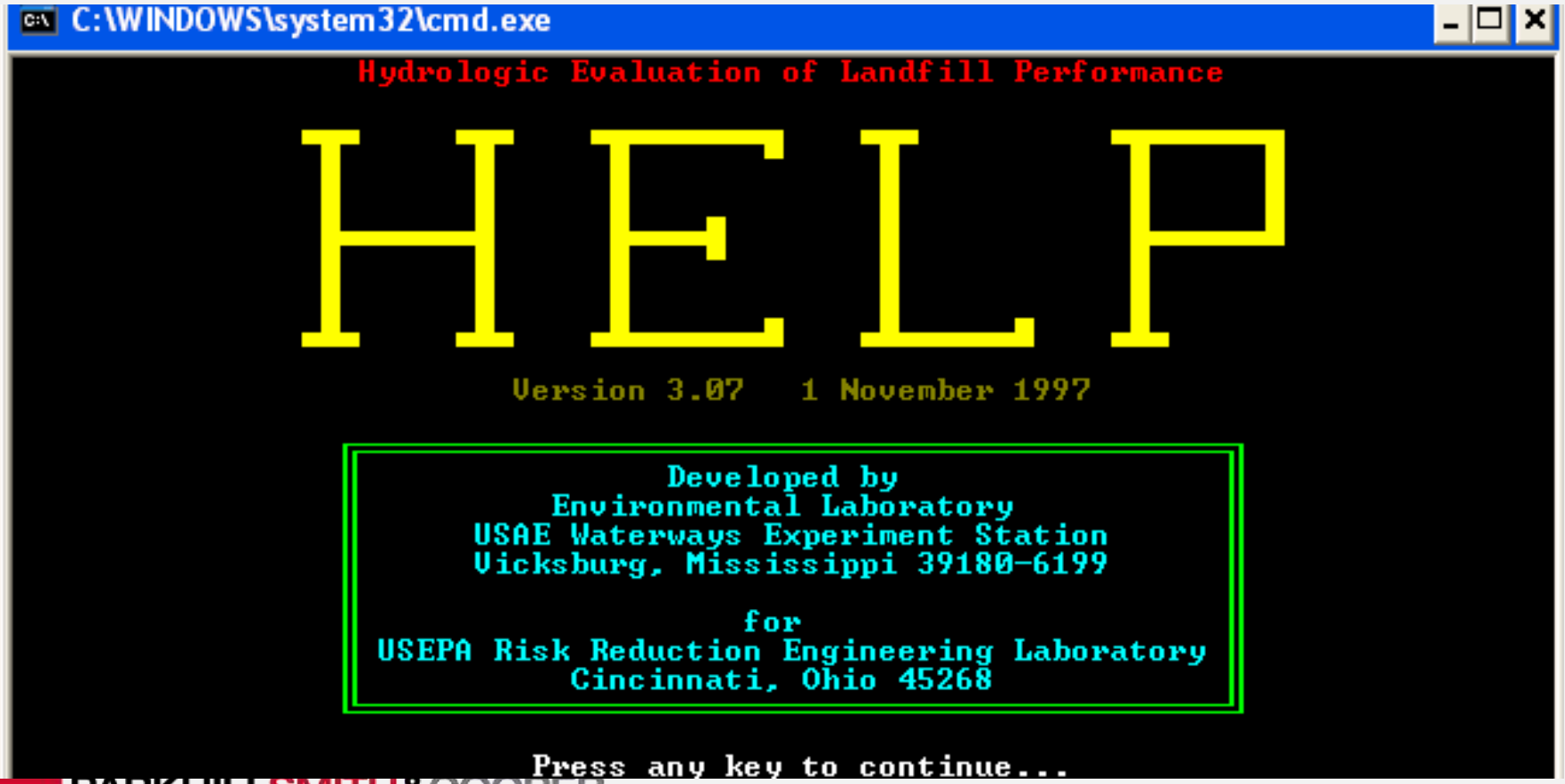
HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE (HELP)



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HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE (HELP)

- Developed to help hazardous landfill designers and regulators evaluate to evaluate hydrologic performance for proposed landfill
- To assist in comparisons of alternative closure cap and bottom liner designs using water balance calculations and stability evaluations
- Primary purpose is the comparison of design alternatives as judged by the water balance for the climate of the particular site

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE (HELP)

- Quasi dimensional hydrologic numeric model
- Water balance analysis of landfills
- Water movement across, into, through and out of landfills

HELP MODEL

- Developed by USEPA
- Developed in 1982 by Paul Schroeder (U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi)
- Version 1 – 1984
- Version 2 - 1988
- **Version 3 – 1994 : Current version of HELP**

HELP MODEL

- Applicable to open, partially closed, and fully closed landfills
- Process description:
  - Optional Synthetic Weather Generator (WGEN) by USDA
  - Runoff modelling based on USDA Soil Conservation Service (SCS) curve number method
  - Potential evapotranspiration is modeled by a modified Penman method
  - Evapotranspiration is modeled in the manner developed by Ritchie
  - Plant transpiration Ritchie
  - Vertical drainage Darcy's law

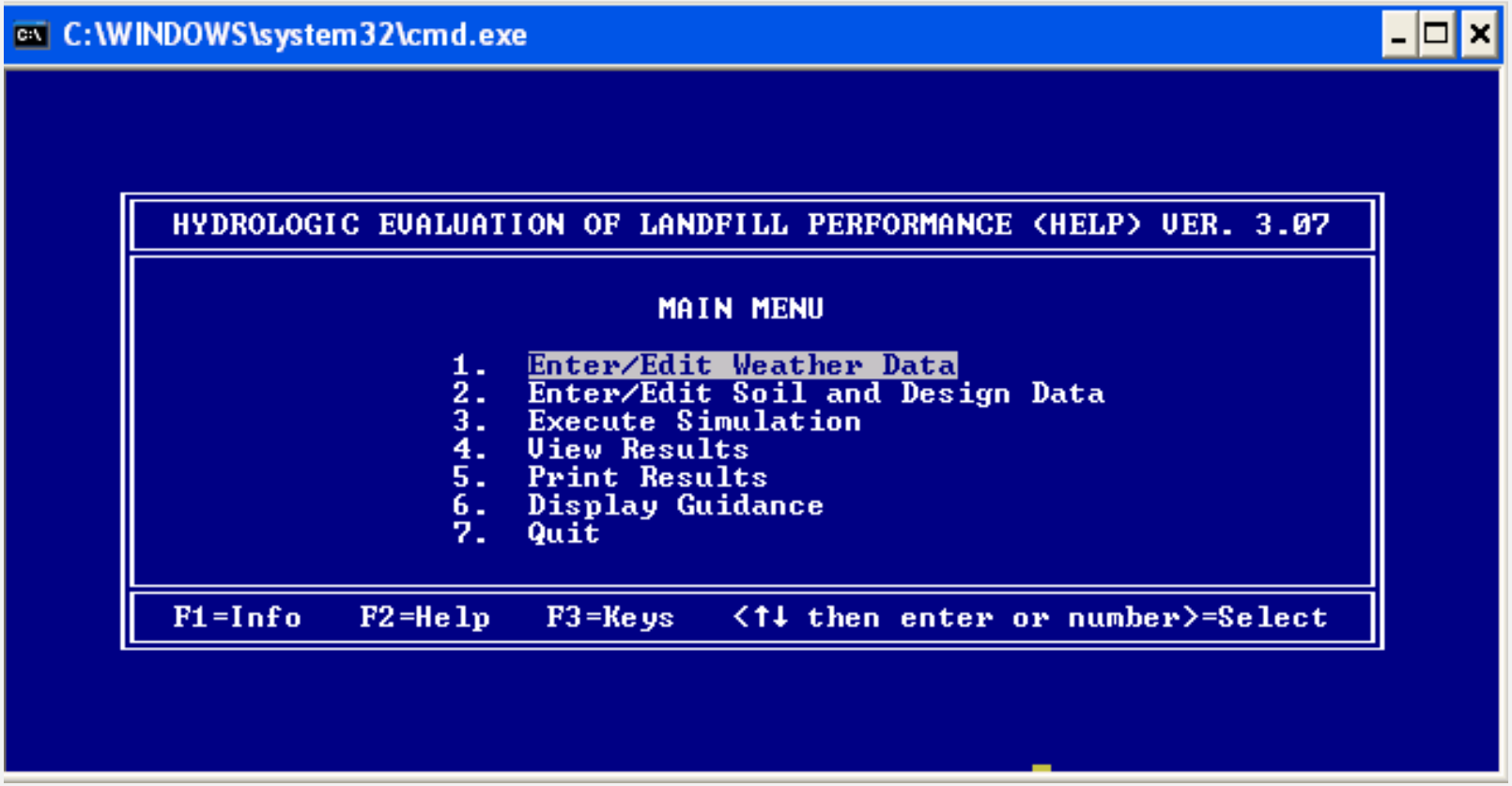
HELP

- Geographical area / climate
- Groundwater intrusion
- Season of year, Growing Season
- Use of covers: daily, intermediate and final
- Operational impacts
- Waste composition

HELP

- Modelling for:
  - Active cells
  - Intermediate Cover
  - Final Cover/ Alternative Cover
- Modelling for:
  - Without Recirculation
  - With Recirculation

HELP MODEL INPUT PARAMETERS



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HELP MODEL INPUT PARAMETERS

- Evapotranspiration Data
  - Evaporative Zone Depth:
    - Maximum depth from which water may be removed by evapotranspiration
    - Cannot exceed the top of the topmost liner
    - Clay: 12" to 60"
    - Silt: 8 to 18"
    - Sand: 4 to 8"
    - Gravel: Few inches
    - Less for surface without vegetation and more for with vegetation

