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SOFTWARE • CONSULTING • TRAINING

**WHI E-News**  
Waterloo Hydrogeologic Inc.

## WHI E-News Topics

2003 March Edition

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Waterloo Hydrogeologic, Inc. (WHI) is a recognized leader in the development and application of environmental software and services.

**Visual MODFLOW  
Survey**

**Win a Dell  
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## Product News

**Recharge Estimates and Landfill Design Using Visual HELP**

Visual HELP is the most advanced hydrological modeling environment available for designing landfills, predicting leachate mounding and evaluating potential leachate seepage to the groundwater table.

Using the latest technologies in software engineering, Visual HELP introduces many new methods for:

- visualizing and managing your projects,
- generating input data,
- presenting modeling results, and
- sharing data between models.

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.

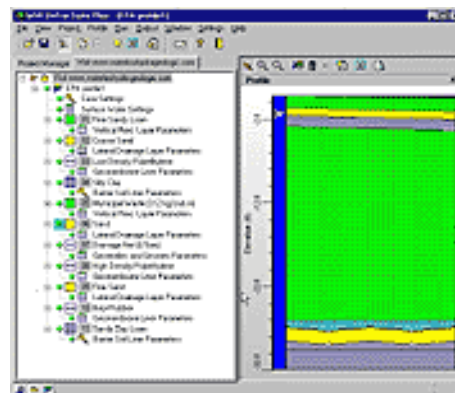
The result is a powerful and easy-to-use modeling tool that makes hydrologic landfill modeling more practical and accessible than ever before!

Use Visual HELP to:

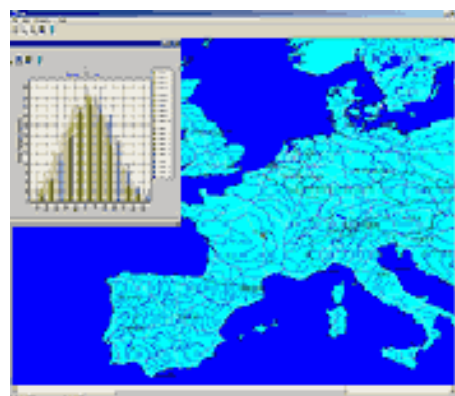
- Simulate multiple landfill profiles to find the most suitable design.
- Evaluate leachate mounding or leakage problems with current landfills.
- Determine the effectiveness of landfill caps for reducing leachate mounding.
- Design and optimize leachate collection systems.
- Estimate groundwater recharge rates.

Learn more about effective landfill design; register today for our "[Landfills and the Vadose Zone](#)" Course.

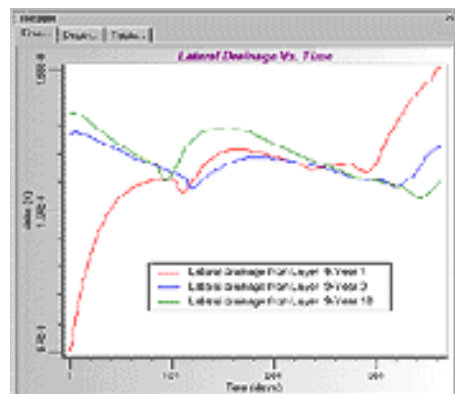
**Visual HELP on Sale now!** Regularly US\$795, Visual HELP is available for US\$695 until April 1, 2003. **Don't miss the savings - [order your copy online today!](#)**



Landfill Profile Design



International Weather Generator



Lateral Drainage vs. Time

For more information about Visual HELP, visit our website or contact us at:

Website: [www.waterloohydrogeologic.com/software/visual\\_help/visual\\_help\\_ov.htm](http://www.waterloohydrogeologic.com/software/visual_help/visual_help_ov.htm)

Email: [sales@waterloohydrogeologic.com](mailto:sales@waterloohydrogeologic.com)

Phone: (519) 746-1798 and ask for the special!

### WHI Expands into the United States!

We are pleased to announce that WHI is expanding its Consulting Services into the United States with a new office in Tampa, Florida! Dr. Robert Cleary, a senior WHI partner and respected groundwater professional, will oversee operations in the new office.

#### Why Florida?

Did you know that Florida has the fastest growing population in the United States? This growth is putting added demand on the water supply and making water protection and site investigation and remediation a necessity. In addition to the rapidly growing demand for clean drinking water, over-pumped wells, salt-water contamination issues, a network of man-made canals, and the desire to restore the Everglades are all complicating Florida's water conservation efforts. Florida's groundwater experts will require sophisticated modeling techniques to competently protect Florida's fragile ecosystem while supplying clean drinking water into the future - and WHI will be there to help.



**Career opportunities in Tampa:** Interested in joining the growing WHI team? Look for Tampa career opportunities on the WHI Website [Careers Section](#).

