EPA
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Environmental Protection
Agency

EPA Tools and Resources Training Webinar: EPA's Hydrologic Evaluation of Landfill Performance (HELP) Model v4.0

Max Krause
Thabet Tolaymat
US EPA Office of Research and Development

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EPA United States Environmental Protection Agency

Hydrologic Evaluation of Landfill Performance (HELP) Model

- The HELP model is used by landfill designers/owners to demonstrate that the leachate depth over a landfill liner does not exceed the 30 cm (one foot) limit required by the Resource Conservation and Recovery Act 40 CFR 264.301 “Design and Operating Requirements” for landfills.
- The HELP model is a quasi-two-dimensional hydrologic model of water movement through landfills. The program can also evaluate:
  - Runoff
  - Evapotranspiration
  - Infiltration of precipitation into the landfill
  - Vertical percolation of leachate
  - Leachate collection rate

HELP Model - Background

The model uses the following key inputs to model the water balance and percolation through waste and leachate collection system:

1. Vegetation cover quality
2. Soil types
3. Geosynthetic materials
4. Initial moisture conditions
5. Layer thicknesses
6. Slope of the bottom liner
7. Leachate collection pipe spacing and liner placement quality

HELP Model - Background

HELP v3.07

1. The HELP model was developed for the EPA by the US Army Corps of Engineers Waterways Experiment Station in the early 1980s. Version 3.0 was published in 1994.
2. It has a Disk Operating System (DOS)-based user interface.
3. The output is provided in a text file. The output file data export into Microsoft (MS) Excel for data analysis is a time and labor-intensive process.

HELP v4.0 Upgrades

1. HELP v4.0 is the latest version of the HELP model available for public use.
2. It uses an Excel workbook with embedded macros to support the user interface. It is platform-independent.
3. Outputs are in spreadsheet format.
4. The number of locations that can be modeled is significantly expanded in this version.

Downloading and Installing HELP v4.0

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

or

Search for “EPA HELP v4.0” on Google

Click on to download the HELP v4.0

Downloads

HELP Model 4.0.1 (zip)

HELP 4.0 User Manual

Documentation to Learn More About HELP

US EPA. (2017) Walkthrough to Install and Operate the Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3.07.

US EPA. (1984) Hydrologic Evaluation Of Landfill Performance (HELP) Model, Volume 1 (PDF). Publication No. EPA/530/SW-84/009.

US EPA. (1984) Hydrologic Evaluation Of Landfill Performance (HELP) Model Volume 2 (PDF). Publication No. EPA/530/SW-84/010.

US EPA. (1994) Hydrologic Evaluation of Landfill Performance (HELP) Model: A (Set Includes, A- User's Guide for Version 3 w/disks, B- Engineering Documentation for Version 3) (PDF). Publication No. EPA/600/R-94/168A, 1994

US EPA. (1994) Hydrologic Evaluation of Landfill Performance (HELP) Model B (Set Includes, A- User's Guide for Version 3 w/disks, B- Engineering Documentation for Version 3) (PDF). Publication No. EPA/600/R-94/168b, 1994

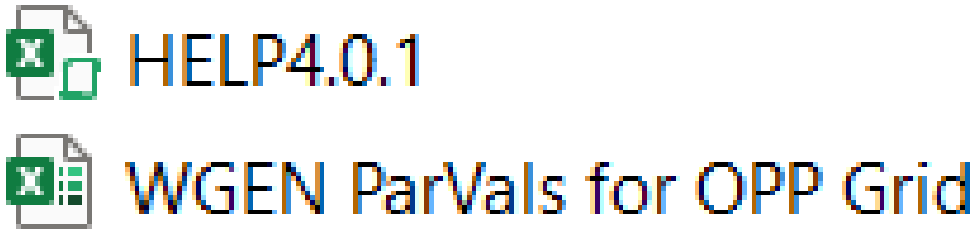
US EPA. (1988) Verification Of The Hydrologic Evaluation Of Landfill Performance (HELP) Model Using Field Data. Project Summary. Publication No. EPA/600/S2-87/050

US EPA. (1987) Verification of the Hydrologic Evaluation of Landfill Performance (HELP) Model Using Field Data. Report. NTIS PB87-227518

This page also contains a **User Manual** for HELP v4.0 and **documentation about the fundamentals of the model.**

Downloading and Installing HELP v4.0

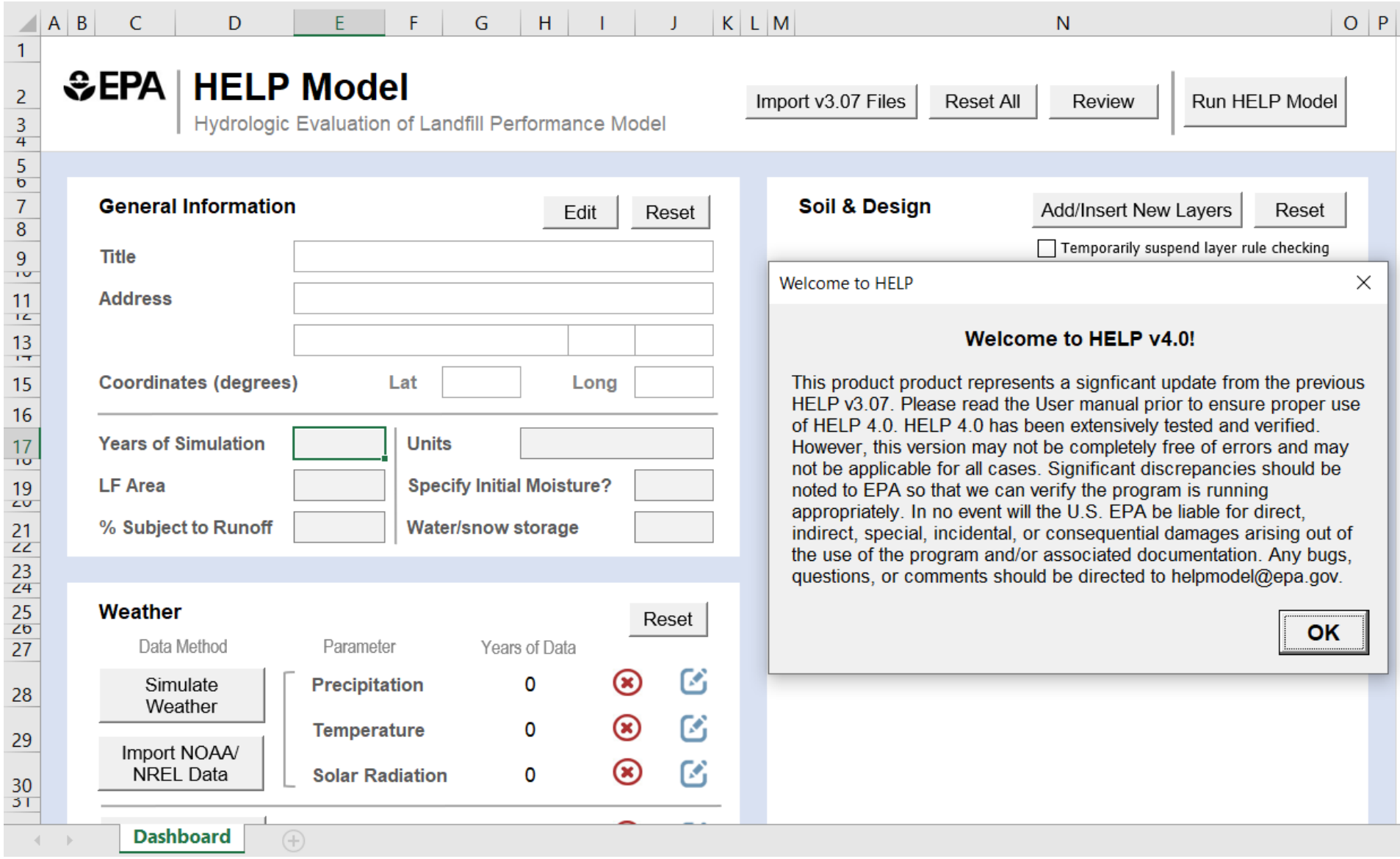
1. Unzip and extract the files from the downloaded zip file.
2. The extracted folder will contain two files, HELP v4.0 and WGEN



3. The ‘HELP4.0.1’ file is the HELP model.
4. The ‘WGEN ParVals for OPP Grid’ (developed by the US Department of Agriculture (USDA) Agricultural Research Service) file is a synthetic weather generator.
5. HELP 4.0 can stochastically generate up to 100 years of daily precipitation, temperature, and solar radiation data for over 13,000 locations in the US.

