Data Management for Civil Engineering Projects – Mapping the Subsurface

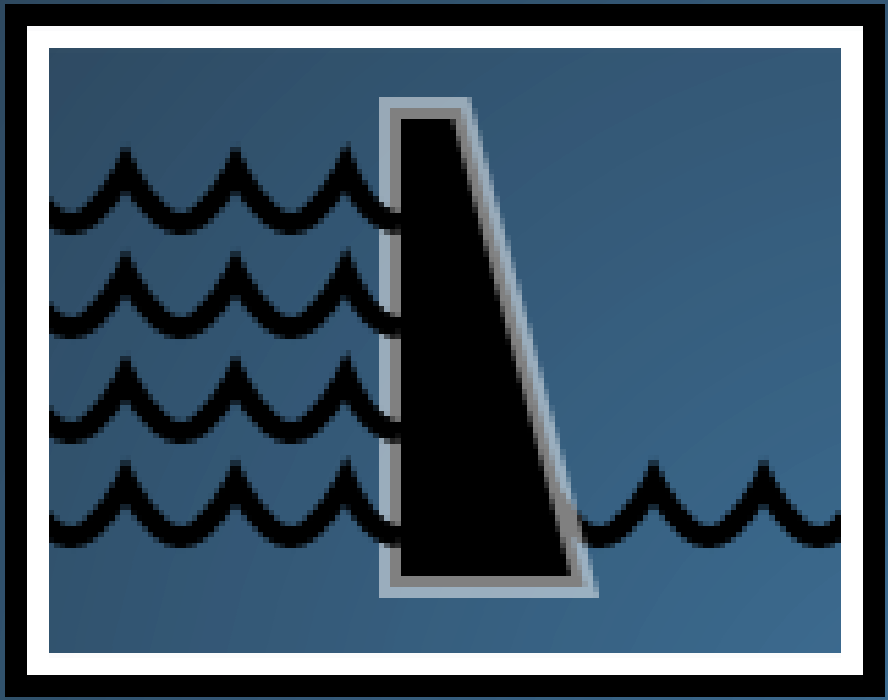
Co-contributors:

John Peake, P.G.

Rebecca Fyfe, Bauer Foundations Canada (presenter)

An Introduction to BAUER

Heavy Civil Foundations



The BAUER Group

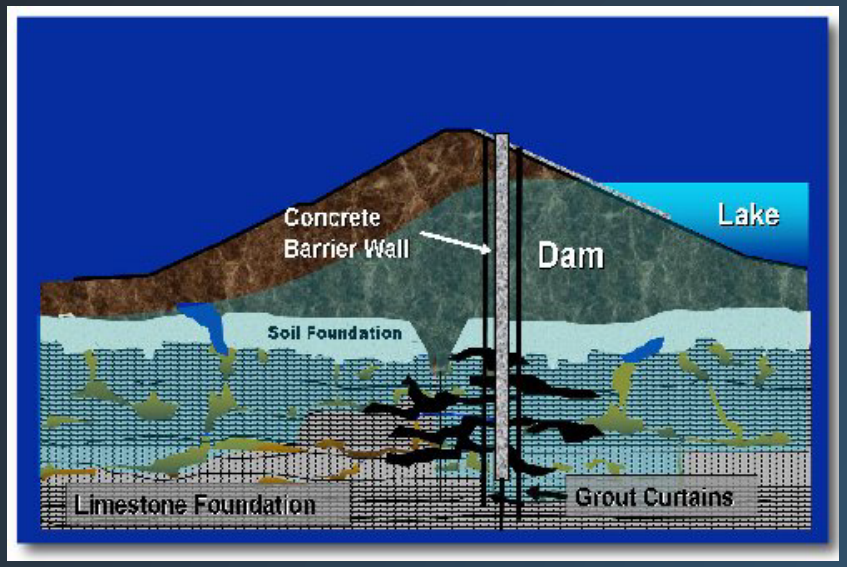
BAUER Spezialtiefbau GmbH, BAUER Foundations US and BAUER Foundations Canada are part of the Bauer Group and are based in Bavaria (Germany), Tampa (USA) and Calgary (Canada) respectively.

John Peake, P.G., has worked on international projects as a Data Manager for BAUER, and has focused on standardizing and evolving data management practices on heavy civil engineering projects. John has designed and developed the BProject Data Management System.

Rebecca Fyfe (presenter) has worked engineering design, quality control and data management for mine construction. She has contributed to the development of BProject.

