Introduction to Visual HELP

Modeling Landfill Hydrology with Visual HELP for Windows 95/98/NT/2000

The HELP Model

The **HELP** model (**H**ydrologic **E**valuation of **L**andfill **P**erformance), is a versatile program used to design, evaluate and optimize landfill hydrology and groundwater recharge rates. The HELP model is used and recognized all over the world as the accepted standard for modeling landfill hydrology, and has become an integral component for projects involving landfill operating and closure permits.

The HELP model is a quasi-two-dimensional, multi-layer hydrologic model requiring the following input data for each model profile:

- Weather data (precipitation, solar radiation, temperature, evapotranspiration parameters)
- Soil properties (porosity, field capacity, wilting point, and hydraulic conductivity)
- Design information (liners, leachate and runoff collection systems, surface slope)

The landfill profile structure can consist of a combination of natural (soil) and artificial materials (waste, geomembranes) with options to install horizontal drainage layers. The HELP model also accounts for the change in slope for different parts of the landfill profile.

HELP uses numerical solution techniques that account for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, leachate recirculation, unsaturated vertical drainage, and leakage through soil, geomembranes, or composite liners.

About Visual HELP

Visual HELP for Windows 95/98/NT/2000 is the most advanced hydrological modeling environment available for designing landfills, predicting leachate mounding and evaluating potential leachate contamination. Visual HELP combines the latest version of the HELP model (v.3.07) with an easy-to use interface and powerful graphical features for designing the model and evaluating the modeling results.

Visual HELP's user-friendly interface and flexible data handling procedures provide you with convenient access to both the basic and advanced features of the HELP model. This completely-integrated modeling environment allows the user to:

- Graphically create several profiles representing different parts of a landfill,
- Automatically generate statistically reliable weather data (or create your own),
- Run complex model simulations,
- Visualize full-color, high-resolution results, ***and***
- Prepare graphical and document materials for your report.

Built-in Database tools include:

- An International Weather Generator for synthetic generation of up to 100 years of daily values of precipitation, air temperature and solar radiation.
- Soil, waste and geomembrane database which contains properties for 42 common landfill materials.

For professional applications in landfill design, Visual HELP is the only software package you will ever need! After running through this demonstration tutorial, we trust you will agree that Visual HELP is now the most complete and easy-to-use modeling tool for designing & optimizing landfill hydrology.

Visual HELP is now available as part of the **WHI UnSat Suite Plus**. This suite of 1-D unsaturated flow models is comprised of Visual HELP, VS2DT, VLEACH, and PESTAN. Now you can model landfill hydrology, predict leachate & contaminant migration, and show degradation of pesticides all with the same easy-to-use software package! For details about the **WHI UnSat Suite Plus,** please call (519) 746-1798 or visit our web page at www.flowpath.com.

New Features of Visual HELP versions 2.1 and 2.2

Profile Viewing and Editing:

- A layer can now be split into two separate layers
- Layers are systematically numbered, and labelled in the Project Tree, which simplifies interpreation of the results

Weather Generating:

- New databases and GIS searching tools have been developed for the major regions of the world (more than 3000 weather stations)
- Data in NOAA format can now be directly imported
- Diagnostics are provided to detect missing records in NOAA files

Output Presentation:

- Output units can be changed without restarting the project
- Water Balance Tables have been added
- New tree-like interface structure allows the user to easily select results
- Report Generator (a new feature of Visual HELP) allows you to display, print and export to Microsoft Word, project input settings and output graphs and tables.

System Requirements

To run Visual HELP, you will need the following minimum system configuration:

- Windows 95/98/2000, or Windows NT 3.5.1 or later;
- IBM PC or compatible,
- Pentium 100 processor;
- CD-ROM drive for software installation;
- 32 Mb of RAM;
- 60 Mb of free hard disk space; and

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- Minimum display resolution of 1024 x 768

The following fonts should be installed on your computer: MS Sans Serif, Arial, and Courier New.

How to Contact Waterloo Hydrogeologic Inc.

To contact Waterloo Hydrogeologic Inc.(WHI), please use the address below:

Waterloo Hydrogeologic, Inc.
180 Columbia Street West, Unit 1104
Waterloo, Ontario, CANADA
N2L 3L3
Phone: (519) 746-1798
Fax: (519) 885-5262

Please forward additional comments or suggestions to the Visual HELP development team at:

Mikhail Gogolev, Product Manager mgogolev@flowpath.com

Demonstration Exercise

Learning Objectives

In this demonstration exercise, you will:

- Use Visual HELP as a tool for landfill design and hydrologic simulation;
- Use the Weather Generator to predict meteorological data for a twenty year period and use the predicted data as input to Visual HELP;
- Run the Visual HELP simulation, view the water balance of the landfill, assess the performance of the drainage and leachate collection system, and
- Prepare a report of the simulation data and results.

The instructions for this demo exercise are provided in a step-by-step format that will allow you to choose the features that you are interested in, and examine them without having to complete the entire exercise.

The default landfill profile used in this exercise was designed in accordance with the EPA's recommendations. This design is also used in the official HELP 3.0 User's Manual. The layer properties for the default landfill profile were taken from the HELP database. The simulated landfill is located near Toronto, Ontario, Canada. The area of the landfill is 1 acre.

Terms and Notation

The following terms and notations will be used throughout this tutorial exercise:

type- Type in the given word or value

select- Click the left mouse button where indicated

a - Press the **<Tab>** key

↵ - Press the **<Enter>** key

☞ - Click the left mouse button where indicated

☞☞- Double-click the left mouse button where indicated

The **bold faced type** indicates menu or window items to click, or values to be entered.

[...] denotes a button to click.

...\...\... denotes a menu selection.

NOTE: All theoretical parts of the demo tutorial are italicized

Starting Visual HELP

To start Visual HELP, you must have it installed on your computer's hard disk. Once installed, click the Windows **Start** button, choose **Programs**, navigate to the folder that contains Visual HELP, and **Visual HELP**.

The installation program will also place an icon on your desktop, which you can also double click to start the Visual HELP demo exercise.

When Visual HELP is started an introductory screen will be displayed as shown below.

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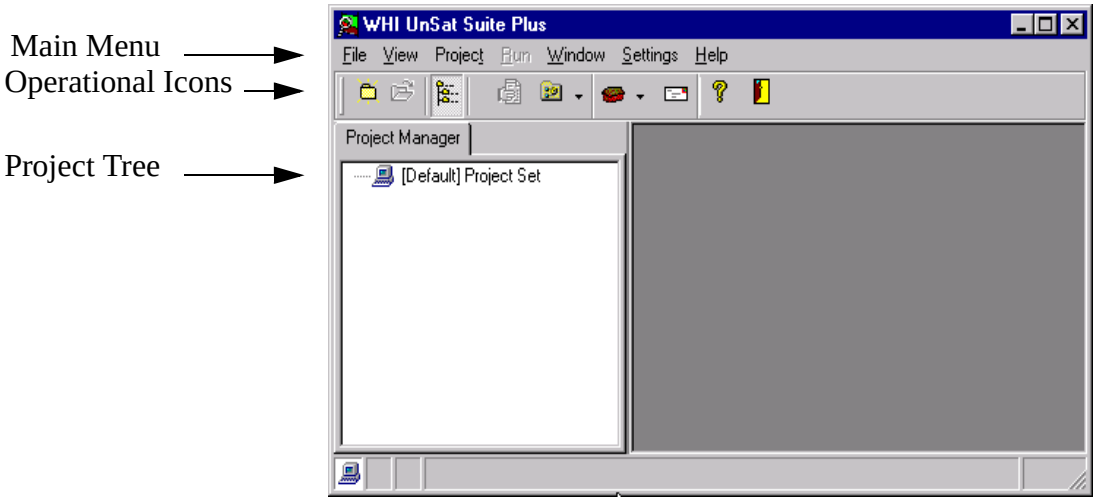
After the program is loaded, the main Visual HELP window will appear on your screen as shown in the following figure.



The Visual HELP interface structure has been designed to help you navigate through the program with ease. The operational icons are located directly below the main menu items to allow quick access to additional options. The Project Tree View is located in the left part of the screen and shows the available projects, and the structure of the model profiles in each project.

Module I: Creating a New Project

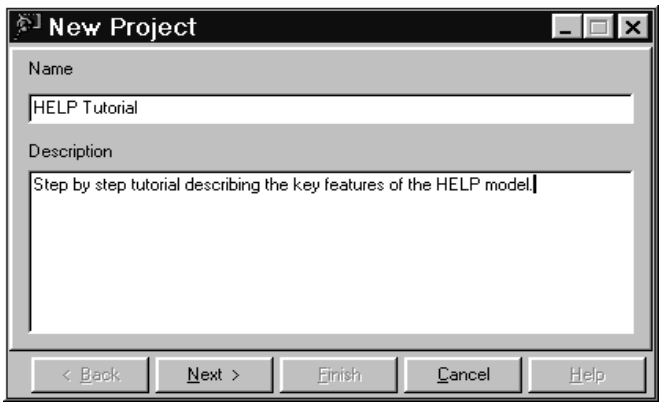
To create a new project,

☞ **File/New Project**, and the **New Project** dialog box will open.

The **New Project** wizard will guide you through the steps required to create a new Visual HELP project.

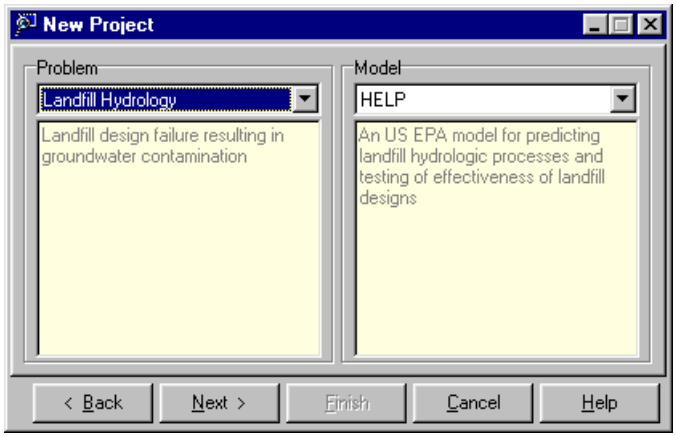
Type: HELP Tutorial, in the **Name** box.

Type: Visual HELP step-by-step tutorial in the **Description** box **.**



☞ **[Next],** to continue with your project setup. A **Problem/Model** dialog window will appear. This allows you to select which type of problem you are working on, and which model you would like to use to solve your problem.

☞ **[Problem]** dropdown menu and select **Landfill Hydrology** from the drop down list. The problem list displays all the problem classes available with the WHI UnSat Suite Plus. Also notice that Visual HELP automatically recognizes the appropriate Model that should be used with the selected Problem type.



☞ **[Next]**

Once completed, the site location must be defined.