Running the HELP model

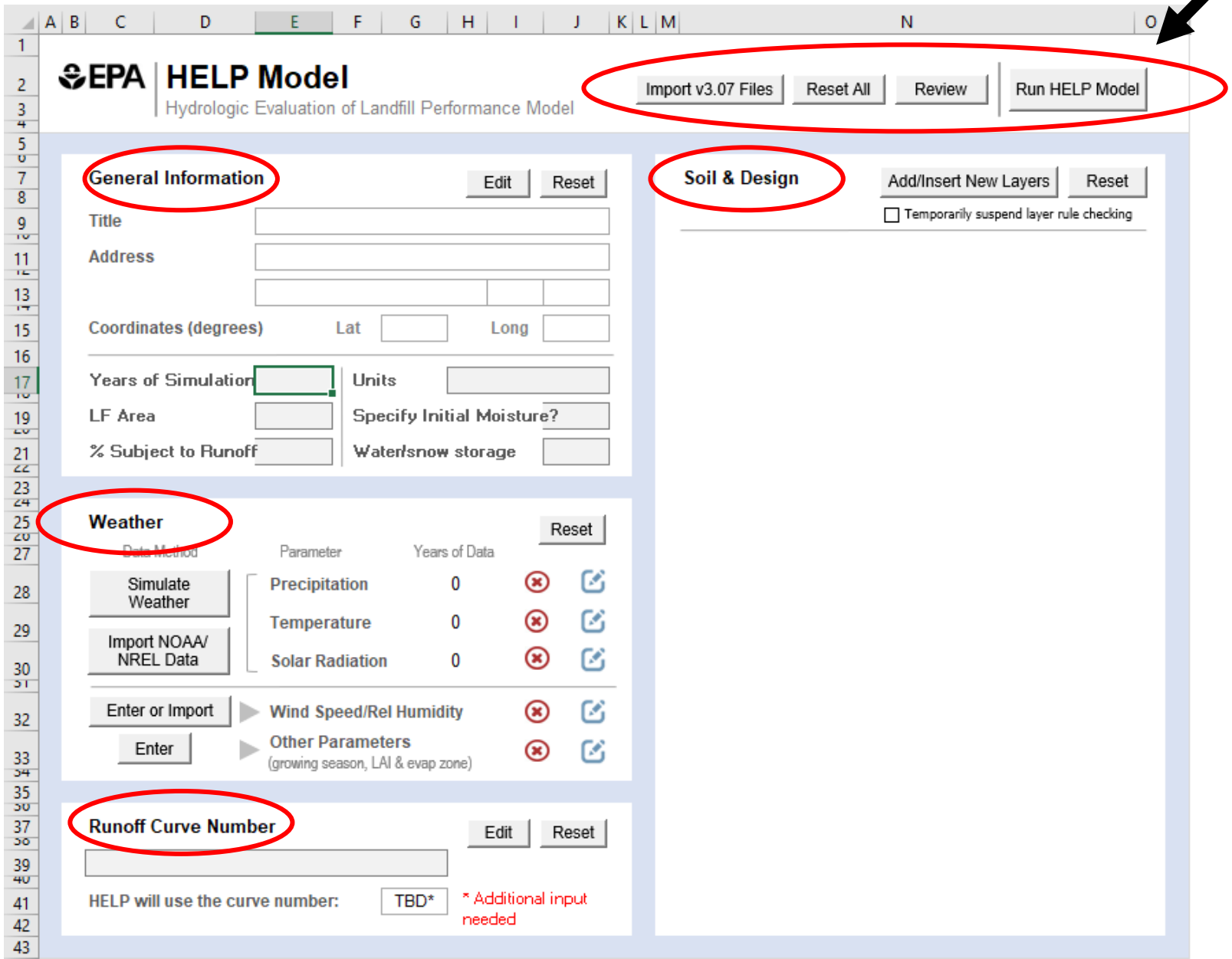
1. Open the file ‘HELP4.0.1’
2. The interface of the model is a worksheet titled **Dashboard**.



Running the HELP model

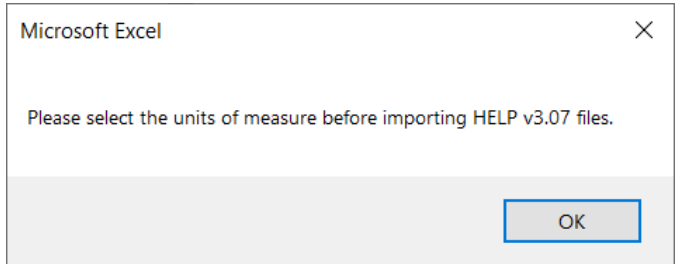
The Dashboard consists of five main panels:

1. General Information
2. Weather
3. Runoff Curve Number
4. Soil & Design
5. Control Panel

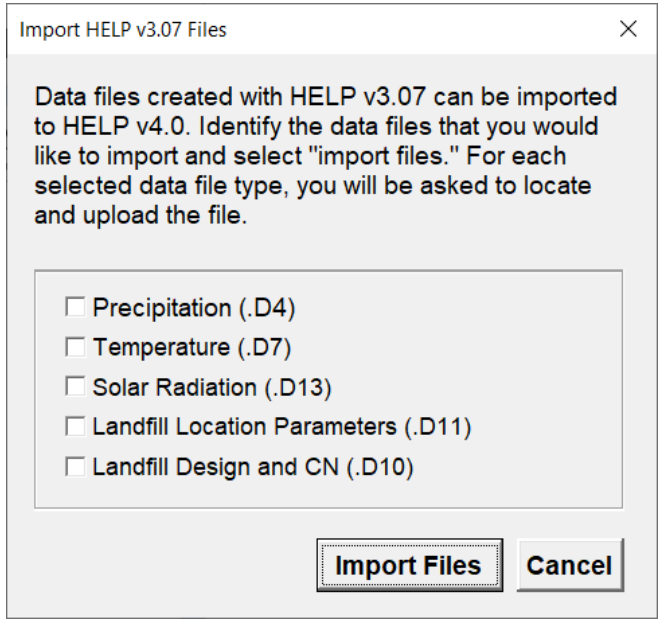


Running the HELP model

- Before the user can input or import any data, the HELP model requires the user to select the unit system.



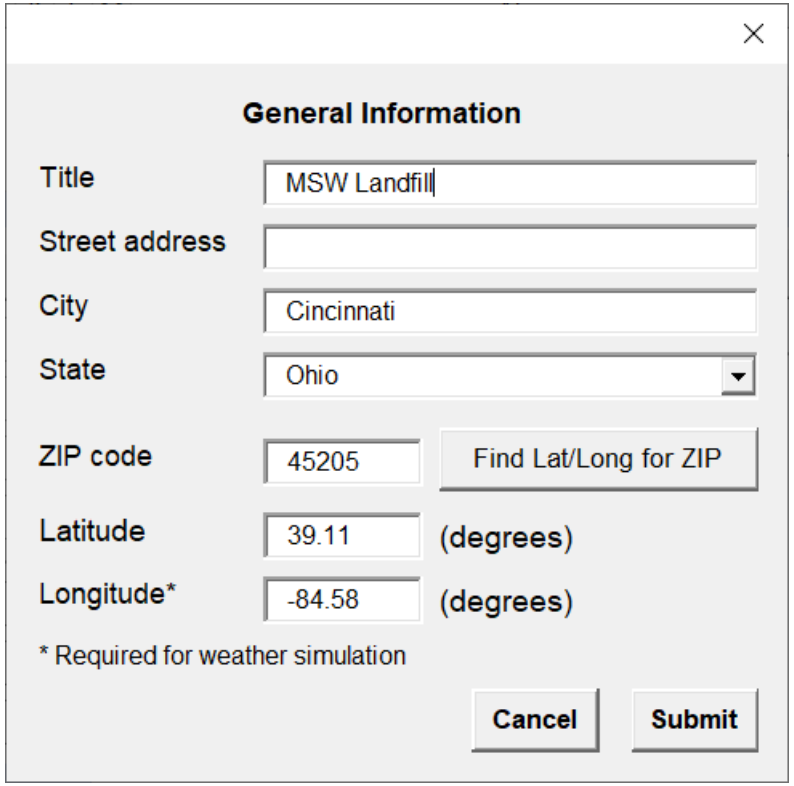
- The Control Panel allows the user to make global changes, including importing data files from HELP v3.07, resetting all fields, reviewing model input, and running the HELP model.
- The new version allows importing one or more v3.0.7 input files. Clicking on the 'Import v3.0.7 files' opens a pop-up window for the user to import.