HELP MODEL INPUT PARAMETERS

- Evapotranspiration Data
  - Maximum Leaf Area Index
    - (Leaf area of actively transpiring vegetation) : (area of land on which the vegetation is growing)
      - Bare Ground: 0
      - Poor Strand of Grass: 1
      - Fair Strand of Grass: 2
      - Good Strand of Grass: 3.5
      - Excellent Strand of Grass: 5

HELP MODEL INPUT PARAMETERS

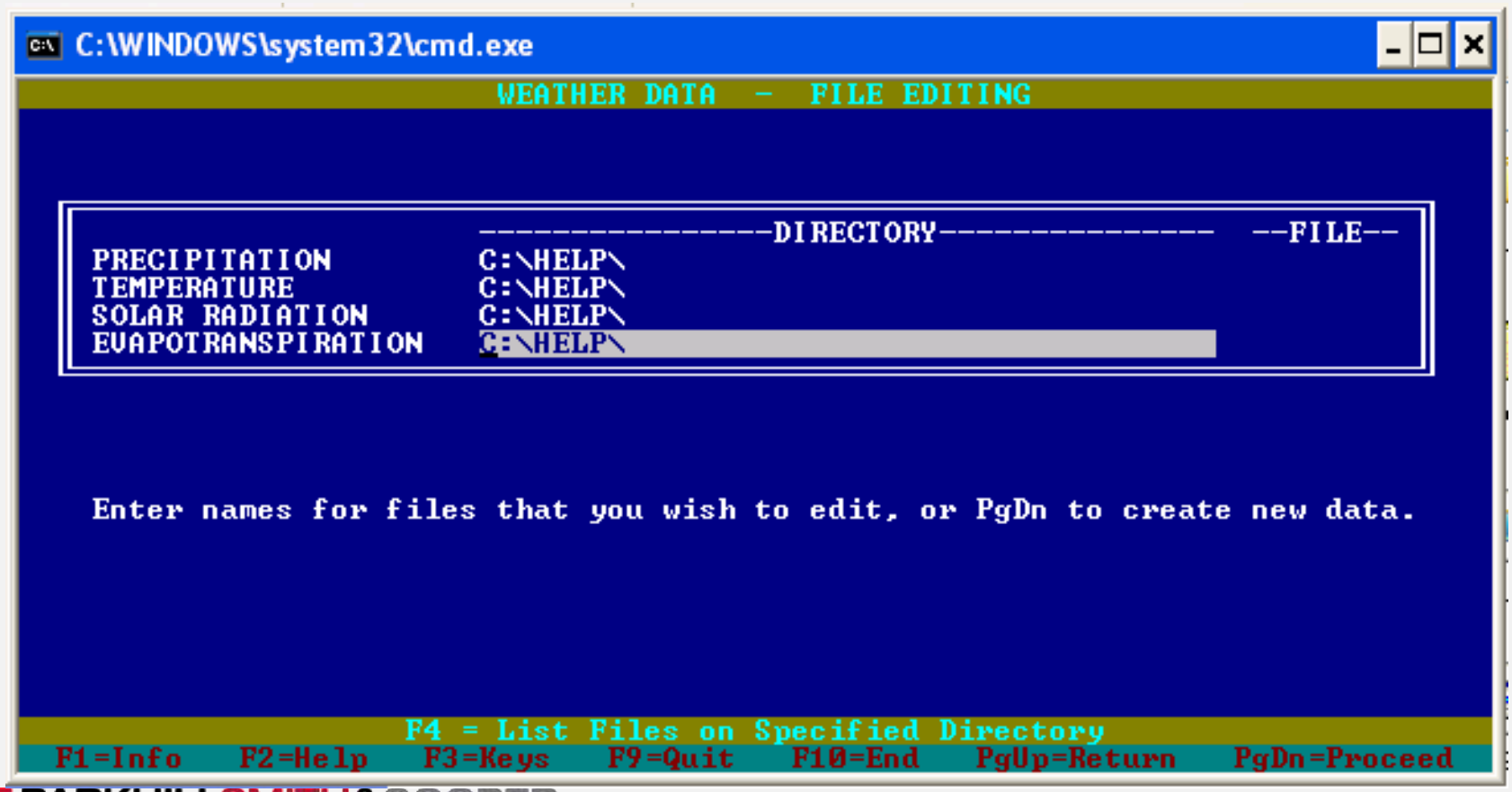
- Evapotranspiration Data
  - Growing Season Start Day:
    - Day of year when the normal mean daily temperature rises above 50-55F.
  - Growing Season End Day:
    - Day of year when the normal mean daily temperature falls below 50-55
- Normal Average annual wind speed
- Normal Average quarterly relative humidity
    - Data available from NOAA climatological data summary

HELP MODEL INPUT PARAMETERS

HELP MODEL INPUT PARAMETERS

- Weather Data:
  - Evapotranspiration Data
  - Precipitation
  - Temperature
  - Solar Radiation

HELP MODEL INPUT PARAMETERS



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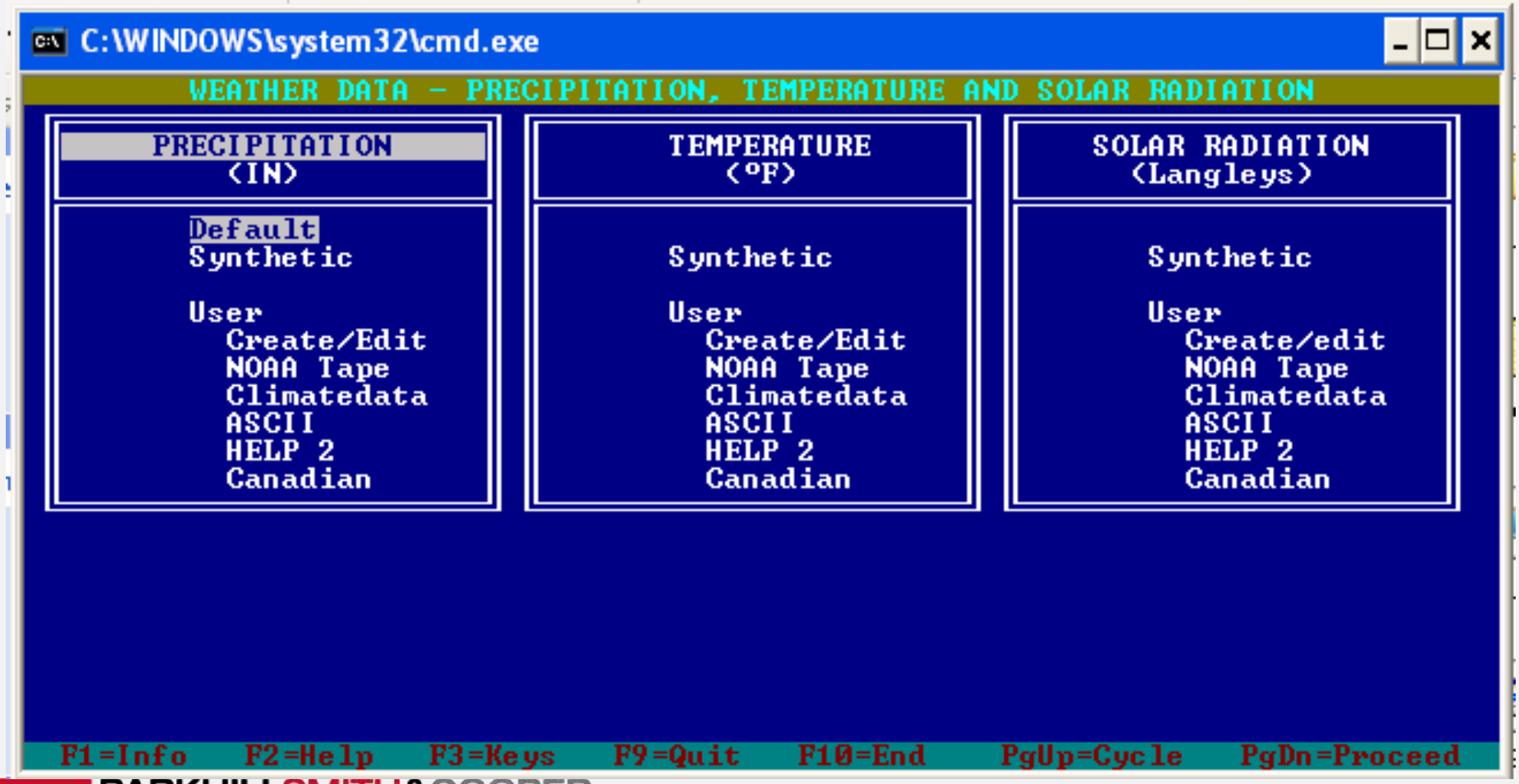

