C Tech's Environmental Visualization System (EVS) and Mining Visualization System (MVS) software are available for personal computers running any version of Microsoft Windows. C Tech unites state-of-the art analysis and visualization tools into extremely powerful software systems developed to meet the needs of geologists, geochemists, environmental or mining engineers, oceanographers, archaeologists and modelers. C Tech provides true 3D volumetric modeling, analysis and visualization to help you unlock the mysteries and discover the trends in your data. The more advanced versions of our software allow these to be customized and combined to satisfy the analysis and visualization needs of any application. Our powerful tools reduce site assessment costs and enhance your company's capability to analyze and present data for assessments, financial and remediation planning, litigation support, regulatory reporting, and public relations.

What do our customers say?

CRA has used C Tech's EVS-PRO and MVS for several years on over 75 projects including:

- *High-resolution topographic relief and digital aerial photography*
- *Groundwater flow regimes and presenting 3-D modeling results*
- *Above-ground facilities including buildings and storage areas*
- *Below-ground facilities including underground storage tanks and sewers*
- *Three-dimensional geologic models including block and fence diagrams*
- *Groundwater plumes and changes in groundwater chemistry over time*

From our experience, three-dimensional visualizations are extremely effective for understanding and communicating complicated environmental systems for our clients. In many cases involving litigation, three-dimensional visualizations of subsurface contamination have been instrumental in reaching settlements with plaintiffs. Visualizations have also been a great asset in presentations to both agencies and the public.

Nicholas Fitzpatrick, M.A.Sc., P.Eng., P.E., Conestoga-Rovers & Associates - Consulting Engineers

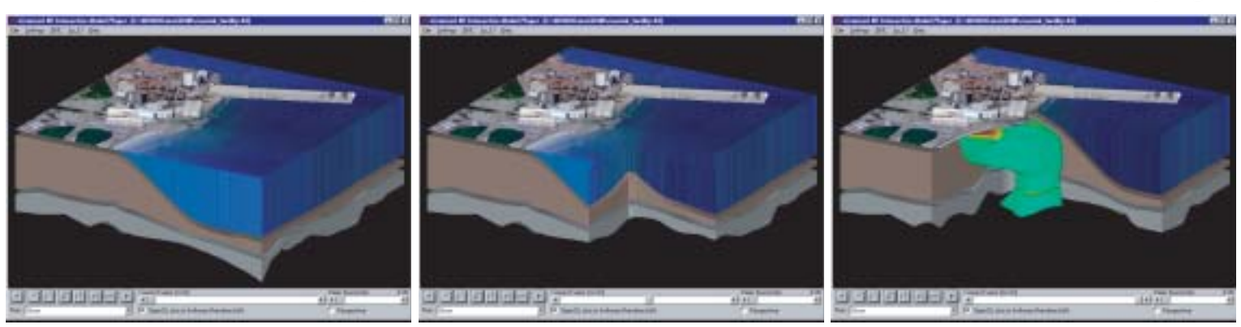
I am writing to say how much I appreciate the work you are doing with EVS-PRO. I have been a user for three years now and have yet to find another software product that is as powerful, yet so intuitive to use. I would also like to compliment you on your customer service and technical support. You are constantly incorporating user's comments into your product and providing timely upgrades. The level of detail in your help system is by far the most comprehensive I have used.

Keep up the great work. You guys are constantly making me look good. Thanks again.

Eric J. Phillips, Information Solutions Consultant, CH2M Hill

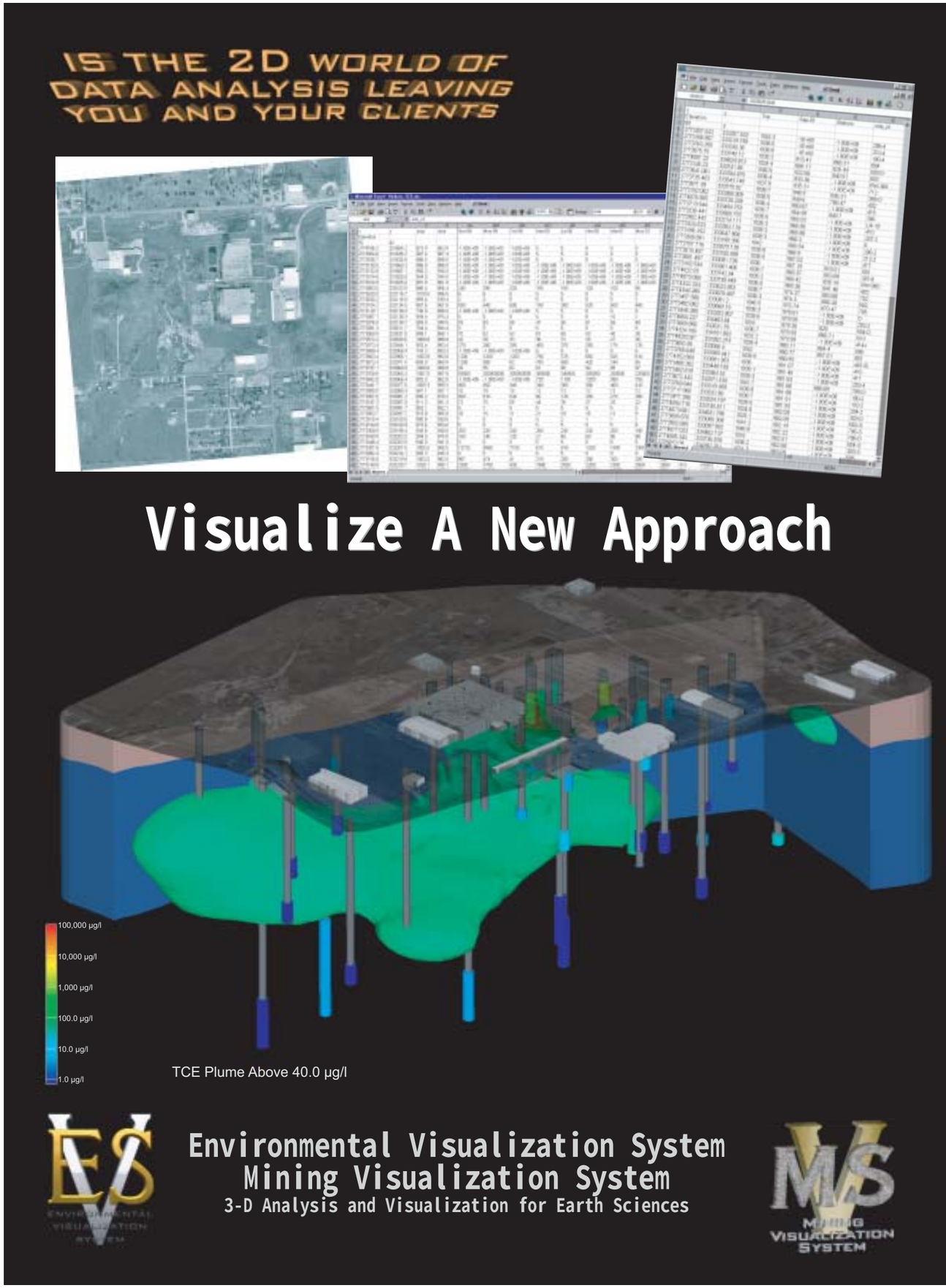
What's Next in 3D Visualization?
THE FOURTH DIMENSION
C Tech Introduces 4D Interactive Model Animations

Only C Tech offers 4DIM (Four-Dimensional Interactive Model) Animations where each frame of the animation can be zoomed, panned and rotated as a static 3D model or while the 4DIM is playing.



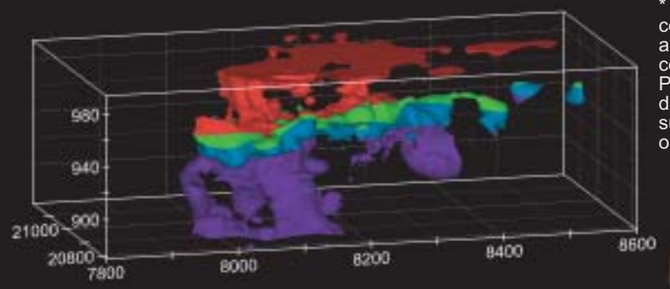
デモCDで、EVS・MVSをお試しください
日本国内販売代理店　有限会社太田ジオリサーチ
Tel 078-907-3120　Fax 078-907-3123
http://www.ohta-geo.co.jp/
e-mail office@ohta-geo.co.jp
〒651-1432　兵庫県西宮市すみれ台３丁目１番地

for a C Tech demo cd & Video contact
C Tech Development Corporation
Phone: 1-800-NOW-4EVS
(800) 669-4387 or (714) 840-7444
fax: (714) 844-9255 e-mail: evs@ctech.com
www.ctech.com for downloads, pricing & more

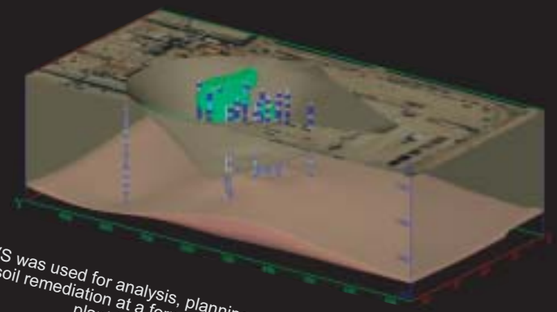


MVS - Mining Visualization System

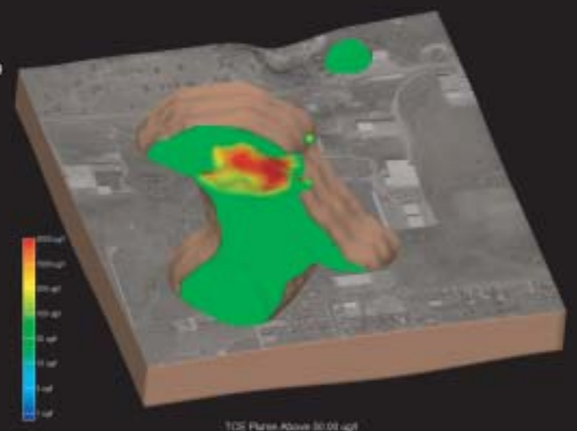
Mining Visualization System (MVS) is C Tech's flagship product for state-of-the art analysis and visualization. As its name suggests, MVS was designed from the ground up to meet the demanding requirements of underground and surface mining analysis; however, its tools are also used by civil engineers and advanced environmental modelers. MVS builds upon all of the capabilities of EVS-PRO and adds powerful new features targeted to the needs of mining engineers, mine planners, civil engineers, or geologists and environmental engineers with the most demanding requirements. Some of MVS's unique features include: 3D Fault block generation; Ore Body and Plume Overburden Modeling; Tunnel Cutting; Mine Pit Modeling; and many additional advanced features.