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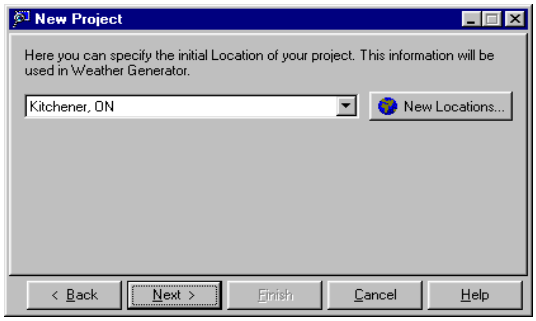
Selecting the Location

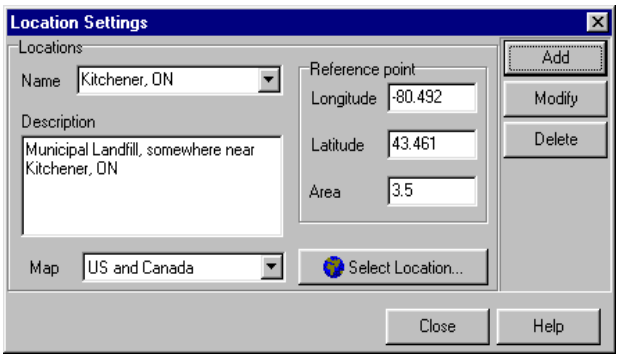
You will now select the location of your project using the GIS Location selection utility. The following dialog box should already appear on your screen.



At this stage, the location list will only contain Kitchener, ON and Buffalo, NY by default. To add a new location,

☞ **[New Locations...]**

The following **Location Settings** dialog box will appear.

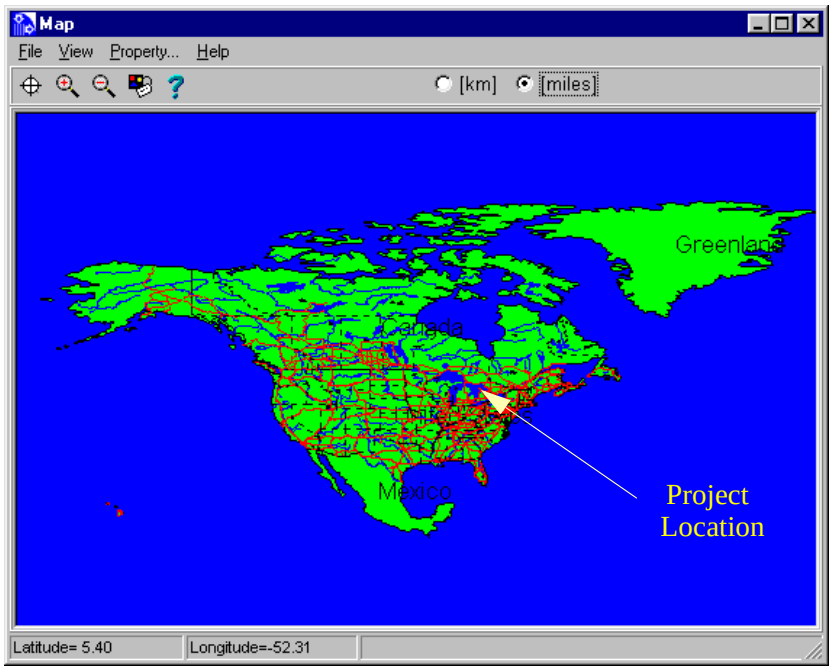


From the **Map** drop-down list,

☞ **North America,** to enable the WHI Locator, developed by WHI. The additional maps found in the list refer to various global regions that will help you to build projects from around the world!

☞ **[Select Location...],** to define our specific project location using the WHI Locator map.

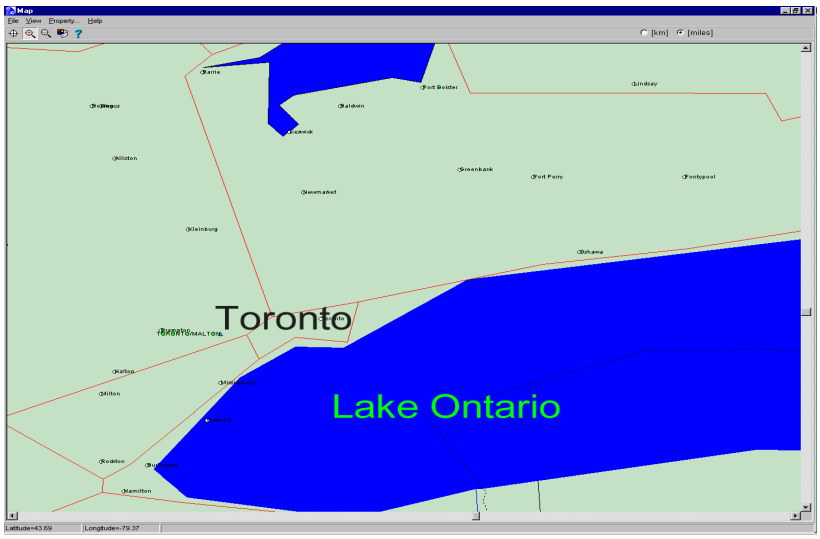
As shown below, a map of USA, Canada, and Mexico appears on your display:.



Now select Toronto, Ontario, Canada as your site location.

☞  , to zoom into the location.

Move the mouse to the right of the region where the landfill project is located (in center of the Great Lakes region). The coordinates, seen in the bottom left of the screen, should read approximately Latitude: 46.8, Longitude:-84.7. Press the left mouse button and stretch a zoom rectangle to the right of the Lake Ontario, release the button (approximate Latitude: 43.3, Longitude:-76.2). After one or two zooms, your screen should resemble the figure below.



Now select **Toronto** to set the longitude and latitude of the project location.

☞  , to activate the crosshairs.

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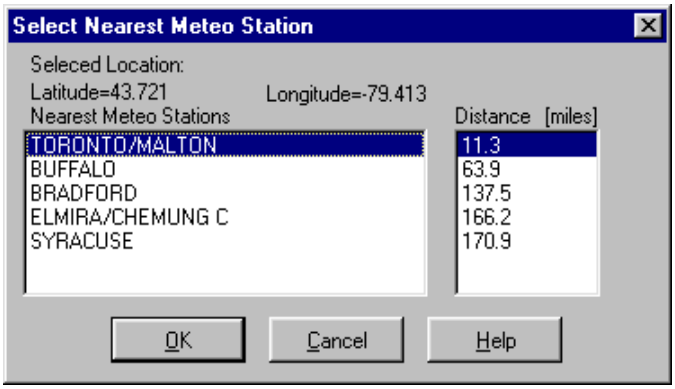
Move the crosshair to the spot on the map where **Toronto** is located and click on it with the left mouse button. The dialog box showing the five nearest weather stations, including distance will appear.



Note: If you wish to calculate the distance in kilometers, simply click the appropriate option button at the top of the map.

In the "Select Nearest Meteo Station" dialog box,

☞ **[TORONTO/MALTON],** as the nearest weather station.

☞ **[OK]**

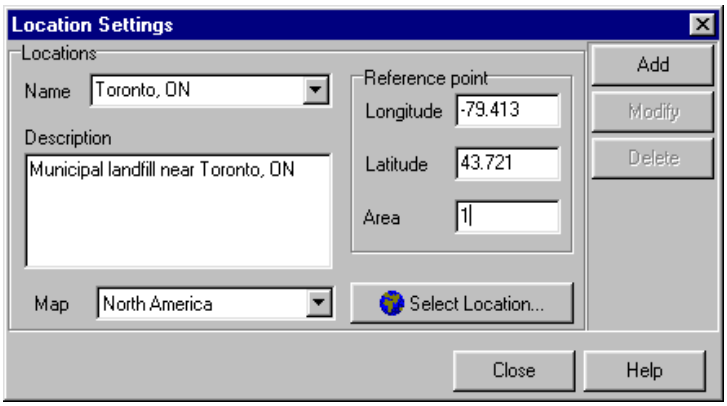
The **Location Settings** dialog box will show the selected weather stations and coordinates of the location you have selected.

Type: Toronto, ON., in the **Name** box.

Type: Municipal landfill near Toronto, ON., in the **Description** text box.

Type: 1 , in the landfill area text box: **1**.

Finally, the **Location Settings** dialog box should appear as follows.



☞ **[Add],** to add the new location to the database for future use.

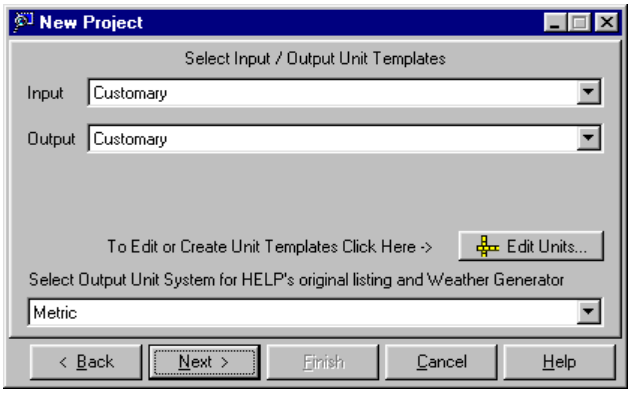
☞ **[Close]**

In the **New Project** dropdown list, select **Toronto, ON**.

☞ **[Next]**

Selecting Units

The next step is to define the units for your project (e.g. Metric or Imperial). This is completed in the "**Select Input/Output Unit Templates**" dialog box. In addition, you may select the units used for the Weather Generator data and original DOS HELP output.



Visual HELP's unit converter capabilities were developed to maximize the flexibility for data input and output unit conversion. To see the range of possibilities, just view the list of available units for hydraulic conductivity by selecting the **[Edit Units]** option.

For this demo exercise we will specify all input units as **Metric**, and output will be in **Customary** units.

From the **Input** drop-down list,

☞ **Metric**

From the **Output** drop-down list

☞ **Customary (in)**.

From the **Select Output Unit System for original listing and Weather Generator** list box,

☞ **Metric**

☞ **[Next]**

Assigning Authors and Clients

Visual HELP allows you to create and maintain your own database of project Authors and Clients for use in future projects. For this exercise we will use the default settings.

☞ **[Next]**

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All the project information will be presented, as seen in the figure below.

☞ **[Finish]** to save the information as a project in the database and add it to the project tree.

After the project settings are specified, the **New Profile Wizard** will open.

Profiles and Multiple Profiles in Visual HELP. *For the purpose of hydrological simulations, a profile represents a part of a landfill that is assumed to have the same cross-section throughout. The profile contains all of the layers of the landfill that it represents. It may also contain details of engineering components such as subsurface drainage, leachate recirculation systems, geomembranes, geonets, and composite liners. The surface of the profile can be sloped, which is typical for the peripheral parts of the landfill, or flat, which is typical for the central part of the landfill. The slope of the landfill usually mimics the shape of the waste body. At the time of landfill closure, the waste layer at the periphery of the landfill is usually sloped and the entire landfill site is capped by several layers, which form the landfill cap. Although drainage pipes are not usually installed in the landfill cap, permeable sand layers in the cap can transport water to the bottom drain or sump that surrounds the landfill. This process can be simulated with Visual HELP.*

A typical landfill can be represented as a set of profiles. This is done by creating several profiles in one project. This is useful because it allows you to use one profile to simulate the middle of the landfill, and several other profiles to simulate the edges, where the cross-section is tapering.

