

# C Tech 3D Earth Science Software

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# Why C Tech 3D Software

- ◆ Address Complex Technical Challenges
  - ◆ Regulatory Issues
  - ◆ Financial Issues
  - ◆ Political Issues
- ◆ Improve Communication Between
  - ◆ Regulatory Agencies
  - ◆ Consultants and other Technical Personnel
  - ◆ Public
- ◆ Defensible, Understandable Analysis
  - ◆ 3D Volumetric Geostatistics
  - ◆ True 3D Visualization & Animation

# EVS Functionality

- ◆ Geologic and geophysical modeling
- ◆ Geostatistical analysis of soil, groundwater, surface water and air data
- ◆ Three-dimensional visualization and animation of models and analyses
- ◆ DrillGuide™: Analytically guided site assessment and optimization.
- ◆ Well Decommission™: Justifiable approach for determining groundwater monitoring wells suitable for decommissioning

# Interface to ESRI ArcView & ArcGIS

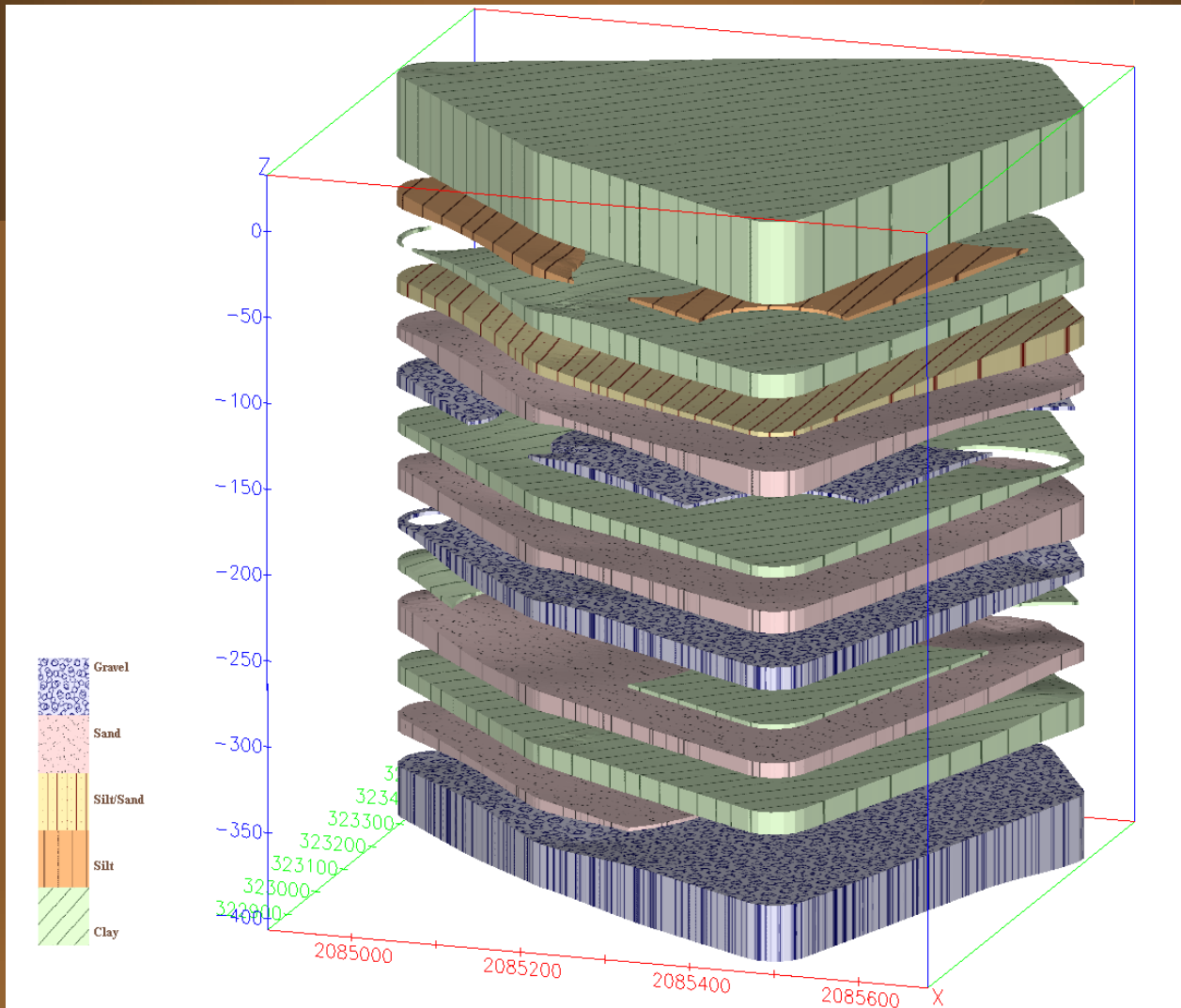
- ◆ Included ArcView/ArcGIS extensions allow you build geology and chemistry data and launch C Tech's software.
- ◆ All EVS versions can import and export 2D & 3D ESRI Shapefiles for annotation.
- ◆ Extrude polygons to create 3D volumetric representations of buildings and objects.
- ◆ Map 2D shapefiles to geologic surfaces.

# Documentation and Tutorials

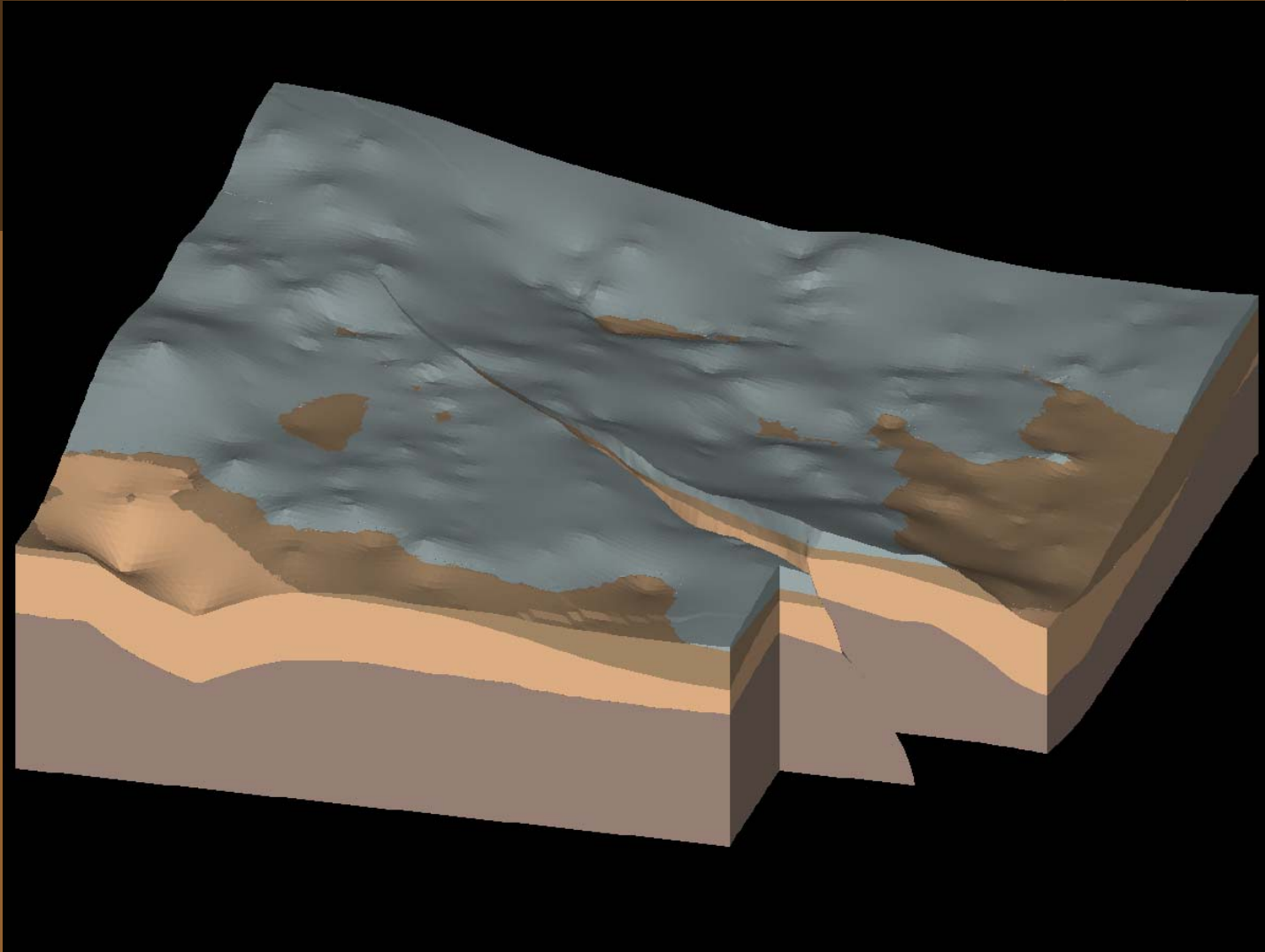
- ◆ Exhaustive on-line and context sensitive help system.
- ◆ On-line interactive tutorials for intermediate level self-training in ~16 hours
- ◆ Proven algorithms in-use by major corporations, DoE, DoD, EPA, USGS and many other government agencies

