

# **Soil and Water Contamination Remediation Using 3D Modeling in ArcGIS**

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Stanley Consultants, Inc.**

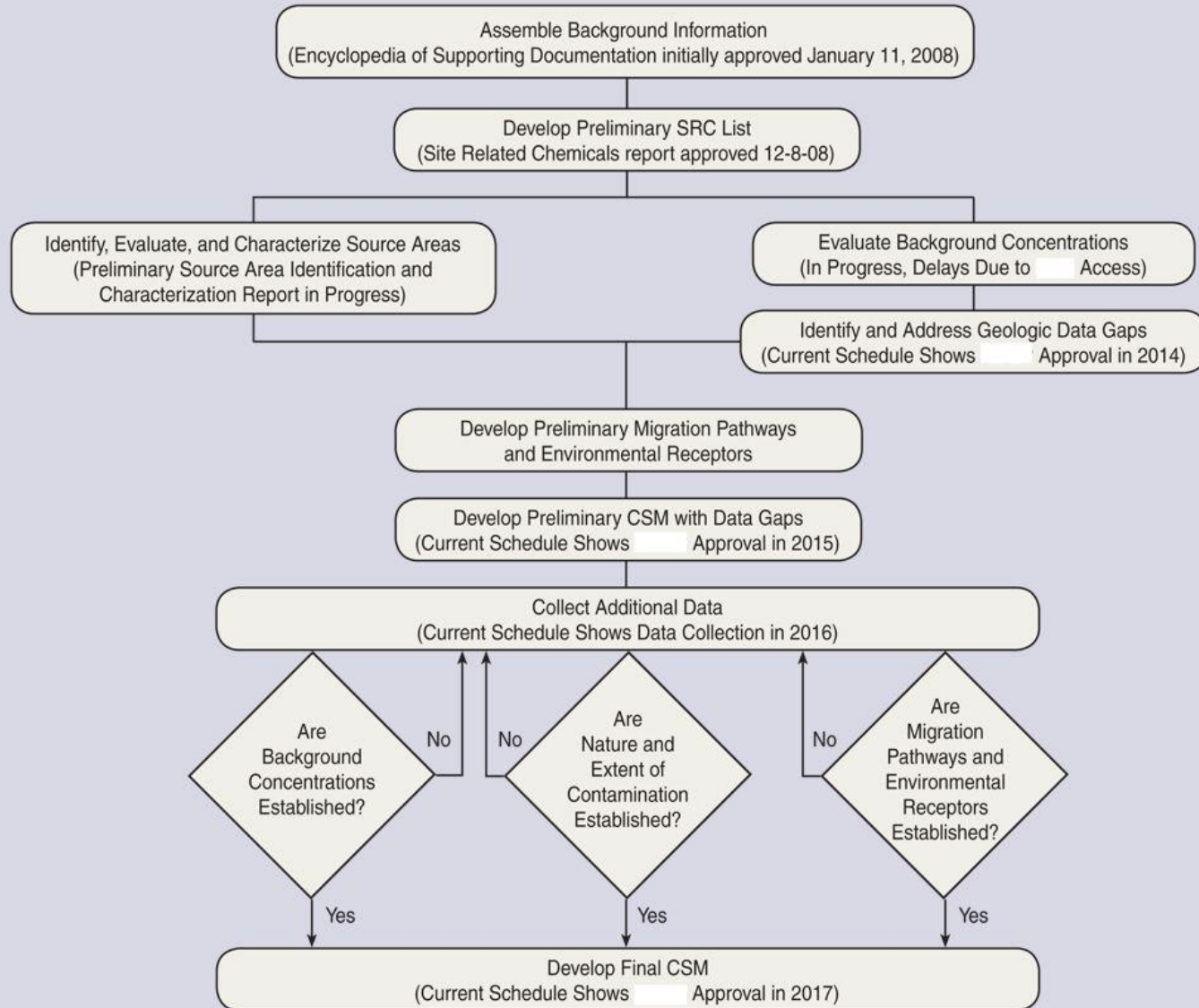


# Project Background

- **Administrative Order on Consent (AOC) proposed by state regulatory department because of significant known soil and groundwater contamination from past activities at coal-fired power plant**
  - Provides legal framework for completing long-term efforts to investigate and address site contamination and remediation
  - Identify potential pathways & receptors for pollutants
- **Develop Conceptual Site-Wide Model (CSM)**
  - Visualize spatial characteristics of site (3D view)
  - Identify geologic data gaps



# CSM Flow Diagram and Schedule



# Environmental Data Management System

- **Data type: groundwater, surface water, soil, solids**
- **Data flow: collection, quality control, storage / management, analysis, reporting**
- **~300 sampling locations actively gauged/sampled four times a year**
- **~50 data points (field notes) recorded for each sampling location in field**
- **~30 lab tests per sampling location**
- **~200,000 unique data measurements in water monitoring database**
- **~25,000 in soil monitoring database (300k Hydraulic Profiling Tool measurements)**



# GIS Tools

- **ESRI ArcGIS (Advanced) platform**
  - 3D Analyst
  - ArcScene
  - Move into ArcGIS Pro – Local Scene
- **MS Access custom databases (personal GDBs)**
- **Shapefiles, file geodatabases, GRIDs, DWGs**
- **CrossView TM extension - for 2D cross-section layouts)**
- **Environmental Visualization System (EVS) Pro - for plume modeling, on-the-fly fence diagrams, inputs to groundwater flow modeling, inputs to 2D mapping in ArcGIS**



# Metadata / Documentation

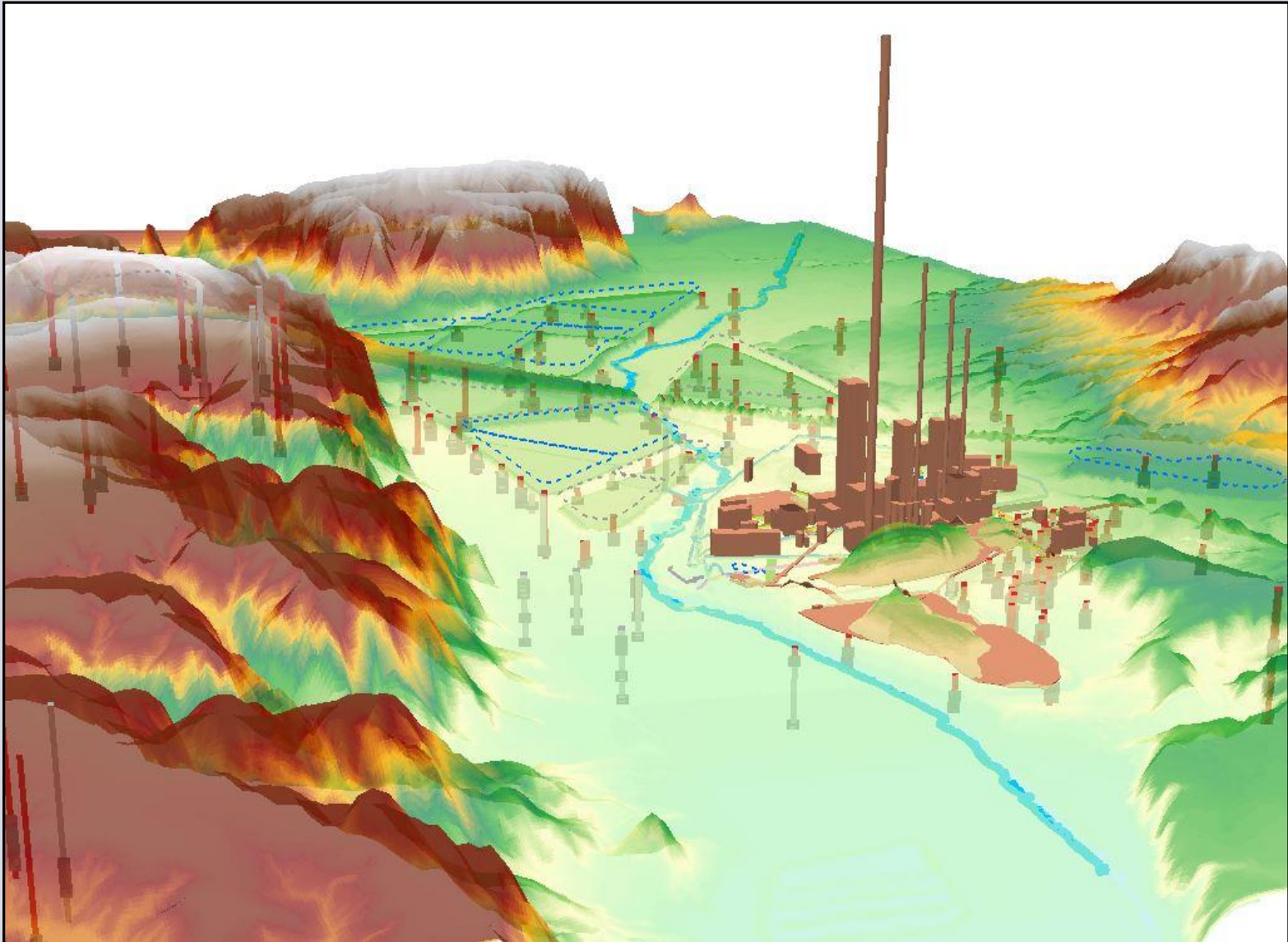
Layer	File Name	File Type	Reference
Wells	CSMWells5.shp	Point Shapefile	Surveys
Screened Intervals	CSMWells5.shp	Point Shapefile	Various boring logs
Springs (depths unknown)	DewateringWellsAndSprings.shp	Point Shapefile	Field reconnaissance
Dewatering Wells (depths unknown)	DewateringWellsAndSprings.shp	Point Shapefile	Field reconnaissance
Ash Trench (1965)	PlantUtilities_AshTrench.shp	Line Shapefile	STOR402738545-1
Ash Line Trench (1967)	PlantUtilities_AshLineTrench.shp	Line Shapefile	STOR425009806-1
Diesel Piping 1.5" 502 Unit 1 (1965)	PlantUtilities_Diesel502Unit1.shp	Line Shapefile	STOR402738545-1
Diesel Piping 1.5" 502 Unit 2 (1965)	PlantUtilities_Diesel502Unit2b.shp	Line Shapefile	MHOE14
Diesel Piping 1.5" 503 (1965)	PlantUtilities_Diesel503.shp	Line Shapefile	STOR402738545-1
Diesel Piping 2" 504 (1965)	PlantUtilities_Diesel504.shp	Line Shapefile	STOR402738545-1
Diesel Piping 4" 501 (1965)	PlantUtilities_Diesel501.shp	Line Shapefile	STOR402738545-1
Fiber Optic Trunk Lines (1999)	PlantUtilities_FiberOptic2Int.shp	Line Shapefile	RGS-025