Running the HELP model

General Information

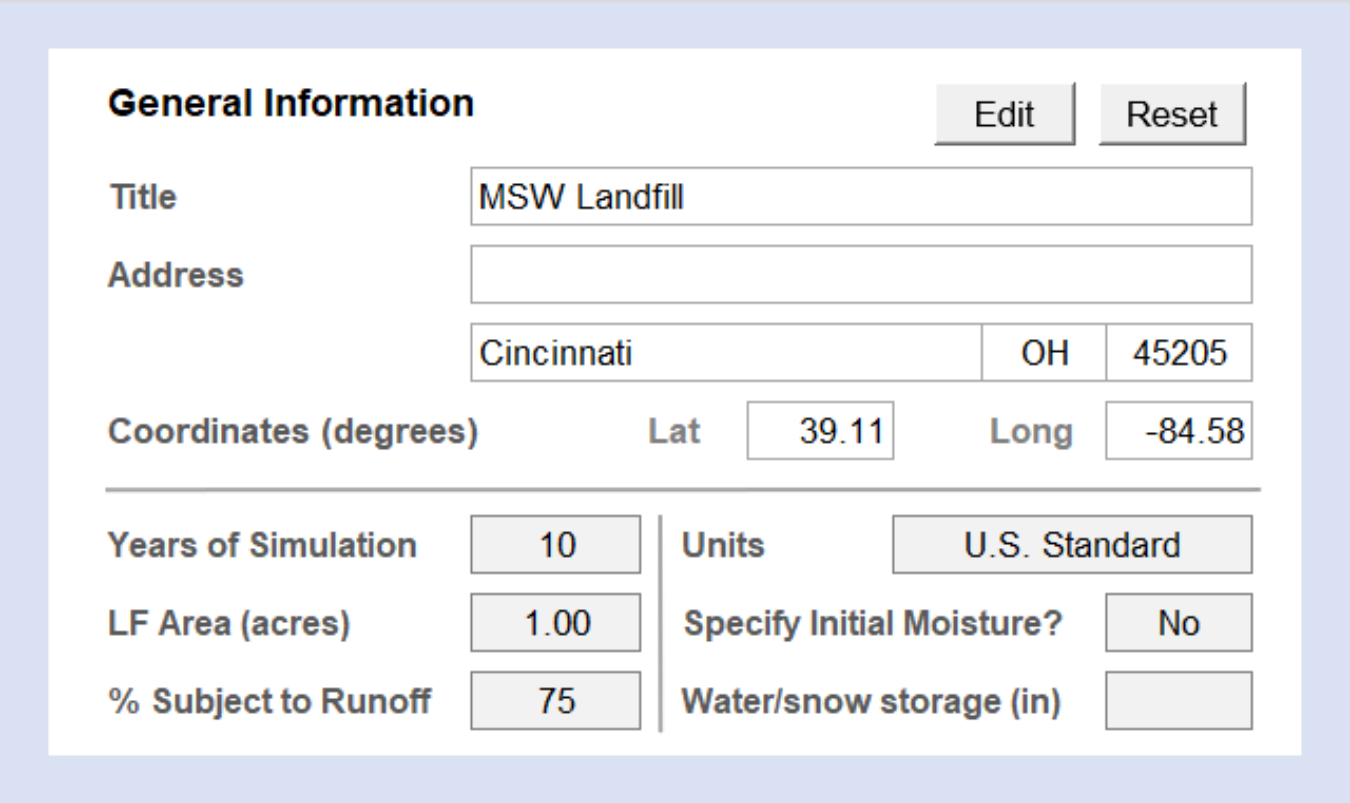
- The HELP model can identify the latitude and longitude of the landfill based on the zip code input.
- The coordinates can be used to generate location-specific weather data.



Running the HELP model

General Information

1. **Years of Simulation (simulation duration):** Should be between 1 and 100.
2. **Landfill Area:** It is the landfill footprint.
    1. The user can run multiple sections individually (e.g., top deck, side slopes) in separate model runs.
3. **% Subject to Runoff:** The portion of the sloped area to promote run off the surface.

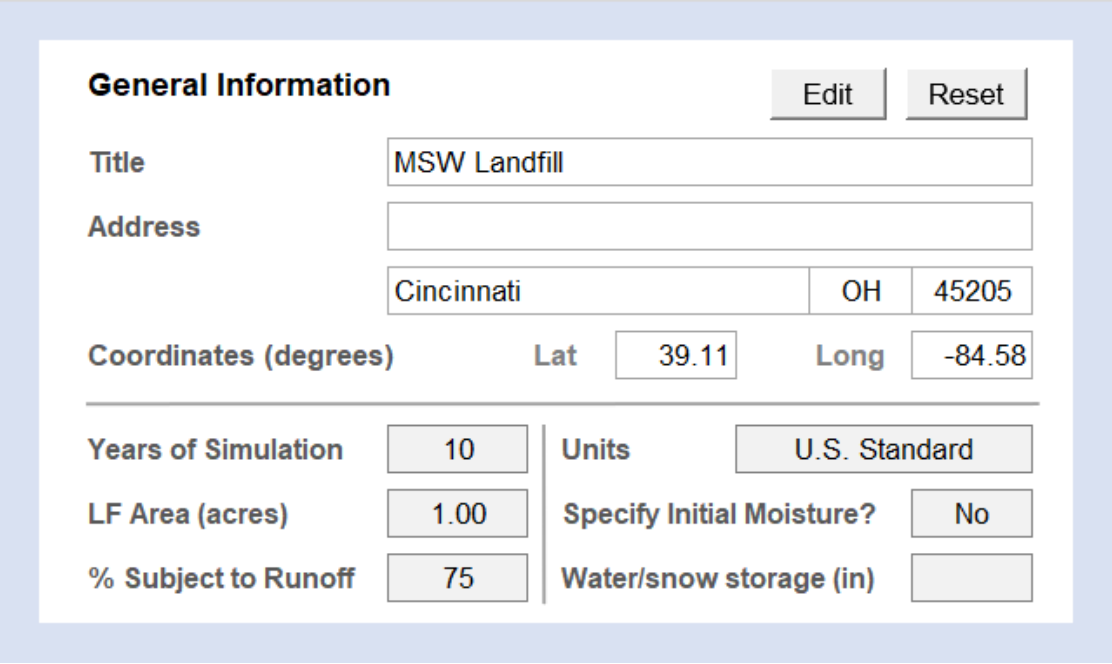


Running the HELP model

General Information

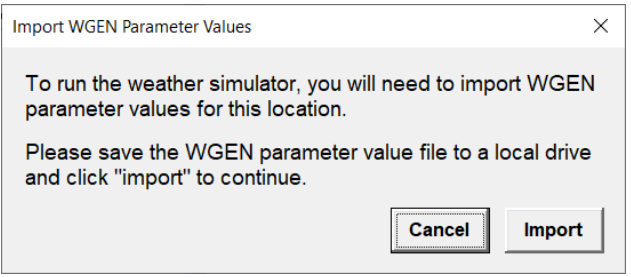
3. **Specify Initial Moisture?:** Initial moisture content for the landfill layers can be specified if data are available by clicking 'Yes.' If 'No' is selected, the model assumes near steady-state values and runs the first year of the simulation to improve the initialization to steady-state. Soil water contents at the end of this year of initialization are used as the initial values for the simulation period.