# Geologic and Geophysical Modeling

# Texture Mapped Site Geology

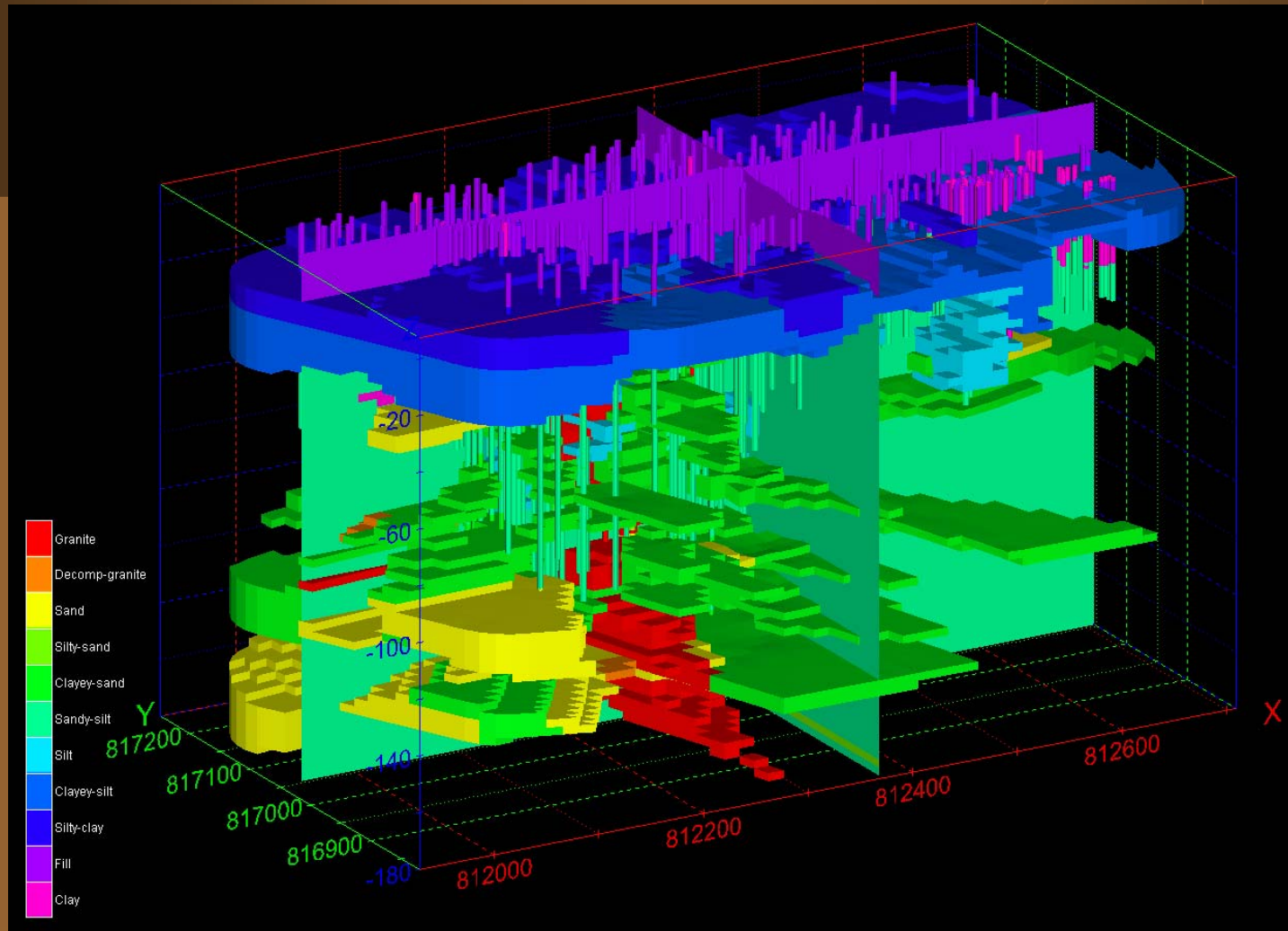


# Complex Geologic Fault Modeling



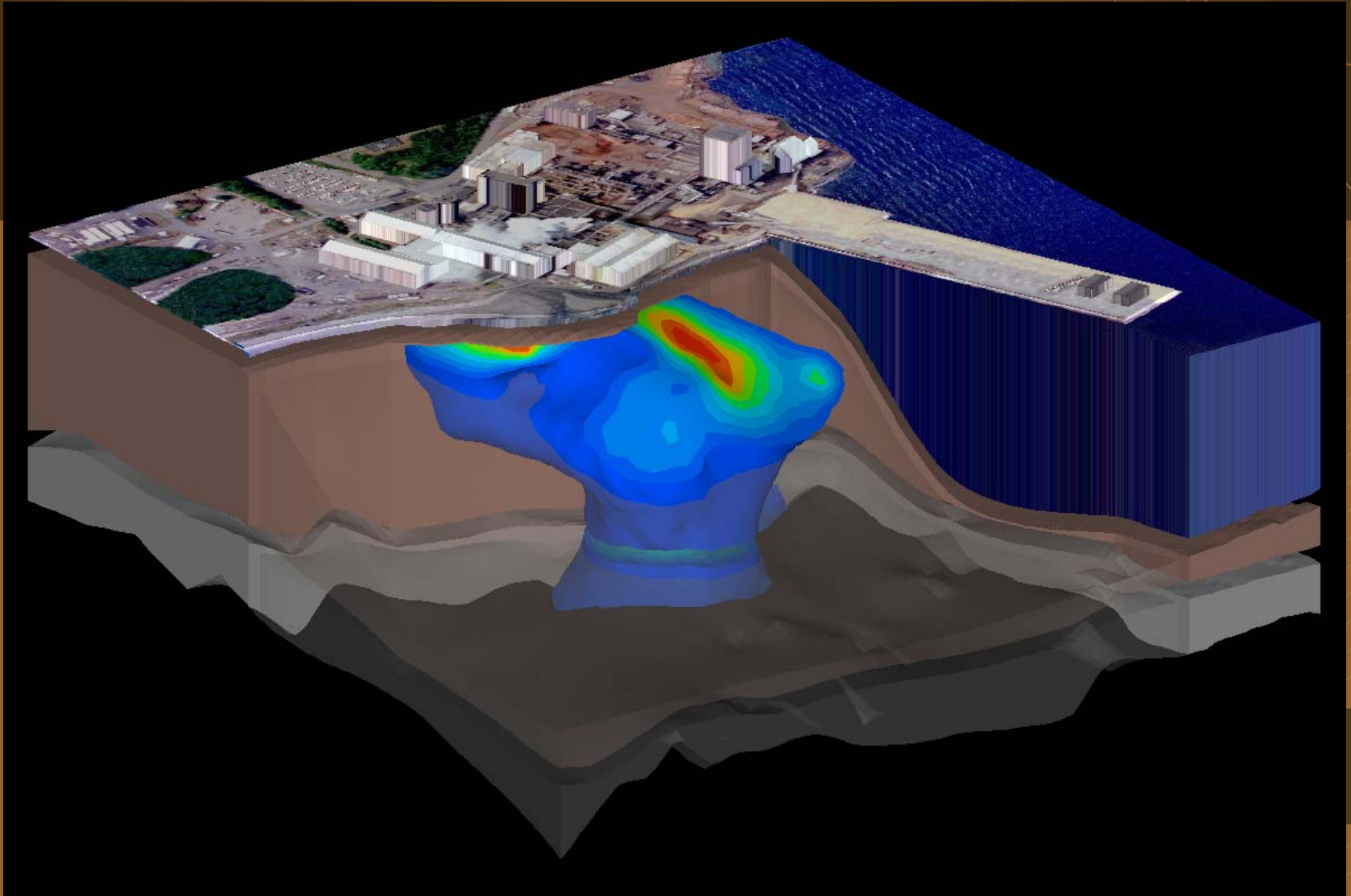


# Modeled with Geologic Indicator Kriging

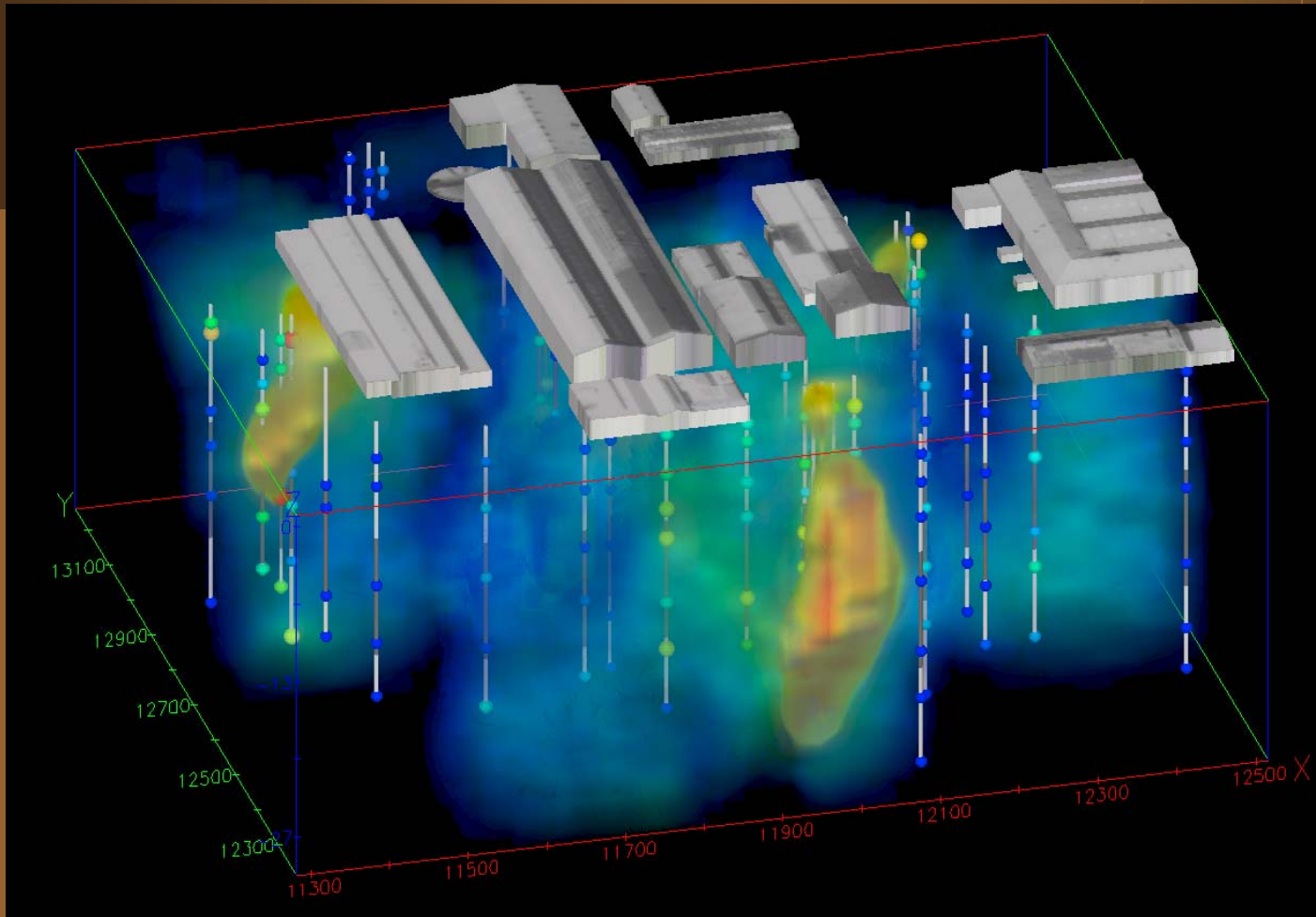


# Geostatistical Analysis of Soil, Groundwater, Surface Water and Air Data

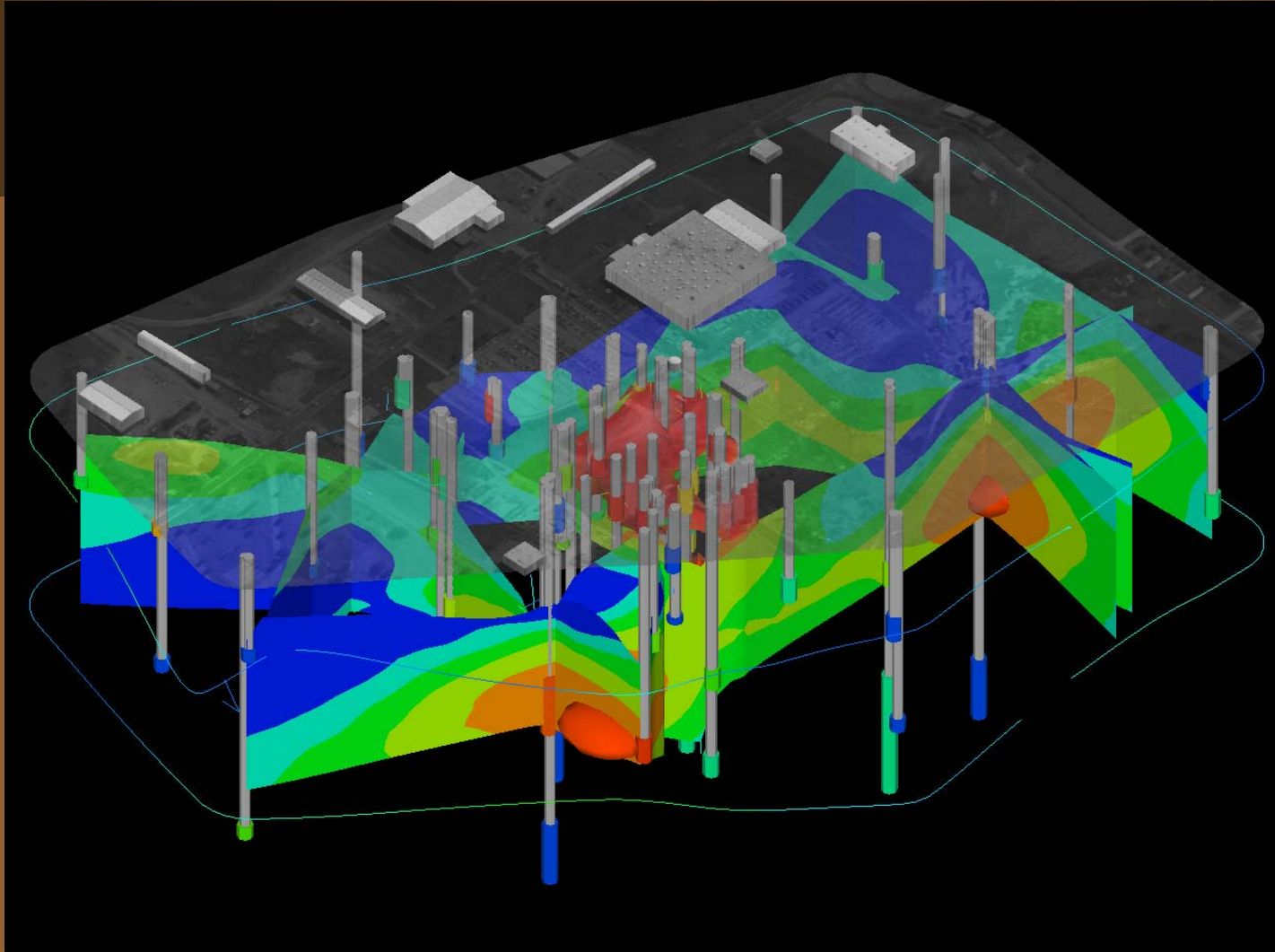
# Coastal Industrial Facility



# Volume Rendered Plume, Sample Data & Buildings



# Groundwater Wells, Fence Diagram and Plume

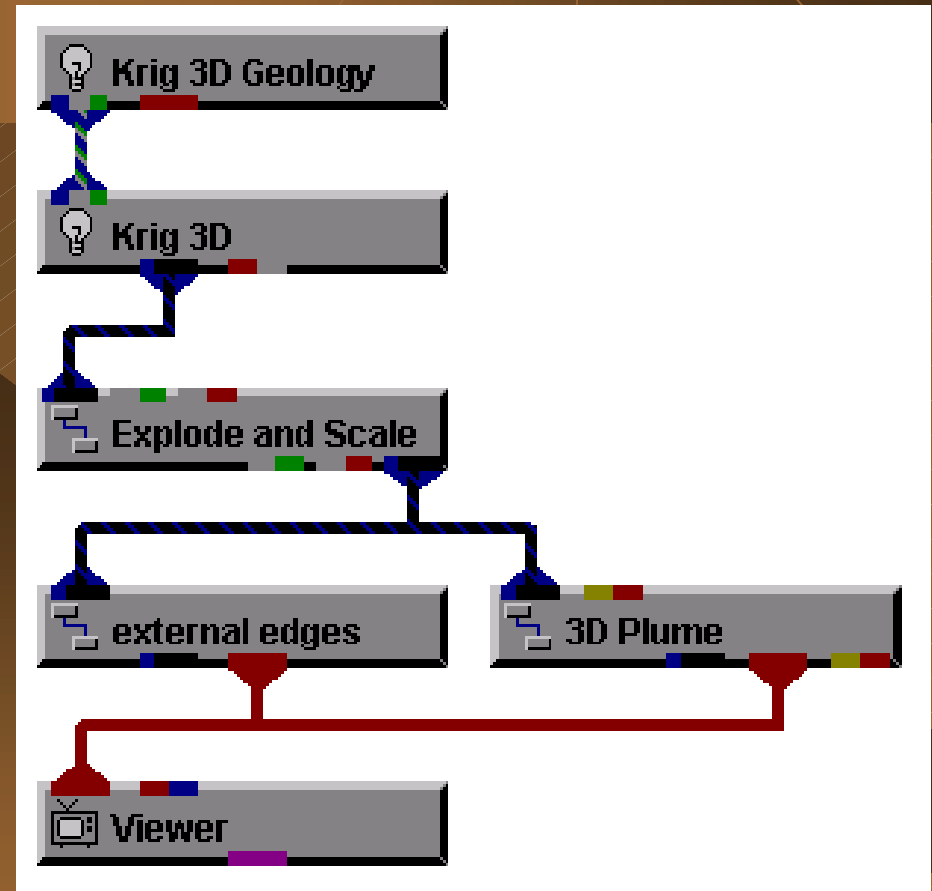


# The EVS Network Paradigm: Graphical Object Oriented Programming

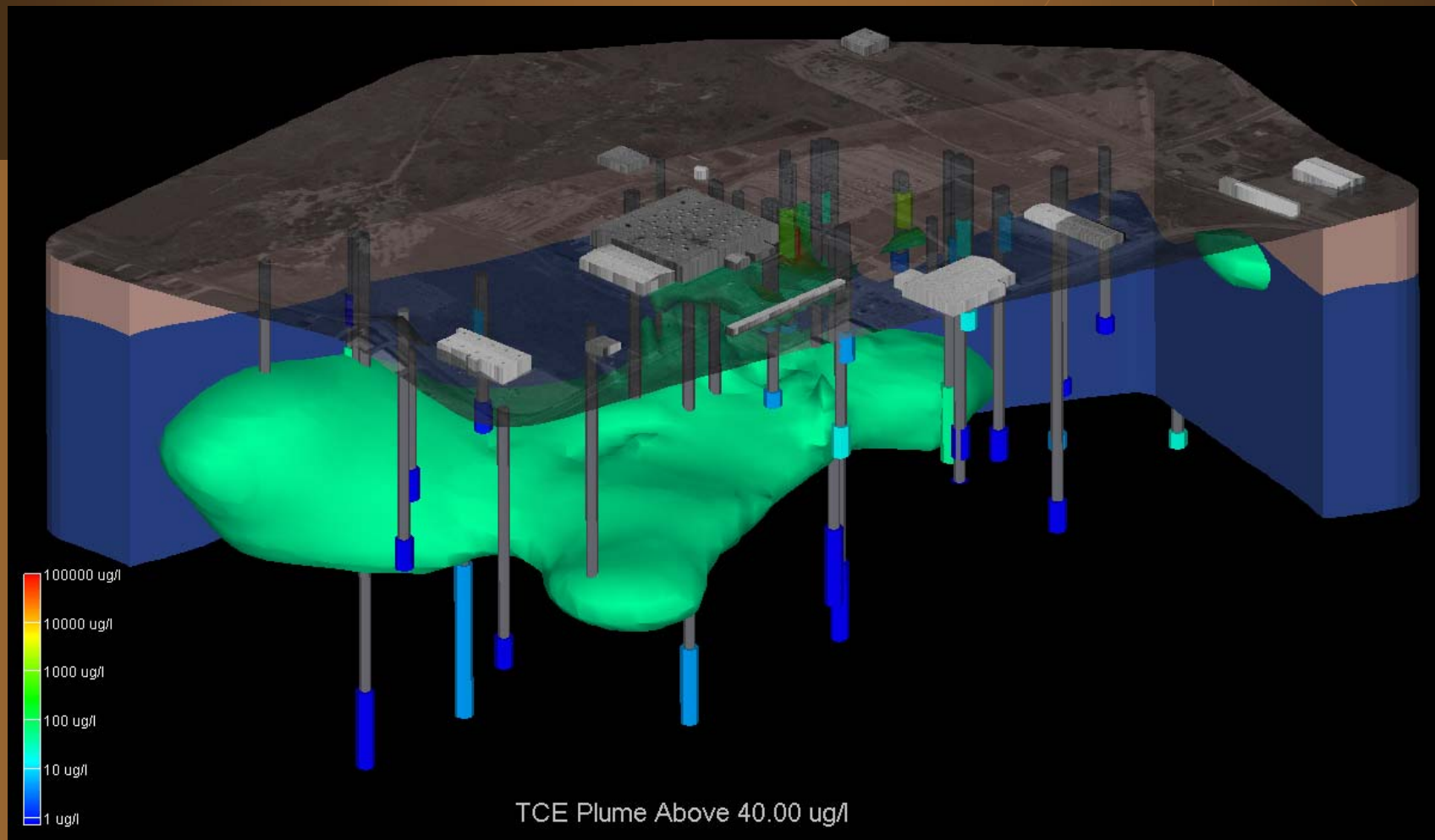
- Libraries with well over 170 modules.
- Each module performs data analysis or visualization functions.
- Applications are collections of modules interconnected to form networks
- Users can build their own networks, use or enhance EVS supplied applications