## o Utilities (Line)

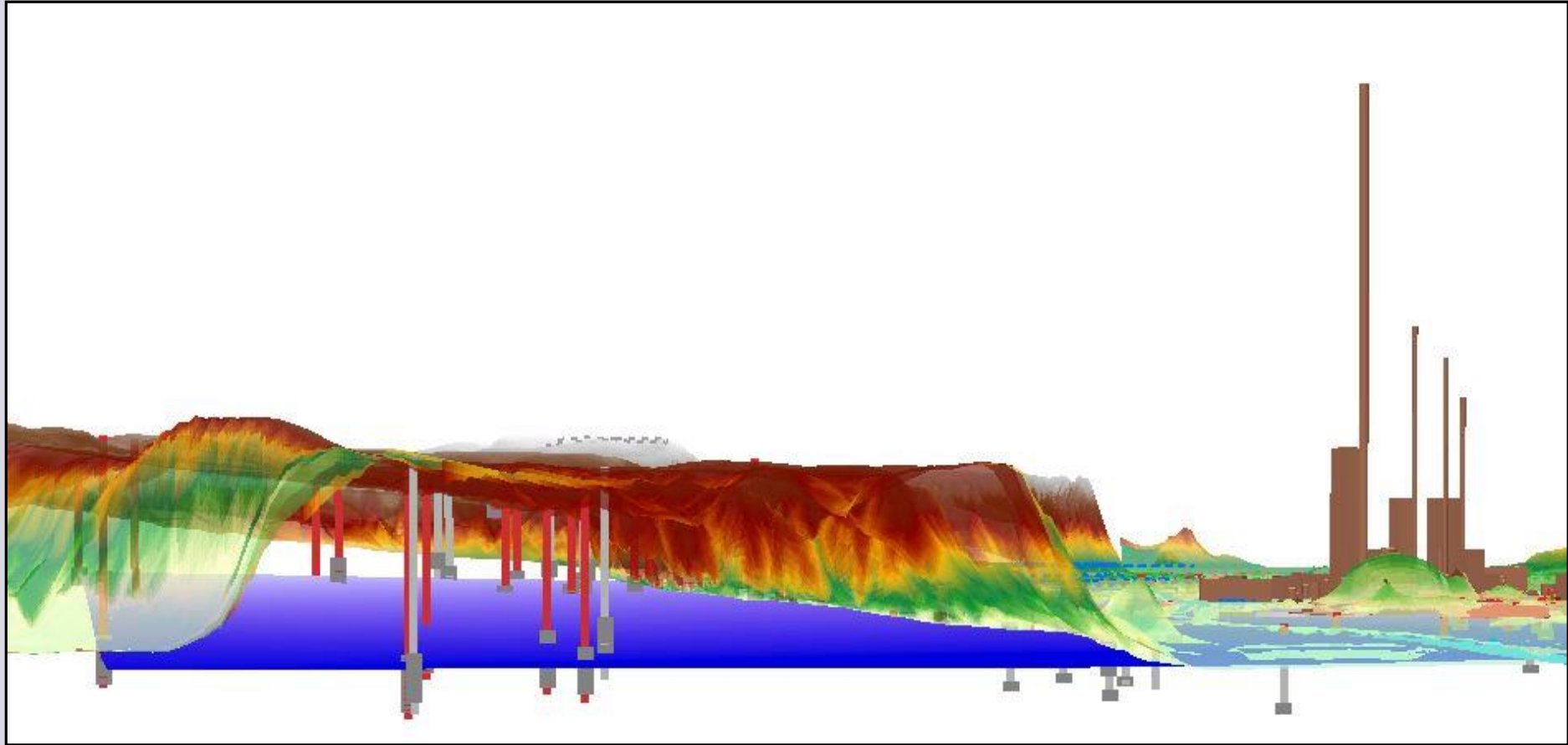
- Priority = Medium
- Action Item
  - Utilities include: ash trench, diesel piping, fiber optic trunk lines, hopper tunnel (reclaim and train), potable water piping, process wastewater piping, sanitary sewer piping
- Metadata
  - *From drawings, scaled off known reference points in order to obtain distances for linework; digitized lines using drawings, 2009 aerial, and existing "structures" polygon dataset in GIS; recorded elevations, if available.*
  - *If lines had recorded slopes in drawings, then created point dataset with elevations, and Kriging interpolation method to create 1-foot raster grid; assigned elevations to line using the interpolated grid with Interpolate Shape tool (i.e. PolylineZM feature)*