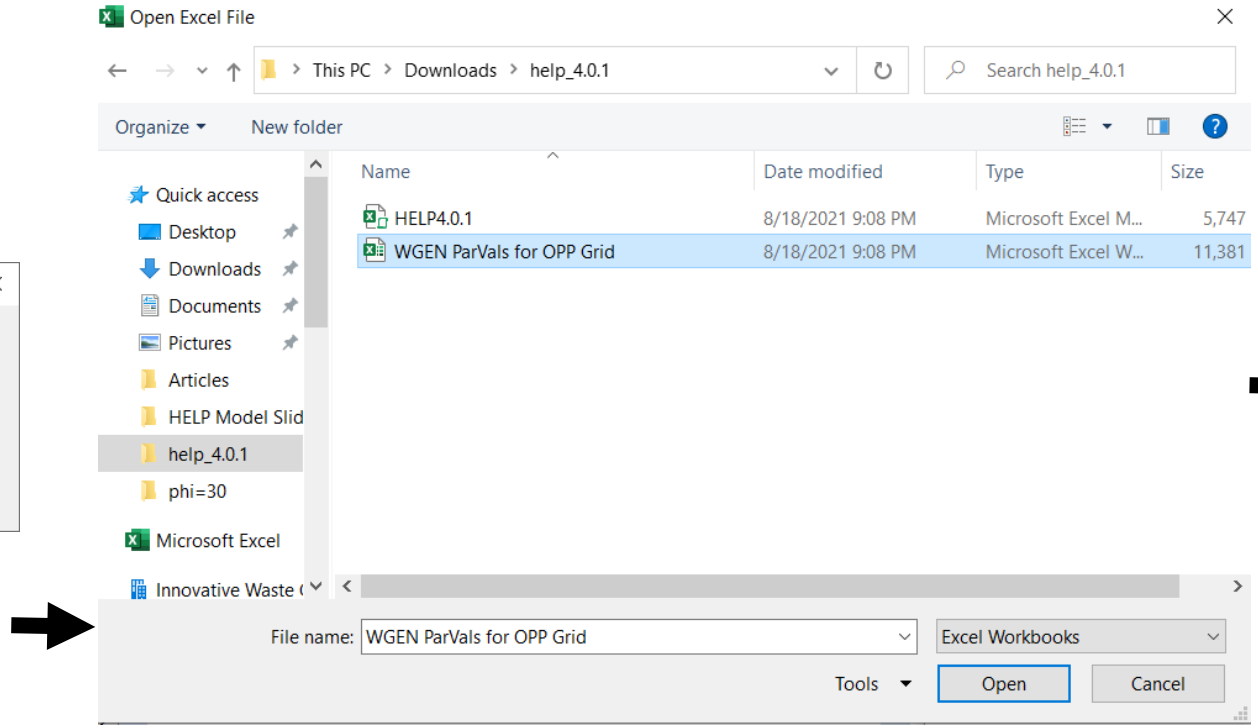
4. **Initial water/snow water storage on landfill:** If the user decides to specify initial moisture, the amount of water or snow water on the landfill surface can be entered.