# Example: 6-Module Network

- ◆ Krig 3D Geology: kriges surfaces
- ◆ Krig 3D: creates a 3d grid with interpolated chemistry
- ◆ Explode and Scale: z-exaggeration & separation of layers
- ◆ external edges: display extents of domain or grid
- ◆ 3D Plume: isosurfaces and mapping of any attribute at any cutoff
- ◆ Viewer



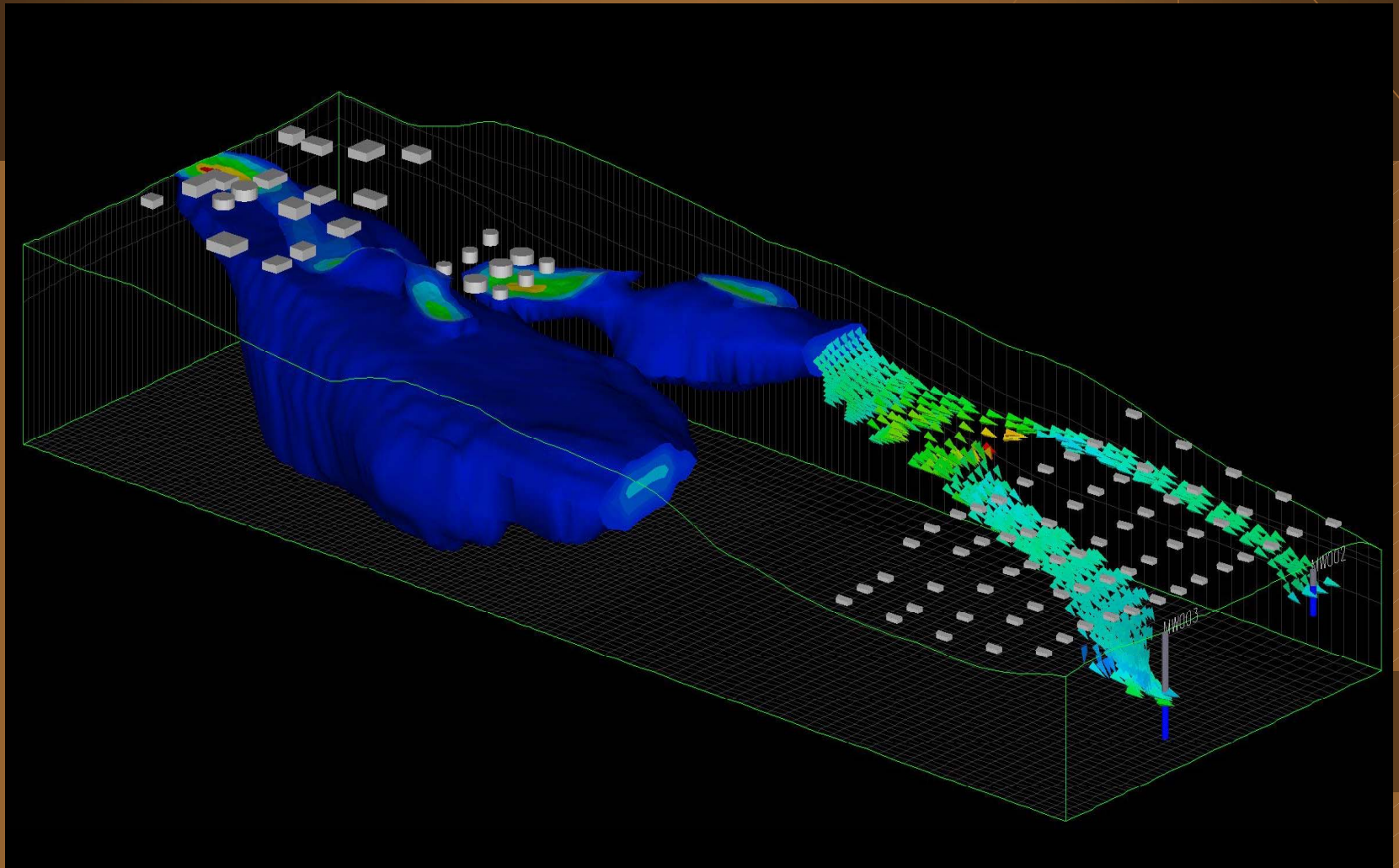
# Chemical and Geologic Data





# Three- Dimensional Visualization and Animation

# Plume Migration in Sand Channels



# EVS Input Formats

- ◆ ASCII data files for:
  - ◆ Chemistry (parameter data)
  - ◆ Borehole, boring logs and surface geology data
- ◆ Annotation Data
  - ◆ Overlay Aerial Photography
  - ◆ AutoCAD DXF files
  - ◆ ArcView shapefiles
- ◆ Finite difference & finite element model output
  - ◆ MODFLOW, MT3D, CFEST, etc.
  - ◆ GMS (MODFLOW, MT3D, Femwater)
  - ◆ Groundwater Vistas and Visual Modflow
- ◆ Database Connectivity
  - ◆ Access,
  - ◆ ODBC interface to dBase, Excel, FoxPro, etc.

# EVS Output Options

- ◆ 3D Rendered Bitmap Graphic Output
  - ◆ Virtually All Image file formats
  - ◆ Animations as AVI, MPEG, HAV
- ◆ 3D Graphics Printing to:
  - ◆ Any windows printer (color & black and white)
- ◆ Vector Output
  - ◆ Shapefiles and AutoCAD DXF
  - ◆ 4D Interactive Model Animations (4DIM)
  - ◆ VRML 1 & 2 Output

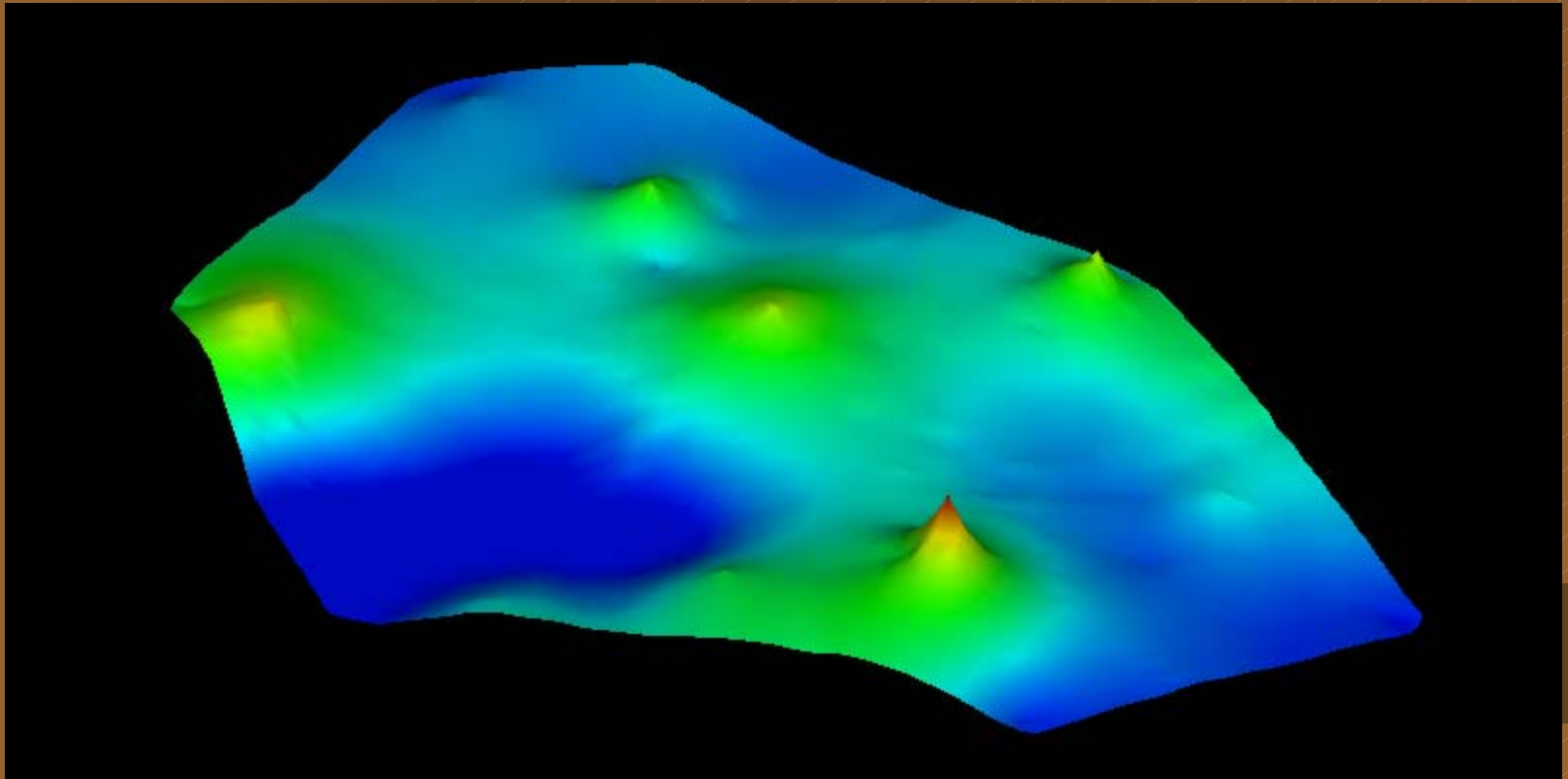
# DrillGuide™

## Analytically Guided Site Assessment

- Determine locations within a site requiring additional sampling.
- Automatically iterates to determine “n” optimal locations
- Focuses on high uncertainty regions where we predict contamination, but with low confidence.