# 3D Visualization

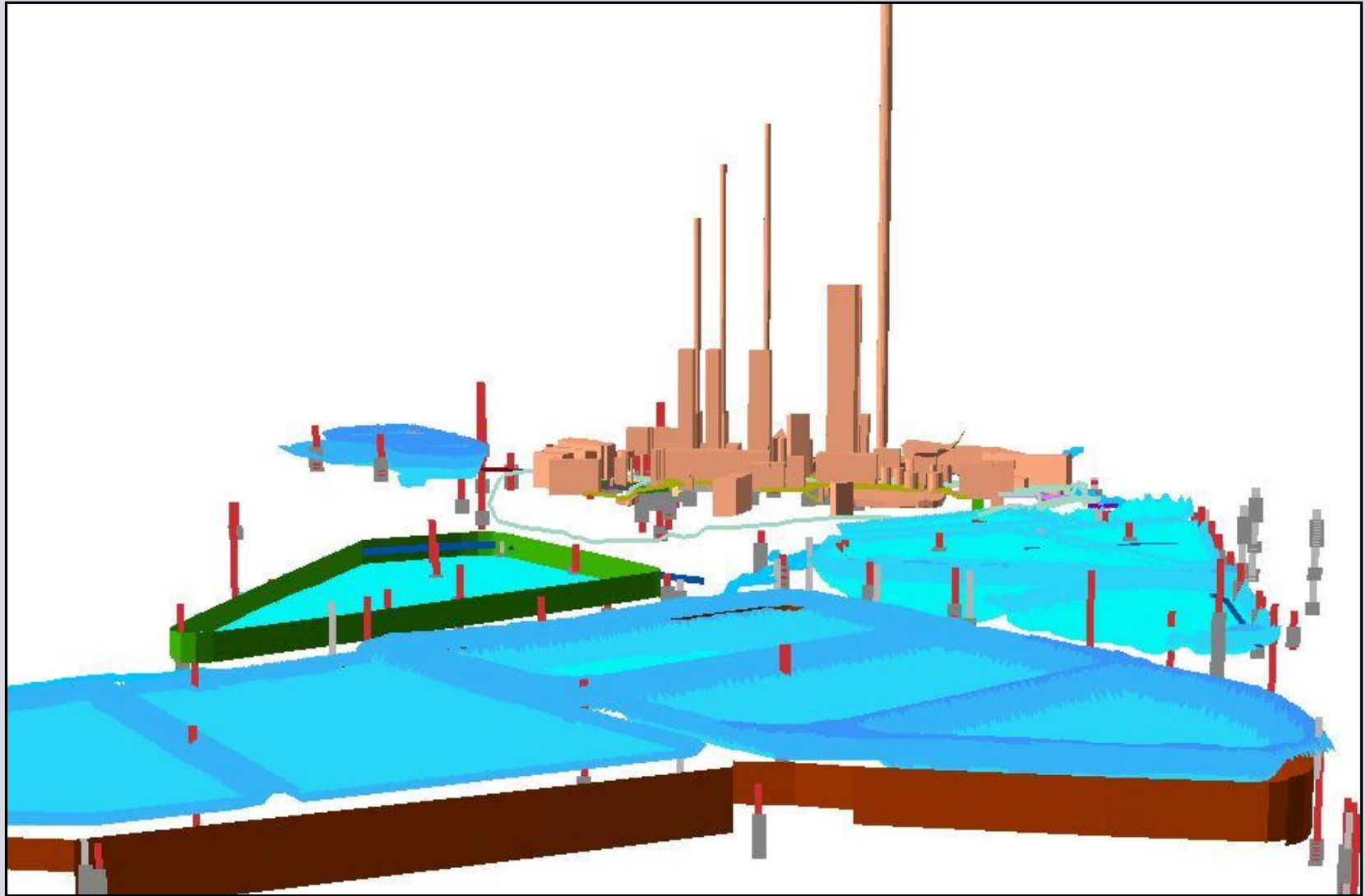


# Groundwater Elevation Surface

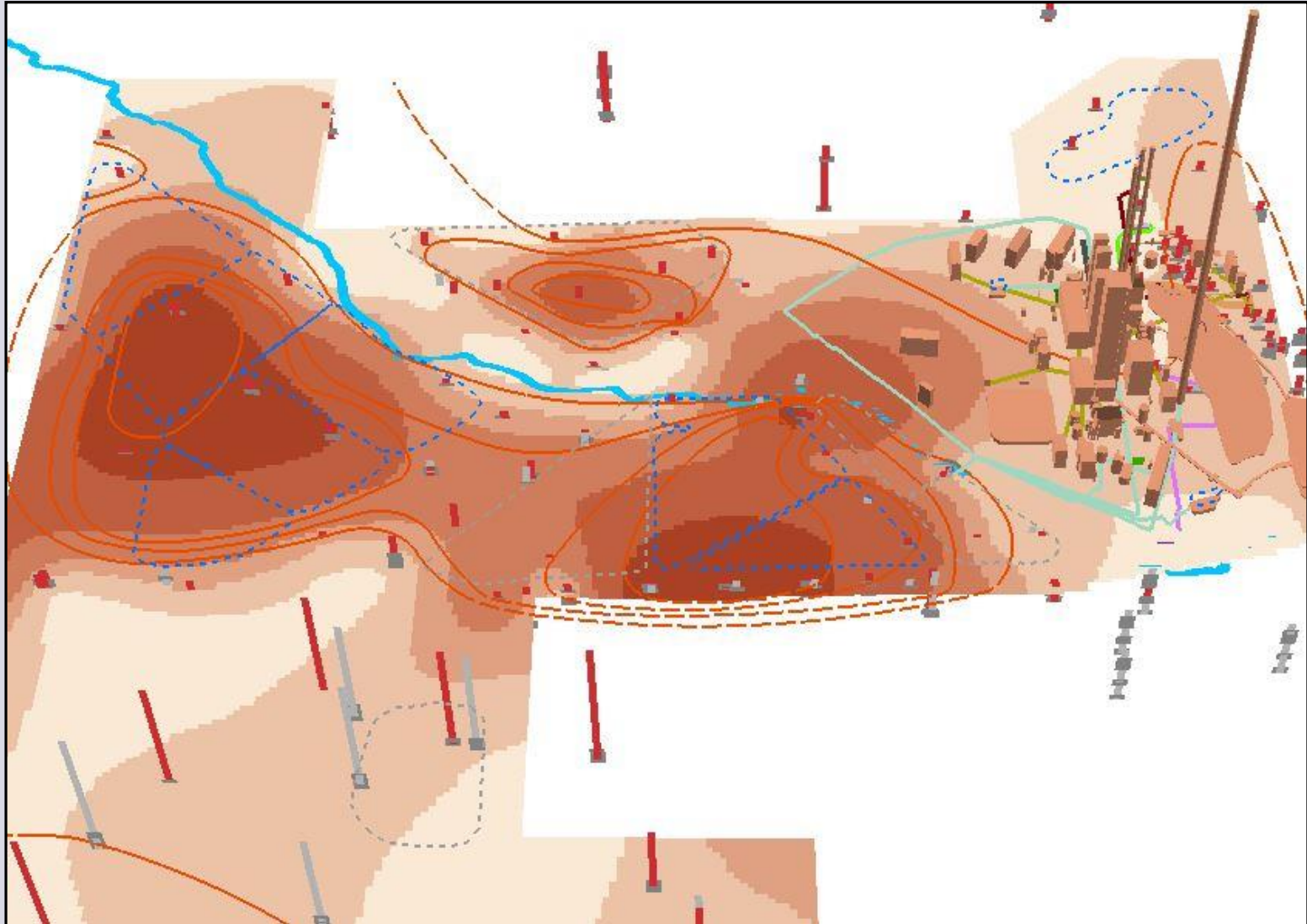




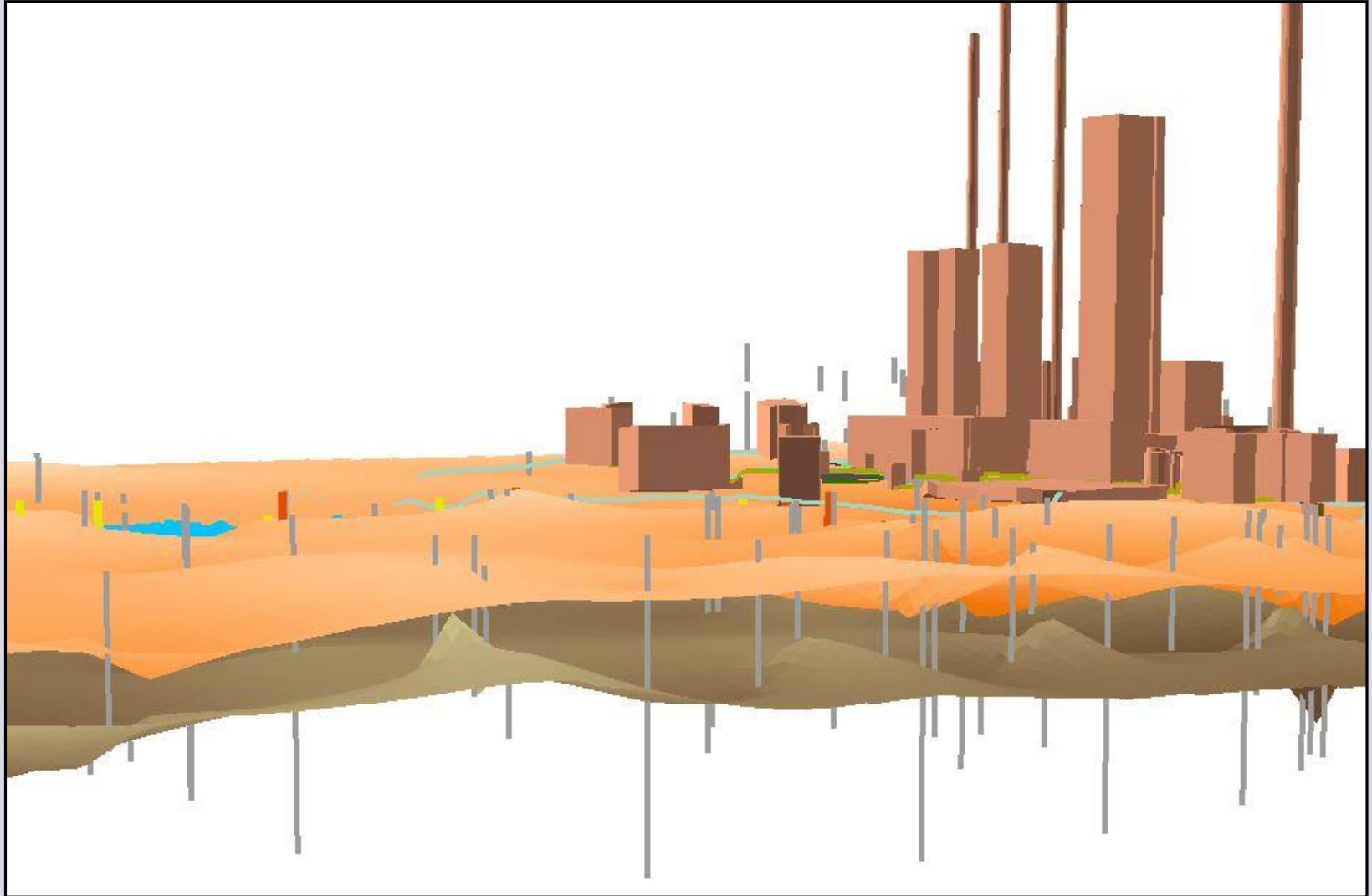
# Pond Bottom Elevation Surfaces



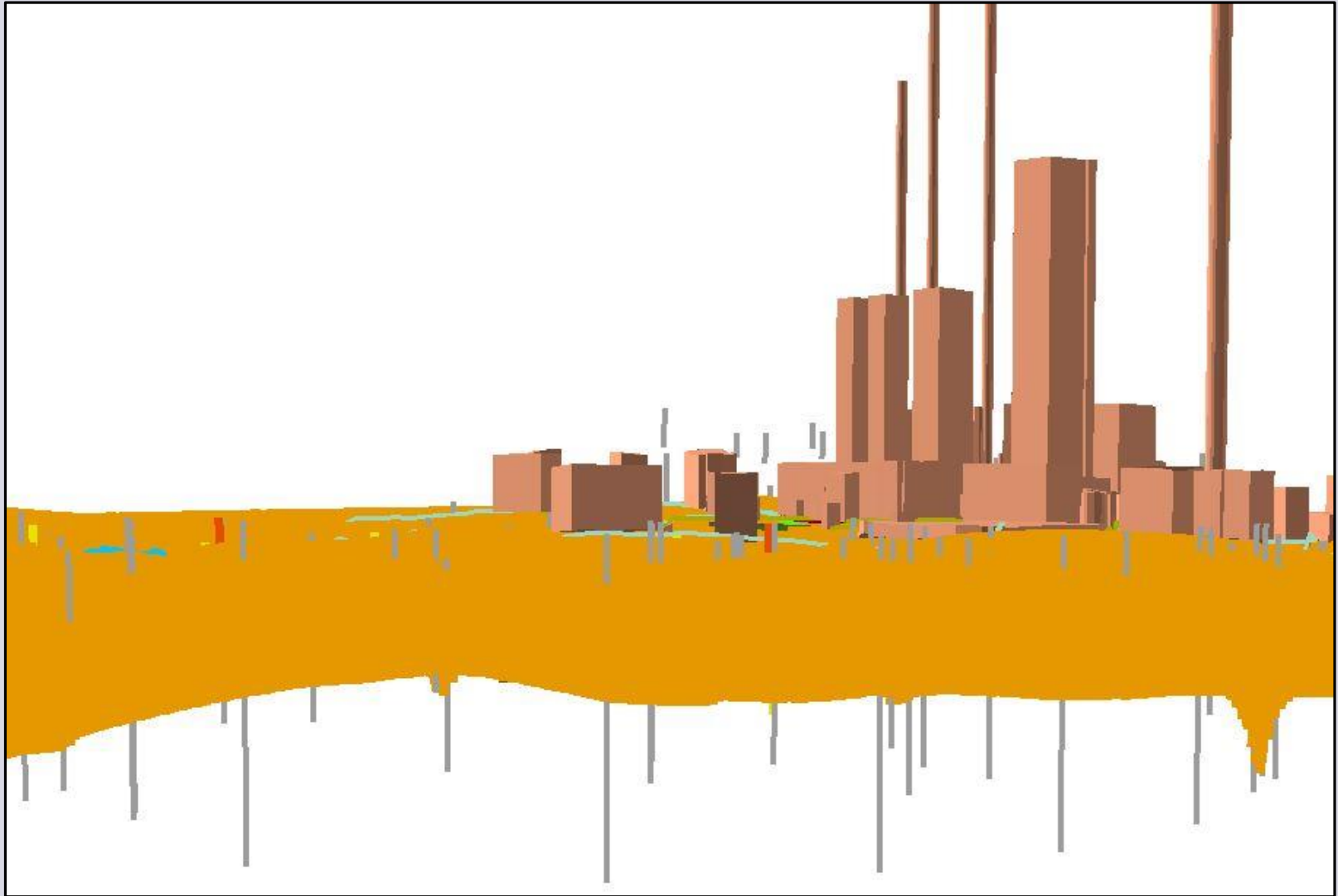
# Total Dissolved Solids Elevation Contours