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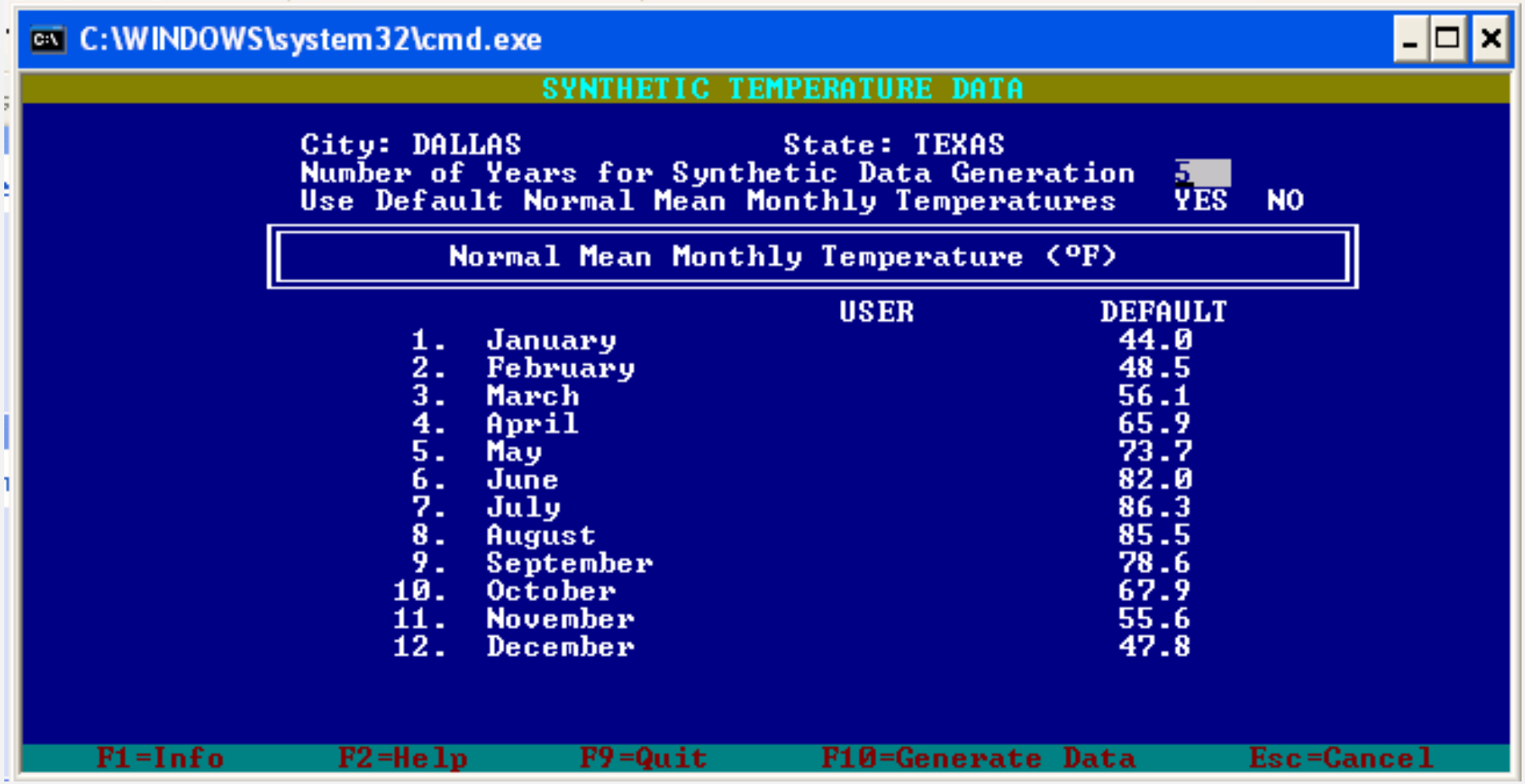

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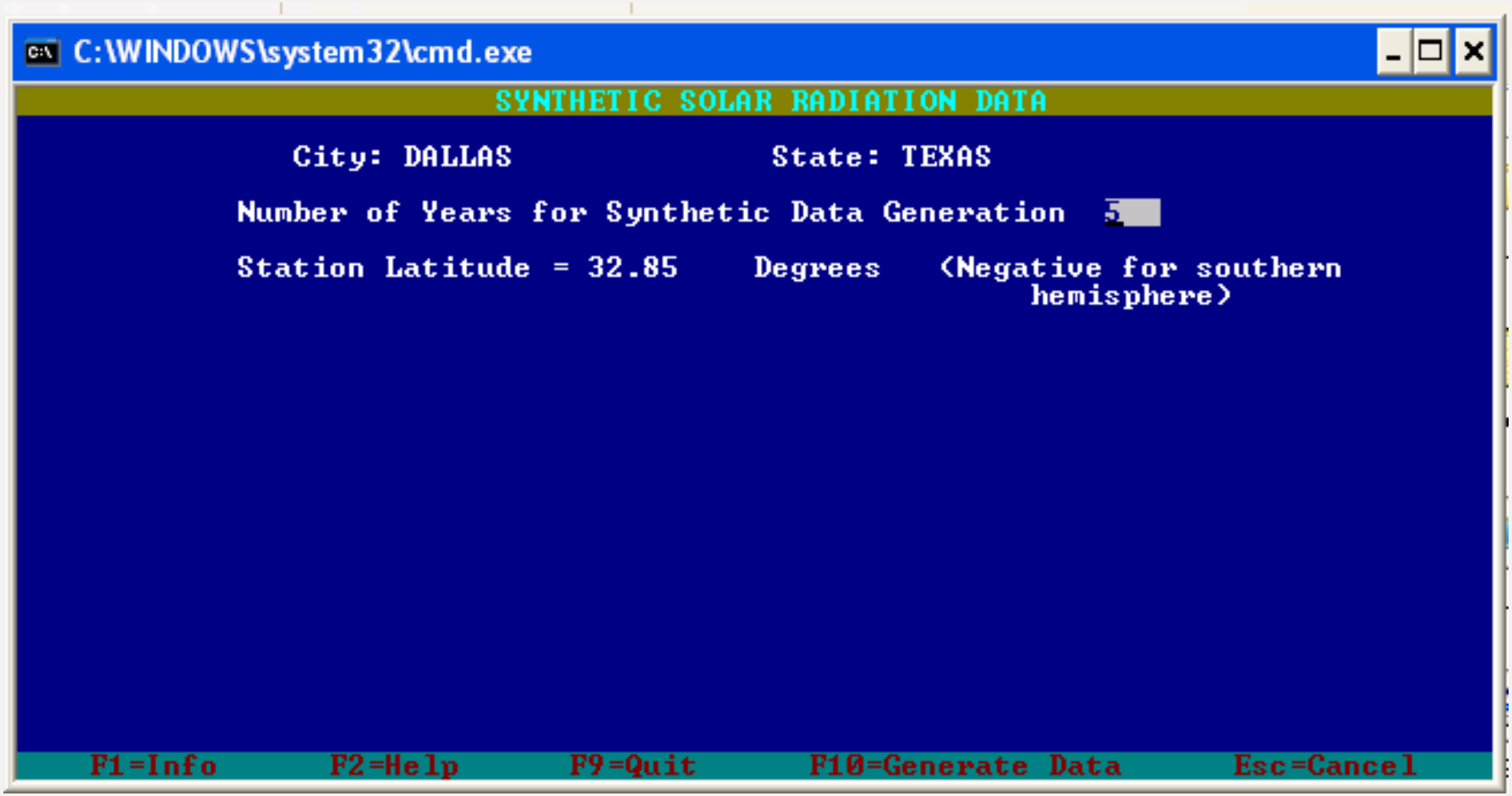
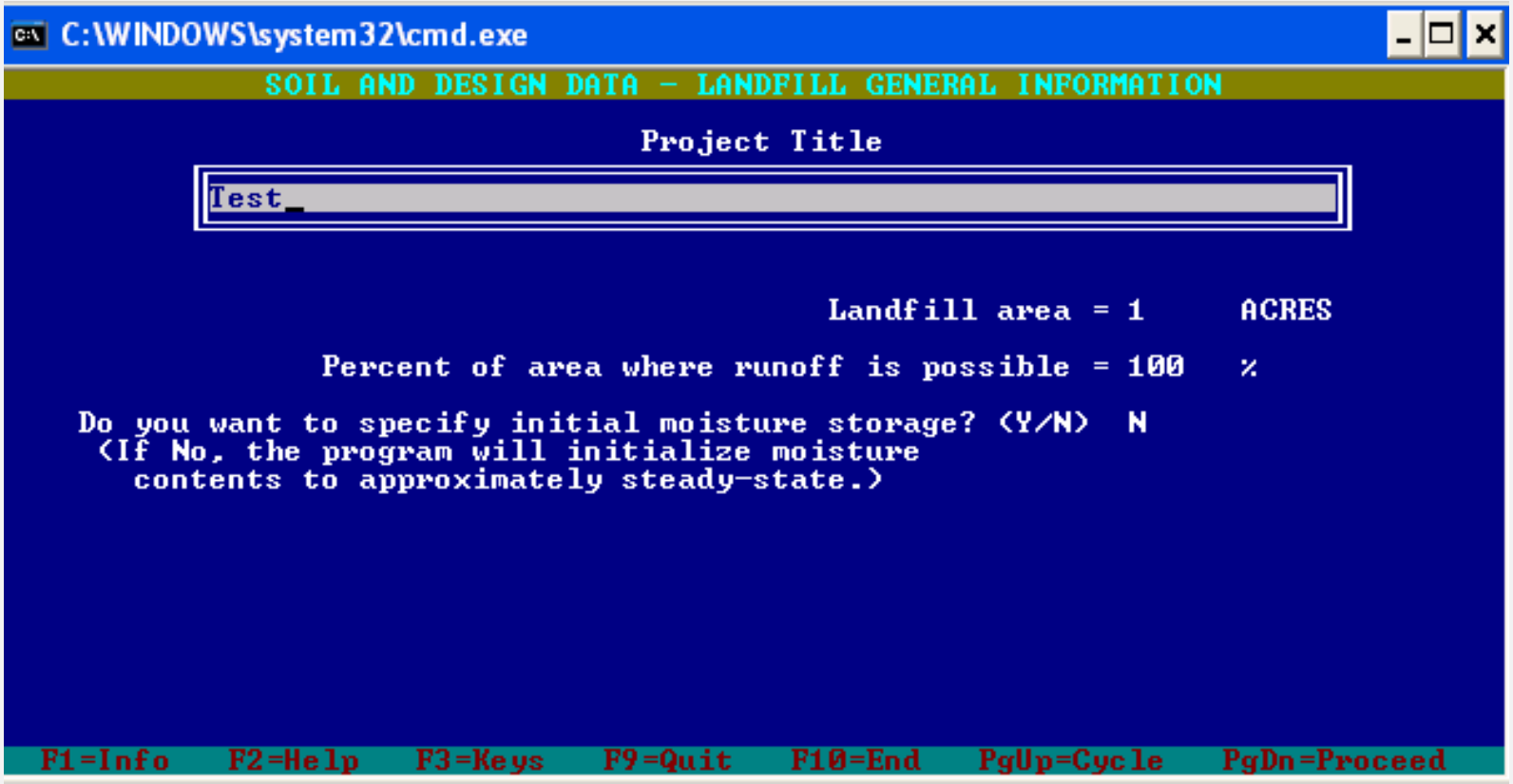