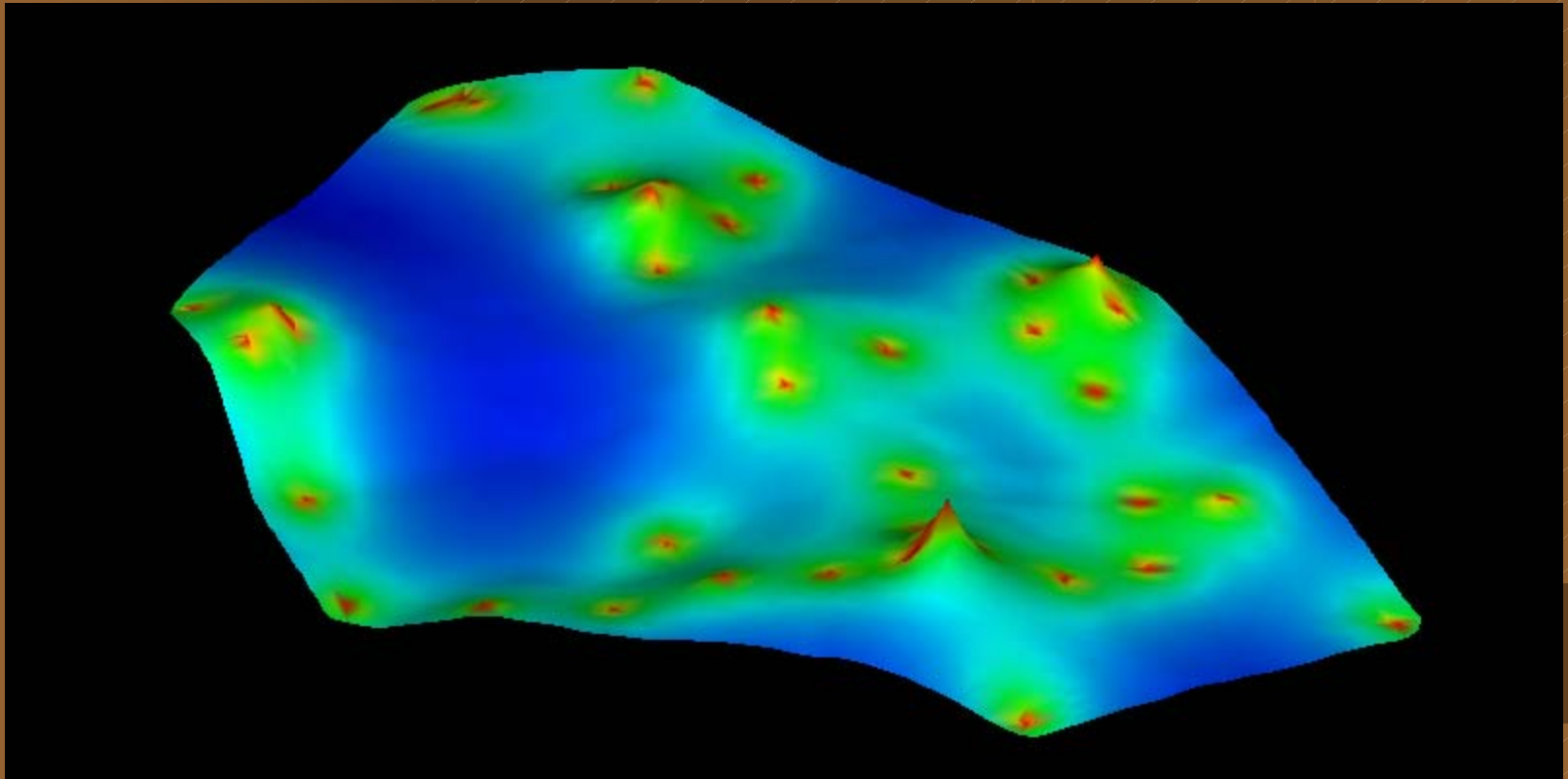
# DrillGuide™ Concentration

- ◆ High concentration regions are mapped to (red) peaks, low areas to (blue) valleys. Region is defined by convex hull of input data.



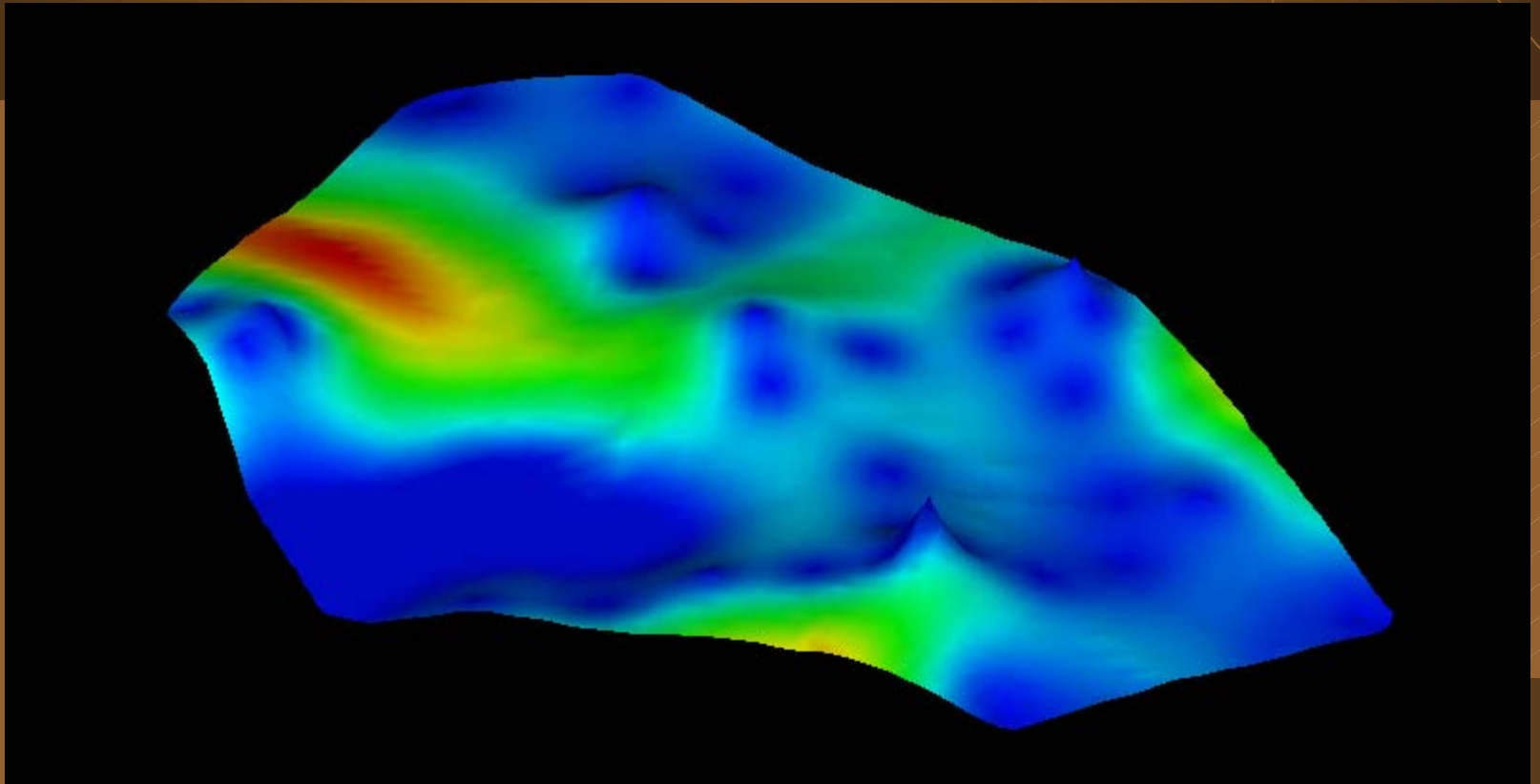
# DrillGuide™ Confidence

- ◆ High confidence regions are mapped to (red) spots, low confidence areas are blue.



# DrillGuide™ Uncertainty

- ◆ Areas of high uncertainty (red) are regions with low confidence and high predicted concentration.



- ◆ High uncertainty regions are locations where we predict contamination, but our confidence in that prediction is low.



# Well Decommission™

Determine groundwater monitoring wells suitable for decommissioning

# Groundwater Monitoring Challenge

- Groundwater contamination sites worldwide are engaged in regular sampling of monitoring wells.
- The typical costs are \$1,500 per well per sampling event.
- Many of these wells are redundant or geostatistically insignificant and can be decommissioned.