# Clay Borings and Elevation Surfaces



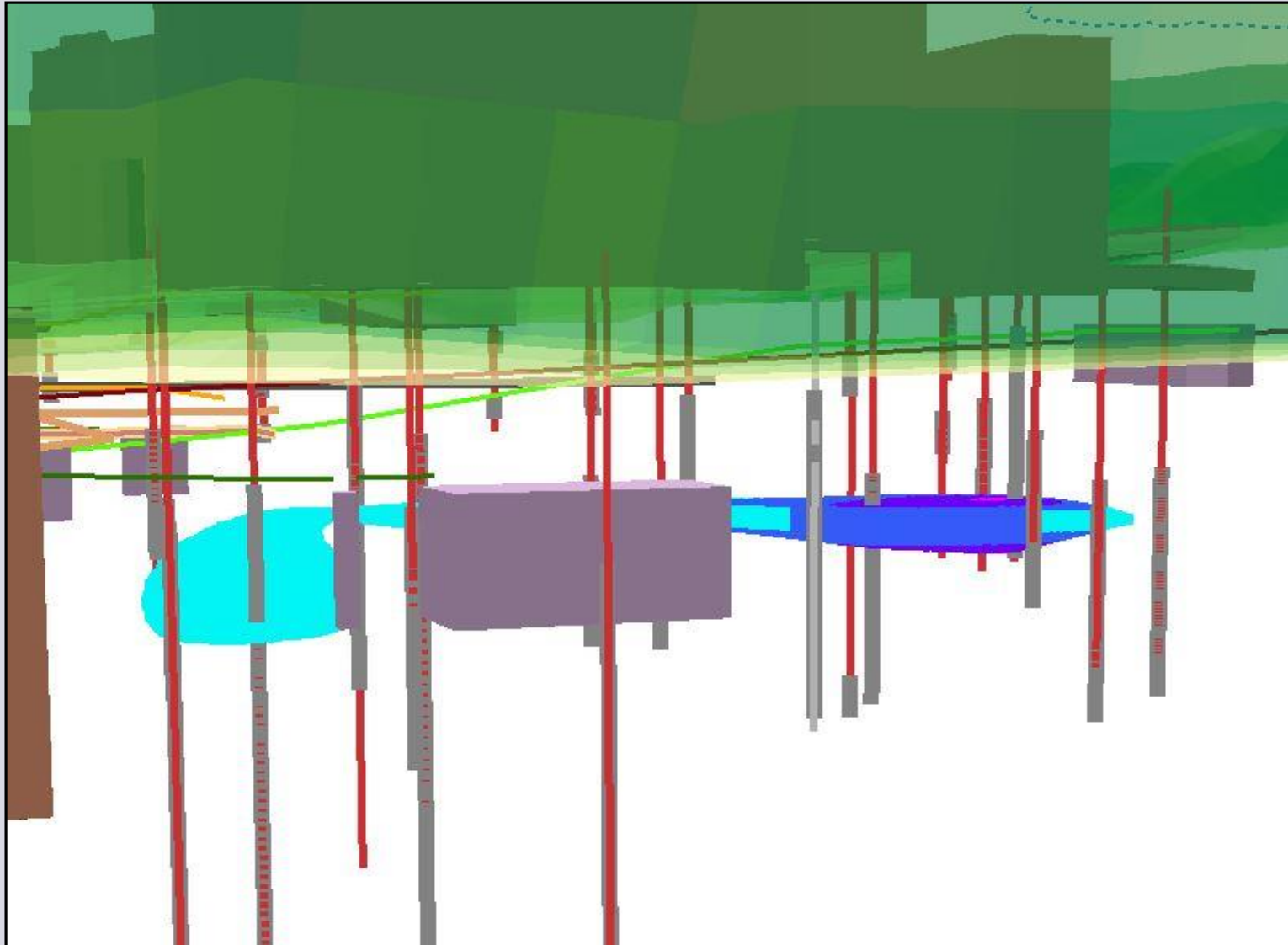
# Clay Thickness



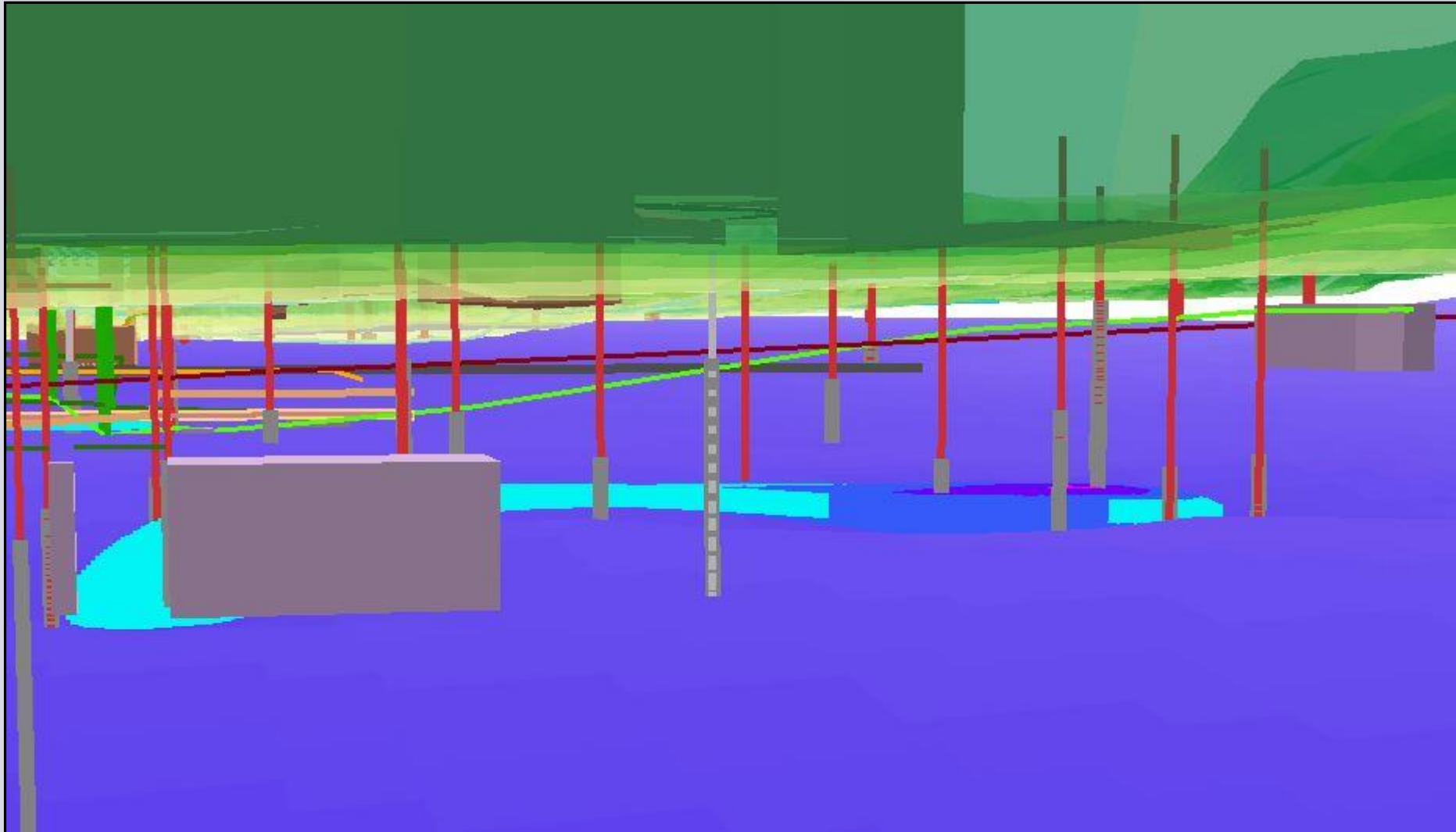
# Diesel Product Plume



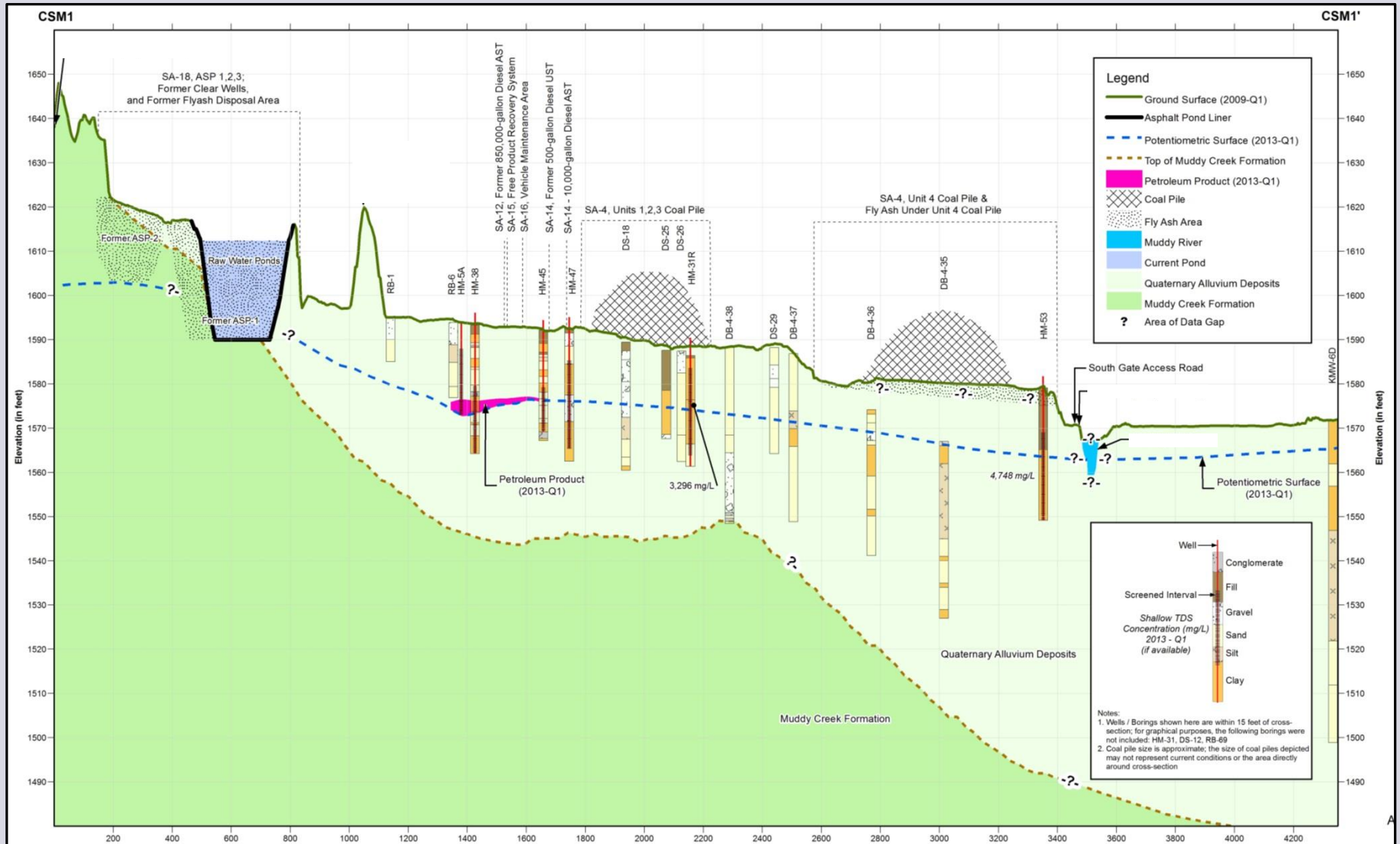
# Diesel Product Plume (Side View)