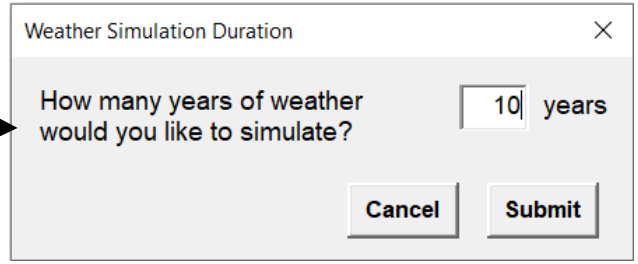


Running the HELP model

Synthetically Generated Weather Data

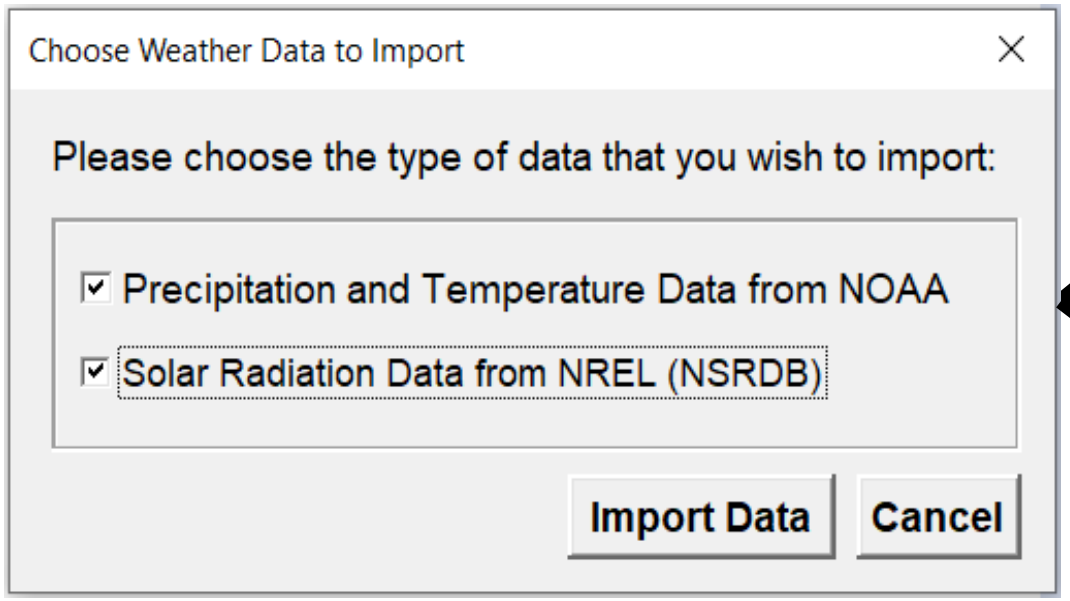


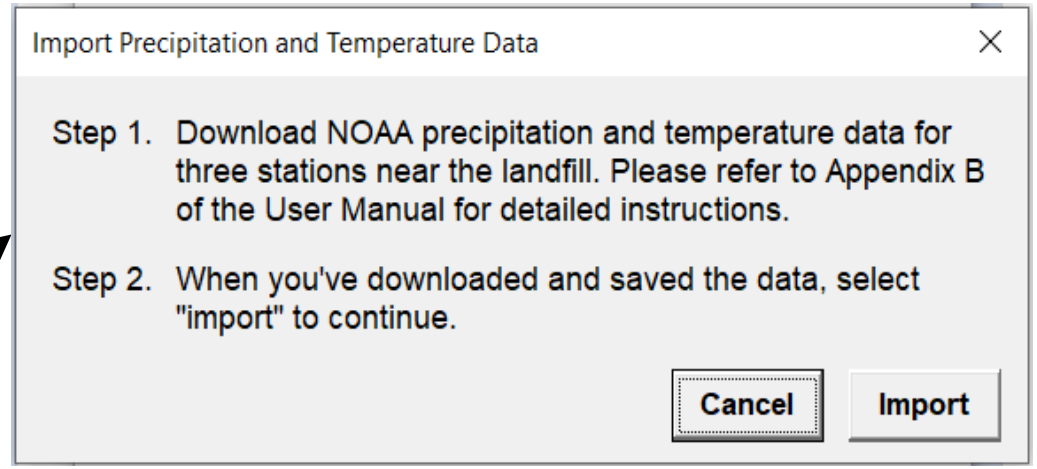


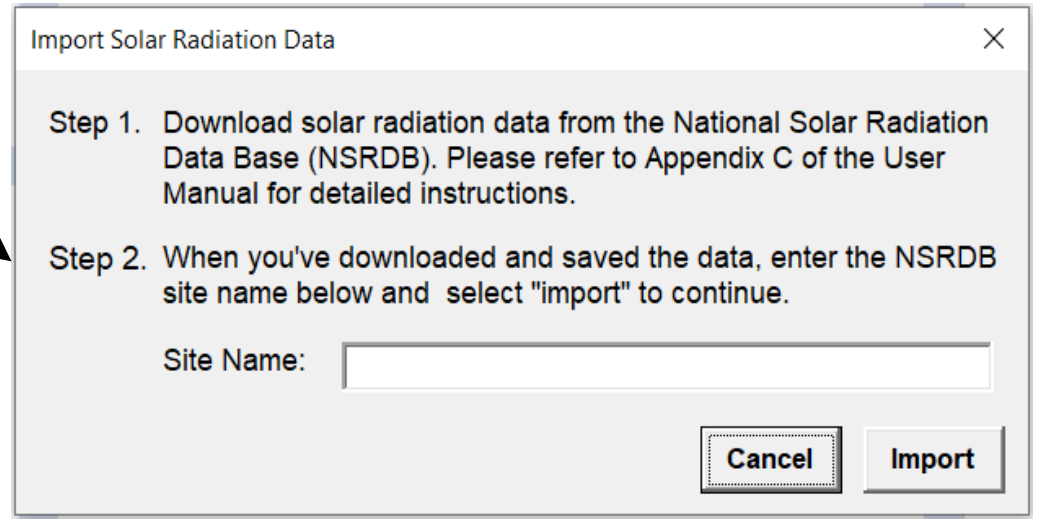


Running the HELP model

Importing Weather Data from NOAA[1]/NREL[2]





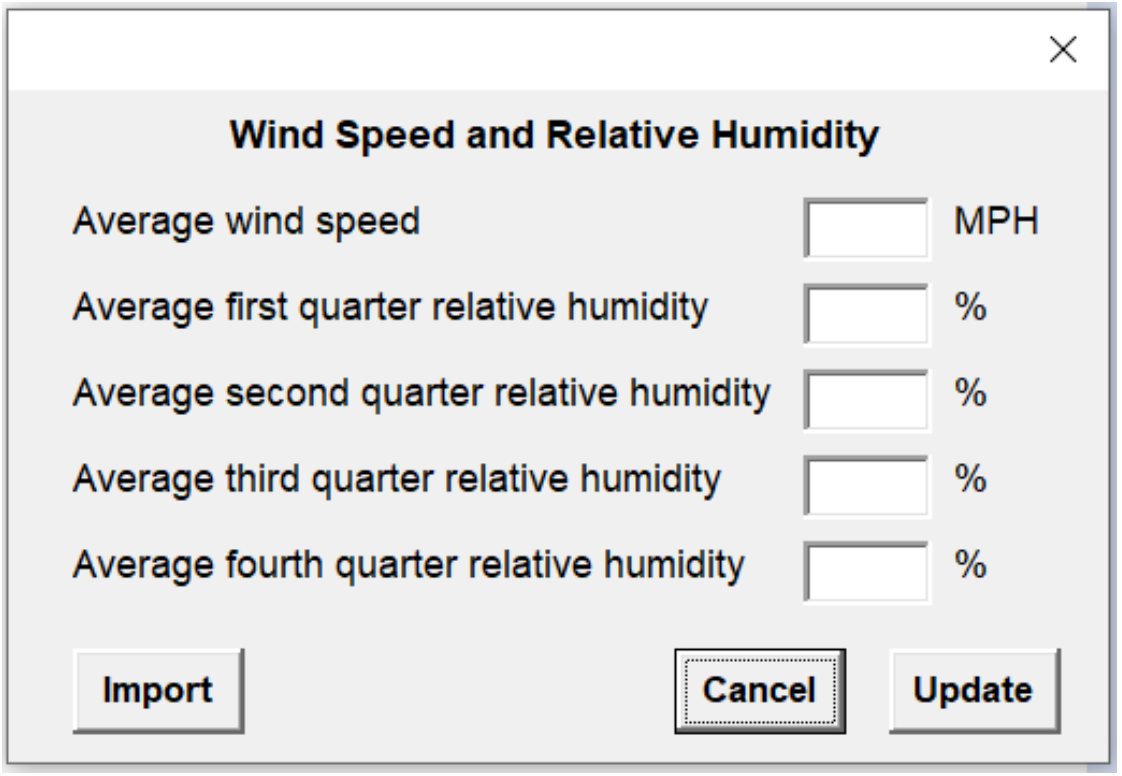


[1]National Oceanic and Atmospheric Administration
[2]National Renewable Energy Laboratory

Running the HELP model

Wind Speed and Relative Humidity

- User may input the average wind speed and relative humidity manually or import wind speed and relative humidity data from the NSRDB[1] website.