* MVS's geostatistics modules were used to estimate gold concentrations using all available assay data. All regions with an Au grade above 30 ppb are displayed, with the ore body colored according to stratigraphy. This visualization of the Twin Peaks region shows the axis of the mineralized vein, the depletion front at the base of the highly oxidized zone, and the surface anomaly extending from the surface expression of the original Au vein.



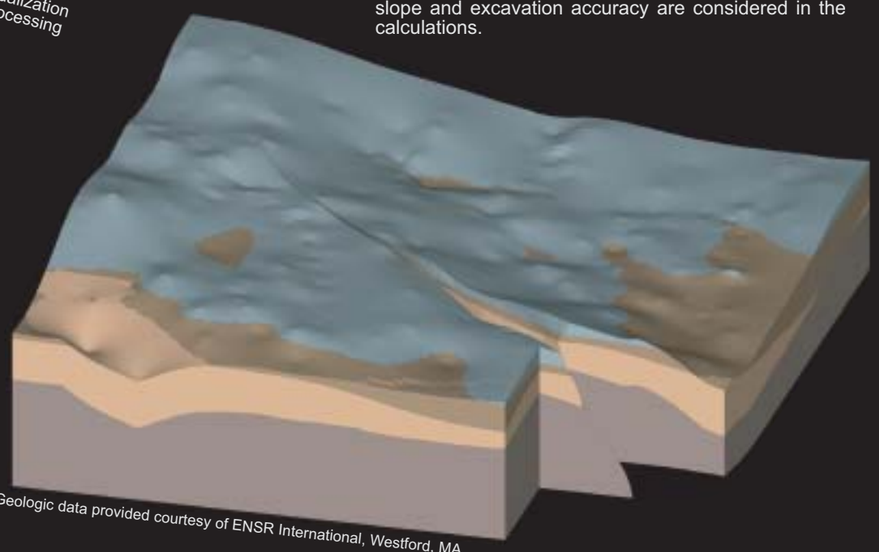
MVS was used for analysis, planning and visualization of soil remediation at a former natural gas processing plant in Central California.



One of MVS's important capabilities is computation of ore body or contaminant plume overburden. With it, you can quickly determine the "pit" required to extract the plume. Geophysical parameters such as pit wall slope and excavation accuracy are considered in the calculations.

MVS is the Ultimate 3D Earth Science & Civil Engineering Analysis and Modeling System.

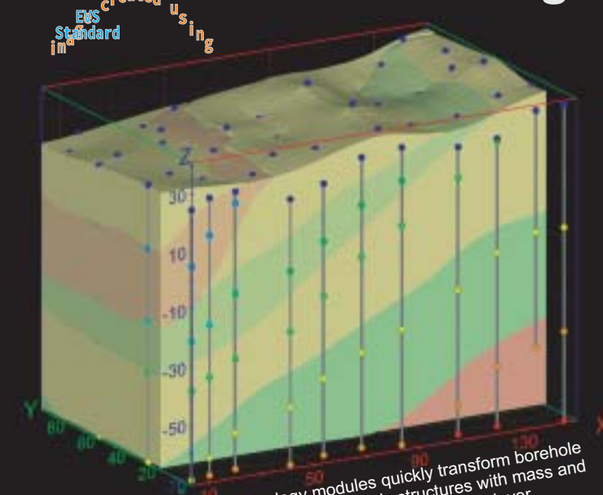
MVS provides the ability to model the most difficult physiographic relations. Complex 3D models of faults, horsts, grabens, folds, salt domes and many other complex geologic structures are easily created using MVS.



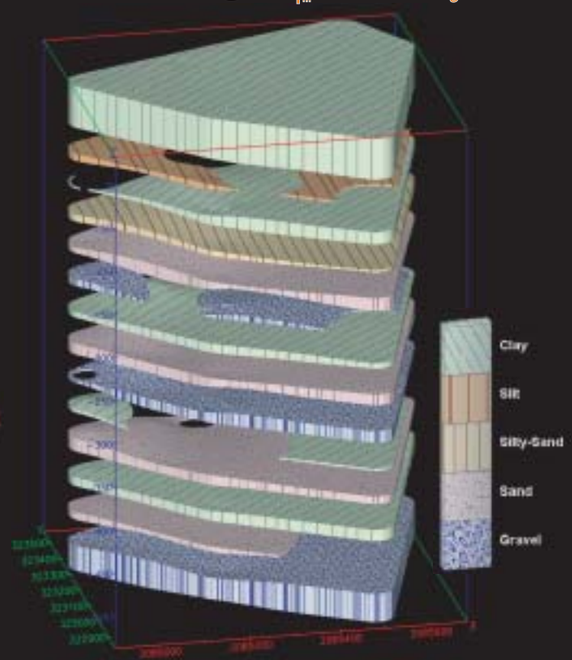
Geologic data provided courtesy of ENSR International, Westford, MA

* Work performed under The Cooperative Research Centre for Landscape Evolution and Mineral Exploration's Project 504 "Supergene mobilization of gold and other elements in the Yilgarn Craton". Dr David J. Gray of CSIRO Exploration & Mining in Perth, Western Australia used MVS as the primary tool to perform 3D modeling of stratigraphy and geochemistry in their research to enhance understanding of supergene processes. Some of the critical studies are the shape of the supergene halo, mass balance for Au and other elements during weathering, and relationships with regolith stratigraphy, geology, and water table. Additional information is available at http://www.ctech.com/testimonials/crc_leme_mvs.pdf.

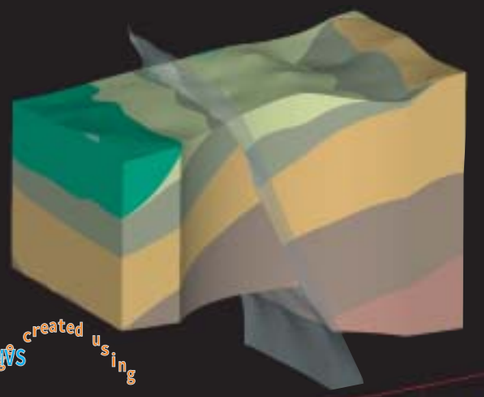
Geologic Modeling

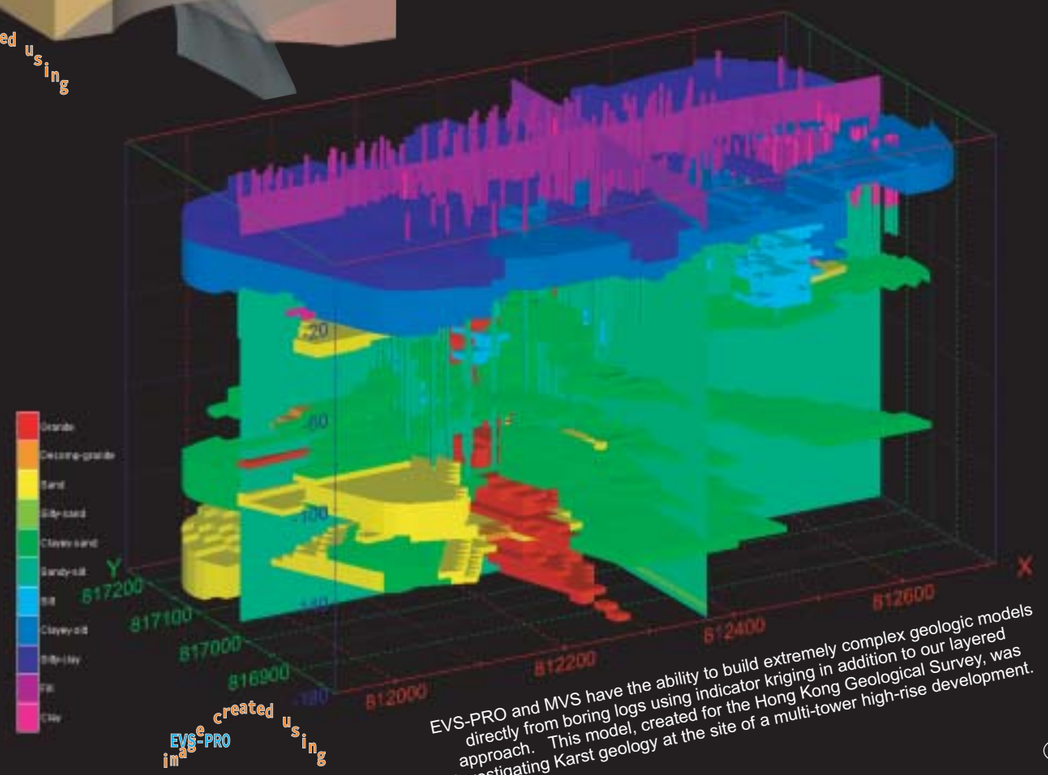


EVS's Geology modules quickly transform borehole observations into geologic structures with mass and volume calculation by geologic layer



Create complex models that accurately represent subsurface lithology

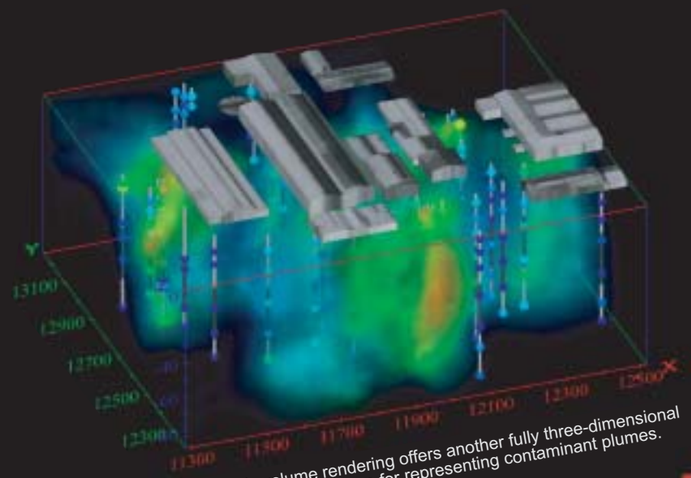




EVS-PRO and MVS have the ability to build extremely complex geologic models directly from boring logs using indicator kriging in addition to our layered approach. This model, created for the Hong Kong Geological Survey, was investigating Karst geology at the site of a multi-tower high-rise development.