HELP MODEL INPUT PARAMETERS

- Soil & Design Data
  - Landfill General Information
  - Layer Data
  - Geomembrane Characteristics
  - Drainage Characteristics
  - Site Characteristics

HELP MODEL INPUT PARAMETERS



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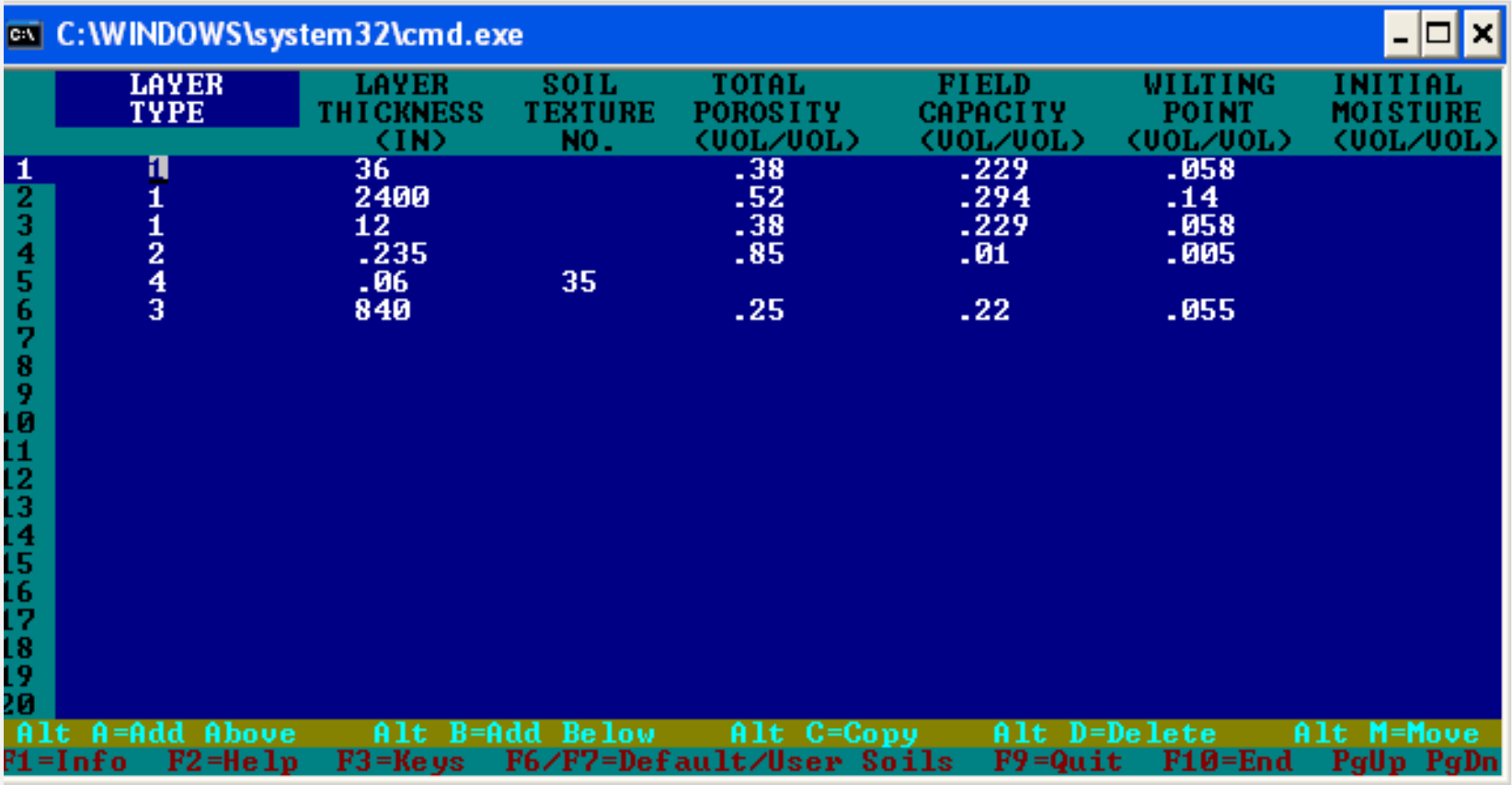

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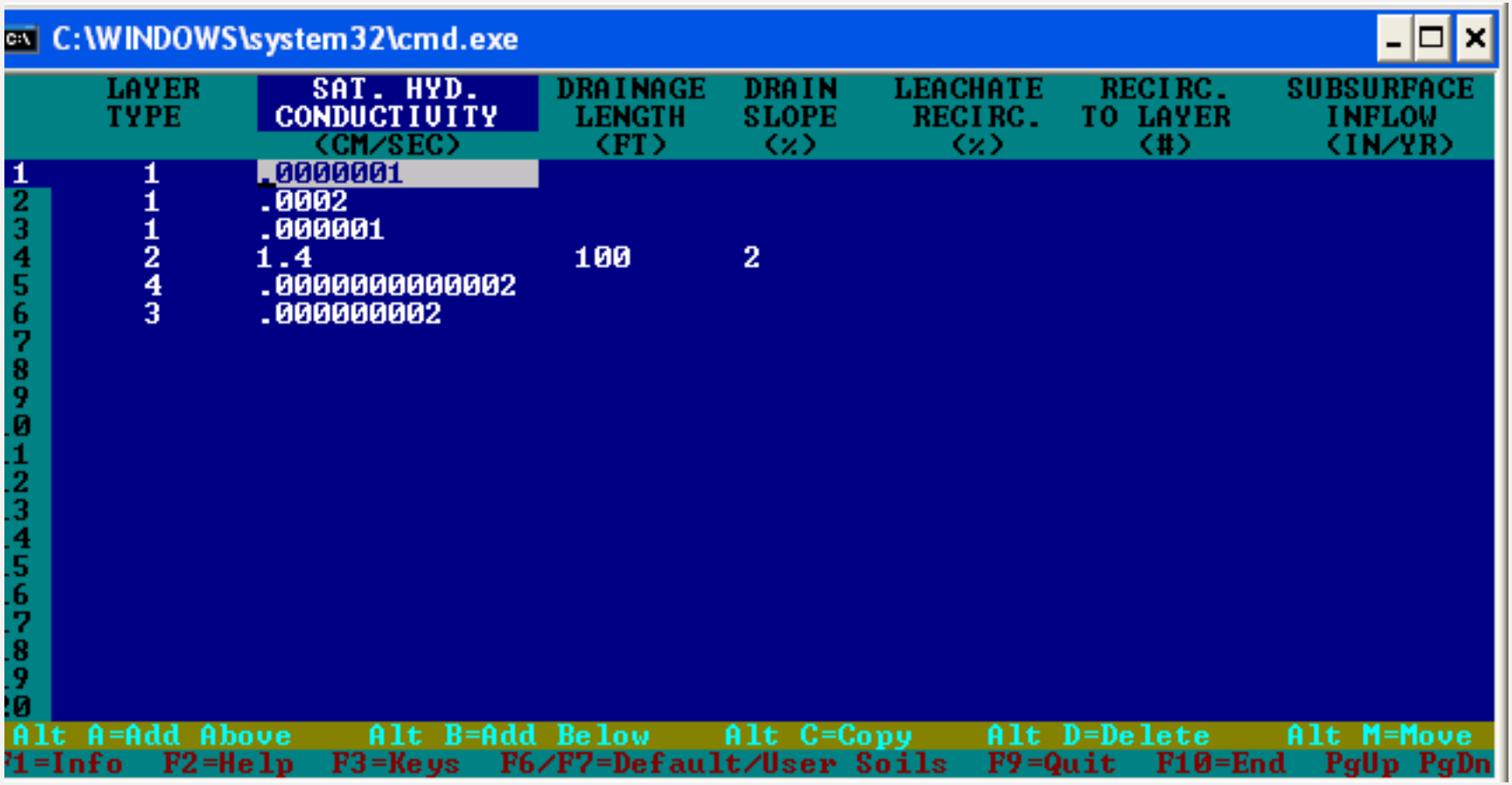