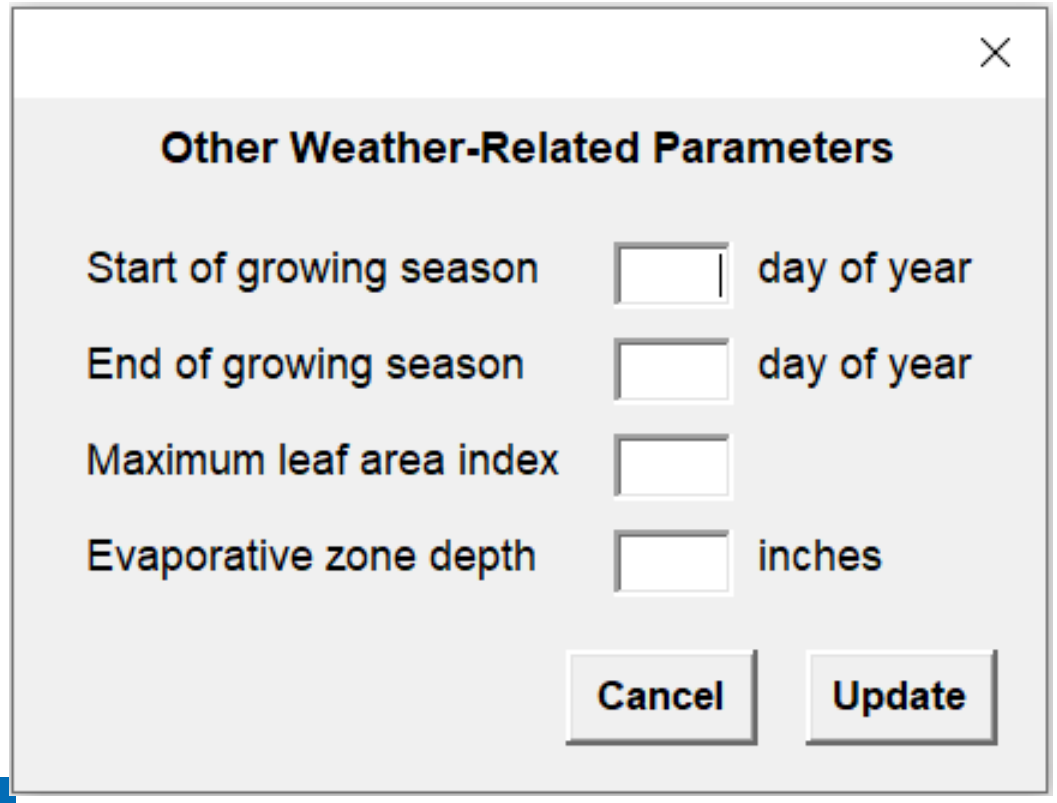


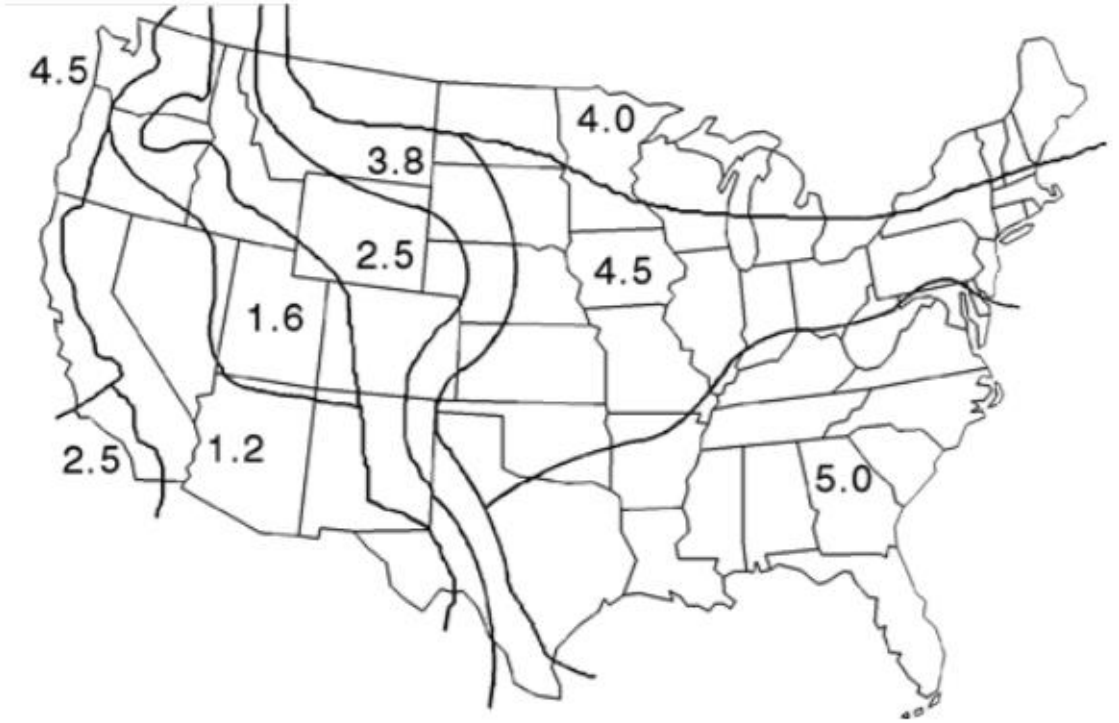
[1]National Solar Radiation Database

Running the HELP model

Other Parameters

- User must input the start of the growing year, end of the growing year, maximum leaf area index, and the evaporative zone depth.
- The start and end of the growing season are dependent on the normal mean daily temperature.





Geographic Distribution of Maximum Leaf Area Index

Running the HELP model

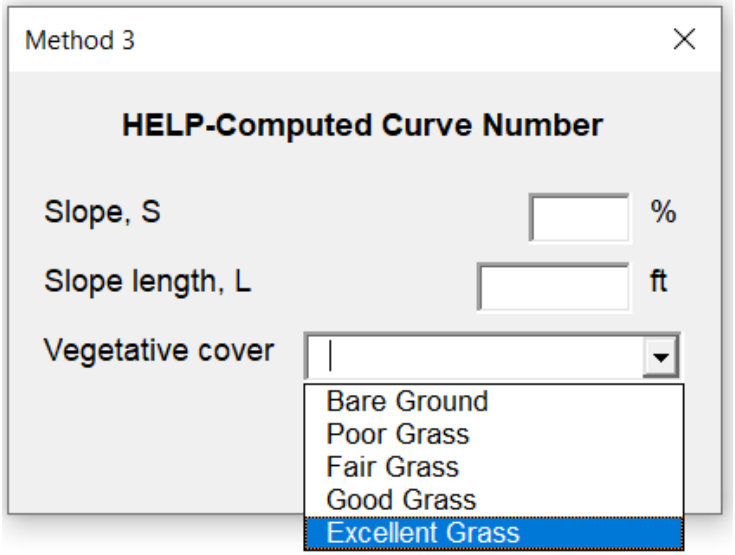
Runoff Curve Number

- The model uses Soil Conservation Society (SCS) runoff curve number (CN) for Antecedent Moisture Condition II (AMC-II).
- The SCS curve runoff number can be input by three methods:

i. **Method 1, User-specified CN:** The user enters an SCS AMC-II CN directly.

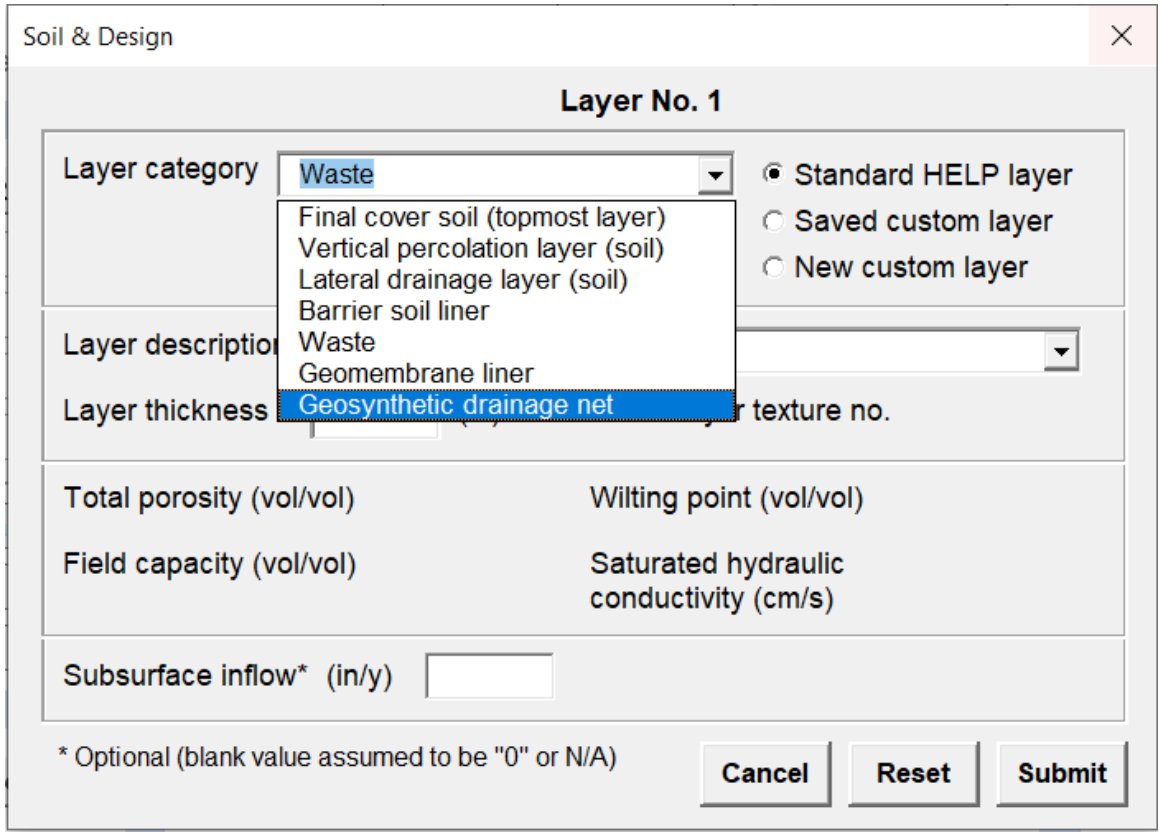
ii. **Method 2, Modified User's CN:** The user enters an SCS AMC-II CN, landfill surface slope, and slope length, and the model computes a modified SCS AMC-II CN, accounting for slope and slope length.