Center Hill Dam and Pine Creek Dam (USACE)

Cutoff Wall Construction for Dam Modernization



http://www.wjle.com/news/2011/center-hill-dam-rehab-transitions-next-phase

The Center Hill Dam and Pine Creek Dam are US Army Corp of Engineers dams that have recently been modernized to increase their safety and stability.

Updating the Main Embankment of Center Hill Dam

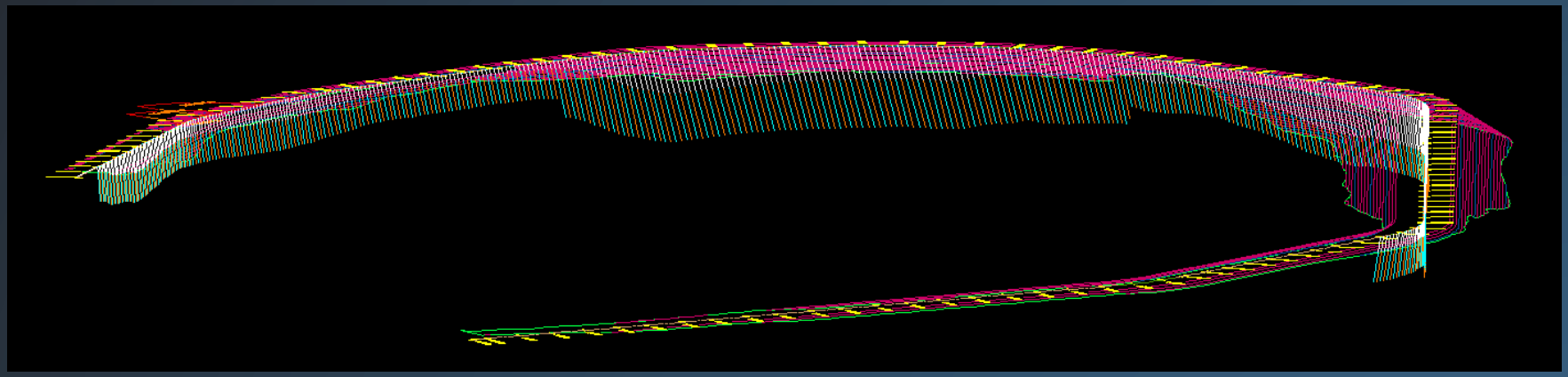
Center Hill Dam with Center Hill Lake supported behind before updating started.

Main Dam embankment with BAUER BG50, MC128 and MC90 (from right to left).

http://www.lrn.usace.army.mil/Locations/Dams/Center-Hill-Dam/

Diavik Diamond Mine – A21 Dike

Grout Curtain Construction for Dike Waterproofing



AutoCAD design drawing of the grout curtain at the Diavik A21 dike

PLEASE ADD Real picture and use the text below in your talk. People are not going to want to read but they will listen to you. I have included your words in the notes below.

Small Hole Drilling at Diavik Diamond Mine – A21 Dike

Heavy Civil Engineering and Construction Data Needs

Engineering and Construction Data Needs

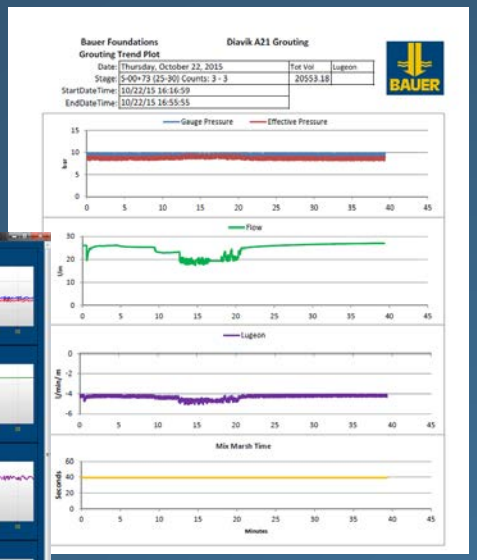
Overview

- Data is collected by instrumentation or personnel
- Need to monitor live flow, pressure and volume
- Need to collect material testing results, geometrical measurements
- Data spatial representation is crucial for making informed decisions
- Proper data organization/storage are part of keeping a timely process