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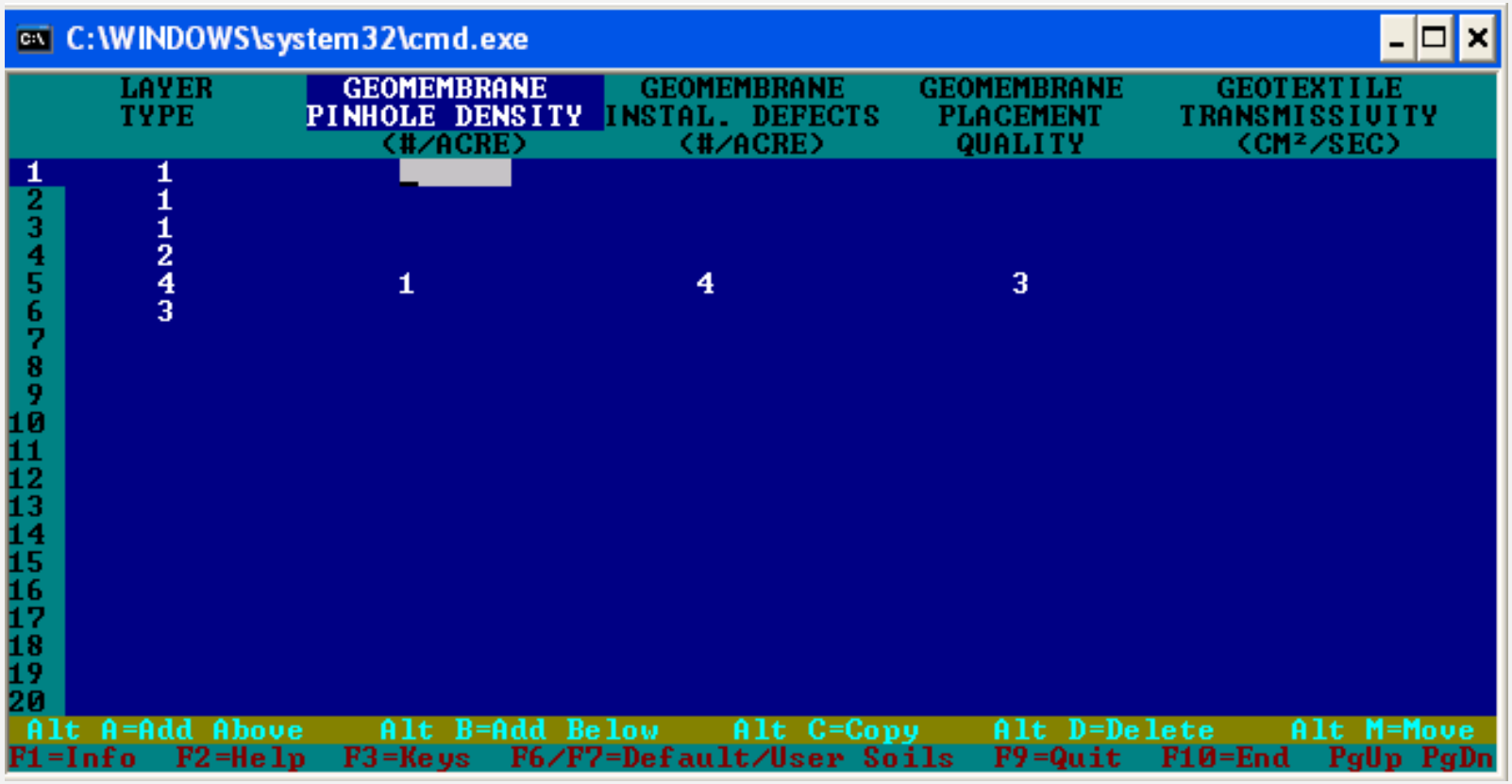

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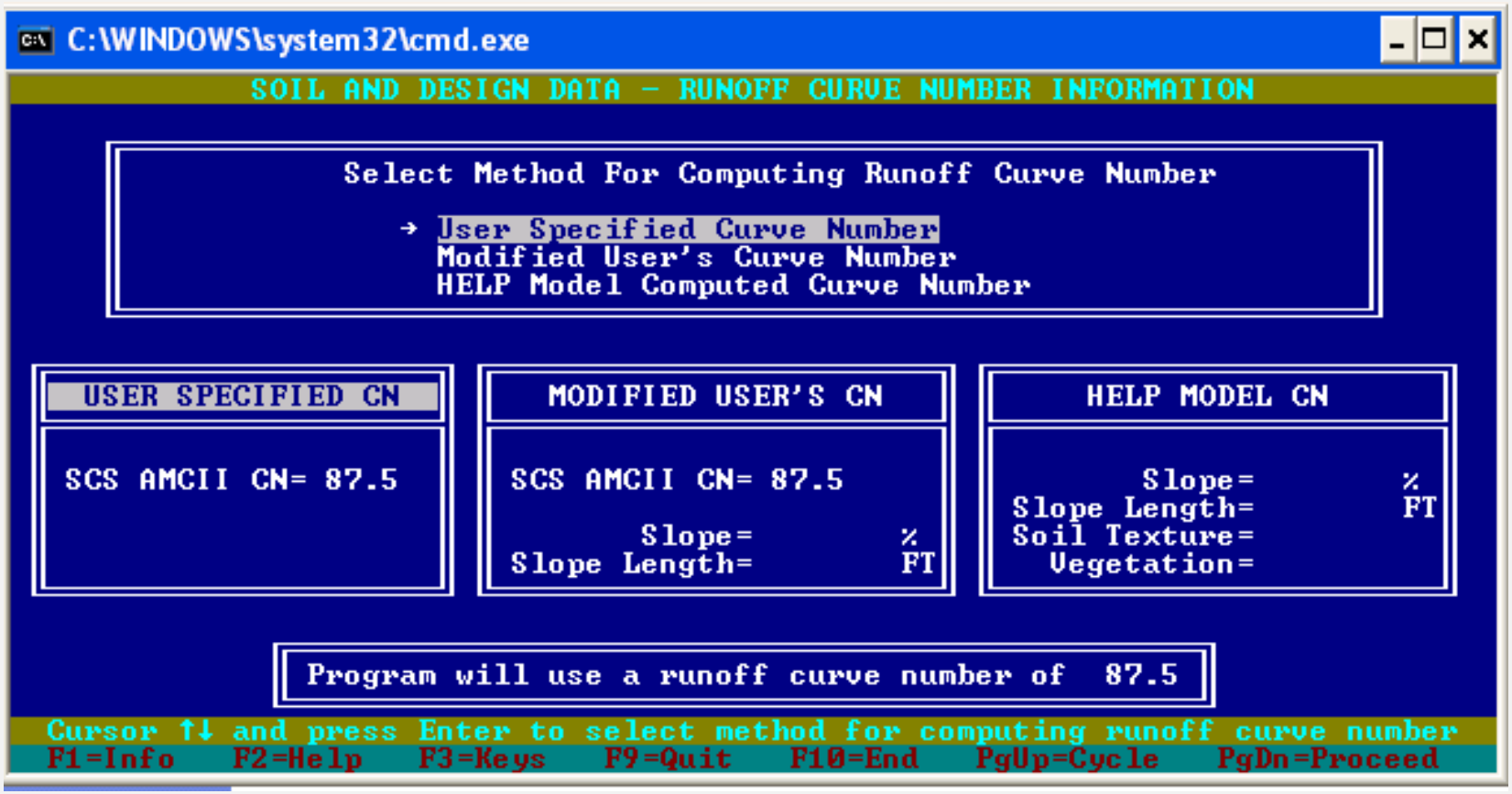

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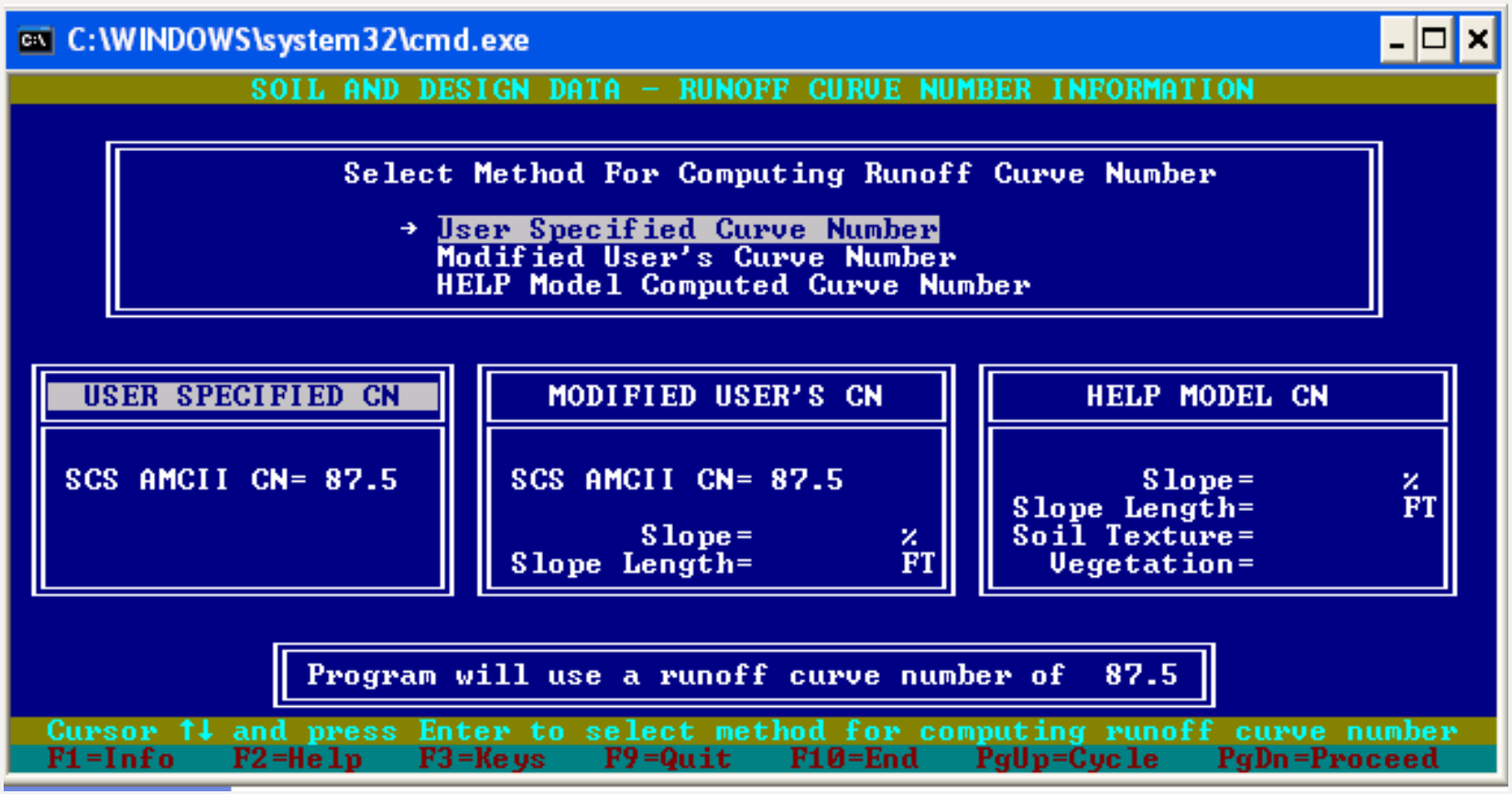