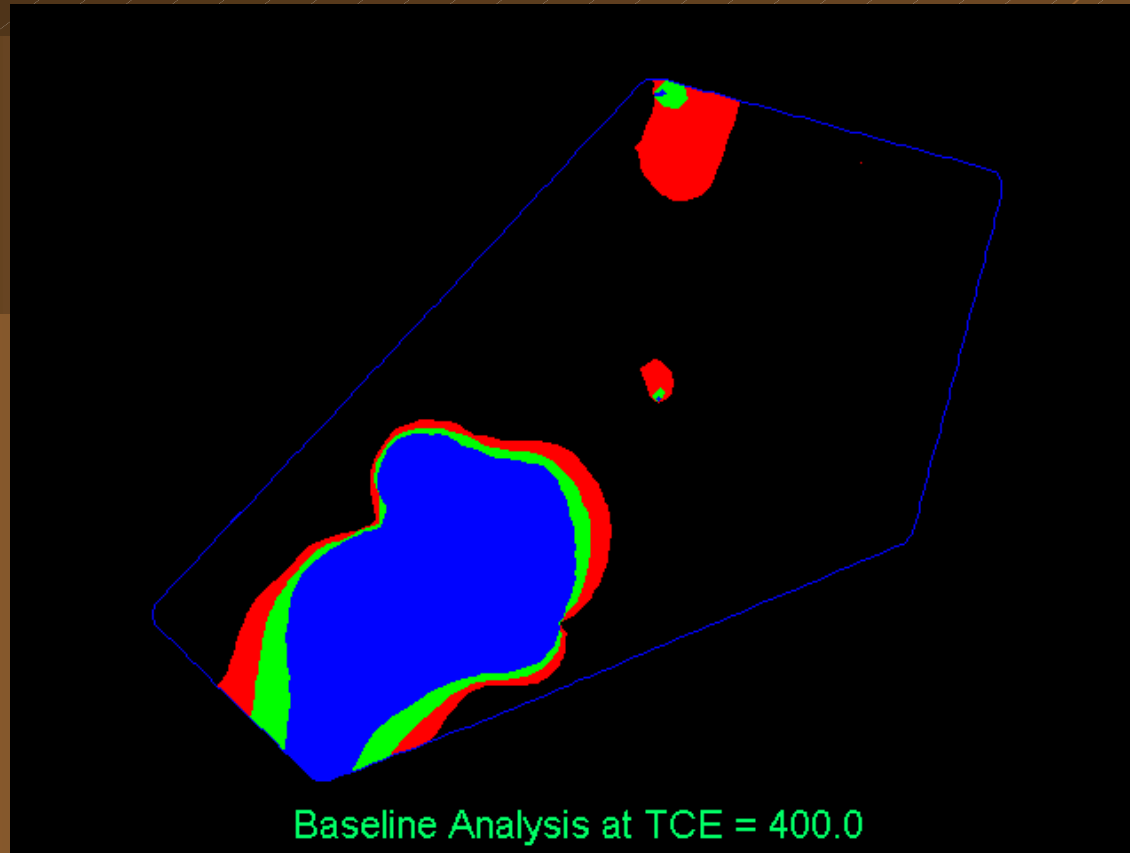
# Well Decommissioning Approach

- ◆ C Tech has developed a new module in EVS-PRO called *Well Decommission*
- ◆ *Well Decommission* analyses all available data and quantifies the impact to site assessment quality of removing each well.
- ◆ Provides area-impact and concentration-weighted area-impact of each well.

# Benefits

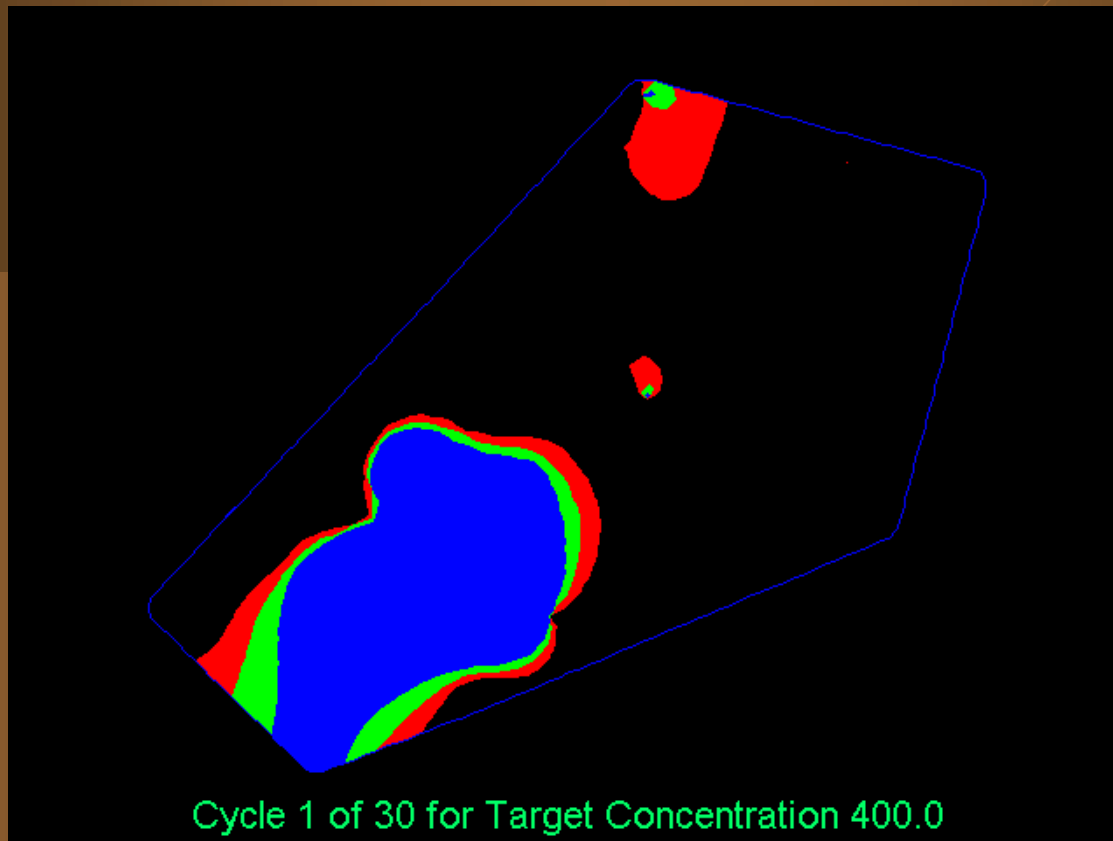
- ◆ *Well Decommission* provides an easy to use method to determine which, if any, wells can be decommissioned.
- ◆ Provides graphical and tabular results.
- ◆ Can analyze the impact of multiple analytes.

# Function and Output



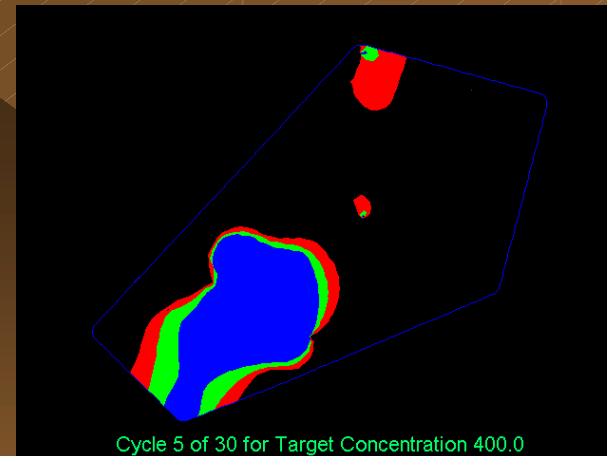
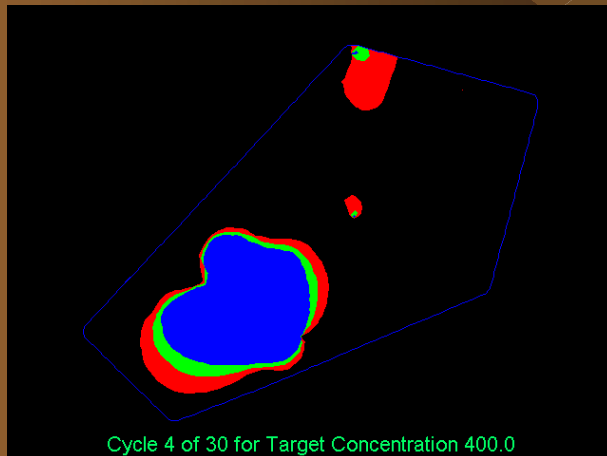
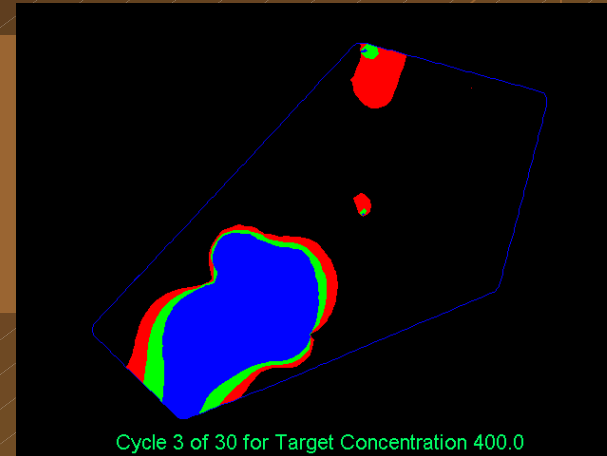
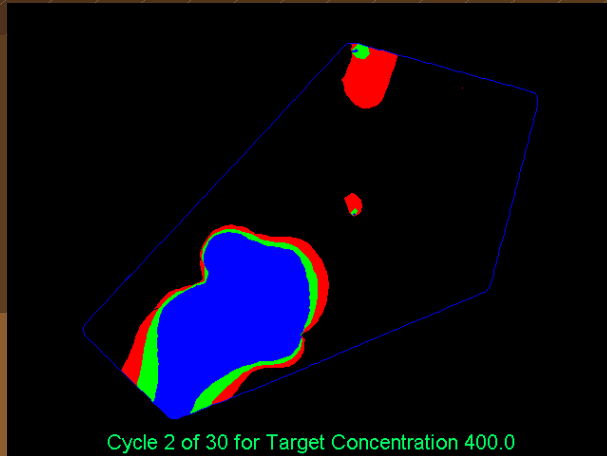
- ◆ Performs baseline analysis using all data
- ◆ Determines statistical variation in plume area (red-max, green-nominal, blue-minimum)