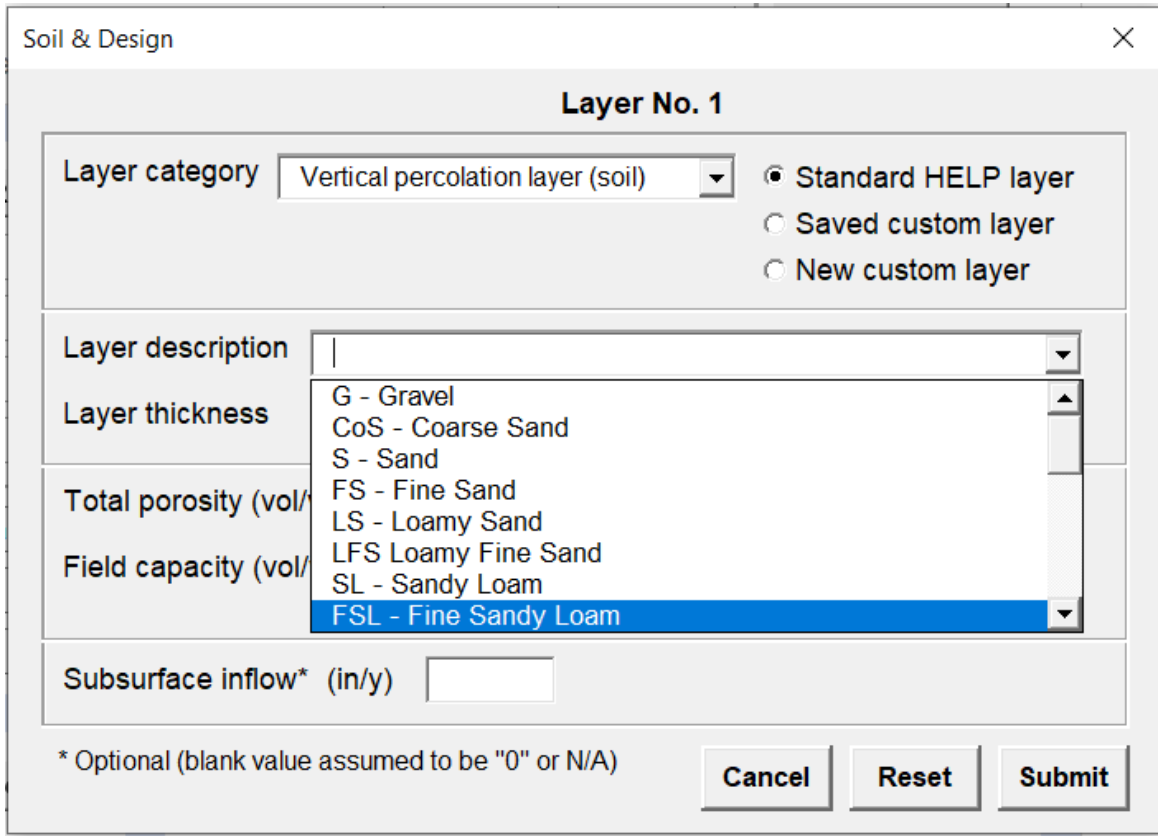
iii. **Method 3, HELP-computed CN:** The user enters the landfill surface slope, slope length, and vegetative cover, and the model computes an SCS AMC-II CN based on these inputs and the soil texture of the topmost layer.



Running the HELP model

Soil and Design





Running the HELP model

Soil and Design

The model also requires that the arrangement of layers in the landfill profile conform to the following basic rules:

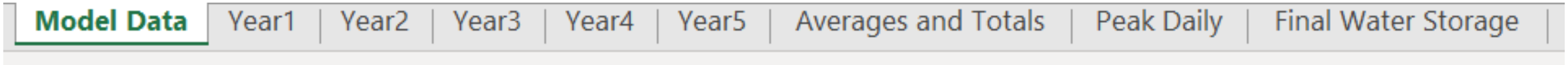
1. A vertical percolation layer cannot be underlying a lateral drainage layer
2. A barrier soil liner cannot be underlying another barrier soil liner
3. A geomembrane liner cannot be placed between two barrier soil liners
4. A geomembrane liner cannot be underlying another geomembrane liner
5. A barrier soil liner cannot be placed directly between two geomembrane liners
6. The top layer cannot be a barrier soil liner
7. The top layer cannot be a geomembrane liner
8. The profile can contain no more than five barrier soil liners and geomembrane liners

Results

Output

The HELP4.0 output file consists of the following tabs:

1. Model Data
2. A tab for each year with daily output data
3. Averages and Totals
4. Peak Daily
5. Final Water Storage

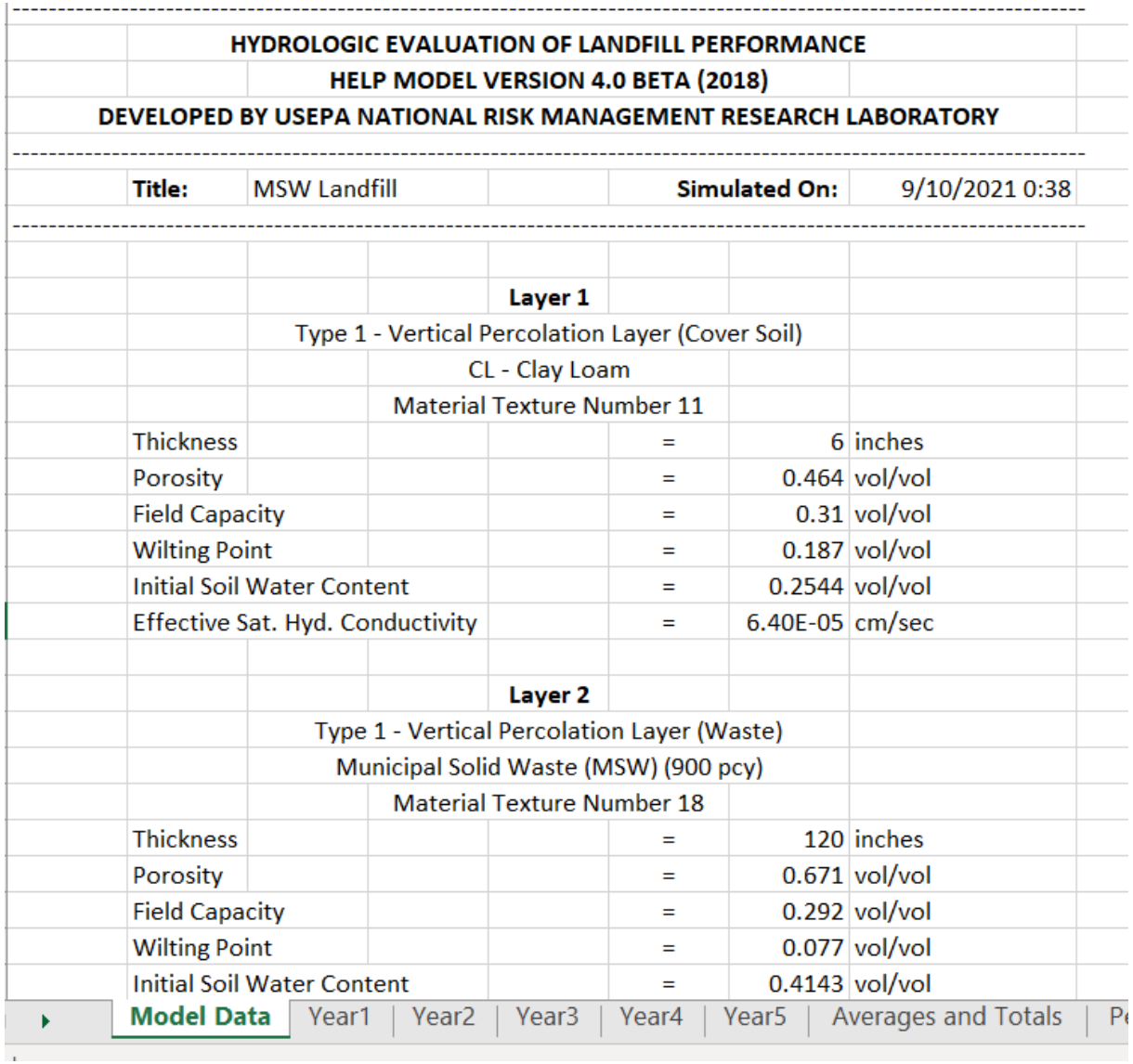


Results

Model Data

The model data tab contains:

1. General information and hydraulic properties of every layer
2. General design and evaporative zone data
3. Evapotranspiration and weather data
4. Normal mean monthly precipitation
5. Normal mean monthly temperature



HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title:	MSW Landfill	**Simulated On:**	9/10/2021 0:38

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
CL - Clay Loam
Material Texture Number 11

Thickness	=	6	inches
Porosity	=	0.464	vol/vol
Field Capacity	=	0.31	vol/vol
Wilting Point	=	0.187	vol/vol
Initial Soil Water Content	=	0.2544	vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	120	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.4143	vol/vol

Model Data | Year1 | Year2 | Year3 | Year4 | Year5 | Averages and Totals

Results

Daily Output Data

The daily output tab contains:

1. Precipitation
2. Runoff
3. Evapotranspiration
4. Evaporation zone water
5. Head on liner
6. Drainage generated
7. Leakage through barrier layer

Daily Output for Year 1

						Column key:	Head #1: drainage from Layer 3		
Title:		MSW Landfill							
Simulated On:		9/10/2021 0:38					Leak #1: leakage thru Layer 4		
Day	Freezing Status*		Rain	Runoff	ET	Evap. Zone Water	Head #1	Drain #1	Leak #1
	Air	Soil	(inches)	(inches)	(inches)	(in/in)	(inches)	(inches)	(inches)
1			0.00	0.000	0.047	0.2465	38.7112	0.0000	1.32E-04
2			0.00	0.000	0.081	0.2330	38.7108	0.0000	1.32E-04
3			0.59	0.000	0.074	0.3186	38.7105	0.0000	1.32E-04
4			0.00	0.000	0.036	0.3126	38.7101	0.0000	1.32E-04
5			0.00	0.000	0.025	0.3085	38.7098	0.0000	1.32E-04
6			0.00	0.000	0.037	0.3023	38.7094	0.0000	1.32E-04
7	*		0.00	0.000	0.021	0.2985	38.7091	0.0000	1.32E-04
8			0.00	0.000	0.058	0.2874	38.7196	0.0000	1.32E-04
9			0.00	0.000	0.091	0.2702	38.7501	0.0000	1.32E-04
10			0.00	0.000	0.126	0.2488	38.7730	0.0000	1.32E-04
11			0.00	0.000	0.107	0.2309	38.7742	0.0000	1.32E-04
12			0.71	0.000	0.120	0.3297	38.7738	0.0000	1.32E-04
13			0.00	0.000	0.063	0.3099	38.7833	0.0000	1.32E-04
14			0.00	0.000	0.054	0.2981	38.9172	0.0000	1.33E-04
15			0.00	0.000	0.057	0.2860	38.9789	0.0000	1.33E-04
16			0.00	0.000	0.085	0.2689	39.0237	0.0000	1.33E-04
17			0.00	0.000	0.061	0.2571	39.0639	0.0000	1.33E-04
18			0.30	0.000	0.076	0.2944	39.0846	0.0000	1.34E-04
19			0.00	0.000	0.069	0.2828	39.0870	0.0000	1.34E-04
20			0.00	0.000	0.082	0.2692	39.0866	0.0000	1.34E-04

Model Data | Year1 | Year2 | Year3 | Year4 | Year5 | Averages and Totals | Peak Daily | Final Water Storage

Results

Averages and Totals

The averages and totals tab contains:

1. Average annual precipitation
2. Average annual runoff
3. Average annual evapotranspiration
4. Average annual leakage through barrier layer
5. Average annual head on liner
6. Average annual change in water storage

Average Annual Totals Summary					
Title:	MSW Landfill				
Simulated on:	9/10/2021 0:39				
		Average Annual Totals for Years 1 - 10*			
		(inches)	[std dev]	(cubic feet)	(percent)
Precipitation		49.60	[7]	180,036.0	100.00
Runoff		6.215	[4.408]	22,558.7	12.53
Evapotranspiration		40.179	[6.559]	145,849.1	81.01
Subprofile1					
Percolation/leakage through Layer 4		0.165454	[0.039013]	600.6	0.33
Average Head on Top of Layer 3		110.2387	[22.5718]	---	---
Water storage					
Change in water storage		3.0379	[5.6053]	11,027.5	6.13
* Note: Average inches are converted to volume based on the user-specified area.					

Results

Peak Daily

The peak daily tab presents peak daily:

1. Precipitation
2. Runoff
3. Evapotranspiration
4. Leakage through barrier layer
5. Head on the liner
6. Change in water storage

Peak Values Summary				
Title:	MSW Landfill			
Simulated on:	9/10/2021 0:39			
		Peak Values for Years 1 - 10*		
		(inches)		(cubic feet)
Precipitation		3.56		12,906.8
Runoff		1.826		6,629.6
Subprofile1				
Percolation/leakage through Layer 4		0.000531		1.9293
Average head on Layer 3		125.9998		
Other Parameters				
Snow water		0.5203		1,888.9
Maximum vegetation soil water		0.4640	(vol/vol)	
Minimum vegetation soil water		0.1870	(vol/vol)	

Results

Final Water Storage

The final water storage tab provides each layer's water storage and volumetric moisture content at the year of the simulation period.

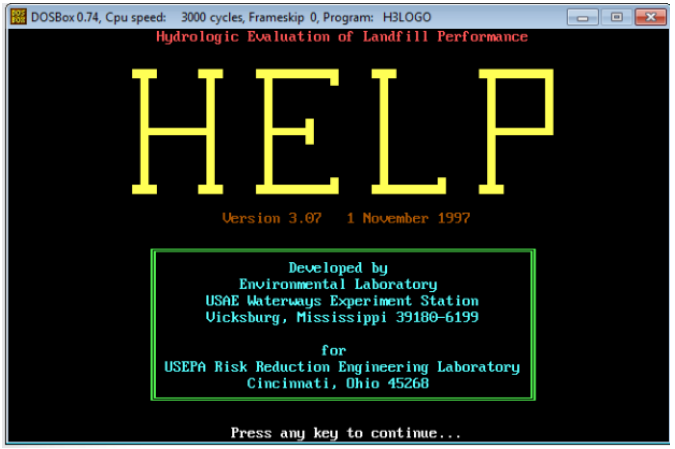
Final Water Storage in Landfill Profile at End of Simulation Period		
Title:	MSW Landfill	
Simulated on:	9/10/2021 0:39	
Simulation period:	10 years	
	Final Water Storage	
Layer	(inches)	(vol/vol)
1	1.1221	0.1870
2	80.4947	0.6708
3	0.0000	0.0000
4	5.4120	0.4510
Snow water	0.0000	---

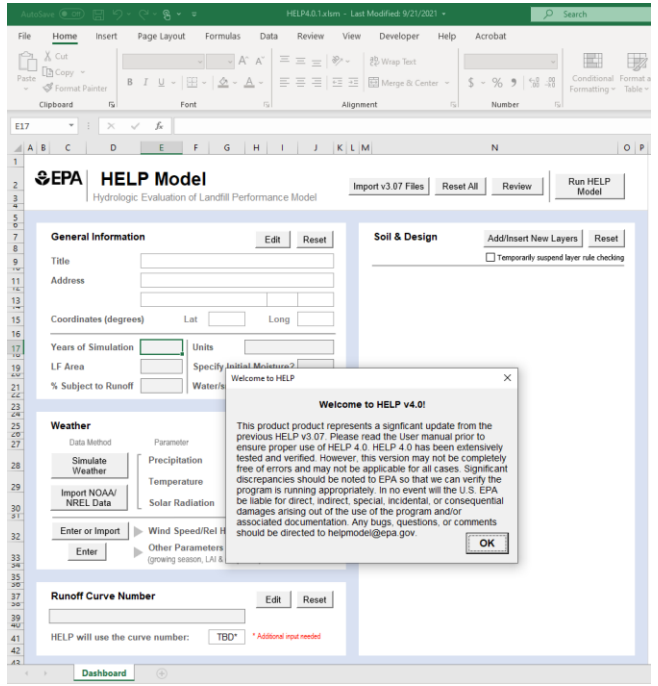
Future Improvements

- Extreme weather events
- More dynamic modeling
- Exposed geomembrane covers
- Liquid introduction

Key Takeaways

- HELP 4.0 for Microsoft Excel
  - Can run on Windows or Mac
  - New visual interface
  - Outputs are in spreadsheet format for easy analysis/review
- Updated weather data for contiguous US
- New updates are in development
  - Exposed geomembrane
  - Extreme weather





Contacts

Thabet Tolaymat
Environmental Engineer
Center for Environmental Solutions and Emergency Response
US EPA Office of Research and Development
tolaymat.thabet@epa.gov
513-429-9941

Max Krause
Engineer
Center for Environmental Solutions and Emergency Response
US EPA Office of Research and Development
krause.max@epa.gov

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