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CHALLENGES WITH HELP 3.07

Operational

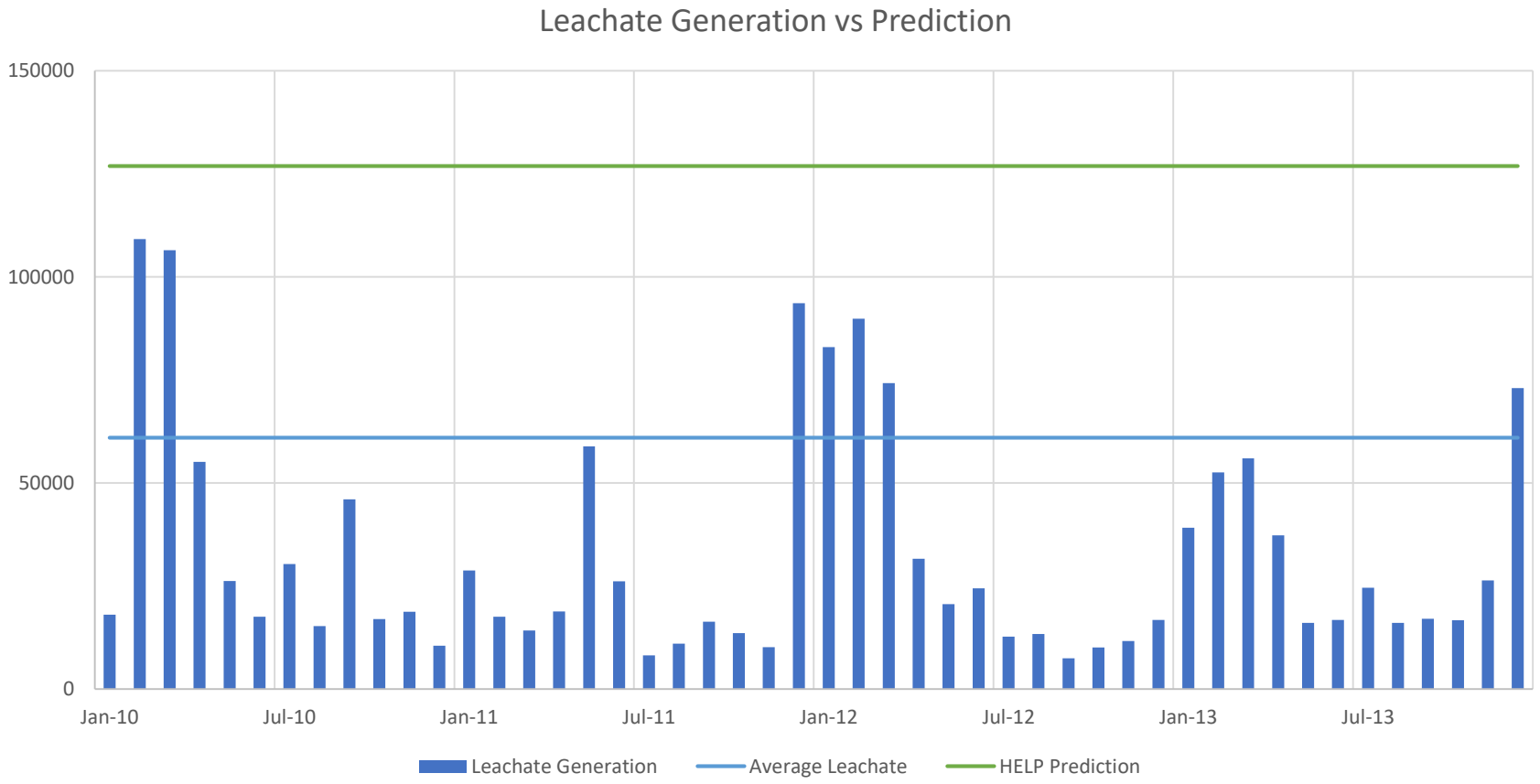
- DOS executable program
- Does not run in a Windows or iOS environment
- 16-bit program will not natively work with 64-bit systems (i.e., most Windows 7 and more recent systems)
- DOS emulator to install the HELP model
  - Windows virtual PC
  - DOSBox

CHALLENGES WITH HELP 3.07

Analytical

- Default Weather Data only available for USA
- Default Weather Data limits to past 50 years of weather
- Considers vertical percolation through waste
- Overpredicts Leachate Generation

CHALLENGES WITH HELP 3.07



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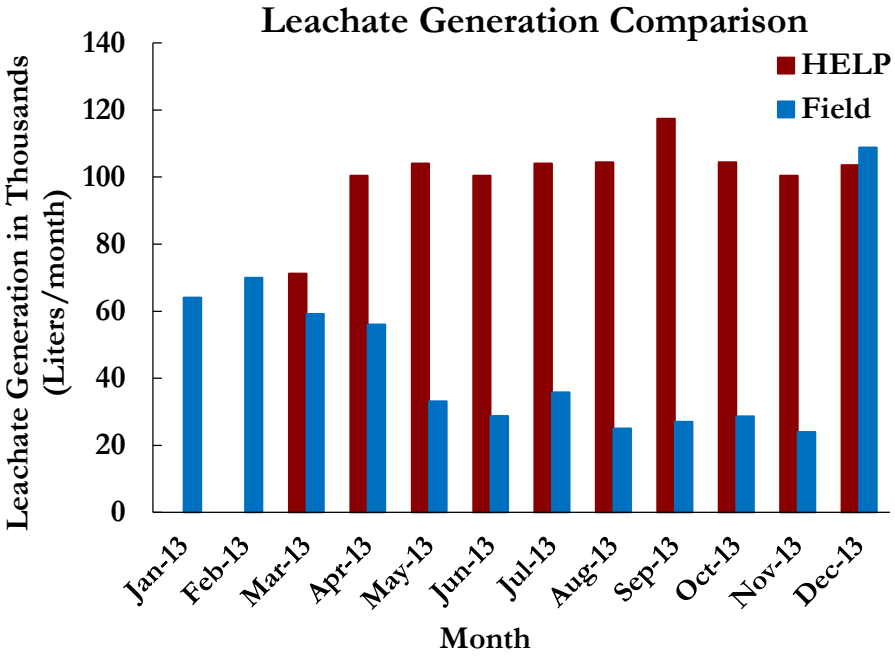