For more information about our new location, please contact:  
Daniel Gomes, M.Sc., International Division Manager / Associate Partner  
Email: [dgomes@waterloohydrogeologic.com](mailto:dgomes@waterloohydrogeologic.com)  
Phone: (519) 746-1798

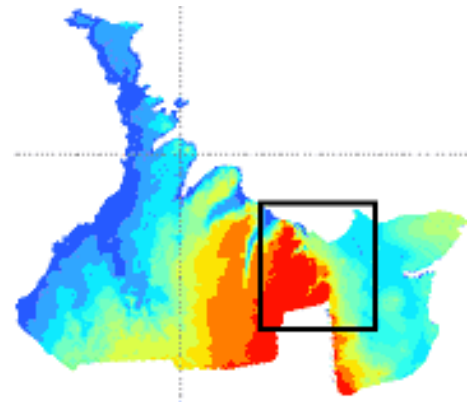
### Innovative GIS Solutions for Regional Groundwater Mapping

#### The Challenge:

During regional groundwater studies, developing an understanding of the geology and hydrogeology of a study area often requires merging information from a variety of different sources and scales, including combining overlapping maps. But, splicing adjoining groundwater maps together can create unrealistic discontinuities across the boundary of the two information sources.

#### The Solution:

To solve this problem, WHI Consultants apply a weighted average technique across the overlap boundary between the two grids to create a continuous integration between the two maps.



Example map with spliced section.

WHI recently applied this technique while merging information from two studies that share a common boundary near the Niagara Escarpment in southern Ontario. Integration of these GIS data to a single grid required joining bedrock elevation maps together (with an overlap of 10 km). The resulting technique was recently presented to regulatory agencies.

*"This is an example of how our consulting staff are applying GIS techniques to the regional assessment of groundwater resources," says William Banks, P.Eng., Senior Hydrogeologist, Waterloo Hydrogeologic, Inc.*

For more information about this technique or other capabilities of WHI's consulting team, visit our website or contact us at:

Website: [www.waterloohydrogeologic.com/consulting/](http://www.waterloohydrogeologic.com/consulting/)

Email: [consulting@waterloohydrogeologic.com](mailto:consulting@waterloohydrogeologic.com)

Phone: (519) 746-1798



## Training News

### **Critical Review of Groundwater Modeling Studies - A new course for Regulators**

The increasing use of numeric flow models in all types of groundwater studies make it necessary for government regulators to continually upgrade their knowledge and skills. Identifying 'gaps' in modeling applications, and understanding how to critically review modeling reports, are key to project success.

To help, WHI has developed a new course entitled "Regulatory Review of Hydrogeology Studies: Approaches and Insights for Reviewing Groundwater Modeling Reports."

Refined in consultation with several regulatory agencies in North America, the course covers:

- Fundamentals of reviewing modeling studies.
- Examining the effects of conceptual models on modeling results.
- Use of analytical and numerical flow and transport modeling codes.
- Principles of capture zone analysis.
- Understanding how boundary conditions influence results.
- Uncertainty analysis of capture zones and contaminant plumes.
- Expert witness testimony.




During the week of February 24, Waterloo Hydrogeologic conducted the five-day course for Ministry of Environment regulators on approaches for reviewing groundwater modeling reports. Reviews of the course were very positive. One participant remarked...

*"All aspects of the course were terrific. Good instructors, material preparation and hands-on exercises. Altogether a great learning experience."*

For more information about this course, please contact:  
Hugh McCreadie, M.Sc., P.Eng., Senior Hydrogeochemist  
Email: [training@waterloohydrogeologic.com](mailto:training@waterloohydrogeologic.com)  
Phone: (519) 746-1798

## Upcoming Training Courses

Upcoming Professional Courses	Dates/Locations
<p><b><u>Groundwater Modeling</u></b> </p> <ul style="list-style-type: none"><li>• Introduction to groundwater modeling.</li><li>• How to build and calibrate a numeric flow model.</li><li>• Principles of contaminant transport modeling.</li><li>• How to use MODFLOW, Zone Budget, MODPATH, MT3D, and WinPEST.</li></ul> <p><a href="#">Register Now</a></p>	<p><a href="#">Gent, Belgium</a> <a href="#">March 25-28</a></p> <p><a href="#">Orange, California</a> <a href="#">April 6-8</a></p> <p><a href="#">Calgary, Canada</a> <a href="#">April 29-May 1</a></p>

 [Click here for our full 2003 training schedule!](#)

 [Click here to request your free 2003 Training Course Schedule Catalog!](#)

For more information about our course offerings, visit our website or contact us at:  
Website: [www.waterloohydrogeologic.com/training/training.htm](http://www.waterloohydrogeologic.com/training/training.htm)  
Email: [training@waterloohydrogeologic.com](mailto:training@waterloohydrogeologic.com)  
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## Tips & Tricks

**Using MODFLOW-SURFACT to Accommodate Over-Pumping Conditions at Pumping Wells Screened Across Multiple Model Layers**

## The Challenge:

The standard USGS versions of MODFLOW-2000 allow you to assign an extraction (or injection) rate to individual grid cells in the model. (In this article, we refer to the grid cells assigned as well boundary conditions as 'well cells'.) But, if you use MODFLOW-2000 to screen a pumping well across several model layers, you must determine how the extraction rate is proportioned among the well cells from each layer.

To complicate things further...