# Diesel Product Plume (Side View) with GWE

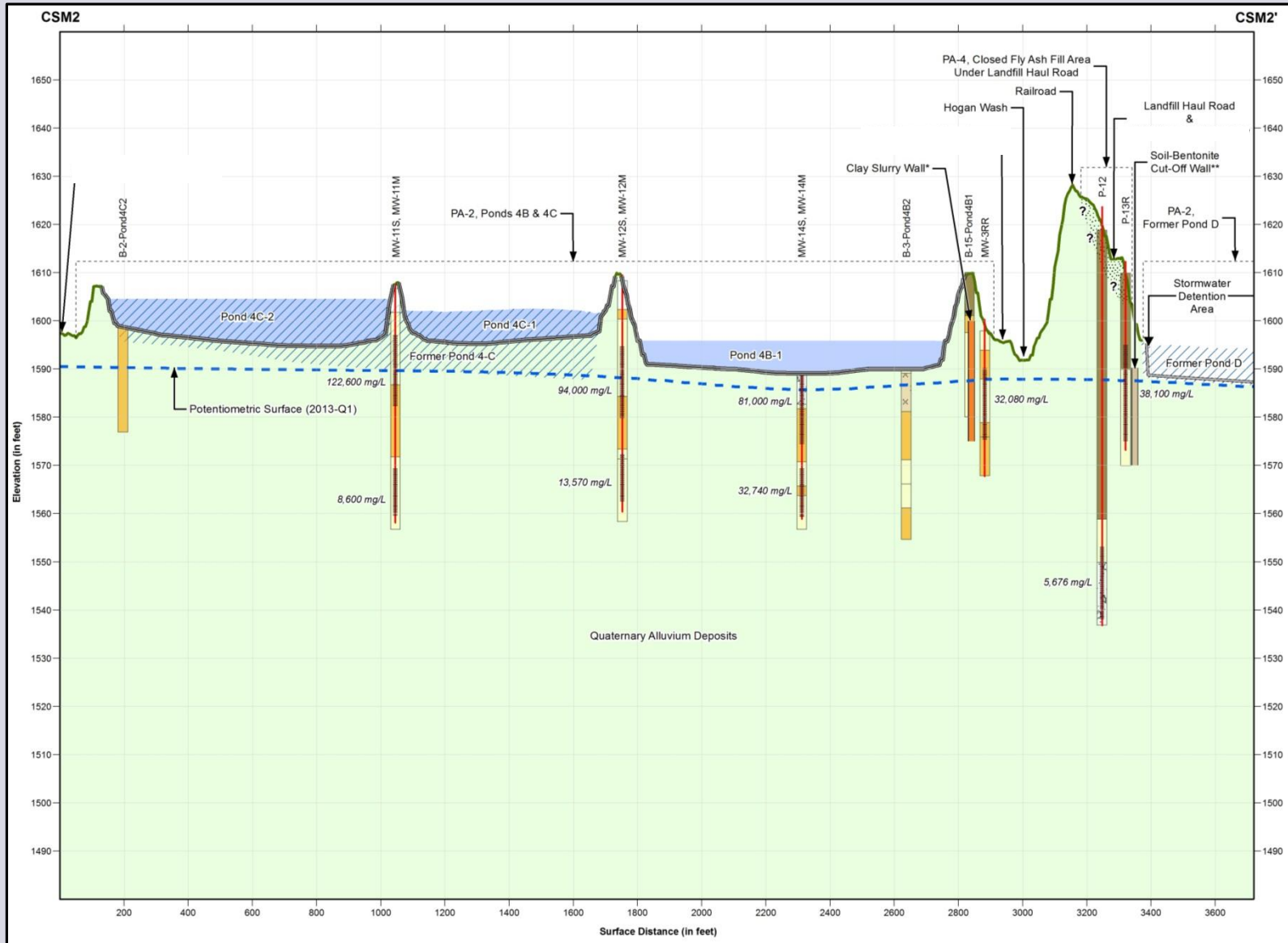


# Geologic Cross-Sections





# Geologic Cross-Sections (3D to 2D)

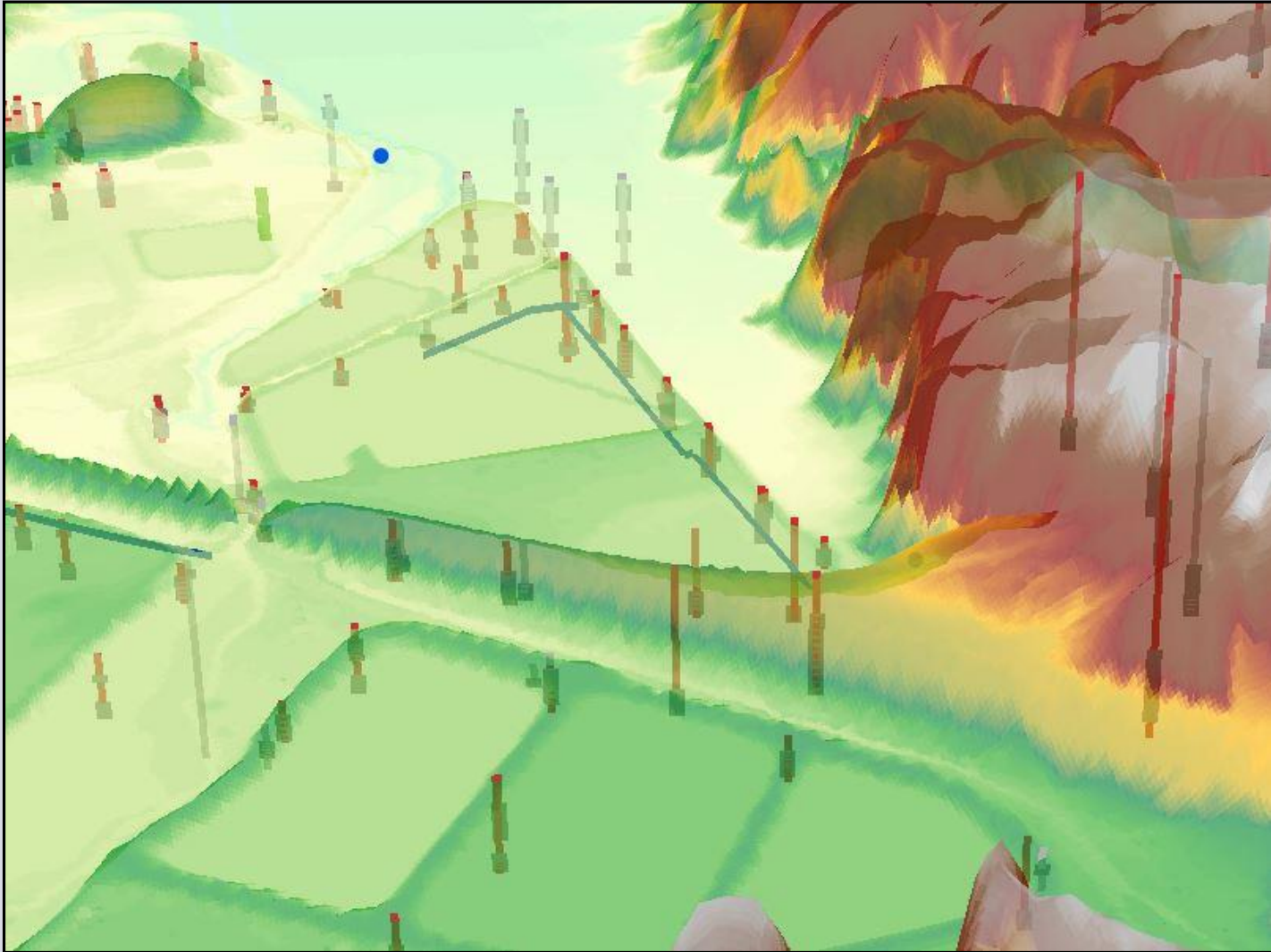


# 3D Model How To

**Create 3D Groundwater Trench with ArcGIS**

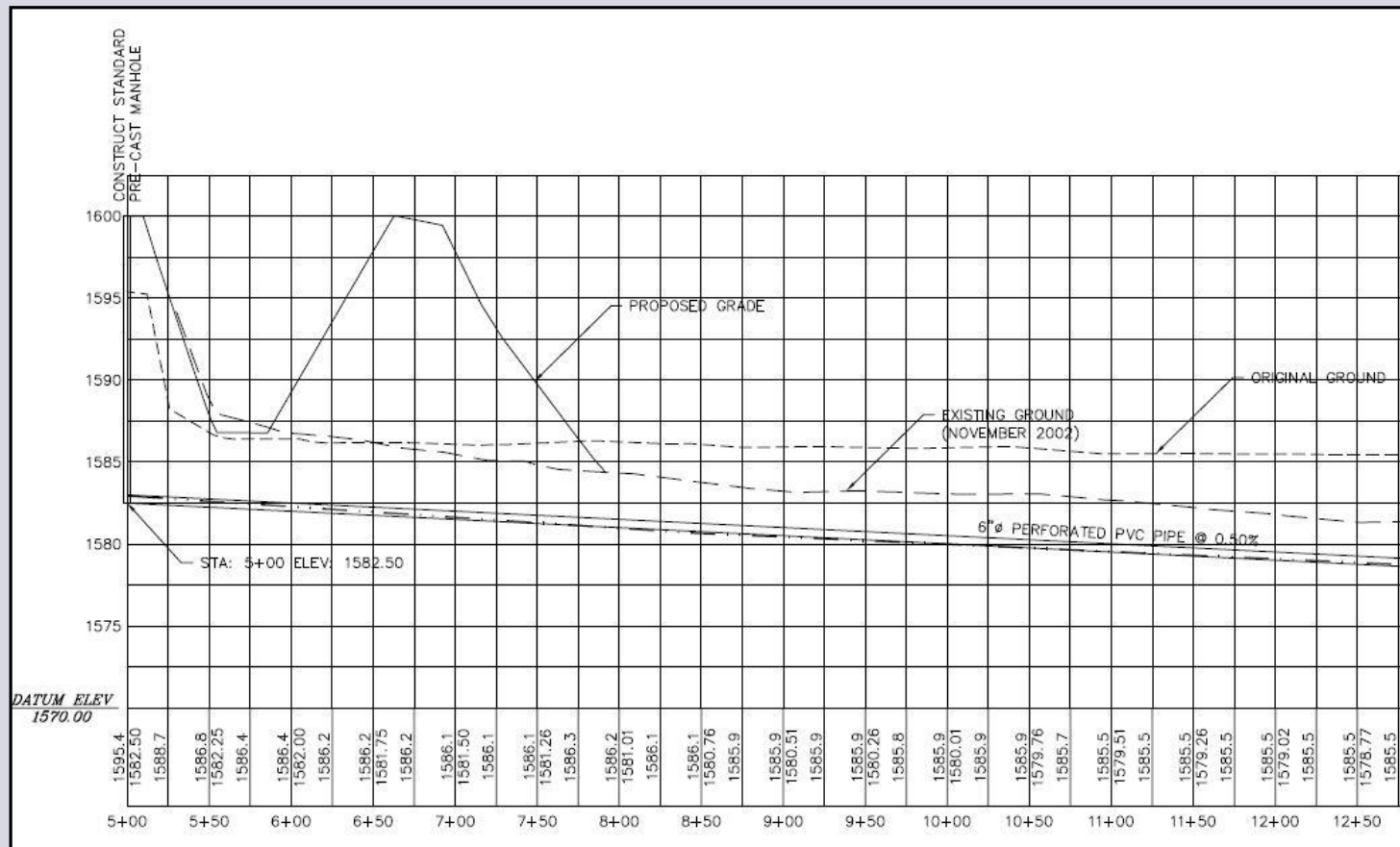


# Groundwater Trench Under Pond (top view)



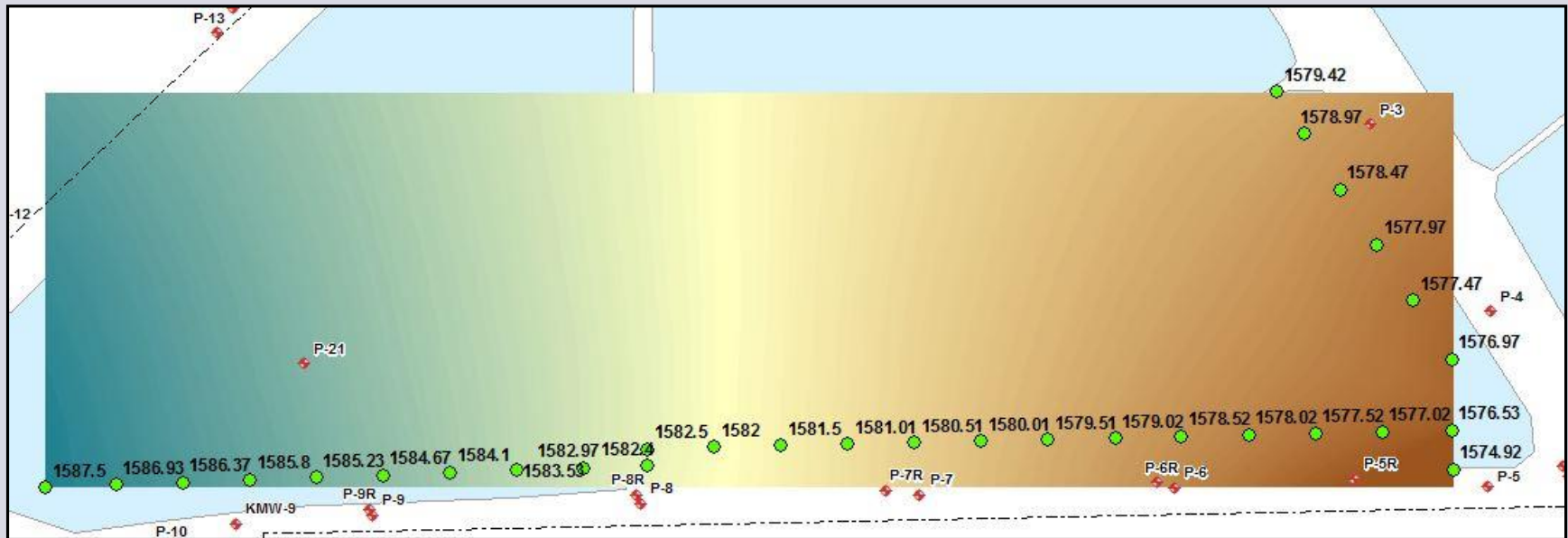
# Create Groundwater Trench in 3D

- Digitize GIS line from engineering drawings
- Digitize GIS points along line and record elevations



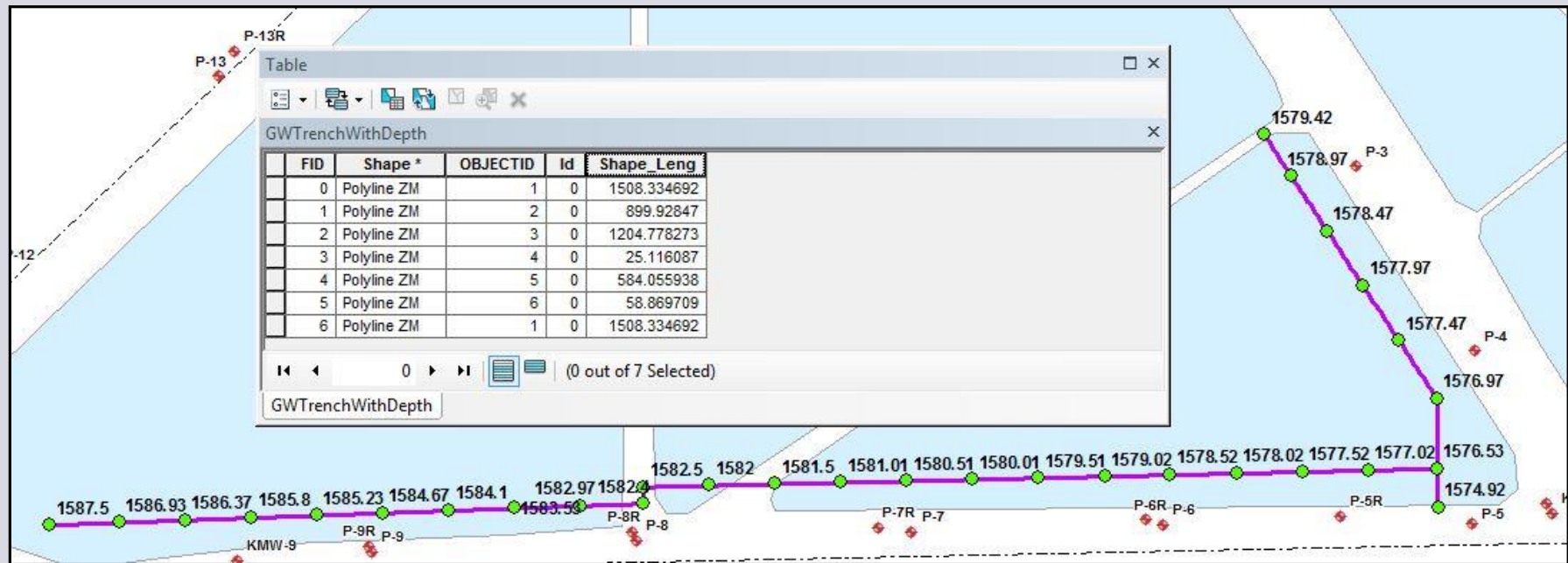
# Create Groundwater Trench in 3D

- Build interpolated grid surface from points
- Spatial Analyst – Interpolation – Spline, Kriging, IDW
- Quality check = Cross-Validation (Geostatistical Analyst)



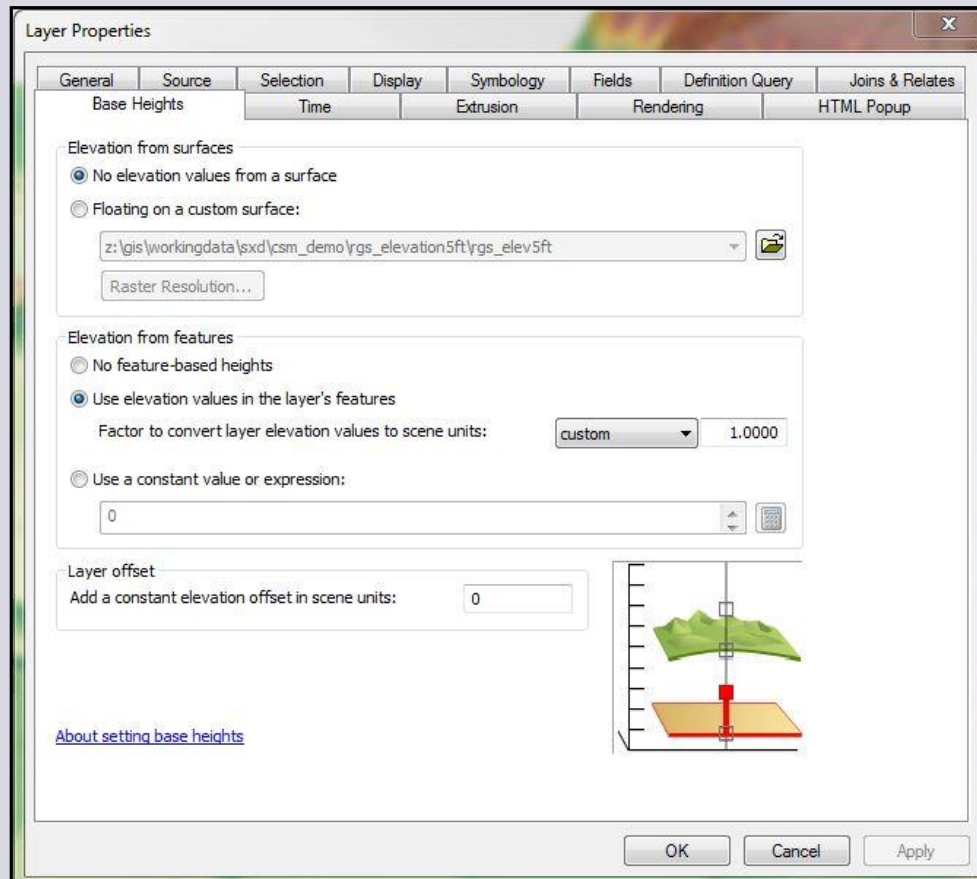
# Create Groundwater Trench in 3D

- Assign z-values (elevation) to line using new grid
- 3D Analyst Toolbox – Functional Surface – Interpolate Shape