EVS-PRO

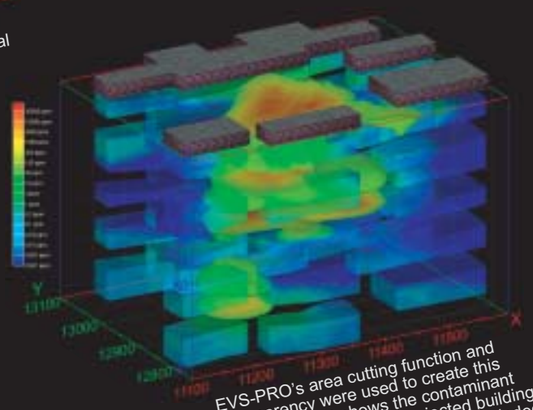
EVS-PRO is C Tech's most popular product for state-of-the art analysis, visualization and animation. EVS-PRO builds upon all of the capabilities of EVS & MAS and adds advanced gridding, model building, output options, geostatistics capabilities, animation and GIS functions to accommodate litigation support, public relations and the more demanding requirements of earth science professionals. Additional features include high level animation support, terrain fly-over, advanced geologic modeling, interactive fence-diagrams, 4DIM & VRML II output, database connectivity, and much more.



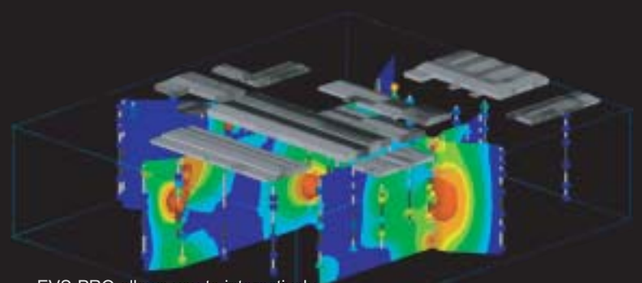
EVS-Pro's volume rendering offers another fully three-dimensional visualization technique for representing contaminant plumes.

EVS-PRO Combines:

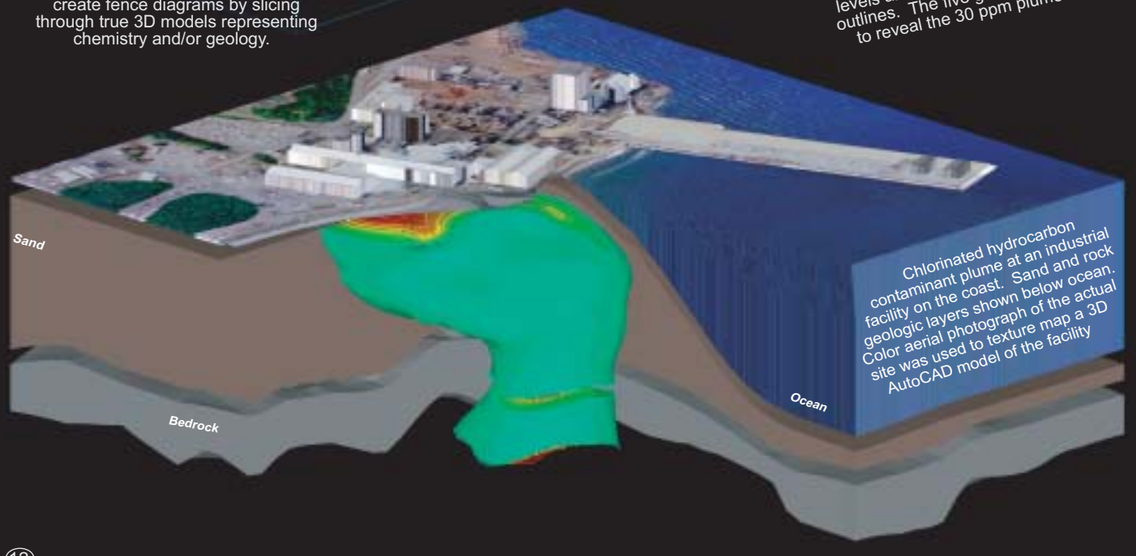
- Site wells, borings & measured data
- Site geologic observations
- Site buildings (3D or outlines)
- Site roads, topography, etc.
- Aerial photographs
- Soil contamination
- Ground water contamination
- Ground water flow
- Lakes, rivers, & ocean data



EVS-PRO's area cutting function and transparency were used to create this visualization that shows the contaminant levels along the downward projected building outlines. The five geologic units are exploded to reveal the 30 ppm plume in each layer.



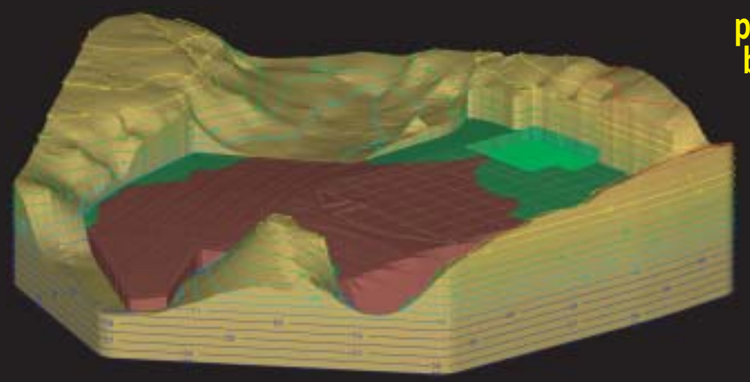
EVS-PRO allows you to interactively create fence diagrams by slicing through true 3D models representing chemistry and/or geology.



Chlorinated hydrocarbon contaminant plume at an industrial facility on the coast. Sand and rock geologic layers shown below ocean. Color aerial photograph of the actual site was used to texture map a 3D AutoCAD model of the facility

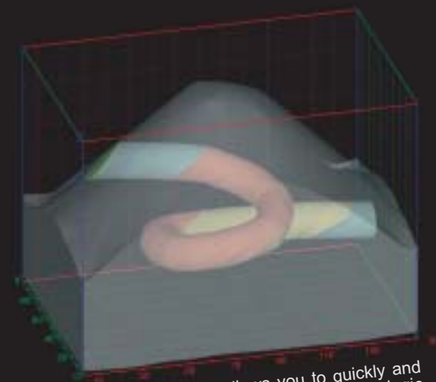
Civil Engineering

For your geotechnical work EVS-PRO and MVS provide capabilities far beyond any CAD program!



MVS was used to determine a cost-optimized excavation design for a shopping center in Poland. Quantification of cut volumes by geologic material and determination of total fill requirements make it possible to obtain no-surprise fixed-

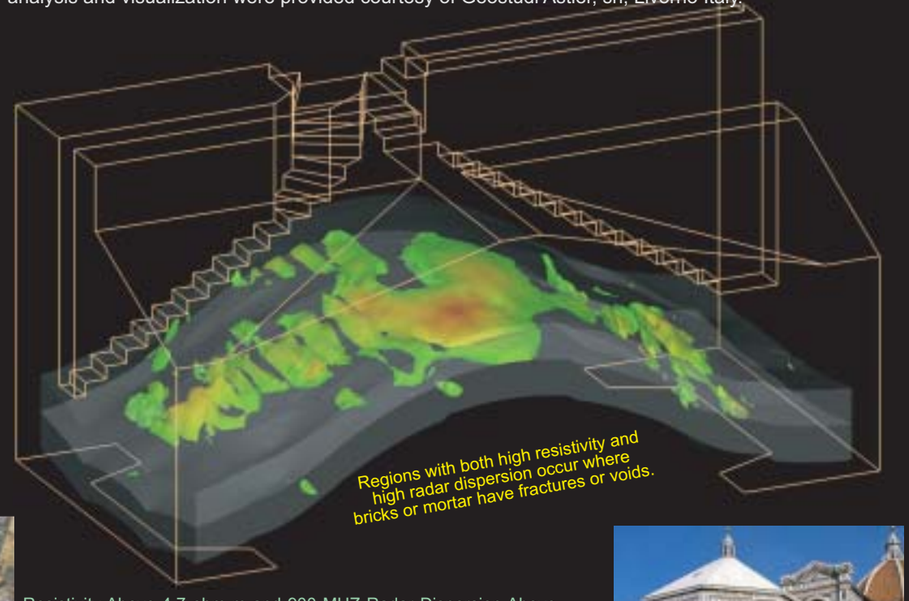
This analysis and visualization were provided courtesy of Kuhn Geoconsulting GmbH, Bonn, Germany.



MVS's Tunnel Cutting allows you to quickly and easily model tunnels through complex geologic models including this spiral tunnel displaying the stratigraphy encountered along the tunnel's path.

Building Restoration

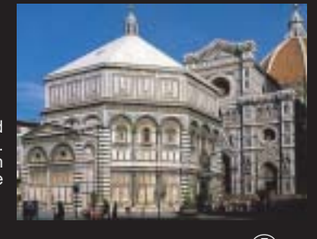
EVS-PRO was used to analyze and visualize multi-sensor data to guide the restoration efforts of the fourth century Baptistery, one of the oldest churches in Florence, Italy. Dual-frequency ground penetrating radar data was processed in EVS to determine radar dispersion. The radar dispersion was combined with resistivity surveys to volumetrically map structural integrity. The analysis and visualization was used to locate fractures and voids in the domed roof structure. This work helped minimize the need for destructive testing, to better preserve the precious original mosaic tile. The analysis and visualization were provided courtesy of Geostudi Astier, srl, Livorno Italy.



Regions with both high resistivity and high radar dispersion occur where bricks or mortar have fractures or voids.