Selecting an Existing Profile

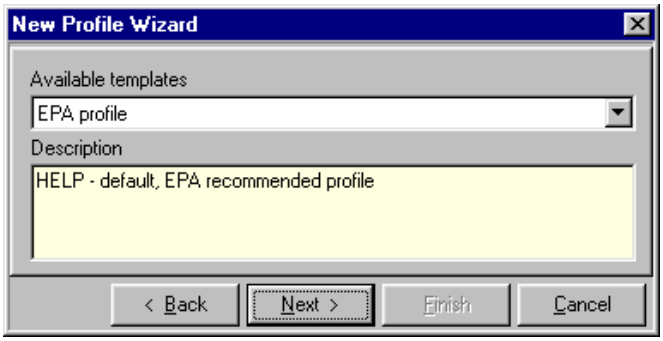
The **New Profile Wizard**, which appears after you finish creating a project, is shown below:

In this dialog box you may select an already existing profile template or you can build a profile 'from scratch'. In this demonstration exercise we will use the default profile template.

☞ **[use existing profile template]**

☞ **[Next]**

The **Available templates** list will appear:



☞ **EPA Profile**

☞ **[Next]**

All the profile information will be presented:.

☞ **[Finish]** to load the profile.

The new project details will be added to the project tree. This concludes creating a new project using Visual HELP. We will now continue with designing the landfill profile.

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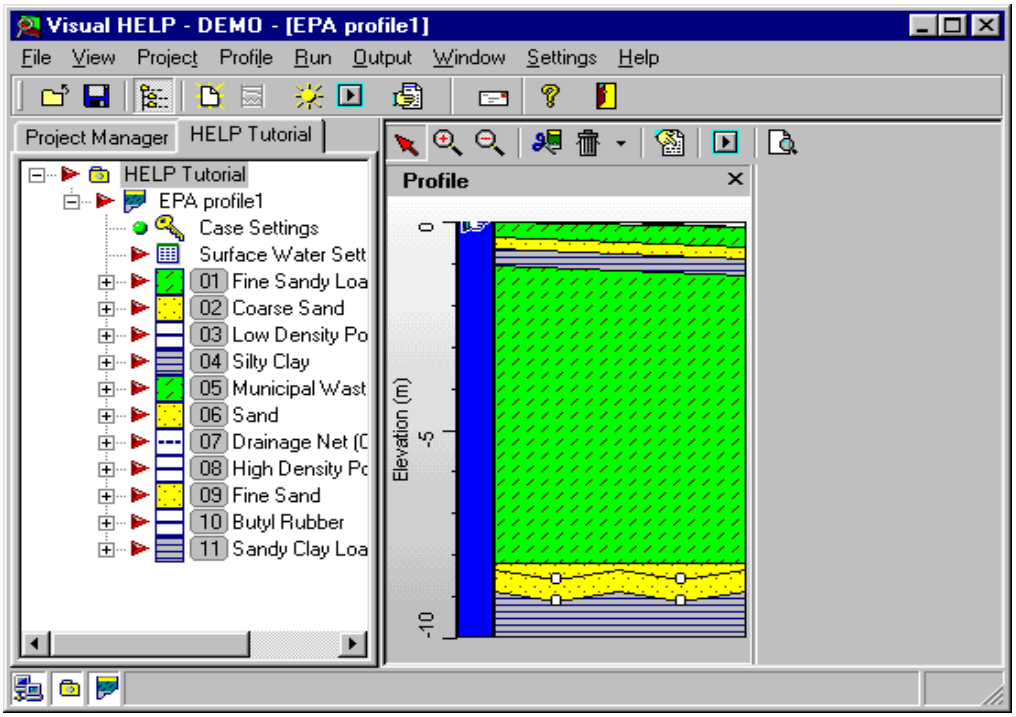
Module II: Designing a Landfill Profile

After you create the project, the following picture will appear on your display.



Viewing the Default Profile

In the Profile View, located in the center part of the Visual HELP window, you will see the loaded default landfill profile with a depth scale.

A description of each landfill layer will appear when the mouse cursor is pointed at the layer.

As you can see, this profile consists of:

- a sloped landfill cap in the depth interval 0.0 - 1.2 m, consisting of fine sandy loam, coarse sand and silty clay
- a 7 m thick waste layer in the depth interval 1.2 - 8.2 m; and
- a double liner leachate collection and removal system in the depth interval 8.2-9.6 m.

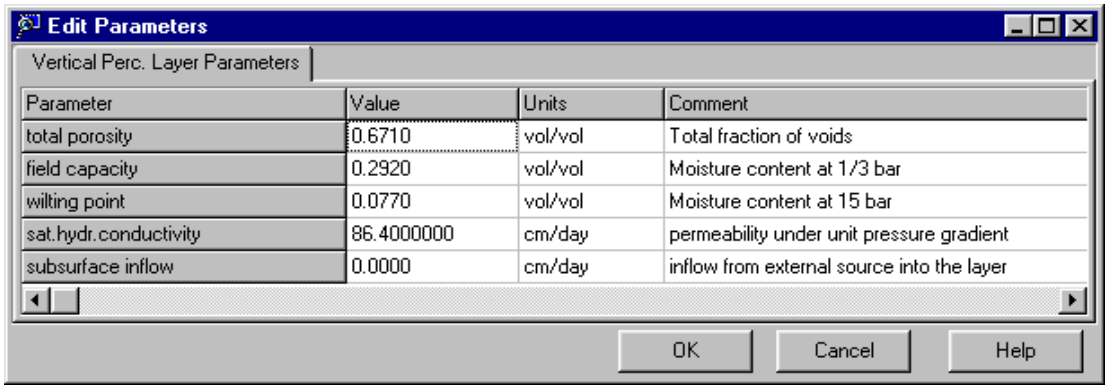
The profile construction can also be seen in the **Project Tree View** in the left part of the screen.

The Project Tree View is also used to view and modify the parameters of specific layers.

☞ **'+'** sign in the box to the left of the **Municipal Waste (312 kg/cub.m)** icon.

☞ ☞ **Vertical Percolation Layer Parameters**. The **Edit Parameters** dialog box will appear.

The **Edit Parameters** menu allows you to modify the values of the parameters associated with the selected layer.



☞ **[Cancel],** in the **Edit Parameter** dialog box to exit.

☞ **'-'** sign in the box to the left of the **Municipal Waste (312 kg/cub.m)** icon.

As you can see, the Project Tree View can be used to easily access specific Profiles, Profile Layers, and Layer Parameters.

Now that you have become familiar with some viewing functions of Visual HELP, you will learn how to edit the profile. In this part of the exercise you will:

- learn how to edit the layer structure of the landfill profile
- learn how to edit parameters of individual layers
- learn how to set initial moisture conditions and runoff parameters of the profile

Editing the Layer Structure of the Landfill Profile

To assist you in designing a landfill, Visual HELP offers many convenient tools for resizing, splitting, inserting and deleting layers. Visual HELP is a graphical user interface for the US EPA HELP model and, as such, obeys all conventions of the original HELP model.

The layers in the landfill are classified by the hydraulic function that they perform. Four categories of layers are available in original HELP:

- *vertical percolation layers,*
- *lateral drainage layers,*
- *barrier soil liners, and*
- *geomembrane liners.*

The topsoil and waste layers are generally vertical percolation layers. Sand layers above liners are typically lateral drainage layers; compacted clay layers are typically barrier soil liners. Geomembranes are classified as geomembrane liners. Composite liners are modeled as two layers. In the original HELP, geotextiles are not considered as layers unless they perform a unique hydraulic function. In Visual HELP, taking into account that this class of landfill material is growing extensively, geotextiles and geonets are defined as a separate category.

Although HELP allows a wide range of layer combinations, there are some basic rules and restrictions for the arrangement of layers in a profile that should be followed. These rules are obeyed by Visual HELP and you will get a warning if you try to delete or insert a layer incorrectly.

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Resizing Layers

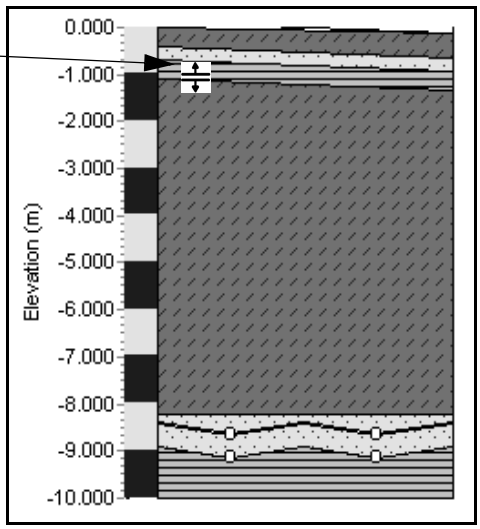
In Visual HELP, the layers are either resizable or non-resizable.

Resizable Layers *Layers built from soil and waste, grouped in the Vertical Percolation, Lateral Drainage, Barrier Soil design categories, are resizable.*

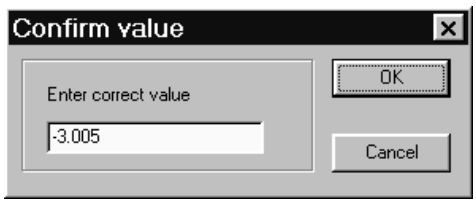
Non-Resizable Layers *Layers built from industrially produced materials with fixed thickness, grouped in the Geomembrane Liner and Geotextile and Geonet categories, are non-resizable.*

To test the resizing feature, move the mouse arrow on the **Municipal Waste (312 kg/cub.m)** layer in the profile view and move the arrow upwards to the top of the layer. As soon as the cursor encounters the layer's boundary, the cursor symbol changes:

New Cursor Symbol



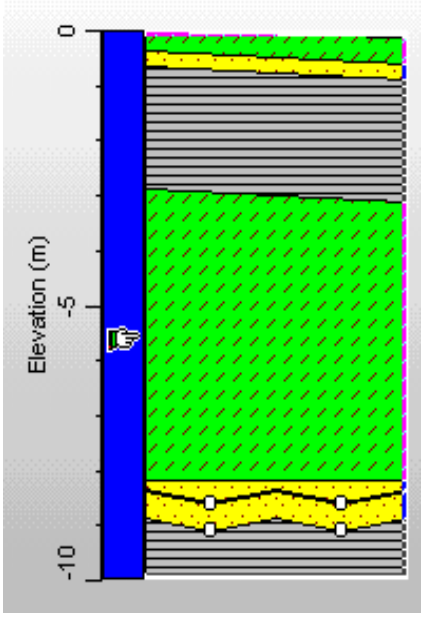
Press the left mouse button and, holding the mouse button, move the cursor downwards to approximately **-3.000** and release the mouse button. A **Confirm Value** dialog box will appear.