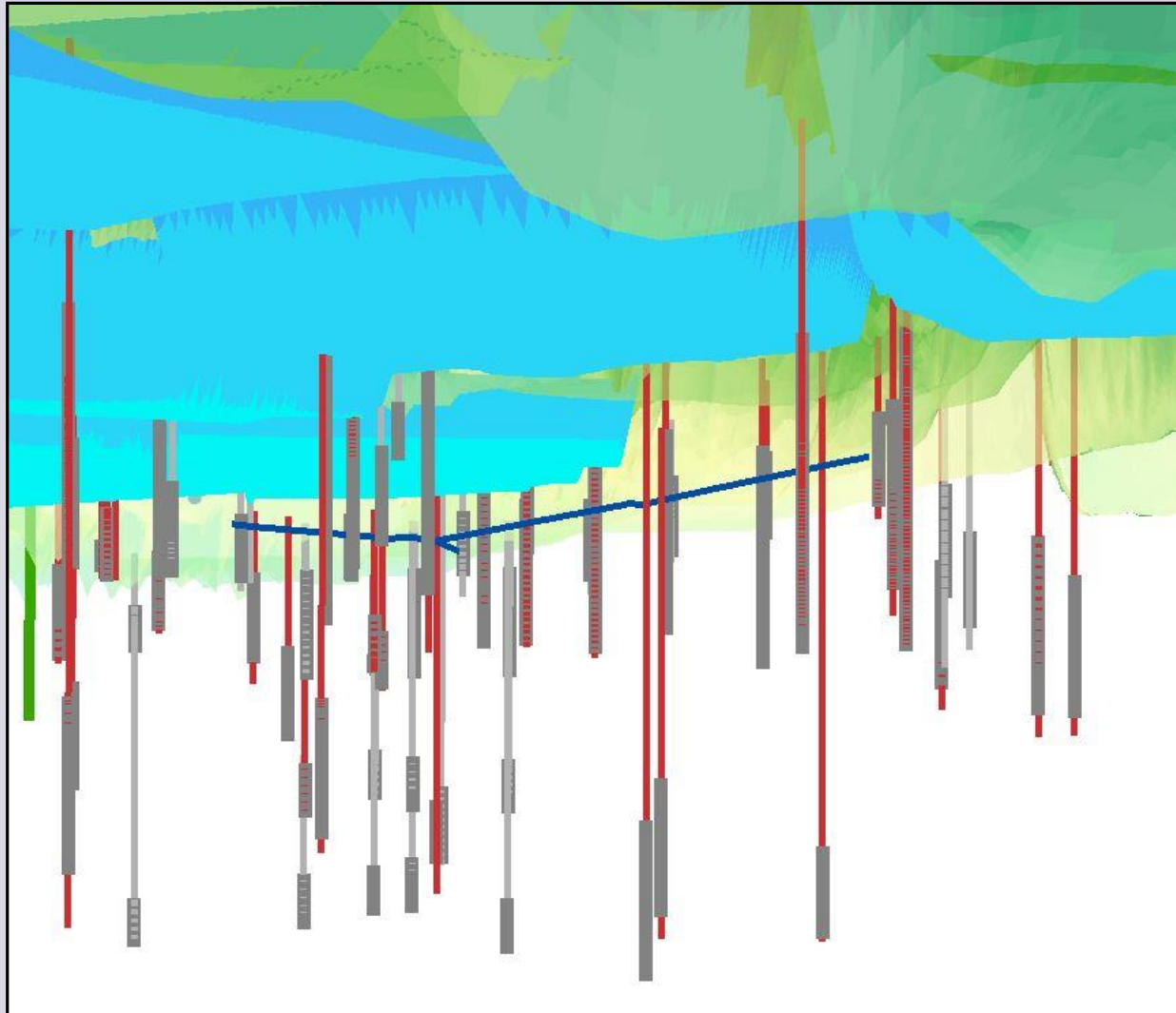


# Create Groundwater Trench in 3D

- Add new polyline-z layer to ArcScene map
- No base heights or extrusion needed for z layer