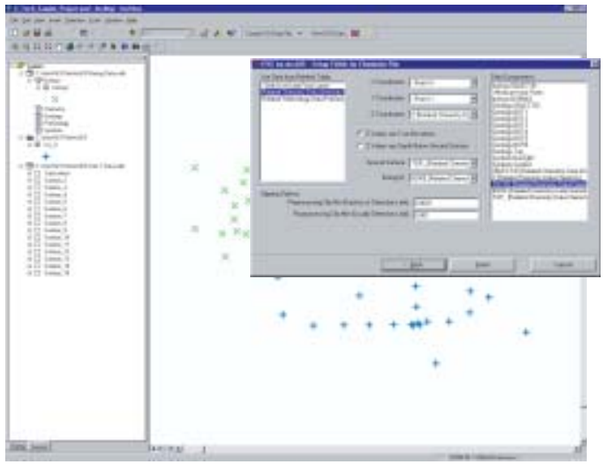
Resistivity Above 4.7 ohm-m and 900 MHZ Radar Dispersion Above

The portion of the Baptistery that was investigated is the protruding gabled roof. It is clearly visible in the lower left corner of the picture to the right. The gold leaf and mosaic tile ceiling that we are striving to protect is shown to the left. The octagonal Baptistery is also shown in the lower center of the picture to the upper left. Il Duomo, Florence's landmark church, dwarfs it.



EVS for ArcView & ArcGIS

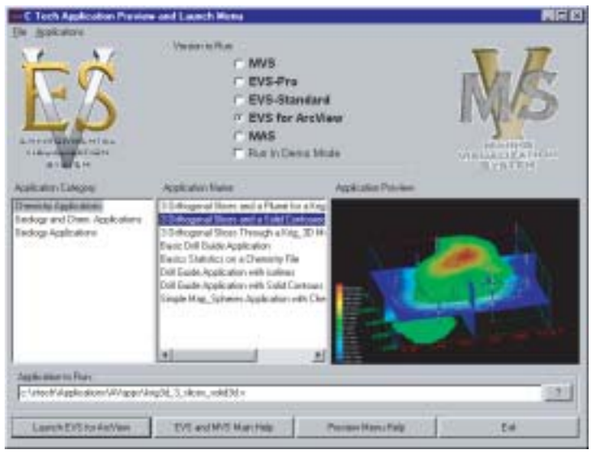
EVS for ArcView is C Tech's easiest to use true 3D analysis and visualization system designed to seamlessly integrate with ESRI's ArcView® GIS or to operate in a stand-alone mode. Features include: borehole and sample posting; mapping isovolumes and isolines; parameter estimation using expert system driven 2D and 3D kriging algorithms with best fit variograms; ability to visualize and explode geologic layers colored by thickness, material, or contamination and much more. Integrated volumetrics and mass calculation for soil and groundwater contamination and ore bodies.



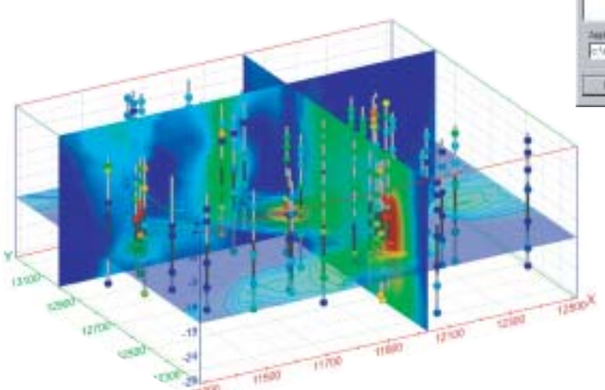
Discover true 3D analysis and visualization seamlessly integrated with ArcView & ArcGIS! Geologic modeling, geostatistics, volumetrics, and mass calculations all in one package...EVS for ArcView. Only C Tech provides this level of true 3D volumetric modeling, presentation graphics and GIS integration.

Launch all C Tech Software from our FREE ArcView® & ArcGIS® Extensions! C Tech's extensions allow you to query your data in shapefiles and/or tables and build chemistry and geology files in EVS format. Once your files are created or existing data is read, the extension can launch one of many applications for analysis and visualization of your chemistry and/or geology data.

Choose your application from our graphical Preview and Launch Menu and see your data as a true 3D volumetric model in seconds.



The application is just one of many included with EVS for ArcView. Interactively move the slice planes with your mouse throughout the 3D volume computed using our expert system driven Kriging. Query the measured data used in the Kriging, shown here as spheres sized and colored according to contaminant concentration.



EVS for ArcView is a subset of the other EVS versions. With EVS-Standard or EVS-PRO the ArcView / ArcGIS extensions are even more powerful.

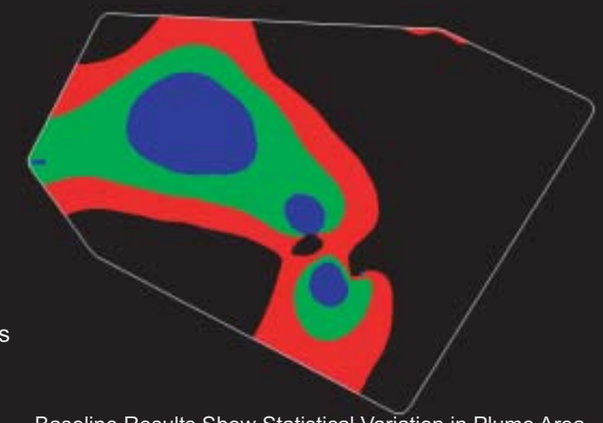
Monitoring Well Decommissioning

Contaminated groundwater sites worldwide are engaged in regular sampling of monitoring wells at a typical cost of $1,500 per well-sampling event.

Many wells are redundant or geostatistically insignificant & can be decommissioned.

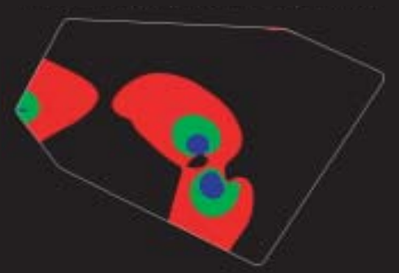
EVS-PRO's Well Decommission module analyses all available data and quantifies the impact on site assessment quality of removing each well.

Step One: Perform a Baseline Analysis Using All Well Data

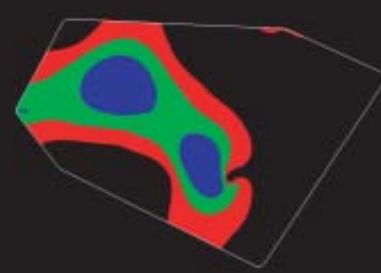


Baseline Results Show Statistical Variation in Plume Area
(red-max, green-nominal, blue-minimum)

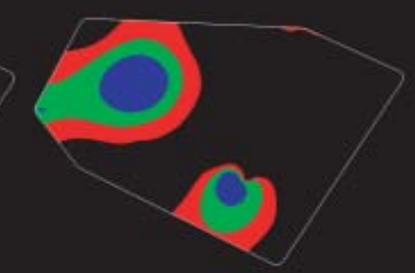
Well MW102 Removed



Well MW7W Removed

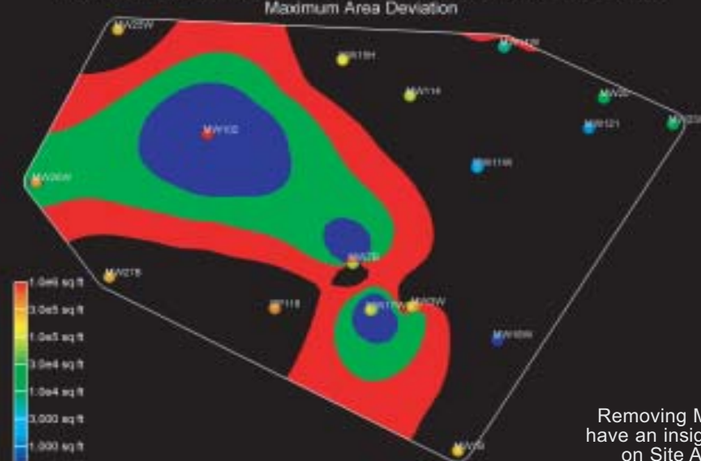


Well MW7B Removed



The three figures above demonstrate that some wells have a profound effect on site assessment.

Well Decommission Final Results for Pentachlorophenol Target Isolevel = 5.00
Maximum Area Deviation



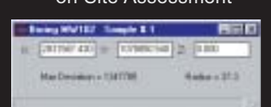
The final output shows each well colored by its impact on the site contaminant area in square feet.

EVS-PRO's Well Decommission technology provides a defensible approach to determining candidate wells for decommissioning. Each decommissioned well can save thousands of dollars per year.

The nominal contaminated area is 1,835,263 square feet. Removing MW18B affects area determination by only 0.026%.

