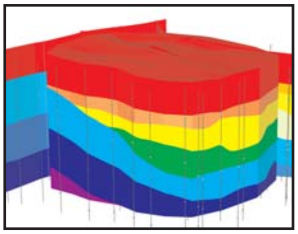
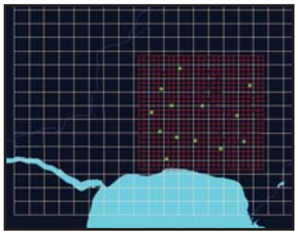
# Software Spotlight

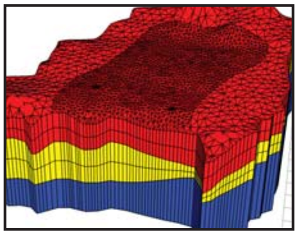
Schlumberger
WATER SERVICES



Define geologic model from boreholes and cross-sections



Local Grid Refinement



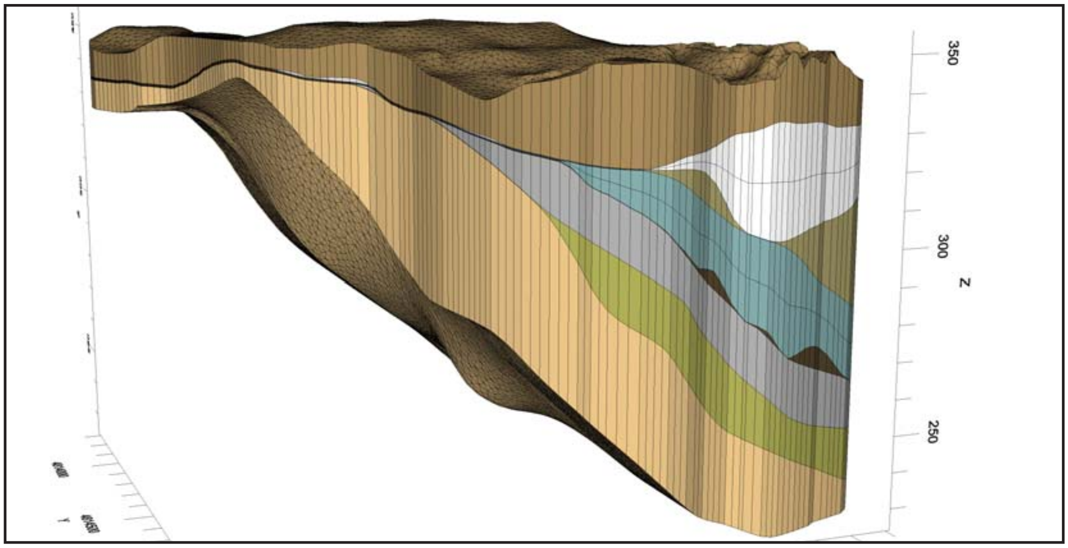
Finite Element Meshes with refinement around wells

**Hydro GeoBuilder Users Include:**

- Groundwater modelers
- Hydrogeologists
- Geologists
- Government agencies
- Environmental consultants
- Remediation engineers
- Mining experts

# Hydro GeoBuilder

## A flexible simulator-independent hydrogeologic modeling environment




Schlumberger Water Services (SWS) has released a new generation of hydrogeologic modeling technology. Hydro GeoBuilder* software represents a significant advancement in the process of building and evaluating groundwater flow models. It is compatible with multiple industry standard simulation packages, and provides an expanded workbench of 2D and 3D tools for conceptualizing the hydrogeologic environment, in addition to increased flexibility for assigning model properties independent of the finite difference grid or finite element mesh.

Hydrogeologists develop models to evaluate the flow of water; the transport of dissolved constituents; and/or heat transport processes in the subsurface. For example, hydrogeologic models are used to predict drawdown in underground water tables — based on estimated recharge and extraction rates — to evaluate whether water supplies will be sufficient to meet changing demand and help develop effective water management strategies. Other uses of modeling include predicting the transport of chemicals discharged into groundwater, perhaps as a result of accidental leakage.

The modeling process is comparable to that used in the oil and gas industry to predict and optimize hydrocarbon production from a well or reservoir. It begins with the development of a static model that describes the subsurface hydrogeology. Next, variables such as rates of extraction or injection at wells are combined with the static model to simulate the dynamic behavior of fluids in the subsurface and predict changes over time based on different scenarios.

The two most widely used simulation software packages for hydrogeologic modeling and simulation, considered as the "industry standards", are MODFLOW and FEFLOW™. MODFLOW is developed by the U.S. Geological Survey (USGS). SWS provides a commercial graphical user interface (GUI) to the software called Visual MODFLOW*. FEFLOW is developed by DHI-WASY GmbH. SWS also uses ECLIPSE-H2O, a proprietary derivative of ECLIPSE, the Schlumberger simulation software that is the most widely used package in the oil and gas industry.