# Groundwater Trench (bottom view)



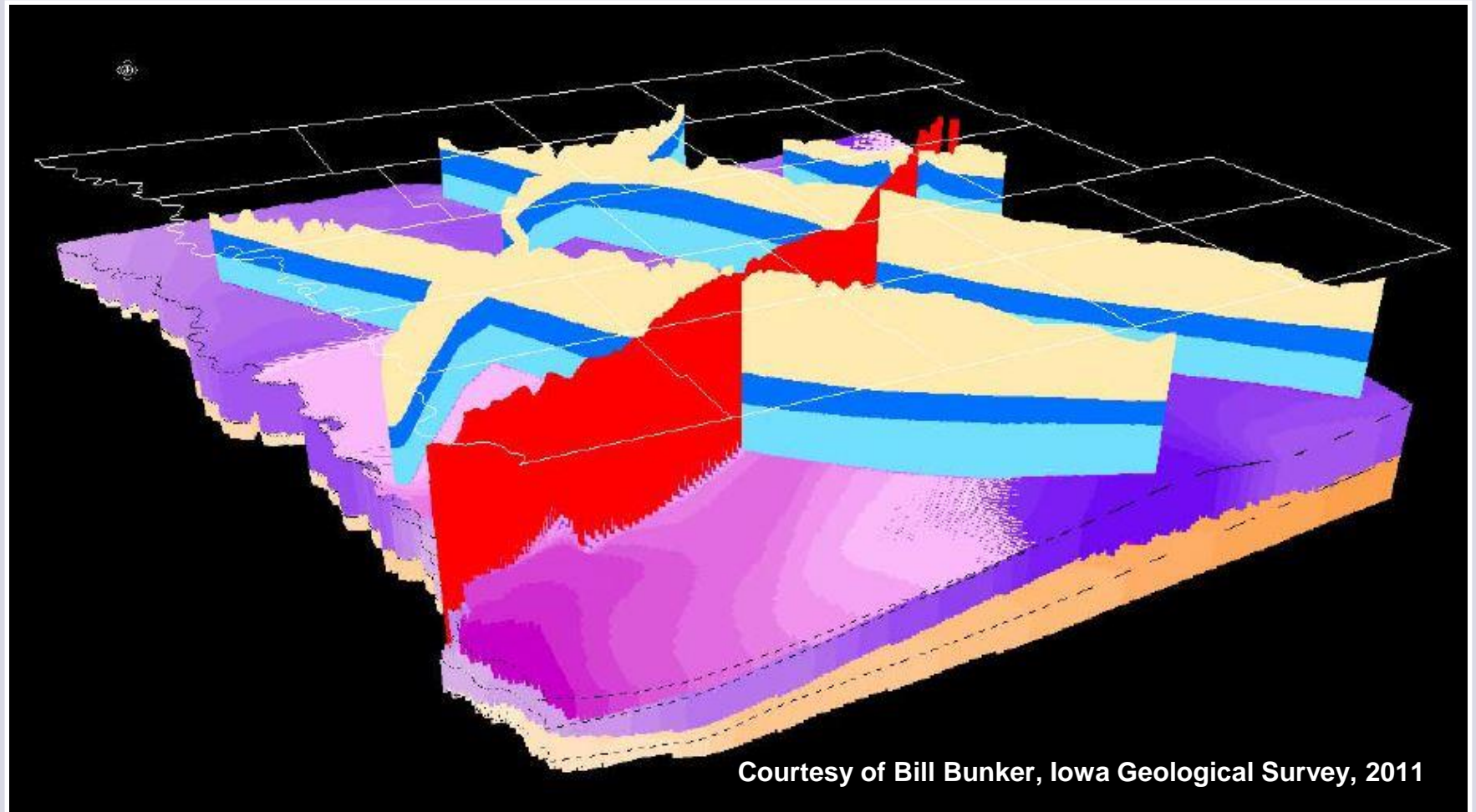


# 3D Model How To

**Build 3D Geologic Fence Diagram with ArcGIS  
(see Conference Proceedings)**

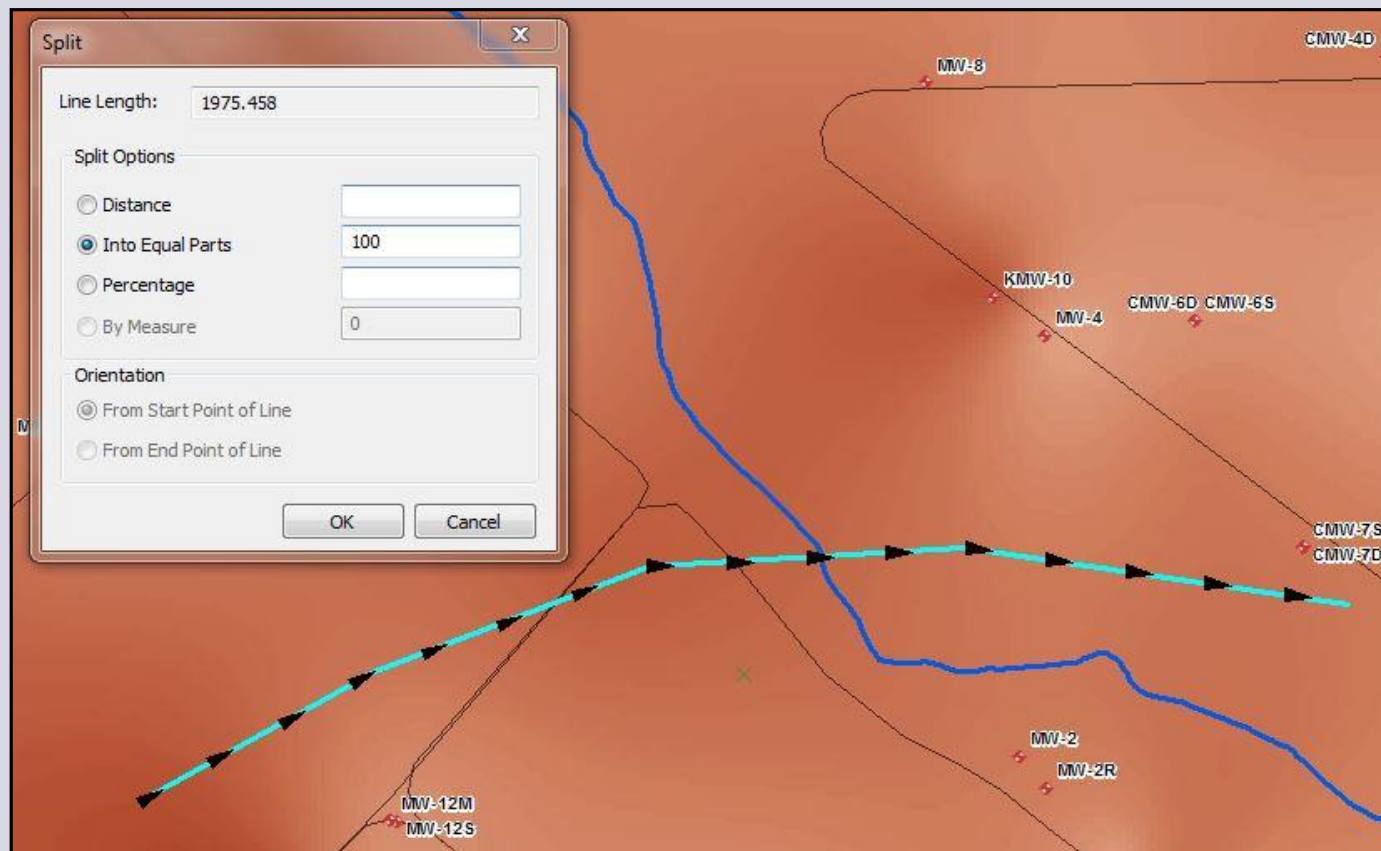


# Fence Diagram (top view)



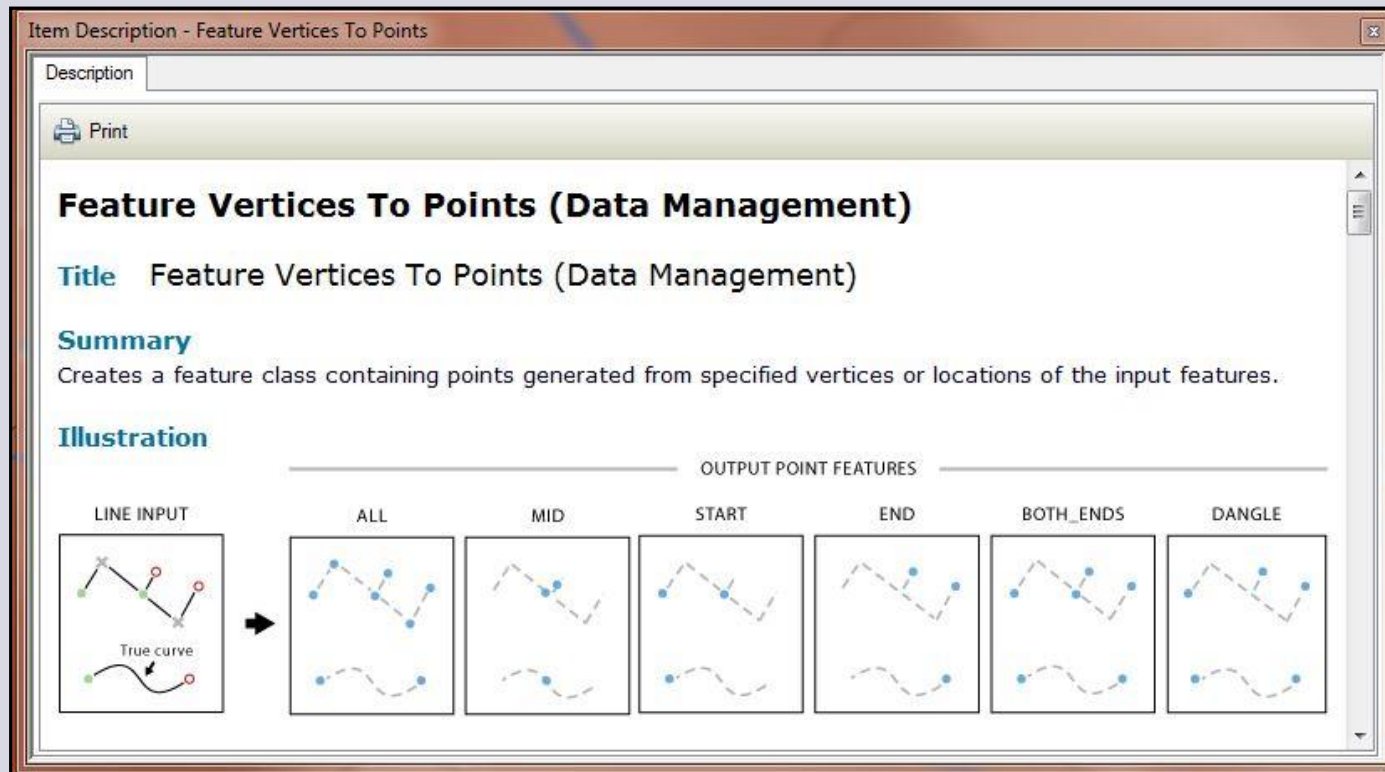
# Create Fence Diagram – 1. Build Profile

- Create line feature class to represent surface profile(s)
- Editor menu – Split – Into Equal Parts to divide line



# Create Fence Diagram – 2. Convert to Points

- Convert multiple line segments to points
- Feature Vertices To Points tool (Data Management)



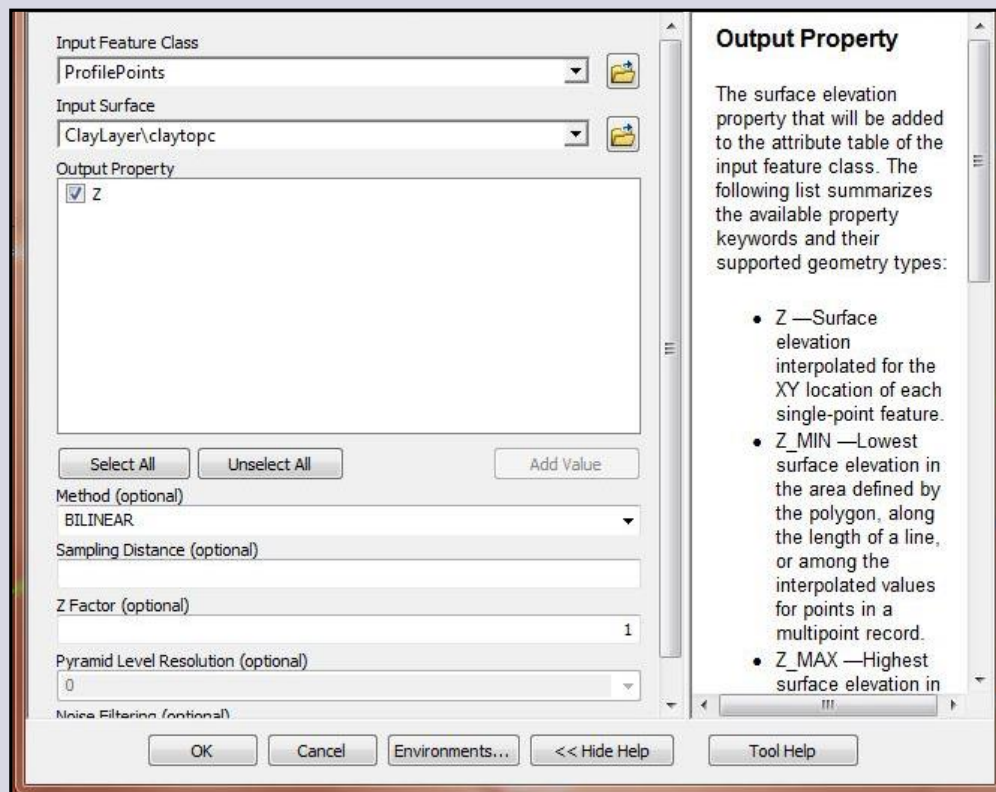
# Create Fence Diagram – 2. Convert to Points

- Points will be used to represent the profile line in 3D



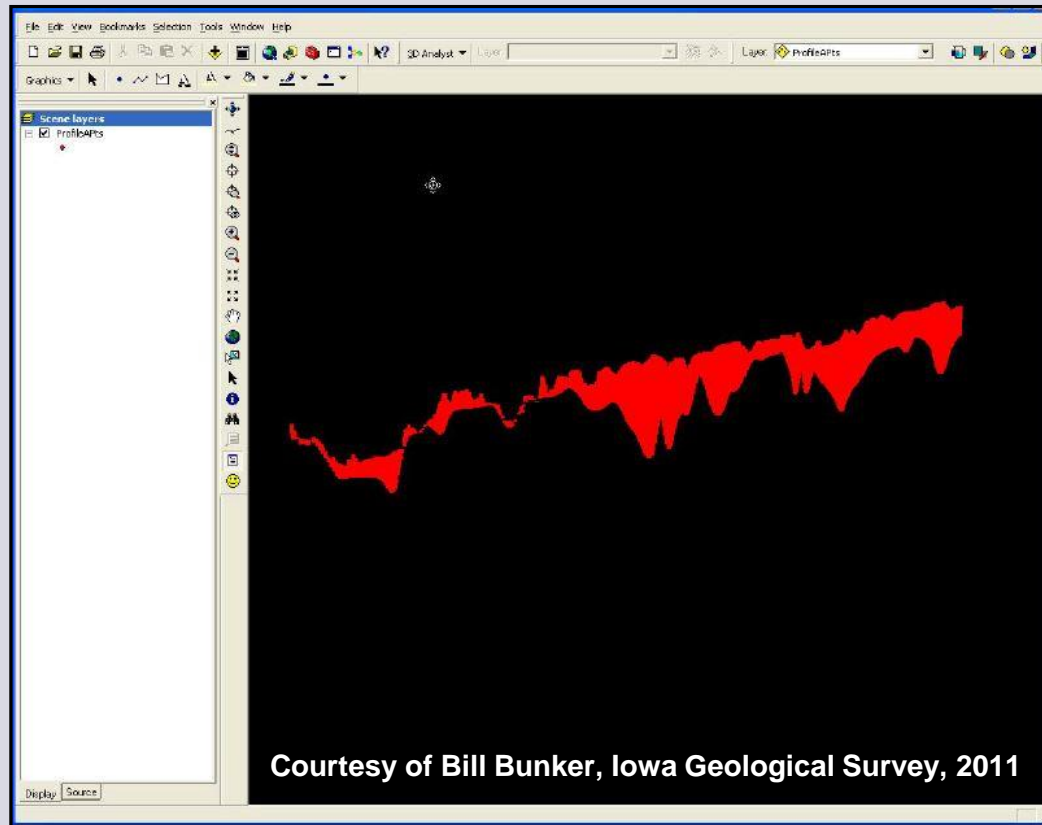
# Create Fence Diagram – 3. Assign Elevations

- Use surface grid(s) to assign elevations to points
- 3D Analyst toolbox – Functional Surface – Interpolate Shape



# Create Fence Diagram – 4. Extrude Points

- Add points to ArcScene
- Use top elevations (z values) in attribute table for base heights and bottom elevations for extrusion