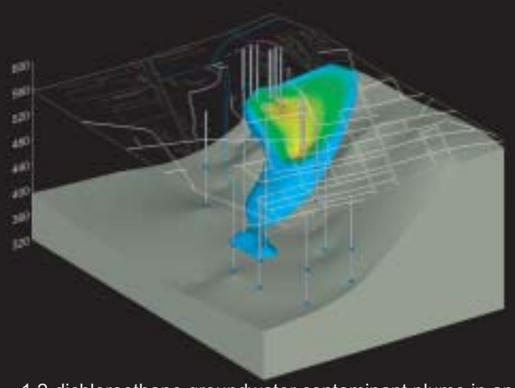
Removing MW18B would have an insignificant impact on Site Assessment

Removing MW102 would have a profound impact on Site Assessment

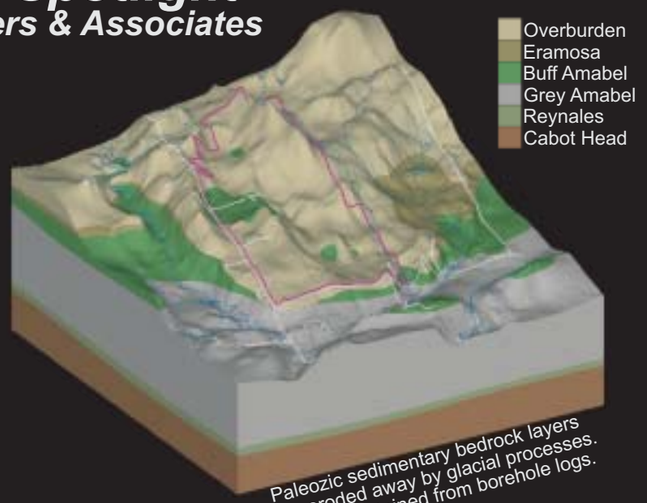


Data provided courtesy of U.S. EPA Region 5

Customer Spotlight
Conestoga Rovers & Associates

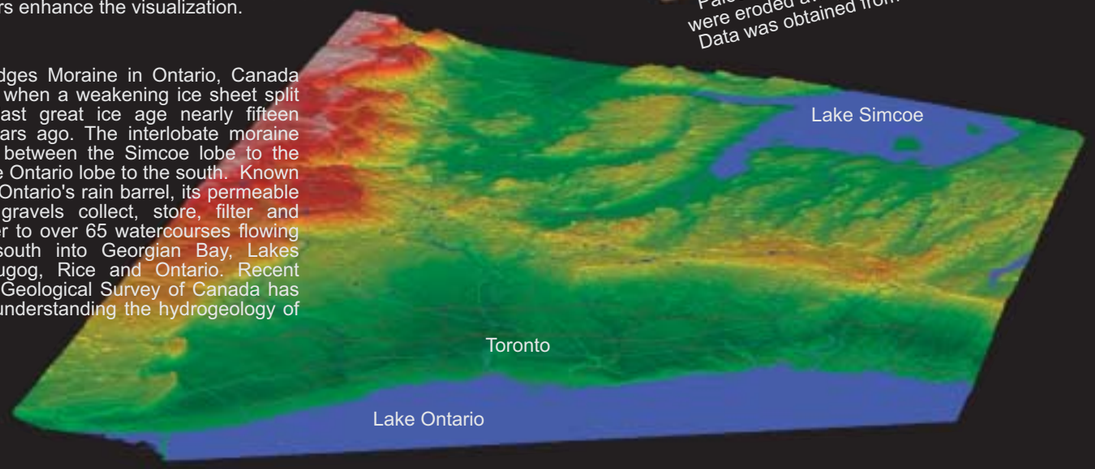


1,2-dichloroethane groundwater contaminant plume in an Ohio bedrock valley aquifer. Detailed maps showing highways, roads and rivers enhance the visualization.

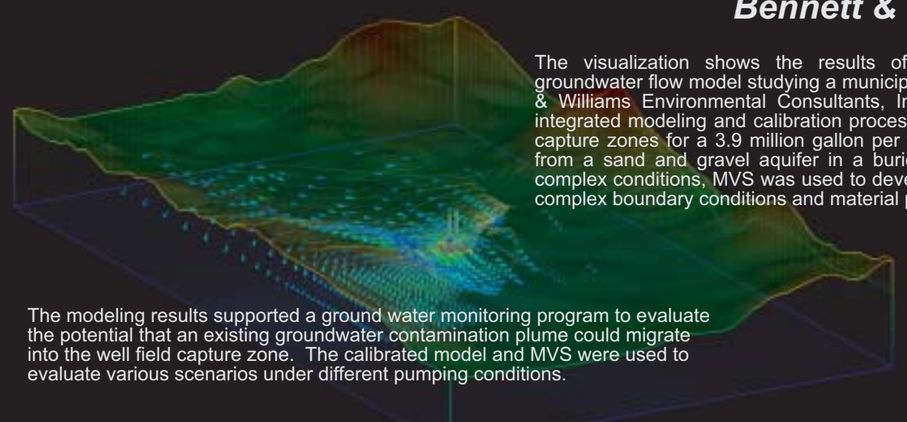


Paleozic sedimentary bedrock layers were eroded away by glacial processes. Data was obtained from borehole logs.

The Oak Ridges Moraine in Ontario, Canada was created when a weakening ice sheet split during the last great ice age nearly fifteen thousand years ago. The interlobate moraine was formed between the Simcoe lobe to the north and the Ontario lobe to the south. Known as southern Ontario's rain barrel, its permeable sands and gravels collect, store, filter and release water to over 65 watercourses flowing north and south into Georgian Bay, Lakes Simcoe, Scugog, Rice and Ontario. Recent work by the Geological Survey of Canada has focused on understanding the hydrogeology of the moraine.



Bennett & Williams



The visualization shows the results of a wellhead protection program, groundwater flow model studying a municipal well field in central Ohio. Bennett & Williams Environmental Consultants, Inc. developed the model using an integrated modeling and calibration process to delineate the one and five-year capture zones for a 3.9 million gallon per day well field. The well field draws from a sand and gravel aquifer in a buried valley system. To simulate the complex conditions, MVS was used to develop a five-layer model incorporating complex boundary conditions and material parameters.

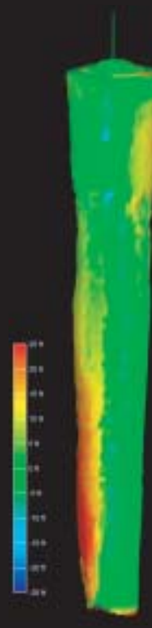
The modeling results supported a ground water monitoring program to evaluate the potential that an existing groundwater contamination plume could migrate into the well field capture zone. The calibrated model and MVS were used to evaluate various scenarios under different pumping conditions.

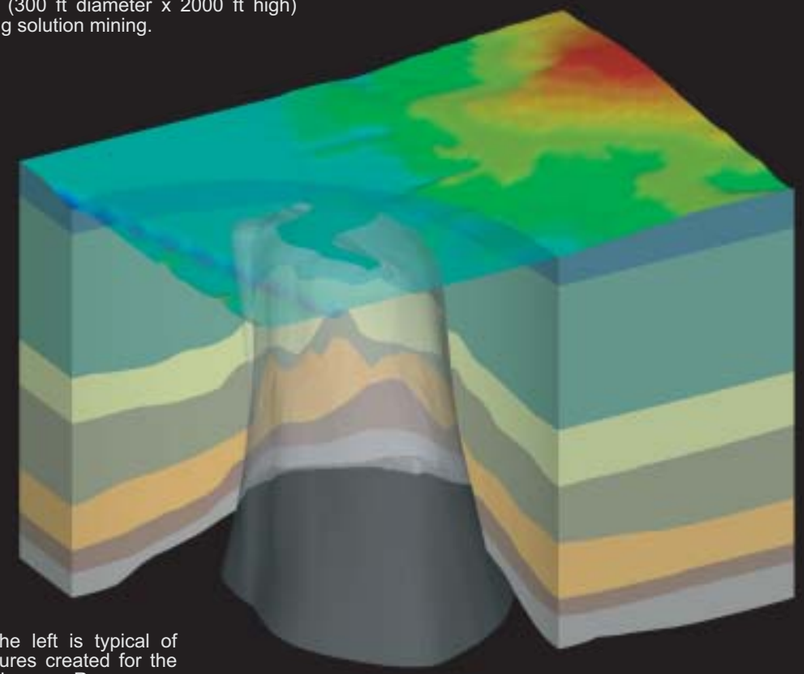
MVS allows us to effectively communicate with project members having different backgrounds such as geologists, hydrogeologists, environmental engineers, and computer programmers, and with our clients who are less familiar with subsurface structure and groundwater modeling. MVS plays a key role in this process and I regard it as a ***"must have"*** *product for any complex environmental studies that require not only accurate scientific results, but also realistic visualization and presentation.*

Ming Zhang, Bennett & Williams Env. Cons. - mzhang@bennettandwilliams.com

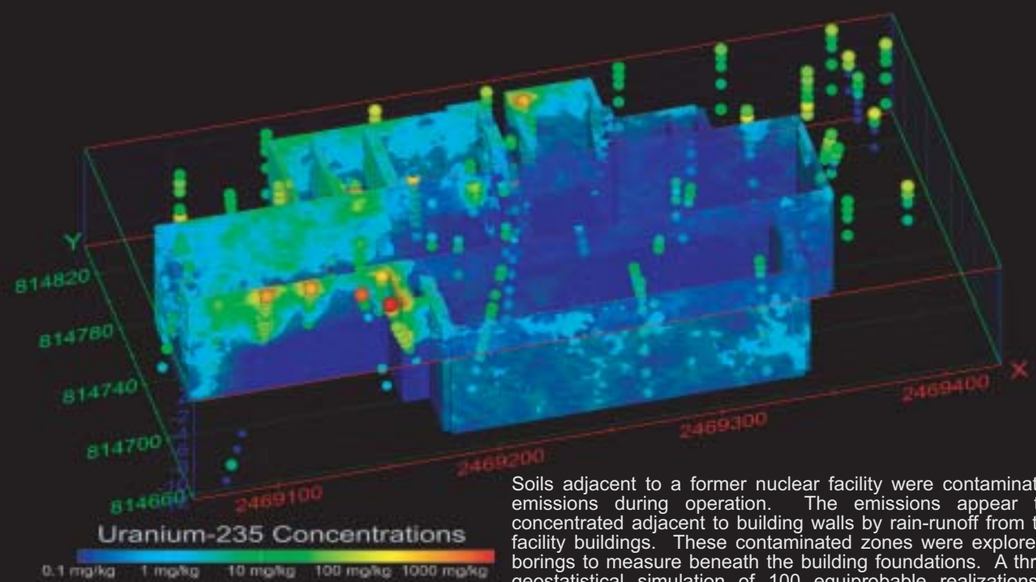
Customer Spotlight
U.S. Dept. of Energy - Sandia National Laboratory

The Bayou Choctaw salt dome in southern Louisiana is used as one of the U.S. Department of Energy's principal underground storage facilities for crude oil as part of the Nation's Strategic Petroleum Reserve. The intrusive salt core has risen many tens of thousands of feet, penetrating various sand-shale sedimentary layers to reach its current spatial position. Crude oil is stored in large (300 ft diameter x 2000 ft high) caverns leached into the salt mass using solution mining.





The salt cavern to the left is typical of solution mining structures created for the Strategic Petroleum Reserve. Dimensional data is used to assess total volume and structural integrity. The surface is colored according to out-of-round condition.