Type: -3.000 in the **Enter correct value** box.

☞ **[OK]**

The profile will change according to the new setting specified.



Note: Moving the layer's boundary resizes both layers which are separated by this boundary, however it does not change the total thickness of the profile. You can also change the thickness of an individual layer.

Now resize the municipal waste layer back to its original size.

Place the mouse arrow on the **municipal waste** layer in the profile view, and move the arrow up until the cursor symbol changes.

Click and drag the boundary to approximately -1.200.

Type: -1.2, in the **Enter correct value** text box.

☞ **[OK]**

Deleting a Layer

We will now examine how to delete a layer.

<Right click> the layer's name **Silty Clay**, in the Project Tree View.

.

Click the right mouse button. A shortcut menu will appear

☞ **Delete**

The layer **Silty Clay** will disappear from the Profile View. Notice an 'X' beside the **Silty Clay** layer to represent a deleted layer.

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Restoring a Layer

Now let us restore the **Silty Clay** layer.

<Right click> the layer's name **Silty Clay** in the Project Tree View.

☞ **Restore** and the original layer returns.

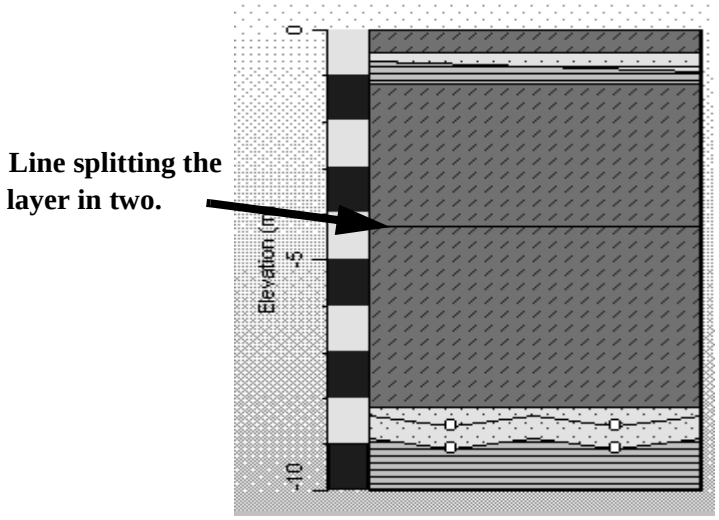
Splitting a Layer

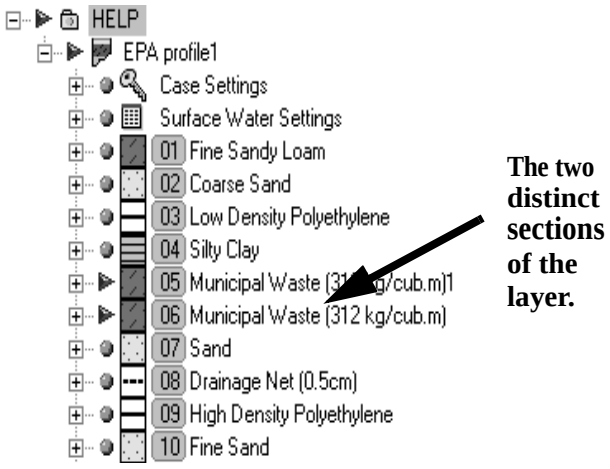
You can split a layer up into multiple sections and substitute materials for each section or assign different values of parameters for each section.

<right click> on the **Municipal Waste (312 kg/cub.m)** layer in the profile view.

☞ **Layer/Split**

A line will appear through the layer at the cursor position and a new layer will appear in the project tree. Now the layer can be edited as two separate layers with unique properties in the Profile View and the Project Tree View.



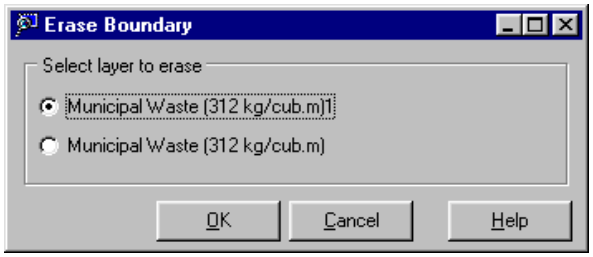


You may also substitute a material in the new layer or insert another layer between two separate parts of the layer. To return to the original profile construction, simply merge the two layers.

Place a cursor at the boundary between two parts of a layer and **<right click>**,

☞ **Merge Layers**.

In the **Erase Boundary** dialog box select the layer to erase: **Municipal Waste (312 kg/cub.m)1**



☞ **[OK]**.

Inserting a Layer

<right click> on **Sand**, in the Project Tree View

The following shortcut menu will appear

:

☞ **[Insert Layer]**

An empty **Profile Material Properties** dialog box will appear. You can now specify the new material to insert.

Note: The new layer will always be inserted above the current layer.

Note: To insert the new layer inside the existing layer, split the layer first with the split function.

Material Category Click a category from the **Material Category** list. The list will be limited to those categories that are specified by the HELP Model only.

☞ **[HELP] Barrier Soil Liner.**

Material Click the appropriate material from the **Material** list. Each layer category is associated with several textures that can be used in the design of the layer. The texture number in Visual HELP corresponds directly to the texture number in the original DOS HELP.

☞ **[Clay Loam**]

Once the material is selected, the top and bottom settings are activated.

Name **Type: Toronto Clay Loam,** as the unique name for the material.

Description **Type: Local material used as a barrier soil liner**, in the comments field.

Type: 0.5 in the **Thickness** box.

Once completed, your **Profile Material Properties** dialog box will appear as shown in the figure below:

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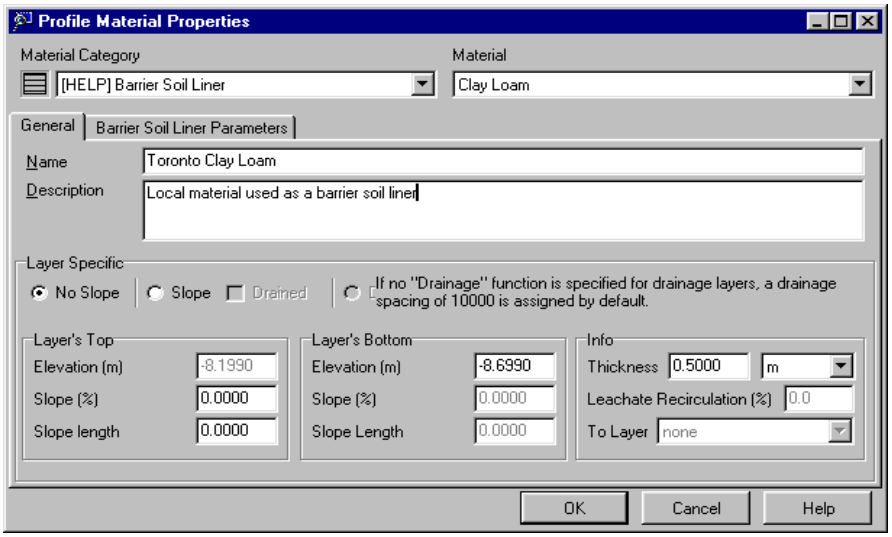
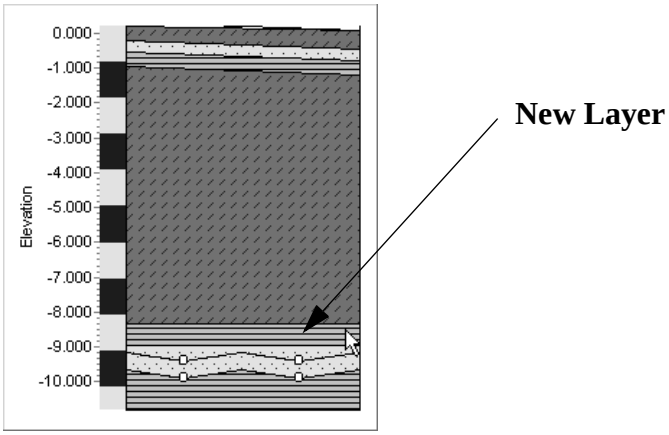


☞ **[OK]**

The new layer is now defined:



The **Toronto Clay Loam** has now become part of the profile and you can modify it like the rest of profile layers.

To return to the original profile construction, which will be used for the rest of this tutorial, delete the recently inserted layer.

<right click> on **Toronto Clay Loam,** in the Project Tree View.

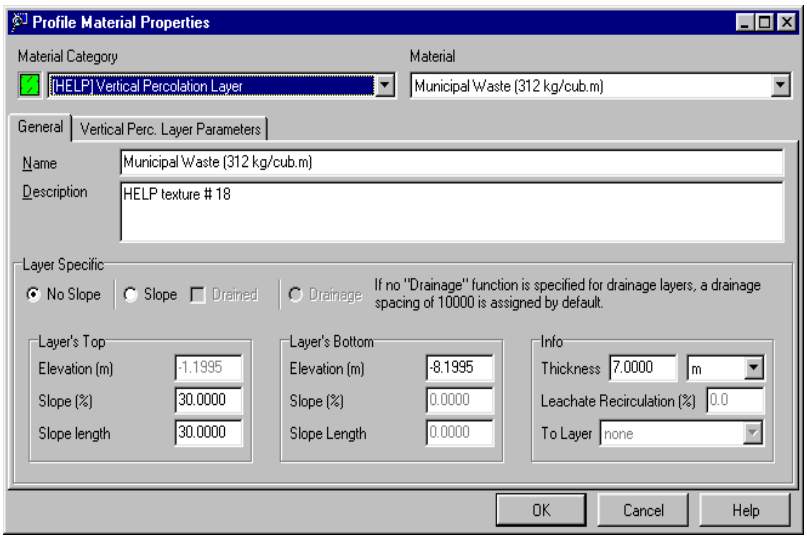
☞ **[Delete]**.

Editing Layer Parameters

The properties of a landfill material depend on the material category.

☞ ☞ the layer name **Municipal Waste (312 kg/cub.m),** in the Project Tree.

The **Profile Material Properties** dialog box will appear.



In this dialog box, you can view and edit information about the layer including;

category, material texture, slope, top or bottom elevation, and thickness.

☞ **Vertical Perc. layer Parameters** tab to edit the material properties of particular layer.