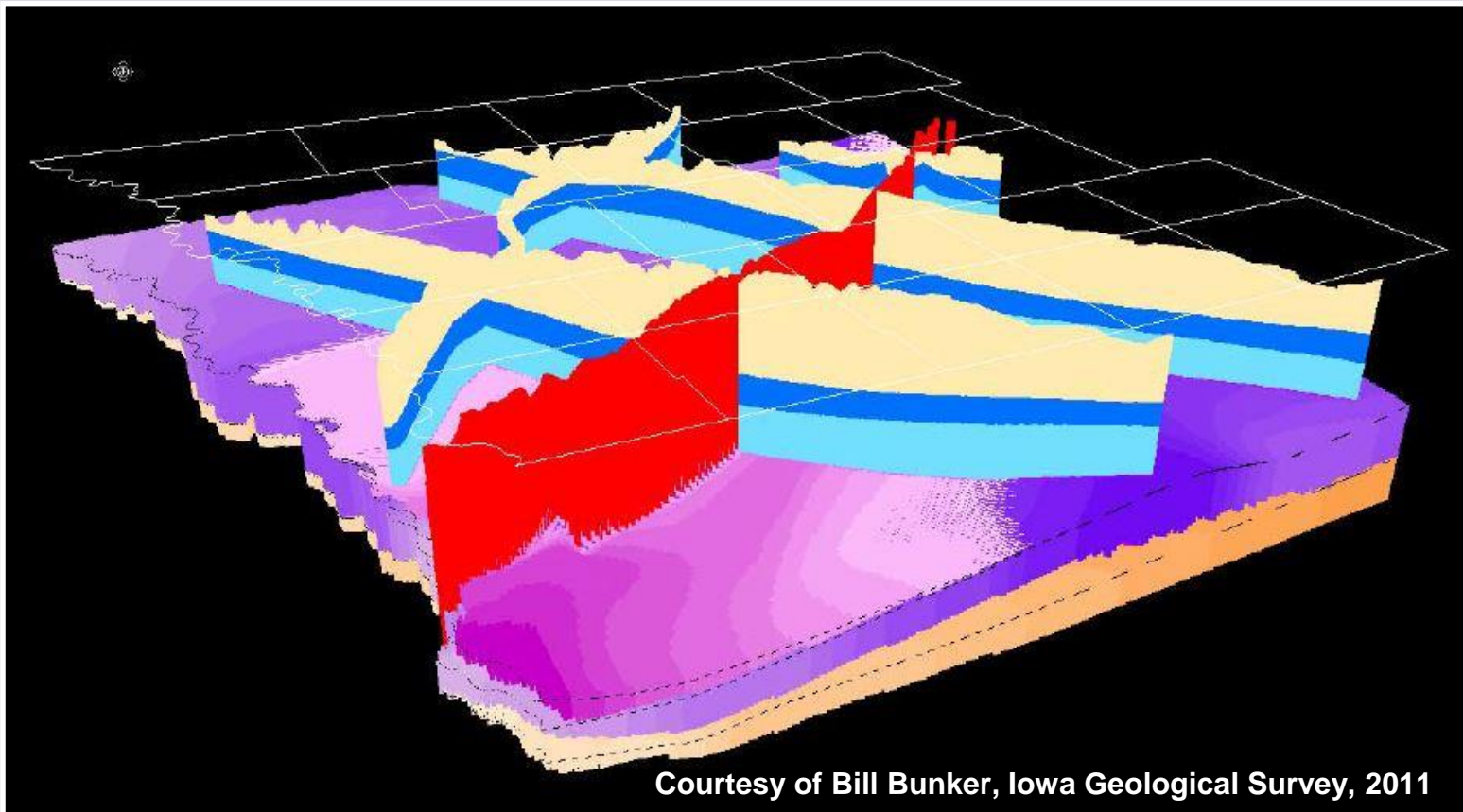


Courtesy of Bill Bunker, Iowa Geological Survey, 2011



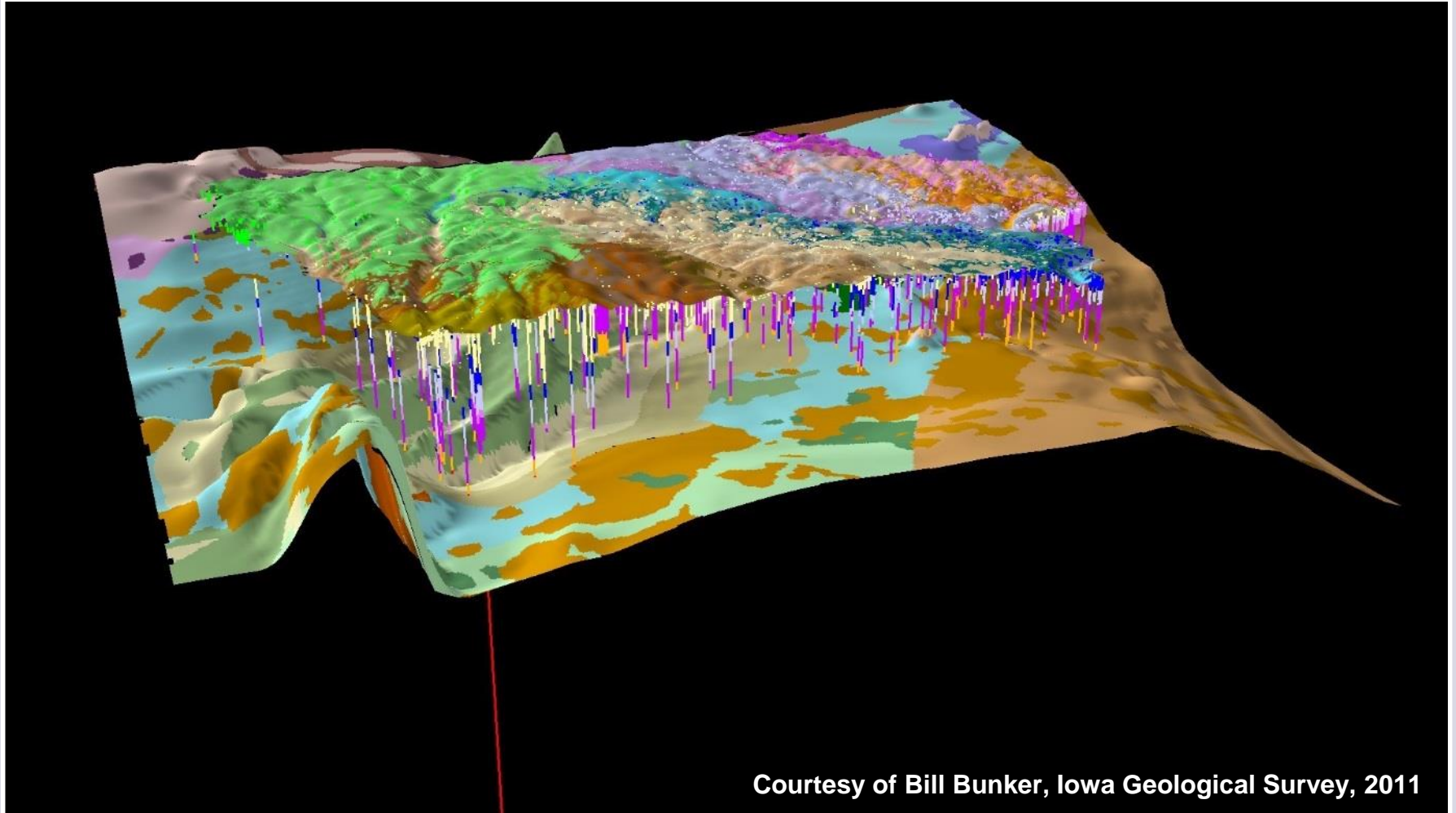
# Create Fence Diagram – 5. Compile Profiles

- **Build multiple profiles and compile in ArcScene**

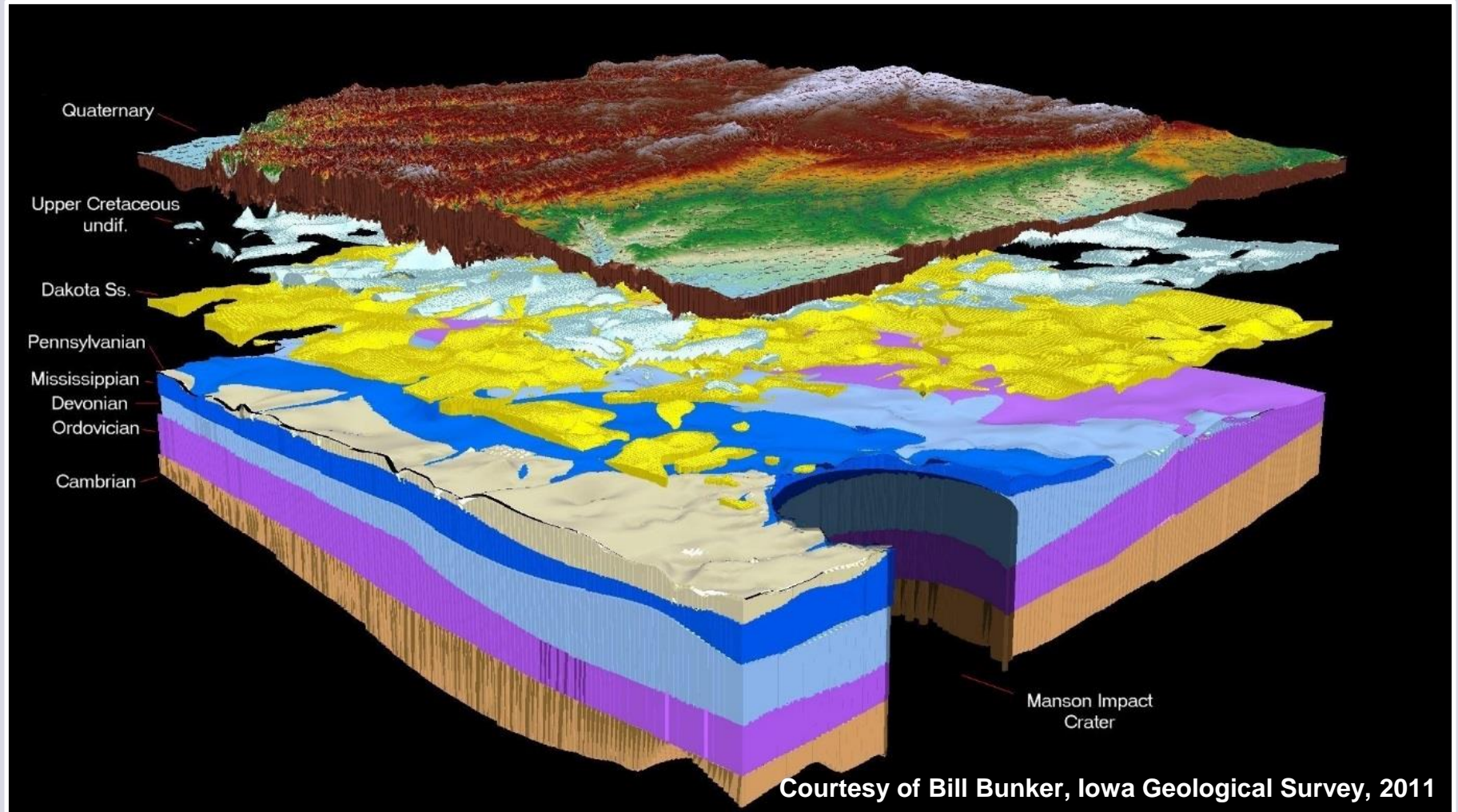




# Build a 3D Geologic Model in ArcScene: Landforms and Wells



# Build a 3D Geologic Model in ArcScene: Topography and Stratigraphy

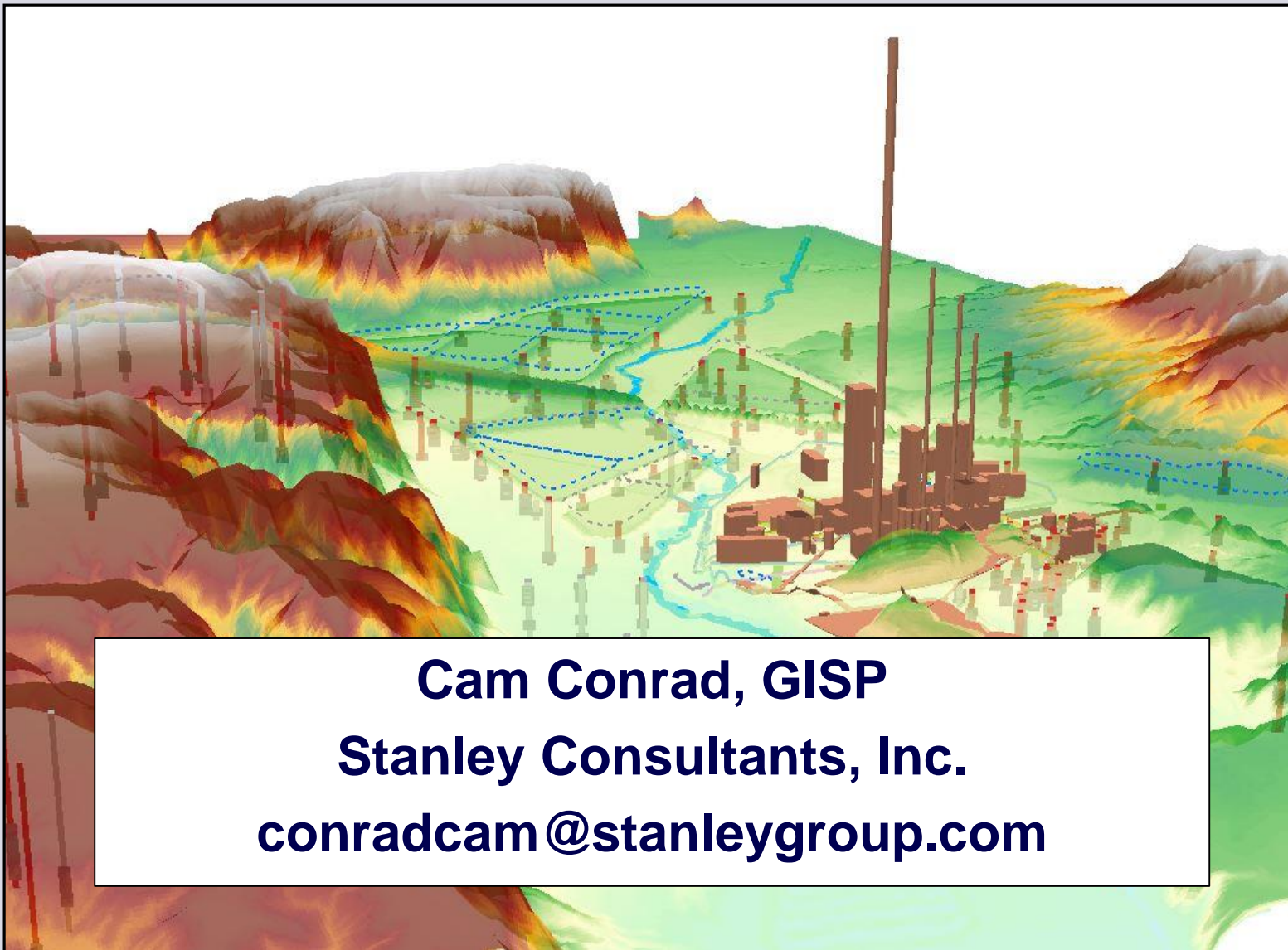


# Summarizing Benefits of the 3D Model... from Different Perspectives

- **Geographic**: Visualizing site from a new point-of-view that incorporates elevation, i.e. seeing geographic features above and below ground surface
  - **Hydrologic and Geologic**: Analyzing water quality and geologic data gaps, including understanding the site's river-groundwater interaction, soil stratigraphy, and environmental pathways and receptors
  - **Project Management**: Decision-making on continued data collection efforts; developing and prioritizing remediation / cleanup alternatives
  - **Financial / Budgeting**: Skip time-consuming and expensive reports that the regulatory agency had originally requested; i.e. money was saved by the client
- **Benefits of the model were well understood by entire team**



# Thank You



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