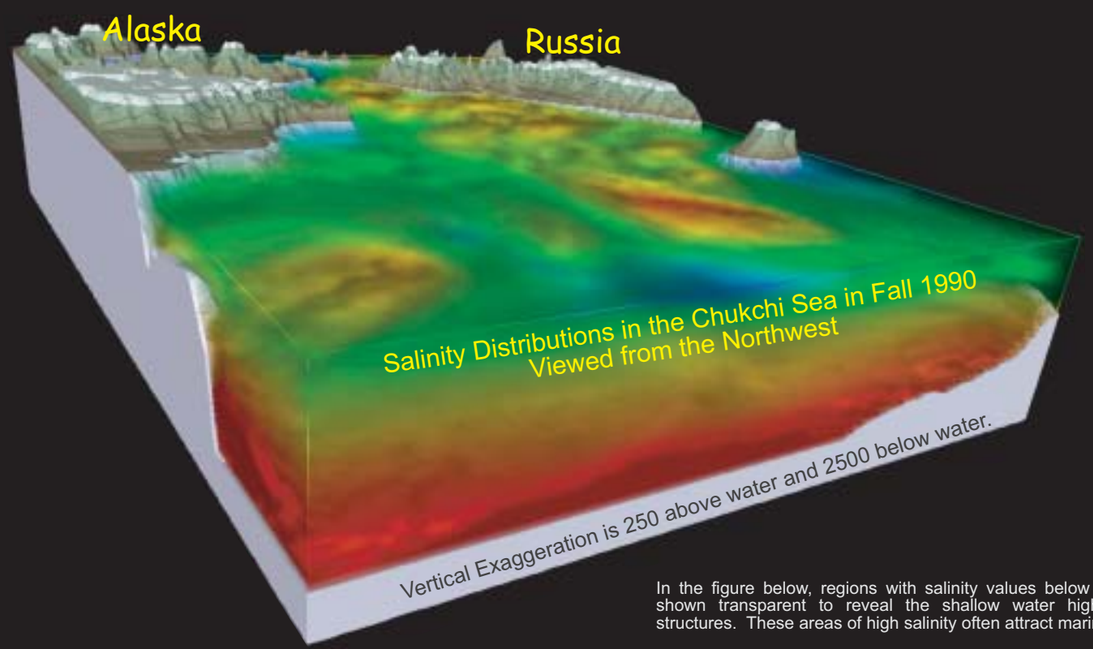
Soils adjacent to a former nuclear facility were contaminated by uranium emissions during operation. The emissions appear to have been concentrated adjacent to building walls by rain-runoff from the roofs of the facility buildings. These contaminated zones were explored using angled borings to measure beneath the building foundations. A three-dimensional geostatistical simulation of 100 equiprobable realizations of this deep uranium was imported into MVS to distinguish the contaminated and total volumes of soils associated with the building walls and footers.

Oceanic Sciences

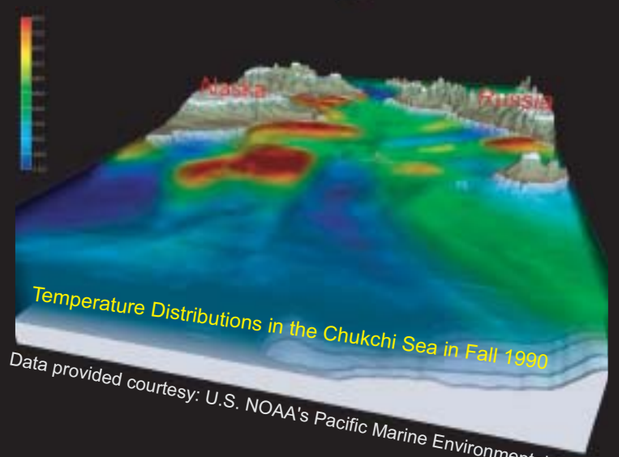
The US National Oceanic and Atmospheric Administration's Pacific Marine Environmental Laboratory and Russia conducted oceanographic research in the Chukchi Sea in September and October 1990 to collect the data represented in these visualizations that were created with EVS-PRO. Waters from the Bering Sea feed the Chukchi Sea through the Bering Strait before entering the Arctic Ocean. The Chukchi serves as a rich feeding ground for Bowhead whales and other marine mammals, and serves as a transition area for pelagic seabird species.

CTD casts to measure Conductivity, Temperature and Depth were used to determine temperature and salinity distributions in the various water masses. This data is used to determine ocean properties that may explain fish and mammal behavior. For example, a strong cold pool or high area of salinity may aggregate prey (invertebrates and planktonic fish), thus providing fertile feeding areas for marine mammals.

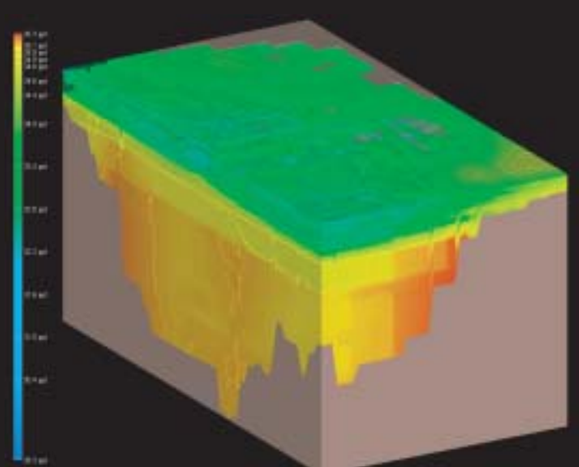
Fisheries ecologists and wildlife biologists attempting to understand the relationship between marine mammal foraging, prey densities and physical environments may overlay foraging data from satellite or radio-tracked animals with oceanographic data to understand these interrelationships during one season or over several years of data.



In the figure below, regions with salinity values below 33.3 are shown transparent to reveal the shallow water high salinity structures. These areas of high salinity often attract marine life.



Data provided courtesy: U.S. NOAA's Pacific Marine Environmental Laboratory

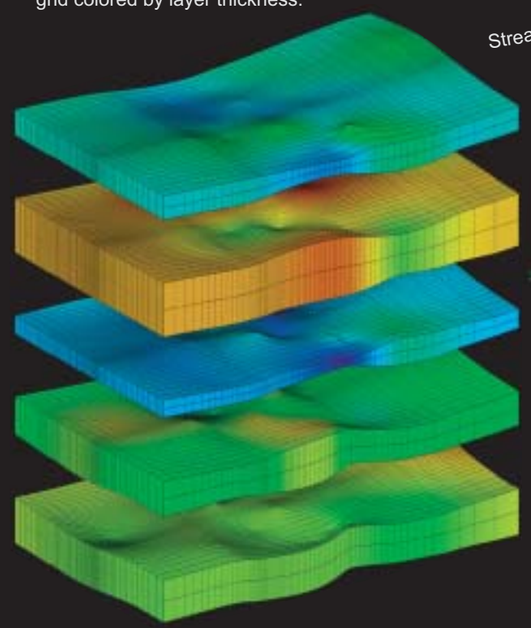


Ornis Consult A/S of Copenhagen, Denmark performed this investigation with EVS-PRO as part of their applied marine ecosystem research on the Skagerrak. The Skagerrak is the outer part of the transitional area between the Baltic Sea and the North Sea, and is connected with the North Atlantic through the Norwegian Trench. The distribution of water masses and fronts in the Skagerrak is controlled by a permanent counter-clockwise circulation at depth and a highly dynamic, primarily wind-driven circulation of up to five different surface water masses. EVS's three-dimensional kriging of CTD data was used to resolve the most stable frontal feature associated with the upwelling structure created by the large-scale circulation.

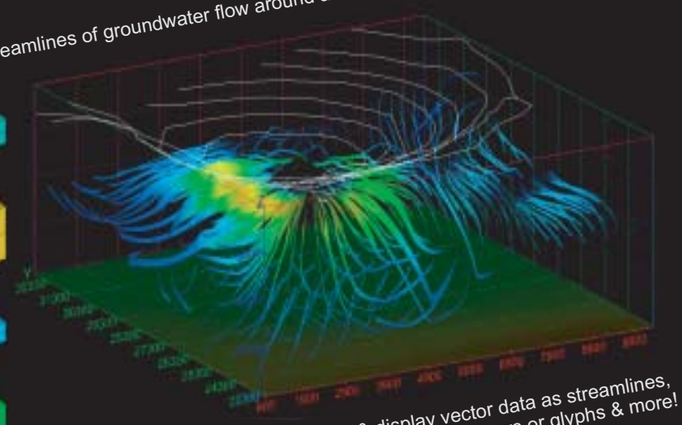
Groundwater and Solute Transport Modeling

Visualization of groundwater and solute transport modeling results can be performed with all versions of C Tech's software except EVS for ArcView. Modeling Animation System (MAS) was developed specifically for animation and visualization of earth science modeling results from third party modeling systems such as Groundwater Vistas© or Visual MODFLOW©. MAS combines a limited subset of the animation capabilities of EVS-PRO and a powerful suite of visualization tools in a fully customizable environment. (MAS does not include any of the geologic modeling or geostatistical functionality of EVS.)

EVS provides high-level integration with Groundwater Vistas. In addition to model visualization, EVS creates complex gridded geologic models that can be easily exported to Vistas for model initialization. The figure below shows such a grid colored by layer thickness.