☞ **Value** beside **total porosity**

Type: 0.62

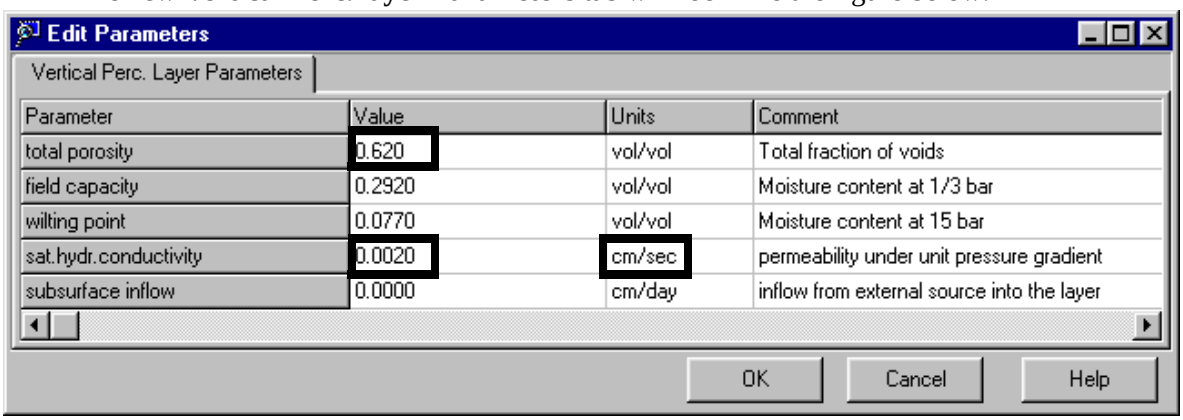
☞ **Units** beside the **sat. hydr. conductivity**, a drop-down arrow will appear.

☞ the drop-down arrow

☞ **cm/sec** from drop-down list of available units

Type: 0.002, in the **Value** field.

The new **Vertical Perc. layer Parameters** tab will look like the figure below:



☞ **[OK]**

☞ **[-] ,**beside **Municipal Waste (312 kg/cub.m)** in the Project Tree.

Now edit the properties of the Lateral Drainage layer. The layers from this category have the same hydraulic parameters as Vertical Percolation layers. In addition, the drainage and leachate recirculation parameters may be specified.

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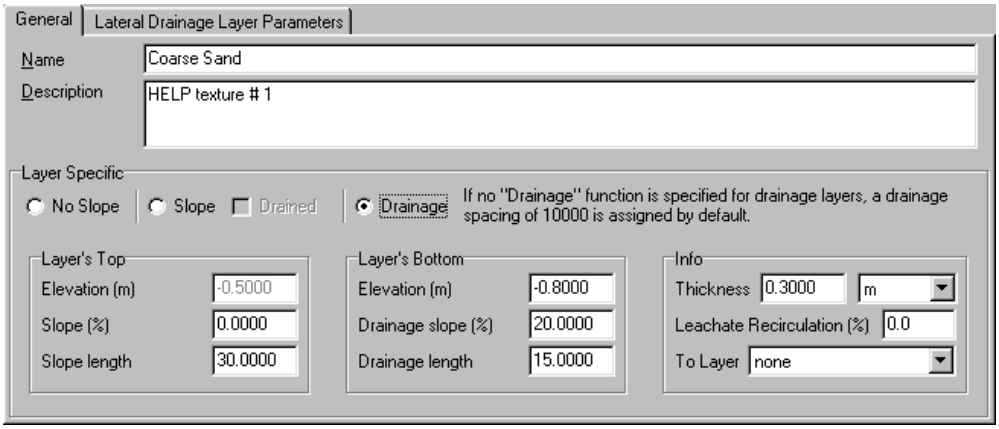
☞☞ **Coarse Sand** in the Project Tree. By default, the **Slope** function is selected for this layer.

Select **Drainage** by clicking the appropriate radial button to set the Drainage function.

Type: 20 (%)for **Drainage Slope**

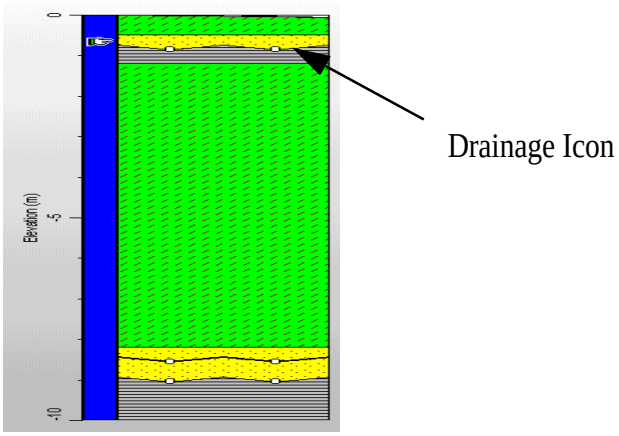
Type: 15 (m) for **Drainage Length**

Once you have made these changes, the properties for the **Coarse Sand** material should be similar to the figure below:



☞ **[OK]**

The Profile View will change to reflect the change of the **Coarse Sand** layer's status.



☞ **[-] ,**beside **Coarse Sand** in the Project Tree.

Finally, you will edit parameters of a Geomembrane Liner.

☞ **[+],** beside the **Low Density Polyethylene**

☞☞ **[Geomembrane Liner Parameters]**

☞ **Units,** beside the **sat. hydr. conductivity**

☞ the drop-down arrow

☞ **[cm/sec],** from the drop-down list.

Type: 7.00E-13, in the **Value** field.

☞ **[Units]**, beside the **pinhole density.**

☞ the drop-down arrow

☞ **[# / acre],** from the drop-down list.

Type: 10, in the **Value** field.

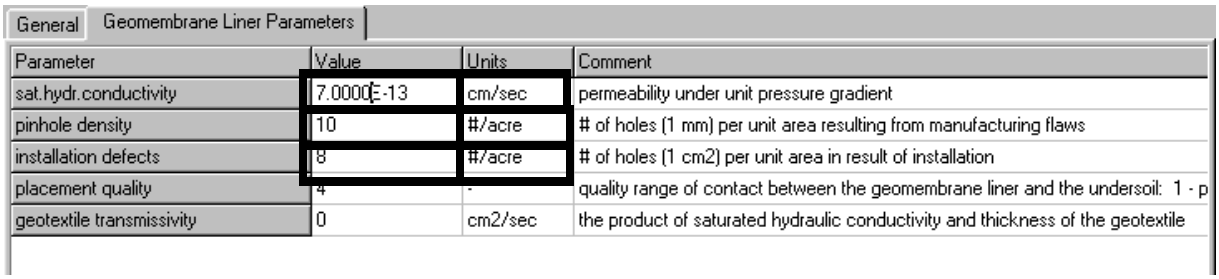
☞ **Units,** beside the **installation defects.**

☞ the drop-down arrow

☞ **[# / acre],** from the drop-down list.

Type: 8, in the **Value** field.

The **Vertical Perc. layer Parameters** tab for LDPE liner will look like the figure below.



☞ **[OK]**

☞ **[-],** beside **Low Density Polyethylene** in the Project Tree.

With this action completed, you have finished editing the parameters of individual layers of your profile.

These sample actions provide only a brief overview of the many profile design features provided by Visual HELP. Once you learn how to fully utilize all of the graphical data manipulation tools in Visual HELP, you will begin to truly appreciate the benefits of this powerful modeling tool.

Setting Initial Moisture Conditions & Runoff Parameters

Finally, you will define our landfills moisture conditions and runoff parameters. This can be completed through the **Case Settings** parameter group located in the Project Tree View.

As with the original HELP model, Visual HELP gives you two options for setting the initial moisture storage and surface water on top of the soil. You may use:

- *the model simulated values, or*
- *the user specied values.*

Depending on the selection made, runoff can be:

- *calculated by the model which will account for the type of material, slope, slope length and type of land cover,*
- *specified by the user,*
- *specified by the user and further adjusted to the slope and slope length.*

In the first case, which is the default, the model will assign realistic values for the initial moisture storage and simulate one year of landfill life. The values of moisture storage obtained from this simulation will be used as initial values.

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For this specific exercise, the runoff curve number and initial moisture content will be calculated by Visual HELP. These functions are selected by default. To view other available options,

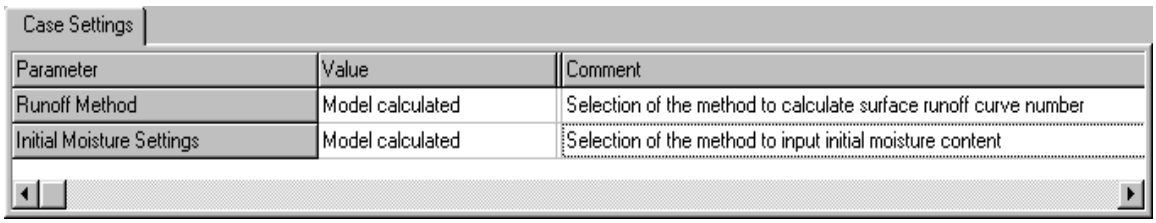
☞☞ **Case Settings** (found in the Project Tree)

☞ in the **Value** field beside **Runoff Method,**

☞ the drop-down arrow. Three options are available in the drop-down list: **User specified, User modified and Model calculated** (see the product Manual for explanation of these functions).

☞ **Model calculated.** The program will automatically pick up the slope and slope length values for the top layer and use them in the runoff calculation.

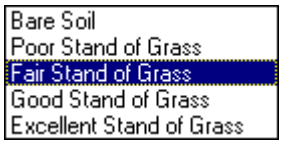
Leave the **Initial Moisture Settings** as **Model Calculated**



☞ **[OK]**

To specify additional parameters for surface runoff,

☞☞ **Surface Water Settings** from the Project Tree View.



To set the various vegetation classes, click in the **Value field**, found beside the **Vegetation Class.**

☞ the drop-down arrow. The drop down list of available types of the land cover will appear.

☞ **Fair Stand of Grass**

Note: Surface Slope and Slope Length which regulate the runoff, may be edited by selecting the top profile layer (in this demo - Fine Dandy Loam), and revising the values in the Layer's Top box found in the General tab in the Profile Materials Properties dialog box.

☞ **[OK]**

The next step is to generate your site specific weather using the USDA Weather Generating program that synthetically generates daily values for precipitation, temperature and solar radiation.

NOTE: Visual HELP is also an effective tool for generating aquifer recharge values that can be used in other models such as Visual MODFLOW. To calculate accurate recharge rates for your project, simply set your model profile to represent your site specific hydrogeological conditions and run!

Module III: Generating Weather Data, Running the Model, Viewing Output, and Reporting

We will now create site specific weather data that will be considered when modeling our landfill profile. As an added feature, Visual HELP also allows you to easily input historical daily data in NOAA and Canadian Climate Centre formats.

IMPORTANT: The HELP model requires three different types of meteorological data that must be provided as daily values:

- *Precipitation (rain or snow),*
- *Solar radiation, and*
- *Mean air temperature.*

In addition, HELP requires a set of parameters to simulate evapotranspiration that are constants for the duration of the simulation.