# Results



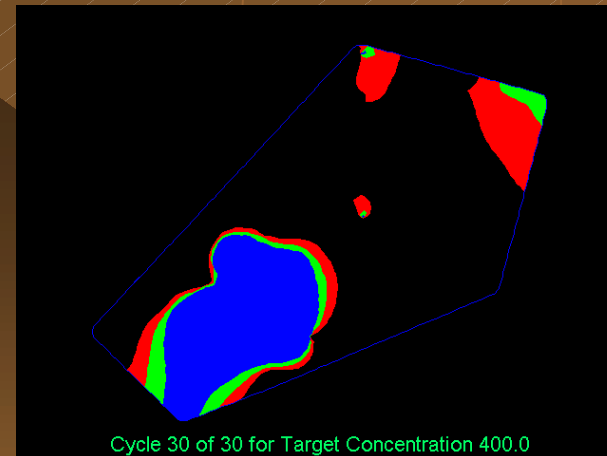
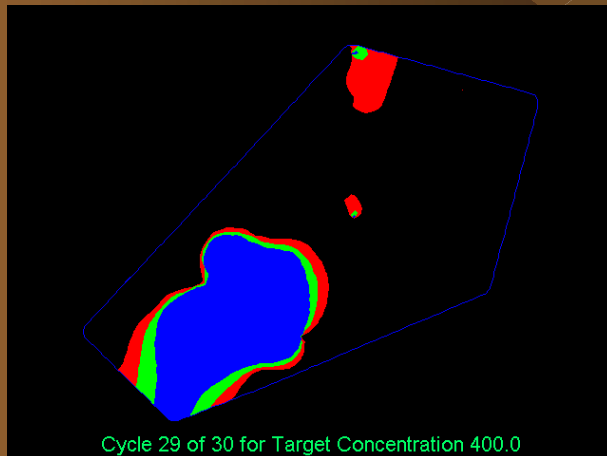
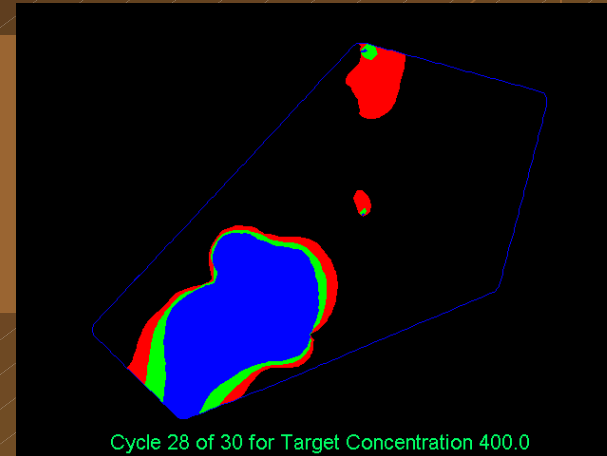
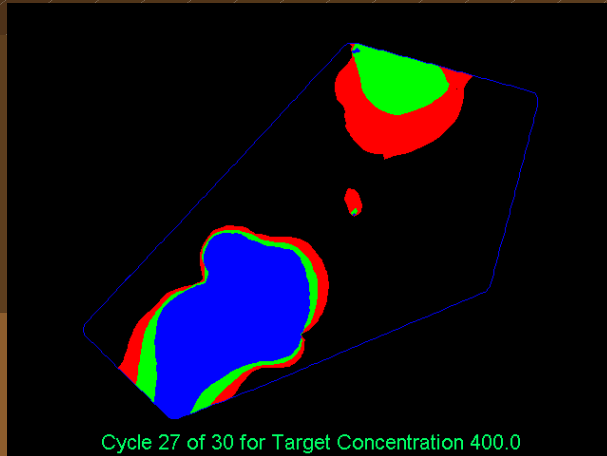
- ◆ Here we see the TCE distributions with the first well removed.

# Results (continued)



- ◆ ...and the 2nd through 5th.

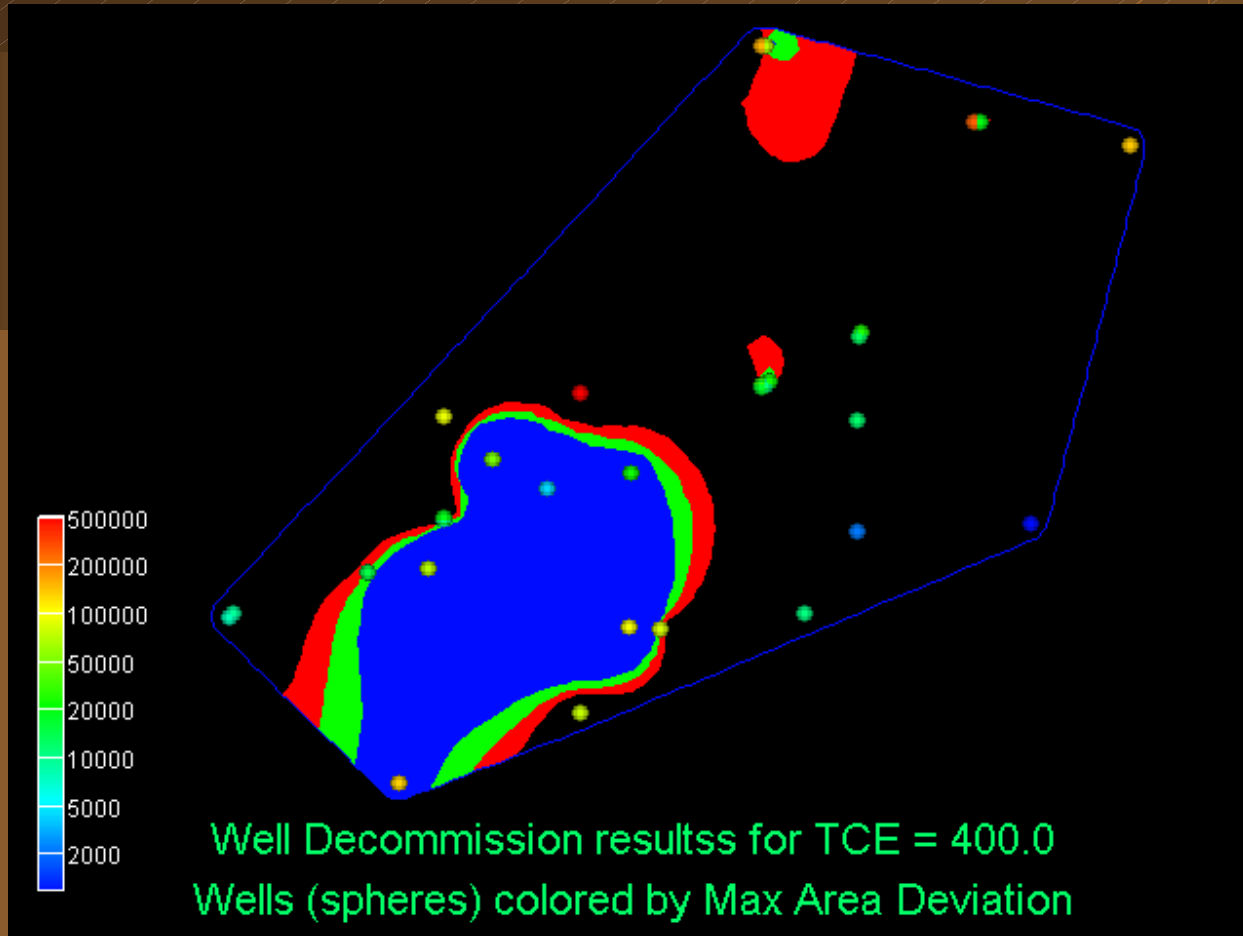
# Results (continued)



- ◆ ...and the 27th through 30th.