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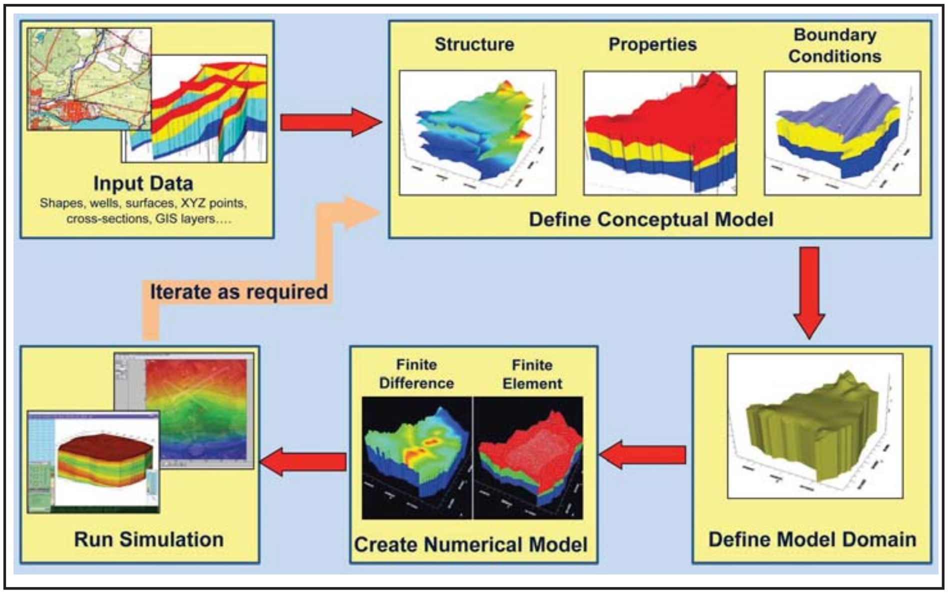
## Numerical Modeling

Traditional approaches to hydrogeologic simulation require the modeler to first decide on the simulator (e.g. MODFLOW or FEFLOW) and then set parameters for the size of the grid or mesh. Model properties and boundaries are then defined based on input data such as surface and borehole geology; soil and rock properties, and information about rivers, streams, and wells. The gridded model is then refined over a number of iterations.

The fact that the grid or mesh must be generated as the first step in the process is a fundamental disadvantage of the traditional approach to numerical modeling. If, during a project, it becomes necessary to change the grid or mesh, or the model dimensions, all the input data must be checked and reworked to ensure that they are in the appropriate location in the new model. Generally the input elements are not easily modified, so they are typically deleted and then reassigned — effectively restarting the process from the beginning. Similarly, if it becomes apparent that an alternative simulation approach would be more effective, the model must be completely redeveloped.




Hydro GeoBuilder Conceptual Modeling Workflow

## More Flexibility and Improved Accuracy When Developing the Hydrogeologic Model

With conceptual modeling, designing the grid or mesh is the last step. A conceptual model is a simplified, high-level representation of a site - such as a complex natural aquifer system - that can more easily be adjusted prior to dedicating effort in developing the numerical model.

Generating an accurate, reliable, and robust groundwater model requires large volumes of detailed information about geologic formations, groundwater flow directions, hydrologic boundaries (e.g. rivers, lakes) hydrogeologic parameters (e.g. conductivity, storage, porosity) extraction or injection from wells (location, depth, screens, rates), and observations of groundwater head and water quality. These data are generated from numerous sources in a variety of formats, such as spreadsheets, databases, GIS, CAD and gridded files.

In a conceptual model approach, all the input data are loaded from their various sources and formats into one environment. The resulting model can then be visualized and parameters, such as flow properties and boundary conditions, can be adjusted before a grid or mesh needs to be defined for a numerical model. This allows more flexibility in choosing grid orientation and discretization, plus the opportunity for multiple interpretations and multiple discretizations. It also provides the ability to change the simulator based on developing project needs. The conceptual model approach also supports definition of fine details such as pinchouts and lenses using shapes and surfaces, which automatically convert to the appropriate grid cells or finite elements in the resulting numerical models.

## More Technical Options with Simulator Independence

The current version of the Hydro GeoBuilder software is compatible with MODFLOW modeling code, Visual MODFLOW and FEFLOW. This multi-simulator capability is unique in the hydrogeologic market.

The fundamental principle behind Hydro GeoBuilder is its power to seamlessly shorten the gap between working with GIS and borehole data and building a high quality numerical model. By maximizing the amount of readily-available data and building the model independently from the grid or mesh, users can gain an in-depth understanding of their groundwater flow system at the beginning, while saving considerably more time calibrating the model at the end.

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