HELP will then use this data to:

- *Calculate the volume of water flowing into the landfill,*
- *Simulate surface runoff, evaporation, vegetation growth and transpiration, and infiltration during warm periods; and*
- *Simulate surface storage, snowmelt, runoff and infiltration during cold periods.*

Visual HELP includes a built-in Weather Generator for synthetic generation of daily values of precipitation, mean temperature, and solar radiation. The WHI International Weather Generator includes a global database with data from more than 3000 stations and a GIS feature for locating the nearest stations globally

To import weather data not found in the database, you must modify the format of your data so that it meets the standards of Visual HELP. If you are in Canada, you can automatically import data in the format of the Canadian Climate Centre. Customers in the U.S.A. may automatically import data in the NOAA format. Visual HELP checks NOAA files for missing daily and monthly records and informs the user about the times, for which data are missing to make the correction process easy.

☞ **Run** from the top toolbar

☞ **Weather Generator**

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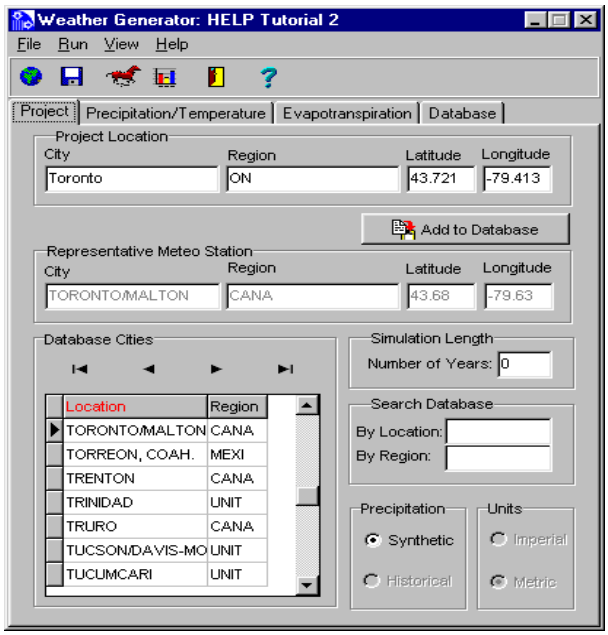
After an introductory splash screen, the Weather Generator dialog box will appear.



For this tutorial, you will be using data for the TORONTO/MALTON weather station. The TORONTO/MALTON station was selected among five stations located nearest to our landfill site.

Parameters for TORONTO/MALTON appear automatically in the text boxes throughout the **Weather Generator** dialog boxes after it starts (if you have time, click **Precipitation/ Temperature, Evapotranspiration and Database** tabs to see the options to customize the weather parameters).

Now you will generate weather data for your site for the next 20 years.

☞ **Number of Years** text box,

Type: 20, to represent the number of years you wish to build weather data for.

To run the Weather Generator,

☞  on the **Weather Generator** toolbar. The Weather Generator will begin computations.

☞  to save the generated files

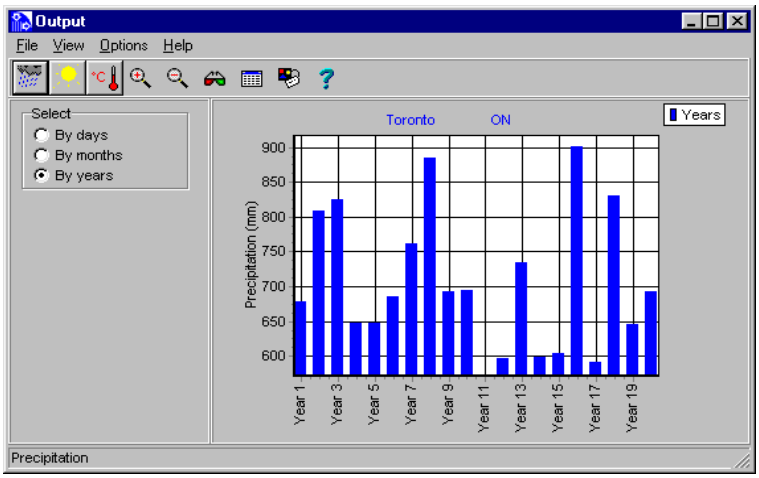
Viewing Weather Data

To view the results for the weather data you just generated,

☞  on the toolbar to view the **Output** dialog box.

☞  on the toolbar to view generated precipitation values

By default annual totals will be presented, as shown below.

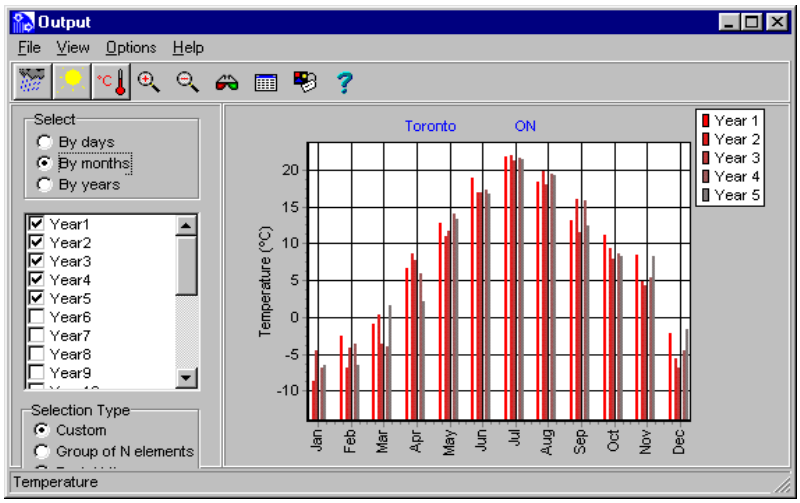


☞  to view the generated solar radiation data.

☞  to view the generated air temperature data.

☞ **By months** to view monthly outputs.

By default, monthly results for the first five years will be displayed:



☞  to view the generated raw data in table format.

☞  to close the table.

☞  to close the graphics.

☞  to exit the Weather Generator.

This completes the data preparation process. You are now ready to run Visual HELP for 20 years using the landfill profile you created.

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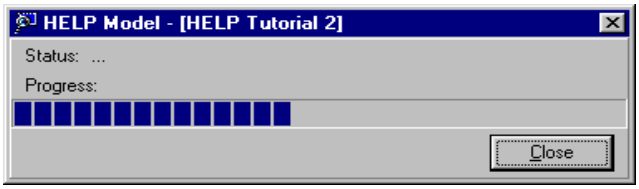
Running Visual HELP

☞  in the Ooperational Icons toolbar to run the HELP simulation.

The program will collect input files and run the HELP model. A progression bar will appear showing you the status of your model run.

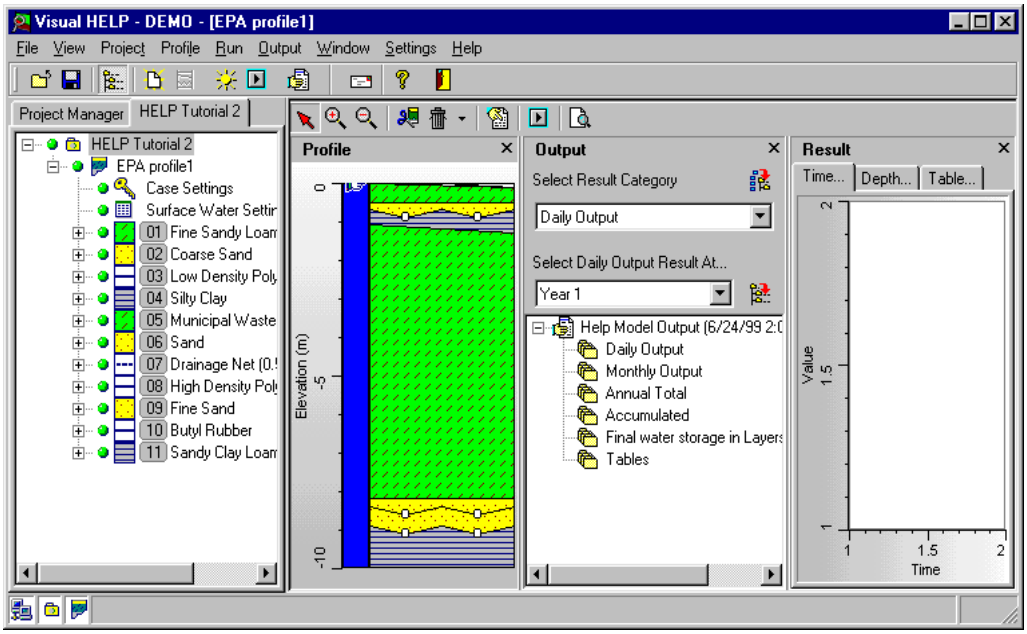


Viewing Results

Although you can easily view and print the original DOS HELP reports, we will only discuss graphical output using the Visual HELP interface.

Viewing the Output Graphs

After the model has successfully run, Visual HELP will display the Output View and Result View windows.



☞  from the Operational Icons bar, to close the Project Manager and enlarge the graphs viewing area

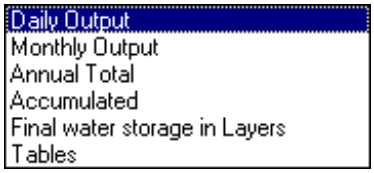
☞ **X** in the Profile View to close the window.

The **Output** View window contains two drop-down fields:

Select Result Category (used to select general result category)

Select Specified (Category Name) Result At.... (used to select specific result category)

To select the general output category, click the arrow in the **Select Result Category** drop-down listbox. The following list will appear:



For this exercise, we recommend viewing your results with an **Accumulated** category. This plot will show you the total volumes of water drained during the simulation period. This allows you to examine the total volume of leachate that percolated through the landfill bottom during the simulated time and assess the total volumes of other water balance constituents.

☞ **Accumulated**

The results for the the **Accumulated** category will appear in the listbox below. To view all available results, click the arrow in the drop-down listbox.

☞ **Select Accumulated Result at...** , to view the available balance types. ie) rate, volume

Rate means the annual rate of the balance constituent, and **volume** means the volume for the area represented by the profile.