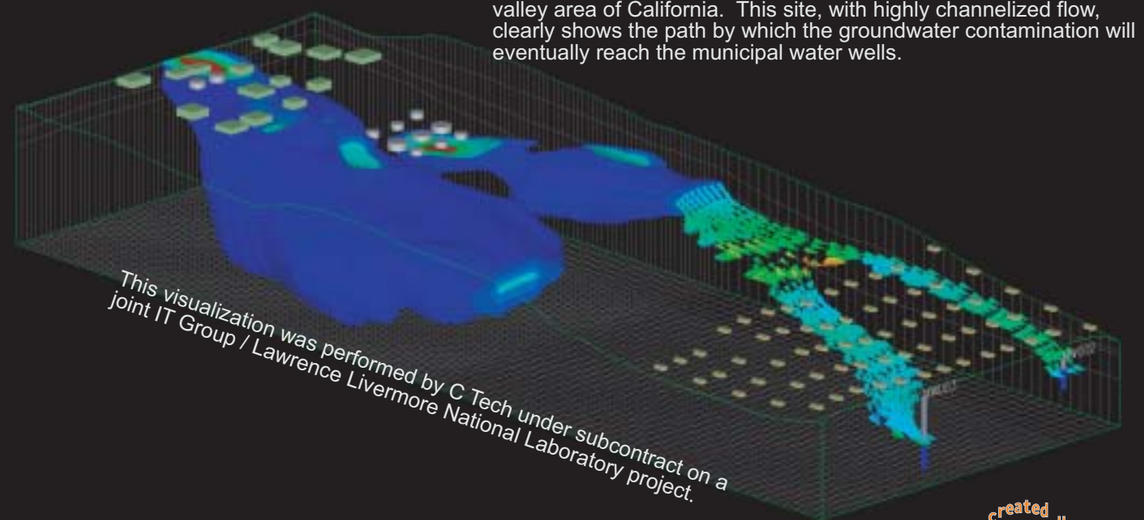


Streamlines of groundwater flow around a mining pit



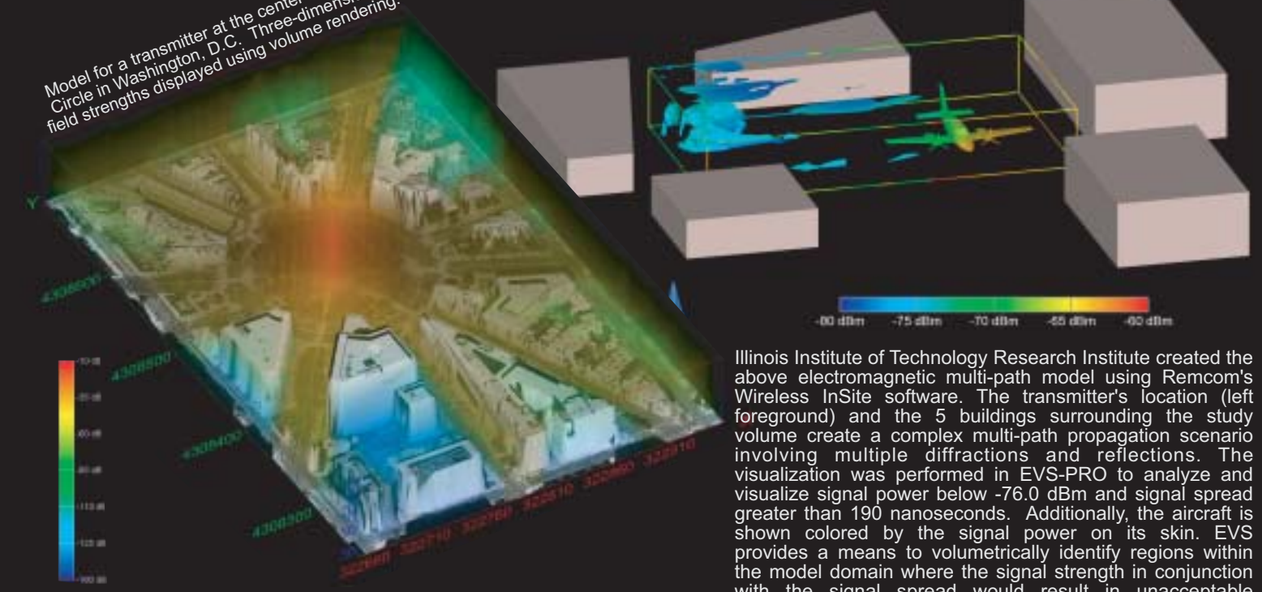
Calculate & display vector data as streamlines, streamribbons, scaled arrows or glyphs & more!

Visualization of the output from a Groundwater Vistas MODFLOW and MT3D99 simulation of a large industrial complex in the central valley area of California. This site, with highly channelized flow, clearly shows the path by which the groundwater contamination will eventually reach the municipal water wells.



This visualization was performed by C Tech under subcontract on a joint IT Group / Lawrence Livermore National Laboratory project.

RF Modeling



Model for a transmitter at the center of Dupont Circle in Washington, D.C. Three-dimensional field strengths displayed using volume rendering.

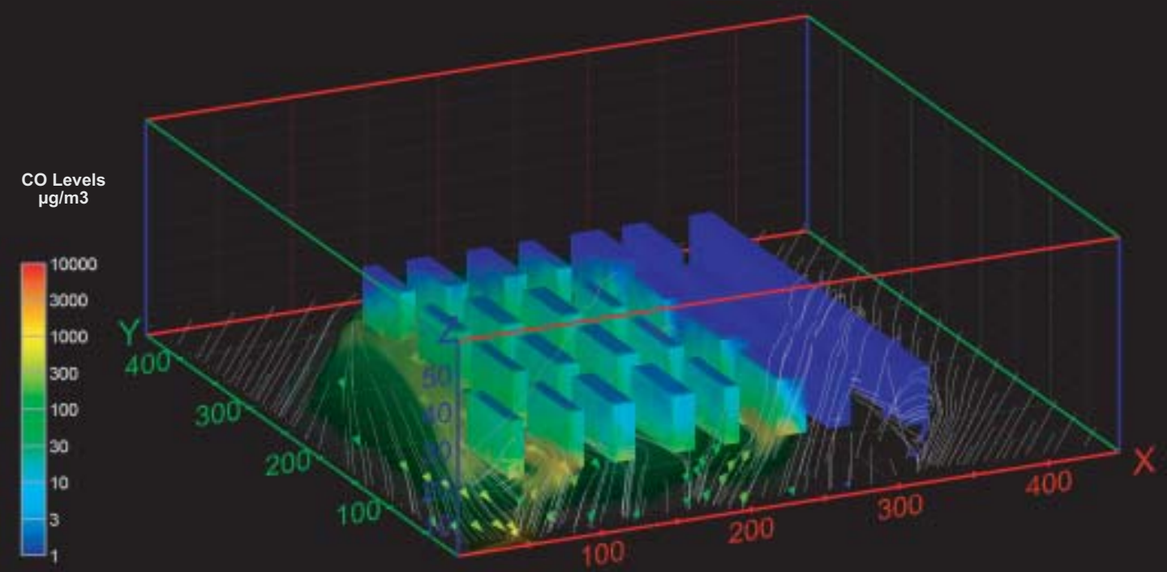
Illinois Institute of Technology Research Institute created the above electromagnetic multi-path model using Remcom's Wireless InSite software. The transmitter's location (left foreground) and the 5 buildings surrounding the study volume create a complex multi-path propagation scenario involving multiple diffractions and reflections. The visualization was performed in EVS-PRO to analyze and visualize signal power below -76.0 dBm and signal spread greater than 190 nanoseconds. Additionally, the aircraft is shown colored by the signal power on its skin. EVS provides a means to volumetrically identify regions within the model domain where the signal strength in conjunction with the signal spread would result in unacceptable reception.

This methodology is being used within the Department of Defense and Intelligence Agencies to analyze RF propagation in urban environments. The technology is equally applicable to wireless companies that must optimize their use of the electromagnetic spectrum.

The above model provided courtesy of the Institute for Telecommunication Sciences, which is the chief research and engineering arm of the U.S. Department Of Commerce National Telecommunications and Information Administration (NTIA). RF modeling software developed by ITS serves as a principal resource for solving the telecommunications concerns of other federal agencies, state and local governments, private corporations, associations, and international organizations.

Air Pollution Modeling

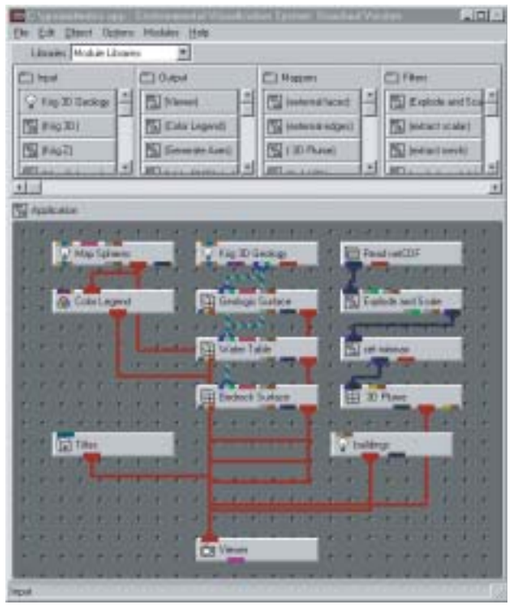
The VADIS simulation data used in this visualization was created by the GEMAC team at the Universidade de Aveiro under the direction of Prof. Carlos Borrego. GEMAC developed VADIS, a true 3D street-canyon model coupling boundary layer flow with Lagrangian dispersion to simulate urban air pollution in city centers. It was specifically targeted at street-canyon pollutant dispersion such as this model of downtown Lisbon, whose air quality problems are largely due to intense traffic.



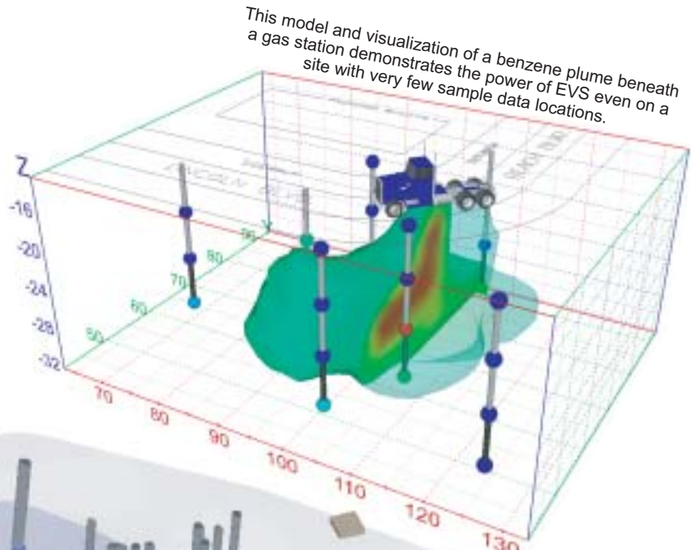
For more information on GEMAC see: http://www.dao.ua.pt/gemac