- » If the pumping well is over-pumping from the aquifer and the water table drops below the bottom of the uppermost well cell, the 'dry' well cell is deactivated and the pumping rate from this cell is omitted from the calculation.
- » If the water table rises above the bottom of the well cell in the next iteration, the well cell is reactivated and the extraction rate from this cell is re-introduced to the model.

As you can imagine, this often results in oscillatory solutions where the well cell cycles between dry and wet as the extraction rate from this cell is repeatedly turned on and off.

In addition, if the model does converge to a solution, MODFLOW does not indicate that the total well pumping rate has been reduced, so the results may be misleading (i.e. the results appear to indicate the response of a well pumping at a rate of 500 m<sup>3</sup>/day, but one of the well cells is dry and the actual pumping rate is only 333 m<sup>3</sup>/day).

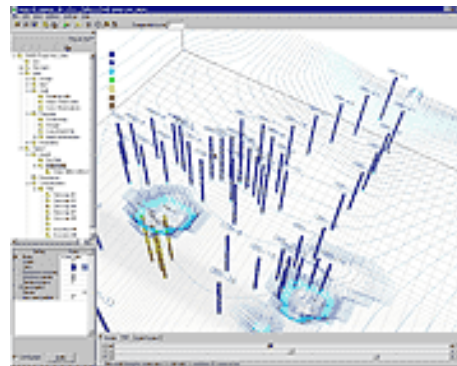
## The Solution - MODFLOW-SURFACT with the FWL4 Package:

MODFLOW-SURFACT with the FWL4 (Fractured Well 4) Package allows you to truly simulate a pumping well that is screened across multiple model layers. It connects the grid cells intersecting the well screen by representing the pumping well as a one-dimensional finite diameter fracture tube spanning the length of the well screen.

You specify an extraction rate for the pumping well and the water is effectively removed from the bottom of the well screen. The volumetric fluxes from each individual cell associated with the well are automatically calculated according to the length of the well screen in the cell and the transmissivity of the cell at each time step. This approach ensures the total extraction rate from the pumping well is always honored unless the water table drops below the bottom of the well screen (i.e. the entire well goes dry).

## An Example:

To the right, the same model was run first using MODFLOW-2000 (Figure A), and then run again using MODFLOW-SURFACT with the FWL4 Package (Figure B) and a well radius of 0.02 m.



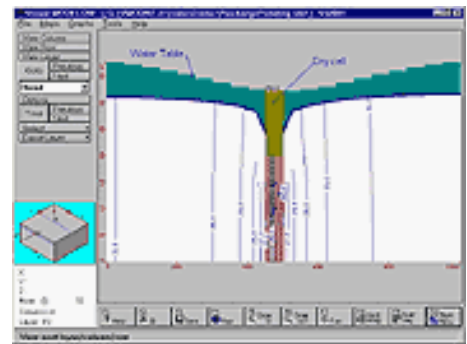
[MODFLOW-SURFACT](#) is a comprehensive three-dimensional finite-difference flow and contaminant transport model based on the USGS modular groundwater flow model, MODFLOW.

As one of its key benefits, MODFLOW-SURFACT provides automatic and correct redistribution of the total flow rate of a well screened through multiple model layers when the upper cell(s) are pumped dry.

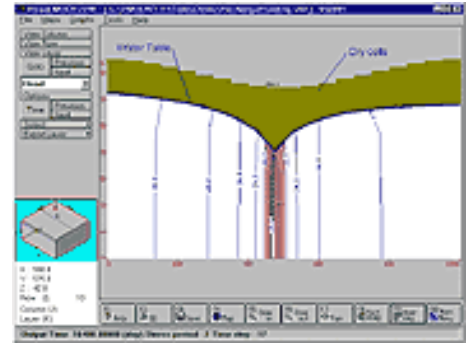
**MODFLOW-SURFACT is now available as a fully integrated add-on package to Visual MODFLOW Pro. Already a registered Visual MODFLOW Pro user? If so, MODFLOW-SURFACT is available to you at a discounted rate.**

In Figure A, the pumping well over-pumps the unconfined aquifer causing the water table to drop below the bottom elevation of the uppermost well cell. This deactivates the uppermost well cell and reduces the total extraction rate of the pumping well from 500 m<sup>3</sup>/day down to 333 m<sup>3</sup>/day.

In Figure B, the water table also drops below the bottom elevation of the uppermost well cell, but the extraction rate of the pumping well is maintained at 500 m<sup>3</sup>/day and produces a more realistic and accurate representation of the drawdown.



A. MODFLOW-2000, standard WEL Package



B. MODFLOW-SURFACT, FWL4 Package

For more information about these products, visit our website or contact us at:

Website: [www.waterloohydrogeologic.com/software/modflow\\_surfact/modflow\\_surfact\\_ov.htm](http://www.waterloohydrogeologic.com/software/modflow_surfact/modflow_surfact_ov.htm)

Email: [techsupport@waterloohydrogeologic.com](mailto:techsupport@waterloohydrogeologic.com)

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**Thank you for reading this month's edition of WHI E-News!**  
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