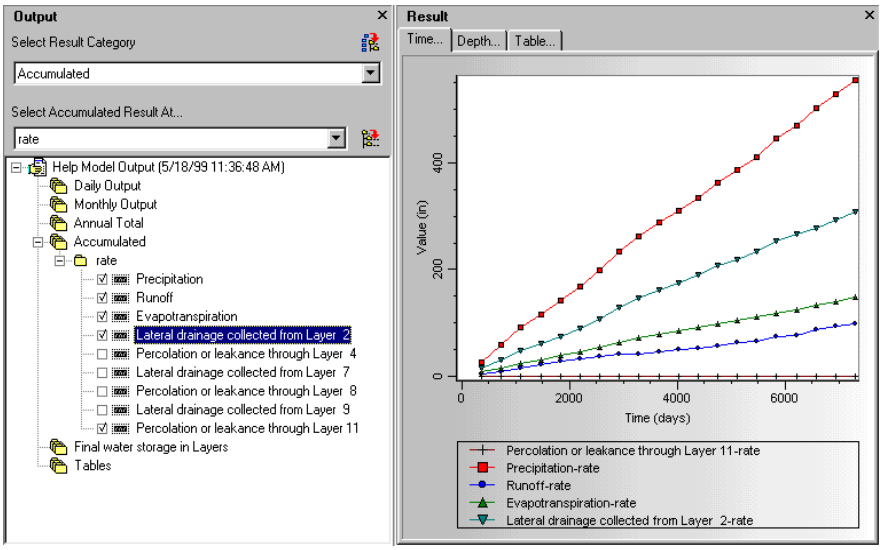
☞ **rate**

☞  To view all the availble results for this specific type of balance, click the icon to the right of the **Select Accumulated Result** at...

The list of available balance constituents will open in the Result Tree.

Click the check boxes beside the following variables: **Precipitation, Runoff, Evapotranspiration, Lateral Drainage collected from Layer 2** (the first drainage layer), **Percolation or leakance through Layer 11** (percolation through the bottom).

The graph of the variables will appear in the Result View window.



To erase a variable from the Result View window, deselect the corresponding check box in the Result Tree.

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From the graph, one may conclude that Runoff, Evapotranspiration, and Lateral Drainage collected from Layer 2 play an important role in the landfill balance while Percolation through Layer 11 (the landfill bottom) is equal or close to 0.

Viewing Tables

To view HELP tables,

☞ **Tables,** from the **Select Result Category** drop-down listbox.

☞ **Accumulated rate**, from the **Select Table Result at..** lower listbox.

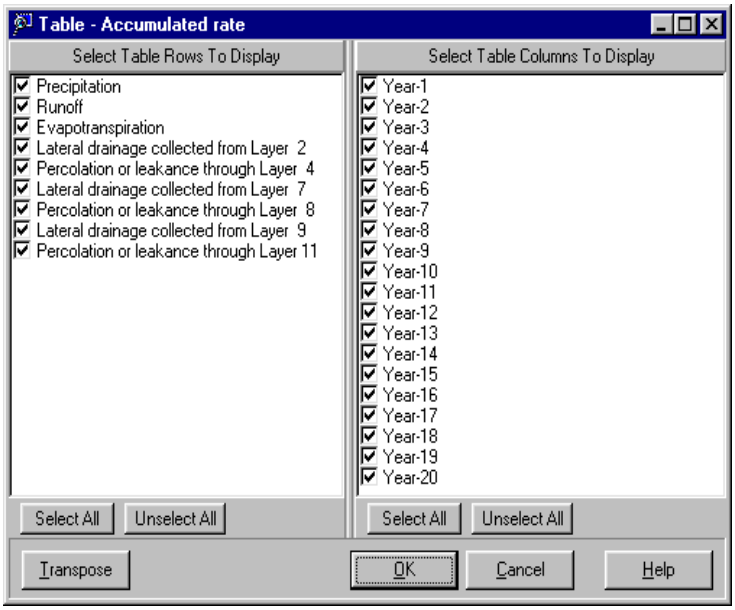
☞  **Add to Output Tree** icon to the right of the lower output listbox

The table name **Accumulated rate** will appear in the Output Tree. For future use, let's place the table results into a new Result Window.

To do this, **<right click>** the name, **Accumulated rate** in the Output Tree. The following menu will appear:

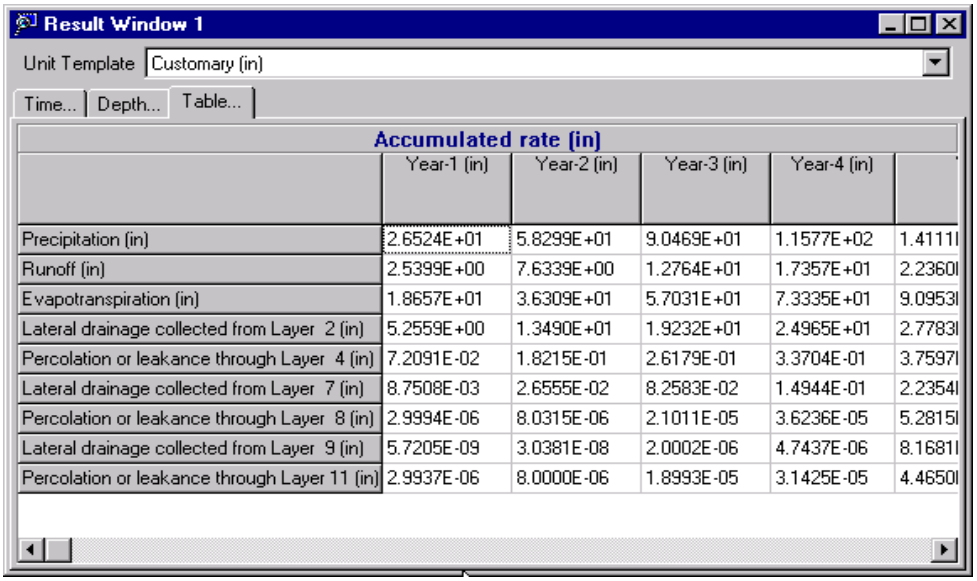
Choose **New Result Window**.

The New **Result Window 1** will open in the background and the table editing dialog box will appear.



☞ **[OK]**

The table will appear in **Result Window 1**:



	Year-1 (in)	Year-2 (in)	Year-3 (in)	Year-4 (in)	
Precipitation (in)	2.6524E+01	5.8299E+01	9.0469E+01	1.1577E+02	1.4111I
Runoff (in)	2.5399E+00	7.6339E+00	1.2764E+01	1.7357E+01	2.2360I
Evapotranspiration (in)	1.8657E+01	3.6309E+01	5.7031E+01	7.3335E+01	9.0953I
Lateral drainage collected from Layer 2 (in)	5.2559E+00	1.3490E+01	1.9232E+01	2.4965E+01	2.7783I
Percolation or leakance through Layer 4 (in)	7.2091E-02	1.8215E-01	2.6179E-01	3.3704E-01	3.7597I
Lateral drainage collected from Layer 7 (in)	8.7508E-03	2.6555E-02	8.2583E-02	1.4944E-01	2.2354I
Percolation or leakance through Layer 8 (in)	2.9994E-06	8.0315E-06	2.1011E-05	3.6236E-05	5.2815I
Lateral drainage collected from Layer 9 (in)	5.7205E-09	3.0381E-08	2.0002E-06	4.7437E-06	8.1681I
Percolation or leakance through Layer 11 (in)	2.9937E-06	8.0000E-06	1.8993E-05	3.1425E-05	4.4650I

Scroll to the end of the table to see the final values for accumulated volumes.

Precipitation	**553.98 in**
Runoff	**74.84 in**
Evapotranspiration	**359.14 in**
Lateral Drainage collected from Layer 2	**119.43 in**
Percolation or leakance through Layer 11	**0.00 in**

These values show that the default EPA landfill design (slightly modified by you during the exercise), provides good ground water protection for our project location. Having made such an optimistic conclusion, lets prepare the Visual HELP report.

☞  to close Result Window 1.

Creating a Report

As an added feature of Visual HELP, we have developed a time saving report generator that will help you prepare professional reports of the model simulation.

 To create a report and add the project input data, click the icon from the Operational Icons toolbar.

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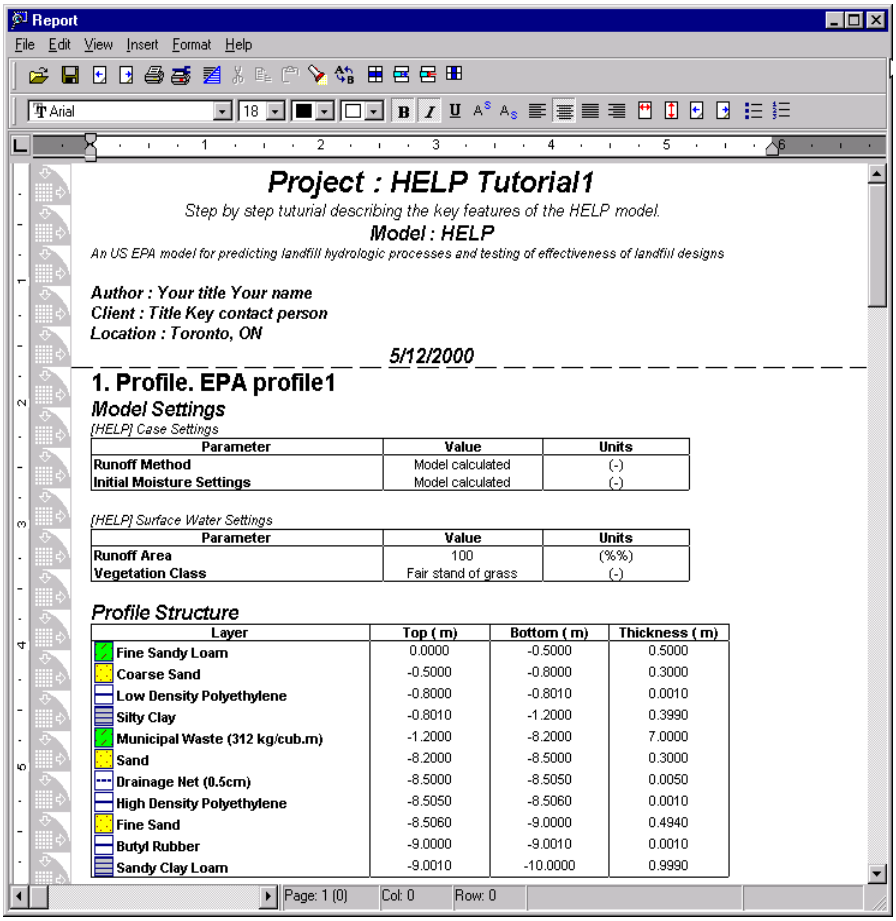
The Visual HELP Report Generator will display your report in a separate window:



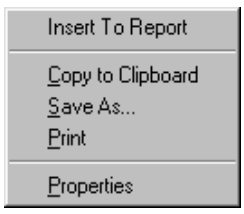
By default, the Report Generator lists all input data for your project. In the **Report** window you may edit the report, input your own text and add any type of graphics or table outputs produced by Visual HELP.

Note: The graphs and tables will be placed at the insertion point.

To add a graph from the Result View to the report:

In the **Report** window scroll the cursor to the end of the report

<right click> the graph in the Visual HELP Result View window. The following menu will appear:



☞ **Insert To Report**. The graph will be inserted into the report.

Go to the "Project" in the main menu and select **[view report]** to continue editing. To re-size the graph you just inserted, click the graph in the **Report** window and stretch it until it reaches the proper size.

To add a table from the **Result Window 1** to the report:

In the **Report** window place the cursor below the imported graph.