EVS Standard

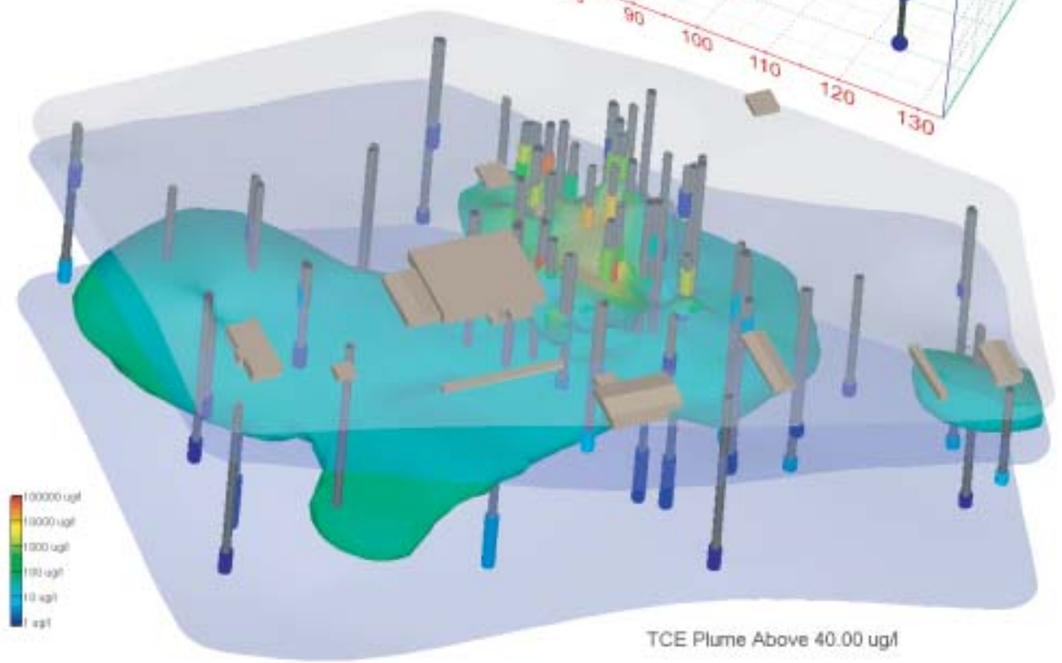
EVS-Standard is C Tech's baseline customizable 3D analysis and visualization system. EVS-Standard includes all of the capabilities of EVS for ArcView and adds a modular, customizable environment for geologists and environmental engineers. Some of its additional features include: finite difference and finite element modeling grid generation; 3D fence diagrams; multiple analyte data analysis; and arbitrary slicing & cutting. In addition it provides pre- and post-processing for MODFLOW, MT3D and CFEST. EVS-Standard is tightly integrated with ESI's Groundwater Vistas.



The diagram to the left is a network of modules in EVS-Standard that was used to produce the figure at the bottom of this page. EVS-Standard is a truly modular software package in which the user graphically interconnects modules to produce customized applications to meet any need. This modular paradigm is the key to the flexibility and power of EVS. The ability to create custom applications and a host of other powerful modules separates EVS-Standard from the more limited



This model and visualization of a benzene plume beneath a gas station demonstrates the power of EVS even on a site with very few sample data locations.

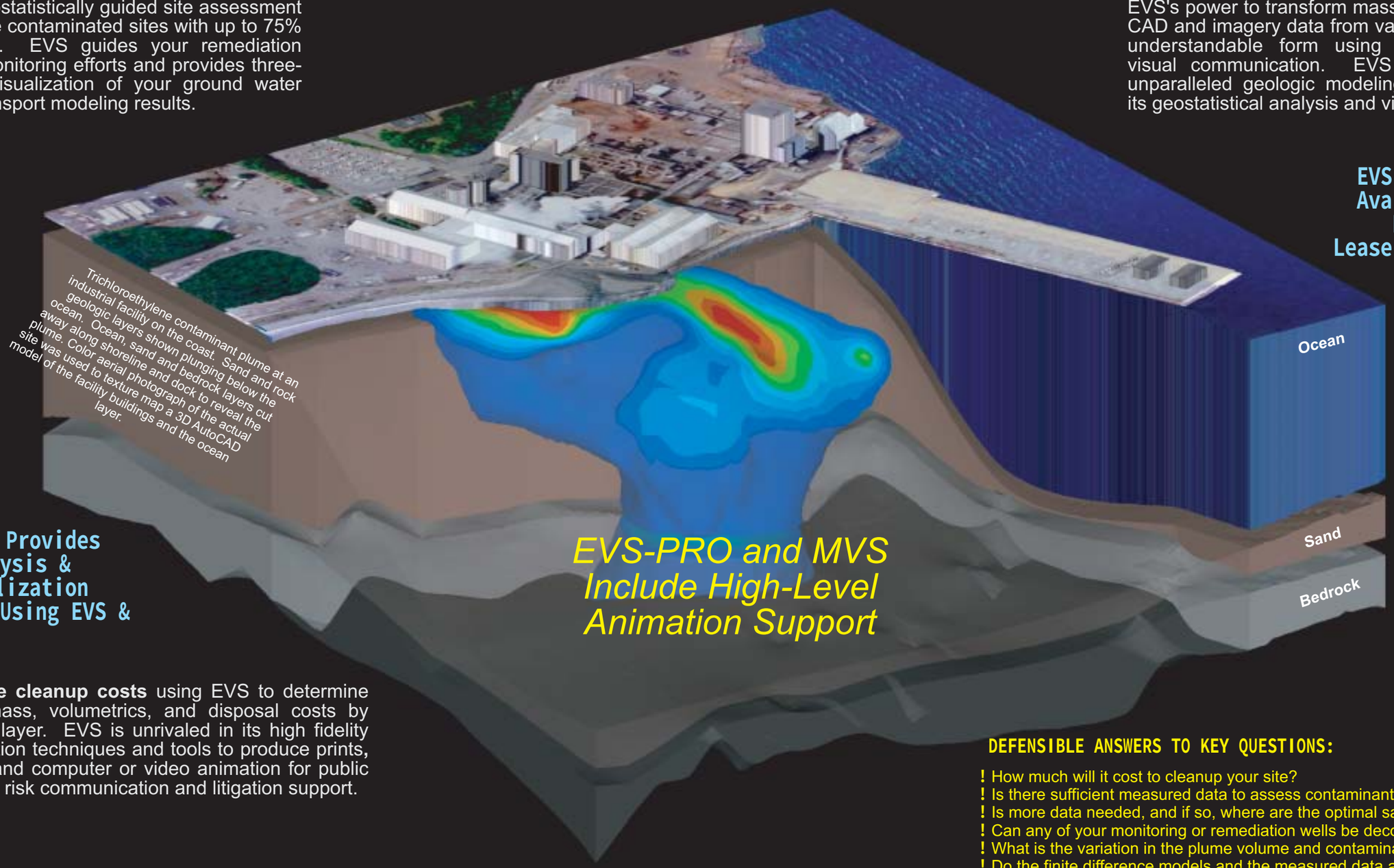


The above model shows the trichloroethylene groundwater plume below the Vickers site. Monitoring well screens colored by TCE level are combined with the 40 ppb plume. Transparent surfaces show ground level, the water table and the bottom of the aquifer. Three-dimensional buildings were added to provide spatial references.

Visualize Your Site in 3D

Discover the cost savings when you use EVS to perform geostatistically guided site assessment to characterize contaminated sites with up to 75% fewer borings. EVS guides your remediation design and monitoring efforts and provides three-dimensional visualization of your ground water and solute transport modeling results.

Unleash your creativity and expertise with EVS's power to transform masses of tabular, GIS, CAD and imagery data from varied sources into a understandable form using three-dimensional visual communication. EVS tightly integrates unparalleled geologic modeling capabilities with its geostatistical analysis and visualization tools.



Trichloroethylene contaminant plume at an industrial facility on the coast. Sand and rock geologic layers shown plunging below the ocean. Ocean, sand and bedrock layers cut away along shoreline and dock to reveal the plume. Color aerial photograph of the actual site was used to texture map a 3D AutoCAD model of the facility buildings and the ocean layer.

EVS & MVS are Available for Rental, Lease or Purchase

C Tech Provides Analysis & Visualization Services Using EVS &

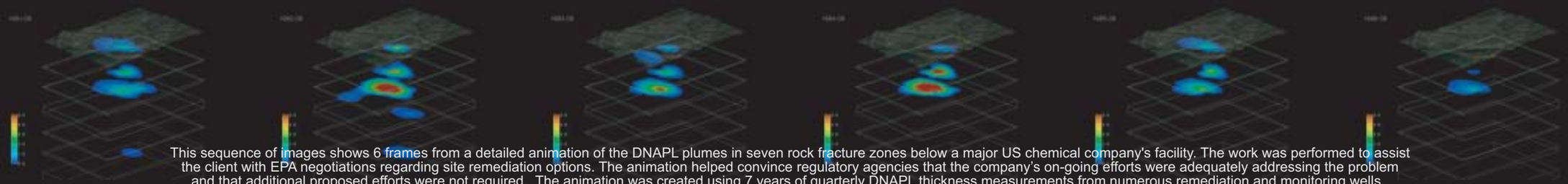
EVS-PRO and MVS Include High-Level Animation Support

Calculate cleanup costs using EVS to determine plume mass, volumetrics, and disposal costs by geologic layer. EVS is unrivaled in its high fidelity visualization techniques and tools to produce prints, posters and computer or video animation for public relations, risk communication and litigation support.

DEFENSIBLE ANSWERS TO KEY QUESTIONS:

- ! How much will it cost to cleanup your site?
- ! Is there sufficient measured data to assess contaminant levels?
- ! Is more data needed, and if so, where are the optimal sampling locations?
- ! Can any of your monitoring or remediation wells be decommissioned?
- ! What is the variation in the plume volume and contaminant mass?
- ! Do the finite difference models and the measured data agree?
- ! How is the site remediation progressing? Does it match the model?

Discover Why **Animation** is the Ultimate Communication Tool



This sequence of images shows 6 frames from a detailed animation of the DNAPL plumes in seven rock fracture zones below a major US chemical company's facility. The work was performed to assist the client with EPA negotiations regarding site remediation options. The animation helped convince regulatory agencies that the company's on-going efforts were adequately addressing the problem and that additional proposed efforts were not required. The animation was created using 7 years of quarterly DNAPL thickness measurements from numerous remediation and monitoring wells.