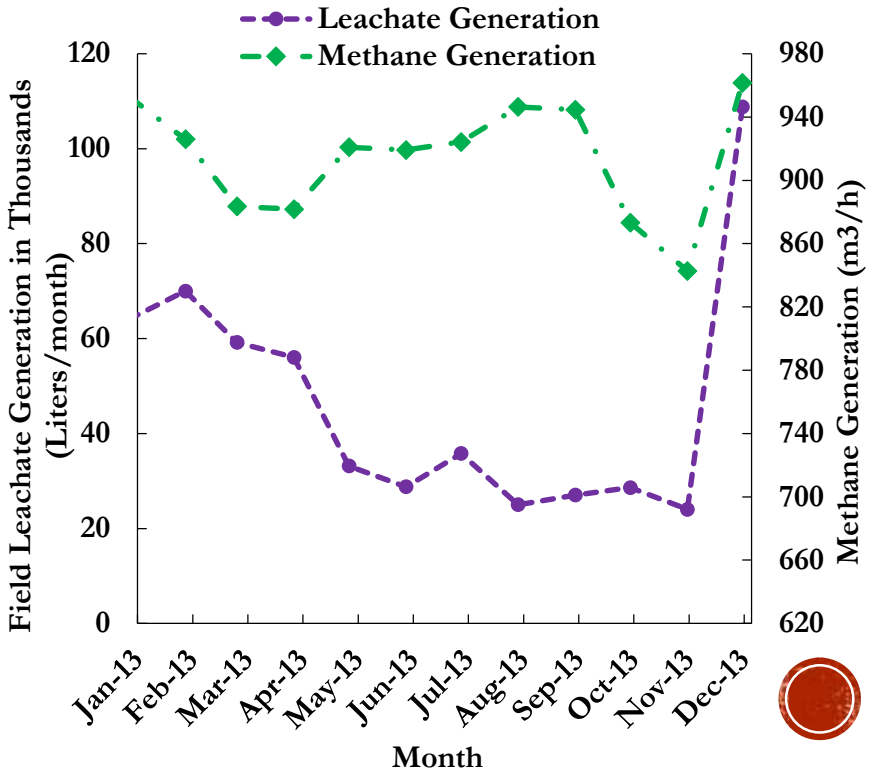

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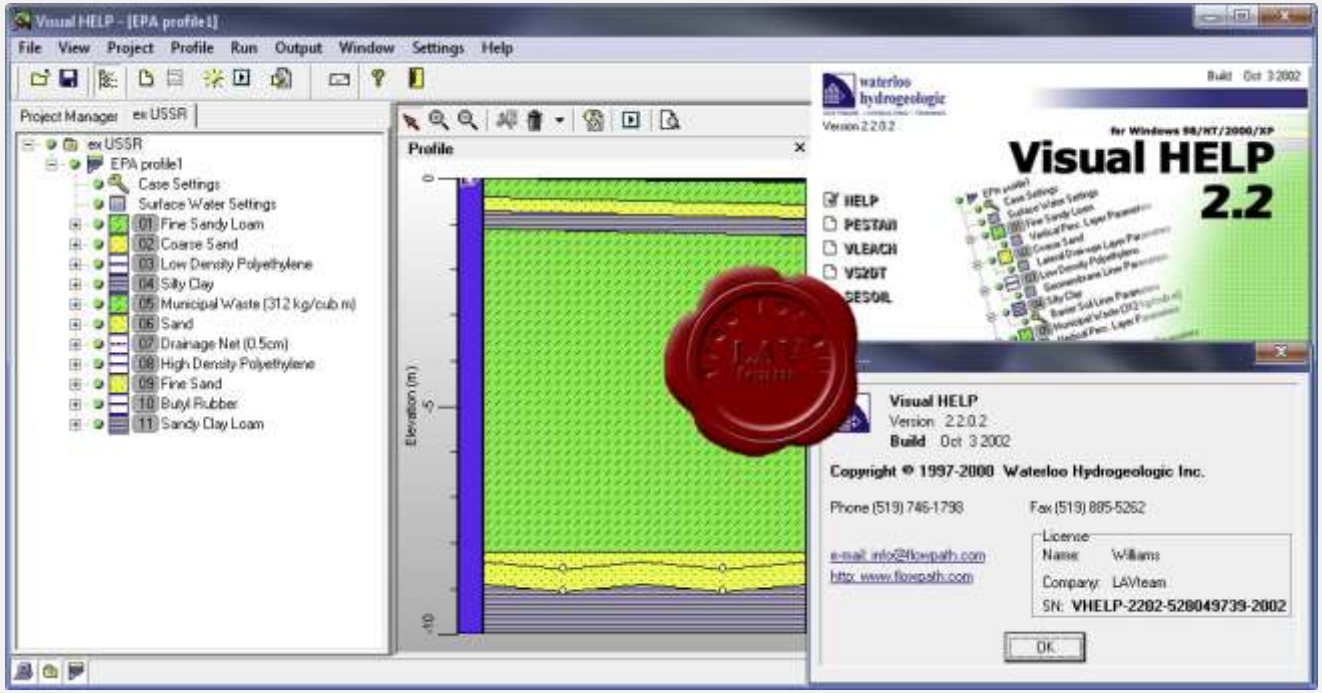
VISUAL HELP MODEL

- Commercial versions:
  - Visual HELP – based on the HELP version 3.07, offers a Microsoft Windows GUI to view and edit soil profiles and to generate weather data.



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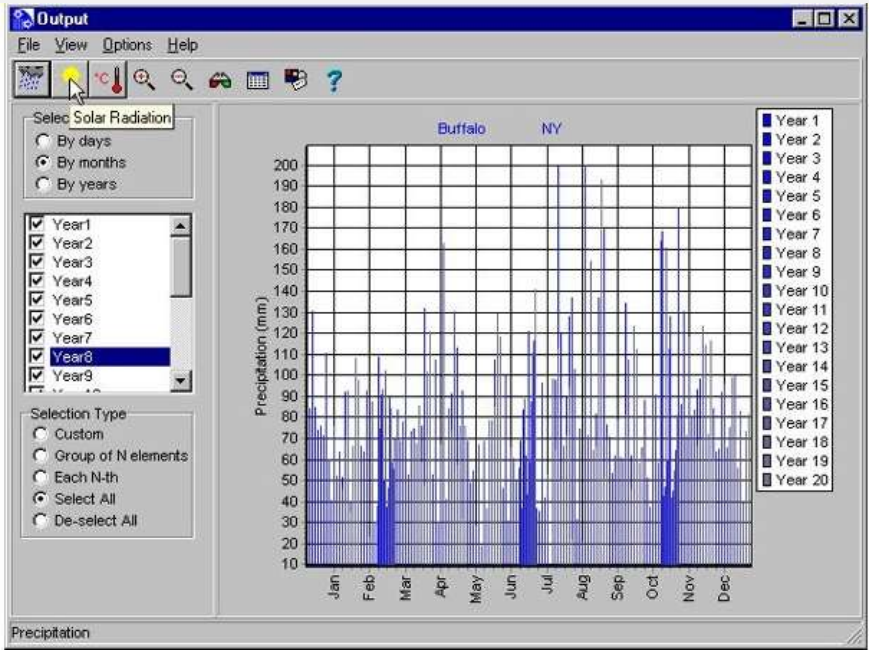
VISUAL HELP MODEL

- Commercial versions
- Developed by Waterloo Hydrologic Software
- Based on EPA's HELP 3.07
- Windows based

VISUAL HELP MODEL

- Advantages
  - Graphically create landfill profiles of the landfill
  - Built in International Weather Generator (GIS Based)
  - Generate reports
  - Analyze model results using daily, monthly and yearly plots
  - Built in landfill material database for 42 materials



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VISUAL HELP MODEL

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  - Graphically create landfill profiles of the landfill
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  - Built in landfill material database for 42 materials

- Disadvantages
  - Cost
  - US Weather Data
  - Validation
  - Accuracy

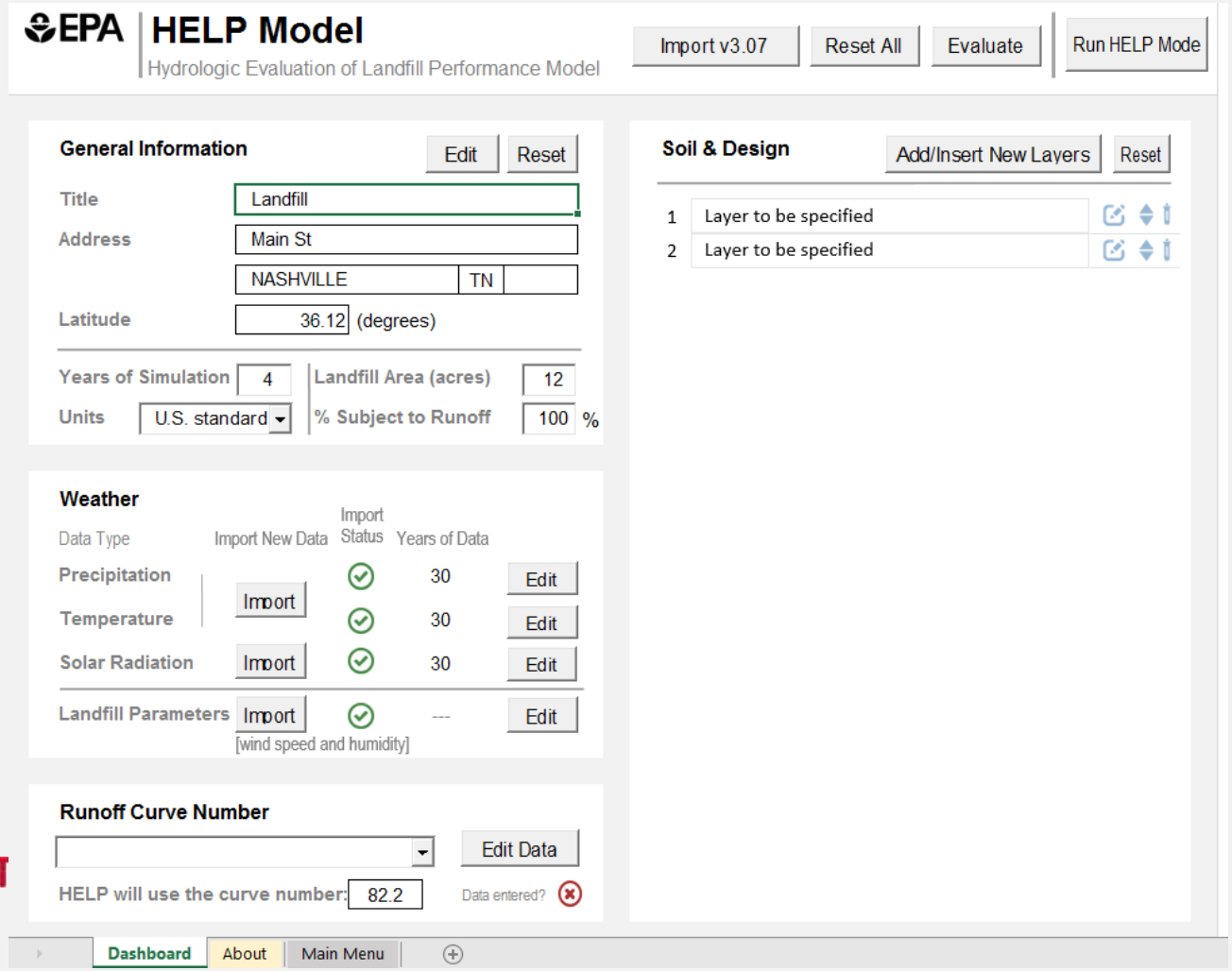
HELP 3.95D MODEL

- HELP 3.95 D – by Dr. Klaus Berger at the University of Hamburg; offers a Microsoft Windows UI and includes the model HELP 3.07 and the enhanced model HELP 3.95 D.