<right click> the table in the **Result Window 1**

3) ☞ **Insert To Report**. The table will appear in the report. Again, go to the "Project" in the main menu and select **[view report]** to continue editing or to view your report at any time.

The table may be larger than the Report window allows. In this case, the table will be automatically wrapped to improve the general appearance of the report. The report is fully customizeable and allows you to, insert headers /footers, change fonts/ letters size, etc..

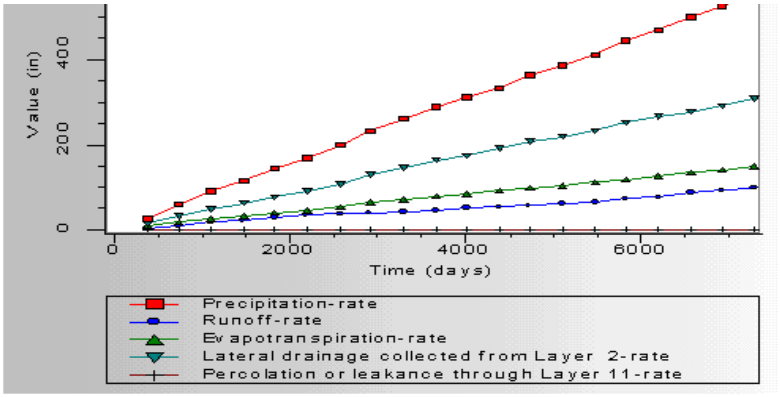


Fig.1 Accumulated balance constituents.

Table 1. Accumulated rate (in)

	Year-1 (in)	Year-2 (in)	Year-3 (in)	Year-4 (in)
Precipitation	2.6669E+01	5.8476E+01	9.0929E+01	1.1642E+02
Runoff	3.9219E+00	9.5287E+00	1.6193E+01	2.2387E+01
Evapotranspiration	8.2591E+00	1.5974E+01	2.4371E+01	3.1858E+01
Lateral drainage collected from Layer 2	1.4484E+01	3.1264E+01	4.8366E+01	6.2130E+01
Percolation or leakance through Layer 4	3.7569E-03	6.5516E-03	9.2846E-03	1.2289E-02
Lateral drainage collected from Layer 7	3.7532E-03	6.5417E-03	9.2717E-03	1.2271E-02
Percolation or leakance through Layer 8	3.7459E-06	8.9520E-06	1.2983E-05	1.7380E-05
Lateral drainage collected from Layer 9	3.5588E-06	8.4902E-06	1.2188E-05	1.6448E-05
Percolation or leakance through Layer 11	1.8707E-07	4.6209E-07	7.9524E-07	9.3185E-07

(continued)

	Year-5 (in)	Year-6 (in)	Year-7 (in)	Year-8 (in)

Once you are satisfied with your report, you may print the report and/or save it for future use. Let's take a look at additional output features available with Visual HELP.

Peak Daily Values

To assess the landfill hydrologic performance in extreme conditions, it is important to know when the peak hydrologic events occurred. The **Peak Daily Values** table picks up the dates of such events.

☞ **[Tables]** from the **Select Result Category** drop-down listbox.

☞ **[Peak daily values]** from the **Select Table Result at..**

☞ **Add to Output Tree** icon to the right of the lower output listbox.

The table name "**Peak daily values**" will appear in the Output Tree. Click the check box beside it.

☞ **[OK]** in the table editing dialog box.

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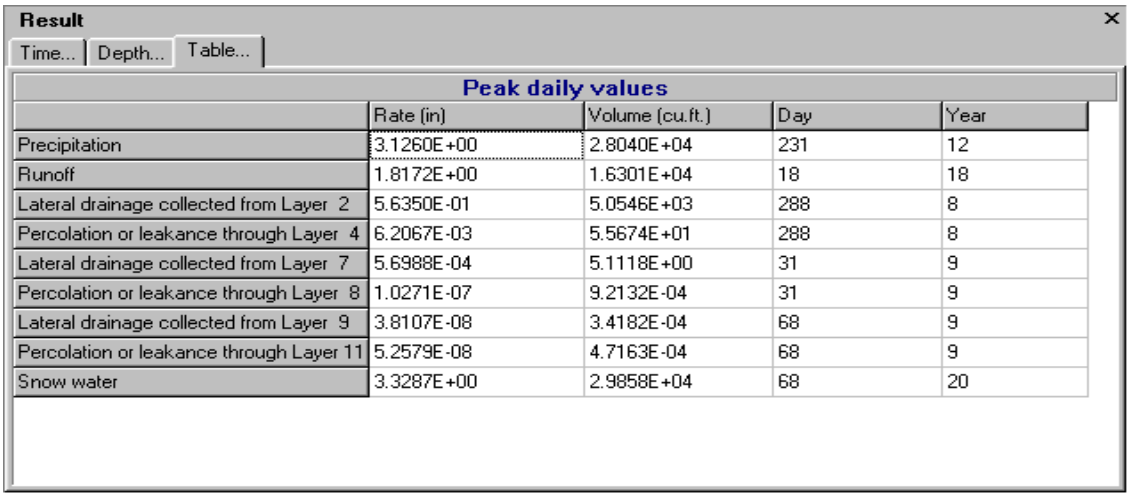
The following table will appear:



Peak daily values

	Rate (in)	Volume (cu.ft.)	Day	Year
Precipitation	3.1260E+00	2.8040E+04	231	12
Runoff	1.8172E+00	1.6301E+04	18	18
Lateral drainage collected from Layer 2	5.6350E-01	5.0546E+03	288	8
Percolation or leakance through Layer 4	6.2067E-03	5.5674E+01	288	8
Lateral drainage collected from Layer 7	5.6988E-04	5.1118E+00	31	9
Percolation or leakance through Layer 8	1.0271E-07	9.2132E-04	31	9
Lateral drainage collected from Layer 9	3.8107E-08	3.4182E-04	68	9
Percolation or leakance through Layer 11	5.2579E-08	4.7163E-04	68	9
Snow water	3.3287E+00	2.9858E+04	68	20

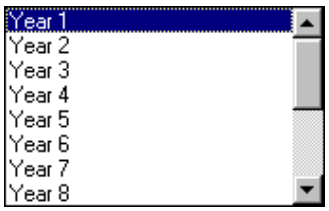
You may conclude that no leakage occurred through the bottom of the landfill (Peak daily percolation/leakage through layer 11). You may also find that the peak precipitation (3.12 in) happened on day 231 of year 12 and that peak runoff (1.81 in) happened on day 18 year 18.

To learn more about the circumstances of these events, Daily Output graphs may be studied.

Daily Output

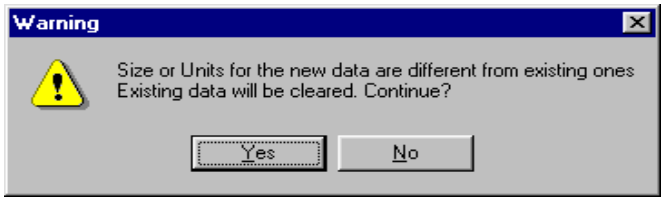
☞ **[Daily Output]** from the **Select Result Category** drop-down listbox.

Next select the year for which you would like to have the results to be displayed from the listbox.



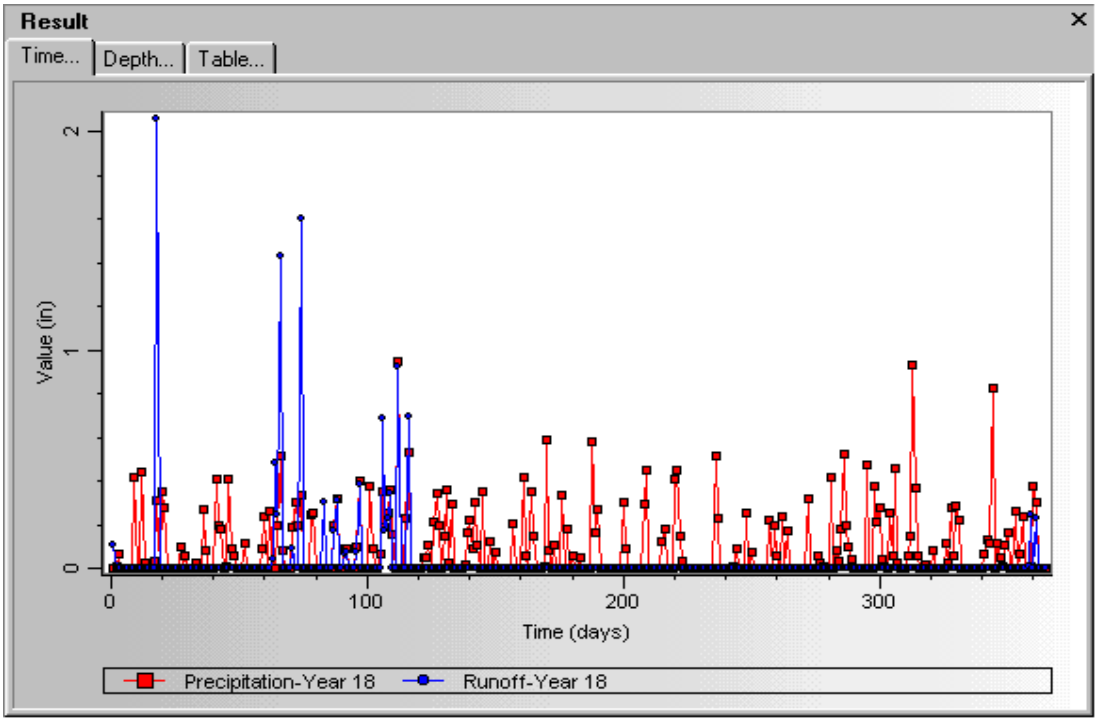
Scroll the list of years, and select the desired year: **18**. To view the available results for this specific type of balance, click the **Add to Output Tree** icon to the right of the lower output listbox.

The tree of available variables for year 18 will appear. Select **Precipitation** and **Runoff** by clicking the appropriate check boxes. This means that you are going to place these graphs to the Main Result Window. A warning will appear:



☞ **[Yes]**

The graph for the daily values of these variables will appear:



This graph shows that the maximum runoff event was not preceded by very intensive precipitation. However, after reviewing the weather data, it appears that day 18 was the first warm day with an average temperature of 5 degrees C (41 Fahrenheit) after a long span of frosty days. The peak runoff was caused by the intensive thaw of snow accumulated during the previous cold period.

Click to close the graph.

This concludes the Visual HELP demonstration exercise. Close Visual HELP by clicking in the top right corner.

We hope these instructions have provided you with a good understanding of the capabilities and tools Visual HELP offers. If you have time, we would encourage you to go back and re-examine some of the other powerful features and analysis capabilities which were not covered by this demo exercise. If you have any questions about the functionality, capabilities, or features of this software, please do not hesitate to contact us (519) 746-1798 or visit our webpage, www.flowpath.com.

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