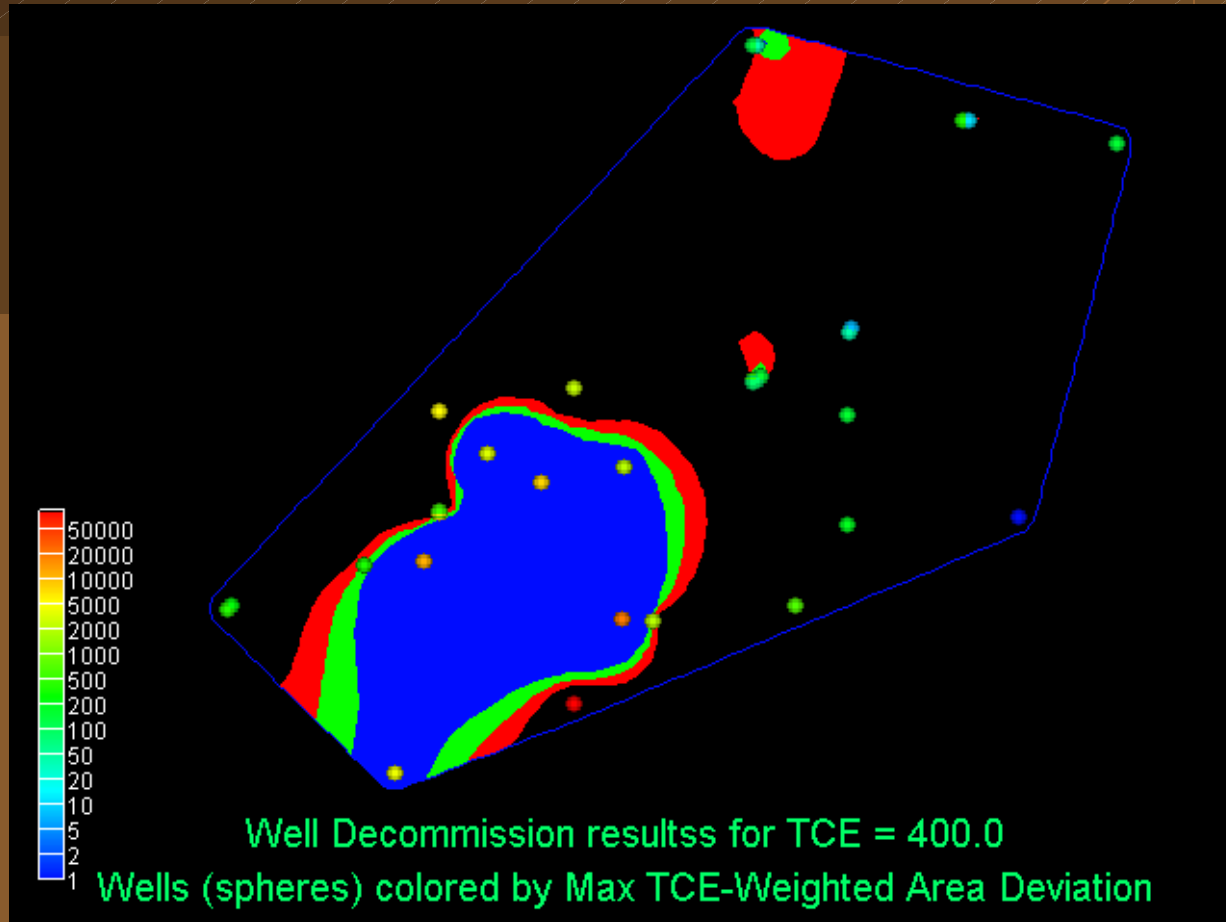
# Final Results



- ◆ The final output screen shows each well colored by its impact on the total site evaluation.

Legend values are in square feet.

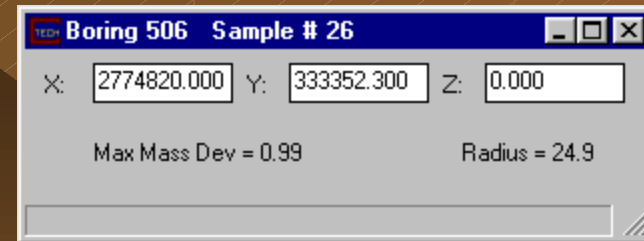
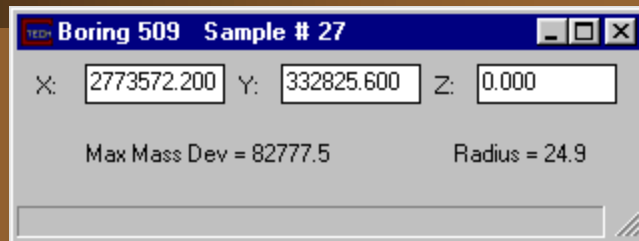
# Final Results (continued)



- ◆ Here the wells are colored by impact on predicted site contaminant area weighted by TCE levels.

Legend values are in square feet times TCE concentration.

# Significant and Insignificant Wells



- ◆ Note the difference in importance between Boring 506 and Boring 509!
- ◆ Boring 506 is a prime candidate for being decommissioned!

# Function and Output (continued)

| Easting<br>Elevation | Northing | Max_Dev     | Dev_of_Min | Dev_of_Nom  | Dev_of_Max  | Max_Mass_Dev | Dev_of_MinMass | Dev_of_NomMass | Dev_of_MaxMass | Well  |
|----------------------|----------|-------------|------------|-------------|-------------|--------------|----------------|----------------|----------------|-------|
| 30 8                 |          |             |            |             |             |              |                |                |                |       |
| 2772601.5            | 333091.7 | 7712.1875   | 4715.375   | 6556.5625   | 7712.1875   | 385.3885     | 53.3683        | 142.1629       | 385.3885       | 501   |
| 2772610.4            | 333100.5 | 9056.8125   | 4067.5     | 5891        | 9056.8125   | 244.1011     | 36.0243        | 93.2116        | 244.1011       | 417   |
| 2772982.4            | 333214.1 | 15410.5     | 3362.5     | 8601.25     | 15410.5     | 339.0013     | 19.497         | 90.0557        | 339.0013       | 410   |
| 2773069.9            | 332631.8 | 133954.9375 | 117973.75  | 133954.9375 | 102679.6875 | 3787.3275    | 505.1796       | 1389.7574      | 3787.3275      | 510   |
| 2773149.9            | 333225.7 | 66315.6563  | 66315.6563 | 26816.25    | 7433.625    | 11094.2833   | 1755.8213      | 4360.1715      | 11094.2833     | 413   |
| 2773192.1            | 333368   | 20042.9375  | 1671       | 6806.8125   | 20042.9375  | 523.4565     | 5.9725         | 104.2514       | 523.4565       | 402   |
| 2773192.5            | 333361.4 | 8460.125    | 8460.125   | 7012.5625   | 5644.375    | 5683.4908    | 887.3185       | 2225.705       | 5683.4908      | 307-8 |
| 2773196.2            | 333647.9 | 90579.1875  | 5174.875   | 16799.25    | 90579.1875  | 4813.269     | 698.0193       | 1827.028       | 4813.269       | 6     |
| 2773326.6            | 333529.3 | 45487.1875  | 45487.1875 | 45241.25    | 22116.875   | 3184.0666    | 802.6611       | 1556.823       | 3184.0666      | 412   |
| 2773480.4            | 333449.2 | 3998.625    | 3057.125   | 779.0625    | 3998.625    | 7533.7011    | 744.2657       | 2431.8874      | 7533.7011      | 411   |
| 2773570.2            | 333713.2 | 464434.75   | 44003.8125 | 194599.6875 | 464434.75   | 2495.9918    | 423.2028       | 1063.0164      | 2495.9918      | 305-S |
| 2773572.2            | 332825.6 | 72971.25    | 72971.25   | 39625.375   | 20408.375   | 82777.4915   | 9112.0425      | 27193.6758     | 82777.4915     | 509   |
| 2773708.8            | 333065.2 | 96146.9688  | 96146.9688 | 57479.6875  | 34675.1875  | 20115.989    | 3469.7635      | 8199.668       | 20115.989      | 406   |
| 2773713.9            | 333494.8 | 24279.75    | 24279.75   | 23357.3125  | 4114.6875   | 2196.0684    | 441.1689       | 985.0665       | 2196.0684      | 306   |
| 2773797.1            | 333060.9 | 79827.625   | 38281.1875 | 63385.25    | 79827.625   | 2194.5692    | 562.5733       | 1117.5803      | 2194.5692      | 405   |
| 2774073.1            | 333738.4 | 32259.5625  | 1888.375   | 3915.5      | 32259.5625  | 441.5857     | 74.3096        | 182.4266       | 441.5857       | 403   |
| 2774073.7            | 334671.8 | 155261.6875 | 1800.75    | 32134.25    | 155261.6875 | 139.1616     | 0.8392         | 17.2493        | 139.1616       | 503-S |
| 2774076.5            | 333728.3 | 18749.0625  | 10463.1875 | 18749.0625  | 6570.875    | 84.6152      | 4.692          | 7.8152         | 84.6152        | 415   |
| 2774085.3            | 333736.6 | 10911.625   | 89.6875    | 863.375     | 10911.625   | 86.5976      | 13.2951        | 32.3635        | 86.5976        | 303-S |
| 2774087.2            | 334674.8 | 64809.5     | 408.0625   | 6232.125    | 64809.5     | 39.9442      | 0.1864         | 3.0341         | 39.9442        | 503-D |
| 2774094.7            | 333745.8 | 24116.8125  | 279.75     | 2408.375    | 24116.8125  | 171.4115     | 34.8032        | 78.7722        | 171.4115       | 303-D |
| 2774194.8            | 333100.9 | 10774.5625  | 112.1875   | 1341.125    | 10774.5625  | 646.0969     | 100.2245       | 253.8854       | 646.0969       | 408   |
| 2774338.3            | 333327.8 | 2291.75     | 144.125    | 1704.75     | 2291.75     | 207.4173     | 30.9924        | 78.7436        | 207.4173       | 300   |
| 2774341.9            | 333638.3 | 12021.625   | 315.375    | 1523.125    | 12021.625   | 164.3233     | 27.7484        | 67.8932        | 164.3233       | 302   |
| 2774344.3            | 333870.5 | 13161.75    | 285.4375   | 766.6875    | 13161.75    | 38.6314      | 8.1736         | 19.4253        | 38.6314        | 502   |
| 2774352.8            | 333882   | 26187.8125  | 967.5625   | 4.1875      | 26187.8125  | 7.5059       | 1.1213         | 2.4146         | 7.5059         | 416   |
| 2774664.2            | 334463.8 | 263568.75   | 456.9375   | 137341.6875 | 263568.75   | 356.5466     | 0.2104         | 80.2273        | 356.5466       | 504-D |
| 2774677              | 334462.1 | 20480.625   | 16.375     | 494.9375    | 20480.625   | 11.4954      | 0.0072         | 0.2888         | 11.4954        | 504-S |
| 2774820              | 333352.3 | 1187.0625   | 33.125     | 888.125     | 1187.0625   | 0.9933       | 0.0148         | 0.4147         | 0.9933         | 506   |
| 2775092.1            | 334397.8 | 138322.3125 | 77.1875    | 22677.5     | 138322.3125 | 160.5222     | 0.0348         | 9.5631         | 160.5222       | 505   |

- ◆ Tabular output for all 8 quality measures is provided.

# Well Decommission Conclusion

- ◆ Well decommission technology provides a justifiable approach for determining candidate wells for decommissioning.
- ◆ *Well Decommission* can save thousands of dollars per year for each well identified for decommission.
- ◆ *Well Decommission* is one of many capabilities in EVS-PRO