HELP 3.95D MODEL

- Advantages
  - Windows user interface
  - Executable in Windows 7 and 8 (32-bit and 64-bit; except maybe for the starter editions) and Windows 10
  - Online help and User Guide in English and in German
  - Additional daily weather data and Evapotranspiration can be synthetically generated for selected locations in Germany
  - US and German soil textures
  - The model HELP 3.95 D outputs daily, monthly and yearly results as tables in separate text (ASCII) files
- Disadvantages
  - Cost
  - Accuracy
  - Limited to US and German data

HELP 4.0 MODEL



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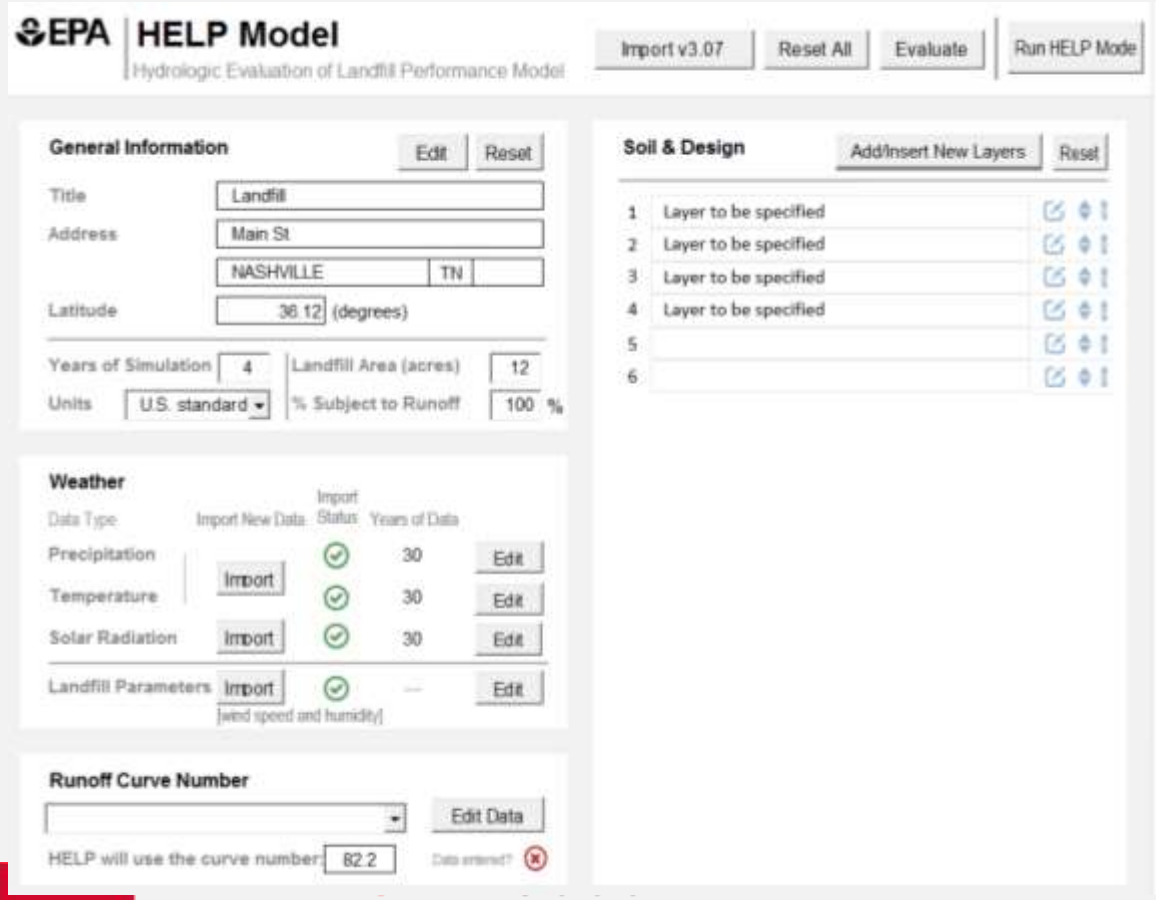

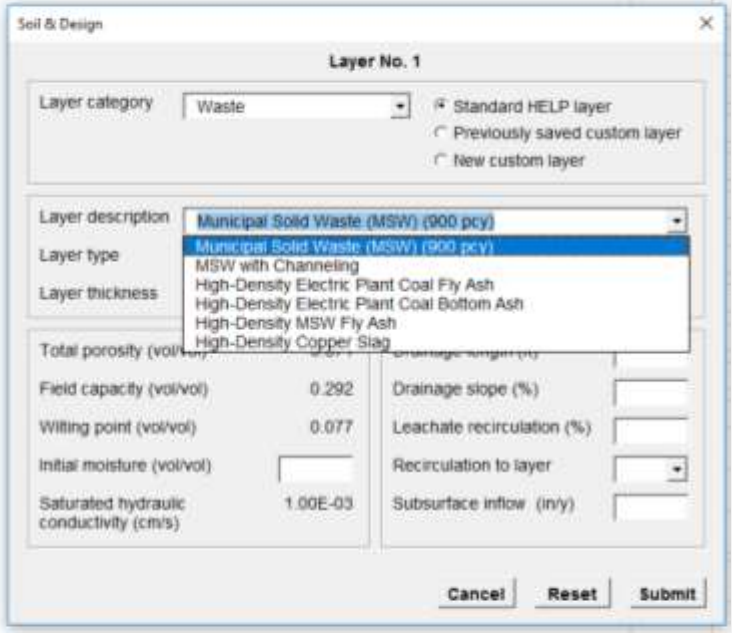

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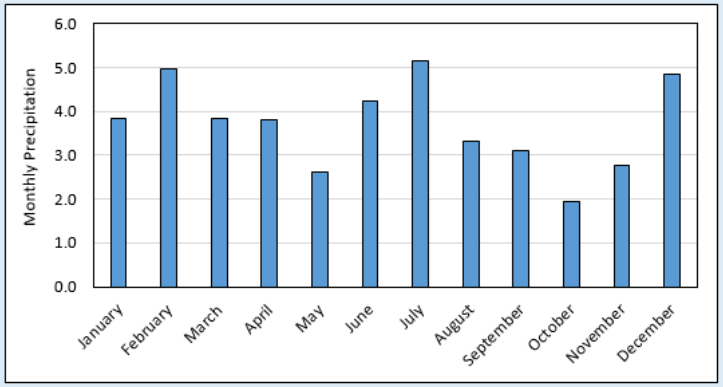
HELP 4.0 MODEL

Precipitation Data for NASHVILLE, TENNESSEE

Return to Main Dashboard

Year	Daily Rainfall (inches)										Row
1	0	0	0	0	0	0.2	0	0	0	0	1
1	0.17	0.02	0	0	0	0	0.01	0	0	0.5	2
1	0.52	0.19	0.54	0	0	0	0	0.12	0	0	3
1	0.02	0	0	0.22	0	0	0	0	0.1	0.39	4
1	0.2	0.26	0.44	0	0.02	0	0.18	0.11	1.15	0.04	5
1	0.5	0	0.62	0	0.02	0	0	0.57	0.07	0	6
1	0.86	0	0.2	0	0	0	0.35	0	0	0.06	7
1	0	0.02	0	0	0	0	0.52	0.99	0.05	0	8
1	0	0	0	0	0	0	0	0	0	0	9
1	0.36	0	0	0.14	0	0.02	0	0	0.01	0	10
1	0	0	0	0.39	0.12	0	0	0.39	0.03	0.11	11
1	0.55	0	0	0	0	0	0.05	0	0	0	12
1	0	0	0	0	0	0	0	0	0	0.96	13
1	0.12	0	0	0	0	0	0	0	0.06	0	14
1	0.36	0.22	0	0	0.74	0.19	0.05	0.71	0	0	15
1	0	0	0	0.22	1.08	0	0	0	0	0	16
1	0	0.63	0	0	0.31	0.57	0.2	0.37	0.4	0	17
1	0	0	0.46	0	0	0	0	0.02	0.09	0	18
1	0.18	0	0.13	0	0	0	0	0.23	0.09	0.2	19
1	0.05	0.58	0	0.18	0	0.02	0.24	0	0.08	0	20
1	0.04	0	0	0.01	0.1	0.06	0.02	0.04	0	0.17	21
1	0.39	1	0.29	0	0	0.16	0.27	0.09	0	0	22
1	0.08	0.47	0	0	0	0	0	0	0	0	23
1	0	1.8	0	0	0	0	0	1.22	0	0	24
1	0	0	0	0	0	0	0	0	0	0.13	25
1	0.14	0	0	0	0	0	0	0	0	0.45	26
1	0.04	0	0	2.57	0	0	0	0	0.18	1.19	27
1	0	0	0	0	0	0.69	0.6	0	0.49	0.05	28
1	0	0	0	0	0.12	0	0	0.01	0	0	29
1	0	0	0	0.68	0	0	0	0	0	0	30
1	0	0	0	0	0	0	0	0	0	0.34	31
1	0	0	0	0	0	0	0	0.62	0	0	32

Monthly Rainfall	Average (in)
January	3.85
February	4.96
March	3.83
April	3.81
May	2.63
June	4.23
July	5.16
August	3.31
September	3.09
October	1.94
November	2.76
December	4.86
Average Annual	52.2



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HELP 4.0 MODEL

- Advantages
  - Windows user interface
  - Executable in Windows 7 and 8 (32-bit and 64-bit; except maybe for the starter editions) and Windows 10
  - Weather Data can be directly imported from NOAA

- Disadvantages
  - Validation
  - Accuracy
  - US Weather Data

HELP 4.0 BETA MODEL SUBSCRIPTION

Max Krause

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Thabet Tolaymat

tolaymat.thabet@epa.gov

https://www.epa.gov/land-research/hydrologic-evaluation-landfill-performance-help-model

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