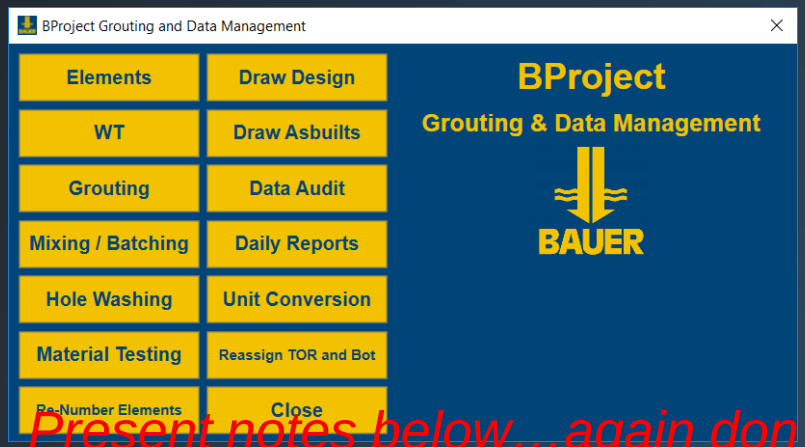
PICTURE OF

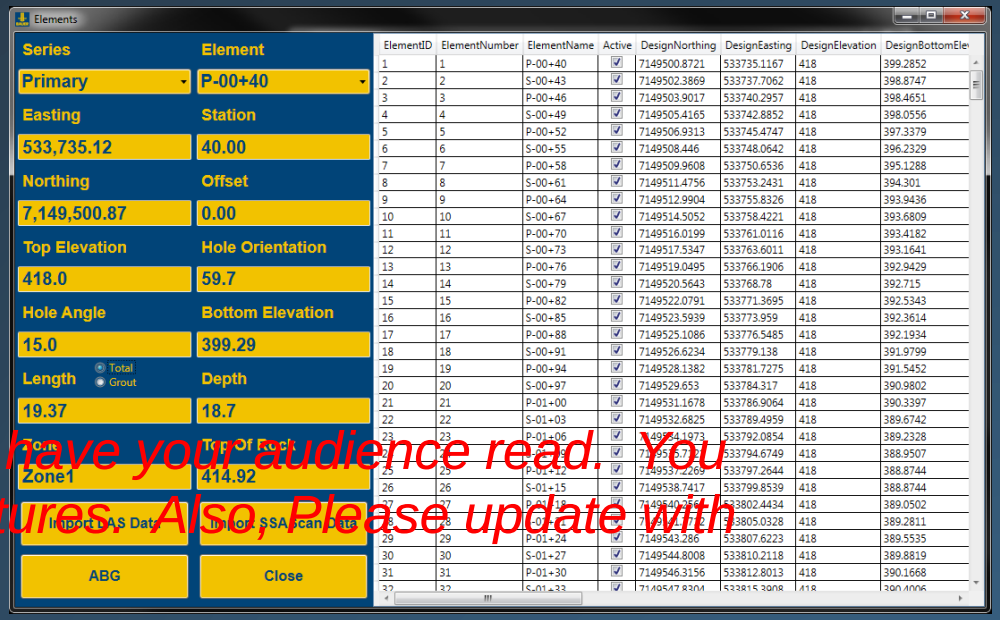
MEASURAND

SAA Scan

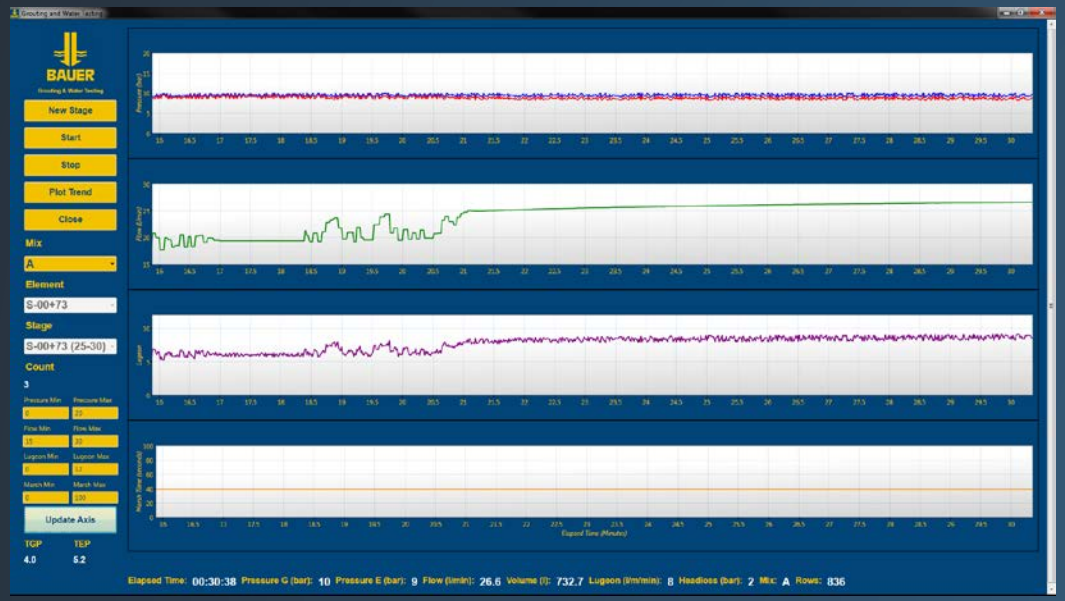


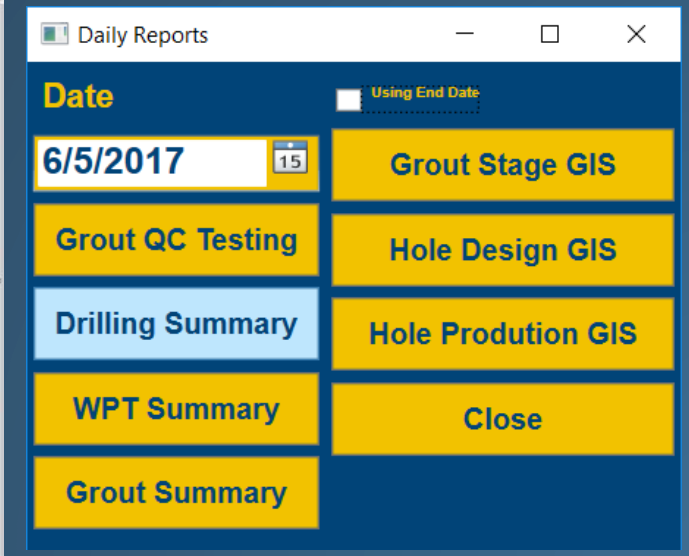
An Introduction to BProject





Present notes below…again don't have your audience read. You present and have them look at pictures. Also, Please update with more current pictures.

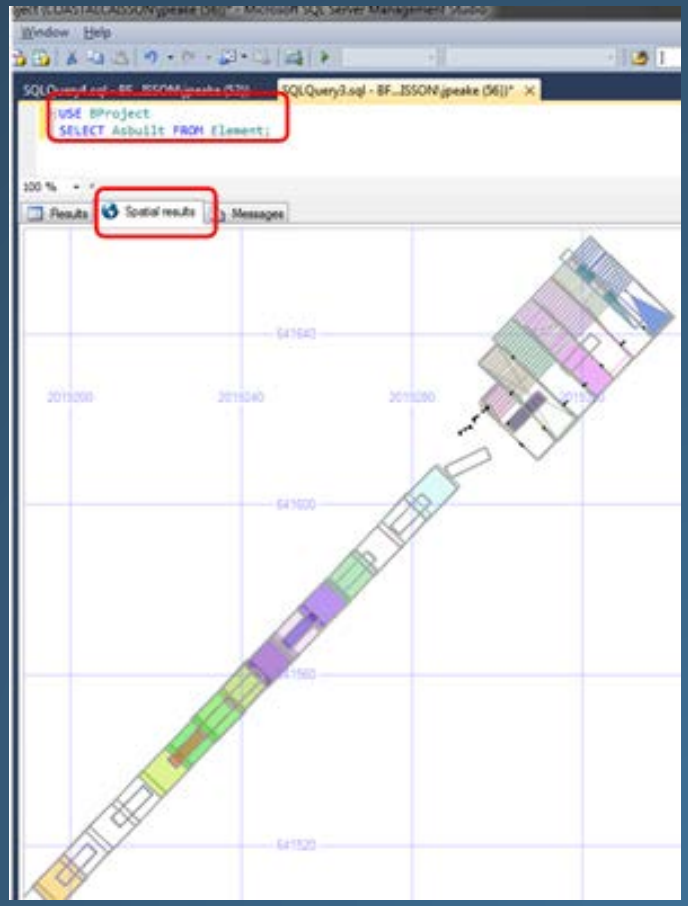




Data Represented as Spatial Objects

- The Microsoft Spatial data type captures the “shape” of an object in the database
  - Recorded as a single binary value
  - Combined with Microsoft SQL Server means easy data querying analysis
  - Spatial data types allow shapes of the elements installed to be stored in a single field no matter what type of shape it is including:
    - Round hole
    - Rectangular hole
    - Polygon hole
  - Of shape types:
    - Lines (single or multi)
    - Points (single or multi)
    - Polygons (single or multi)

Query directly from the SQL Server database using the Spatial data type. Image shows the results for Center Hill Dam directly from Microsoft SQL Server

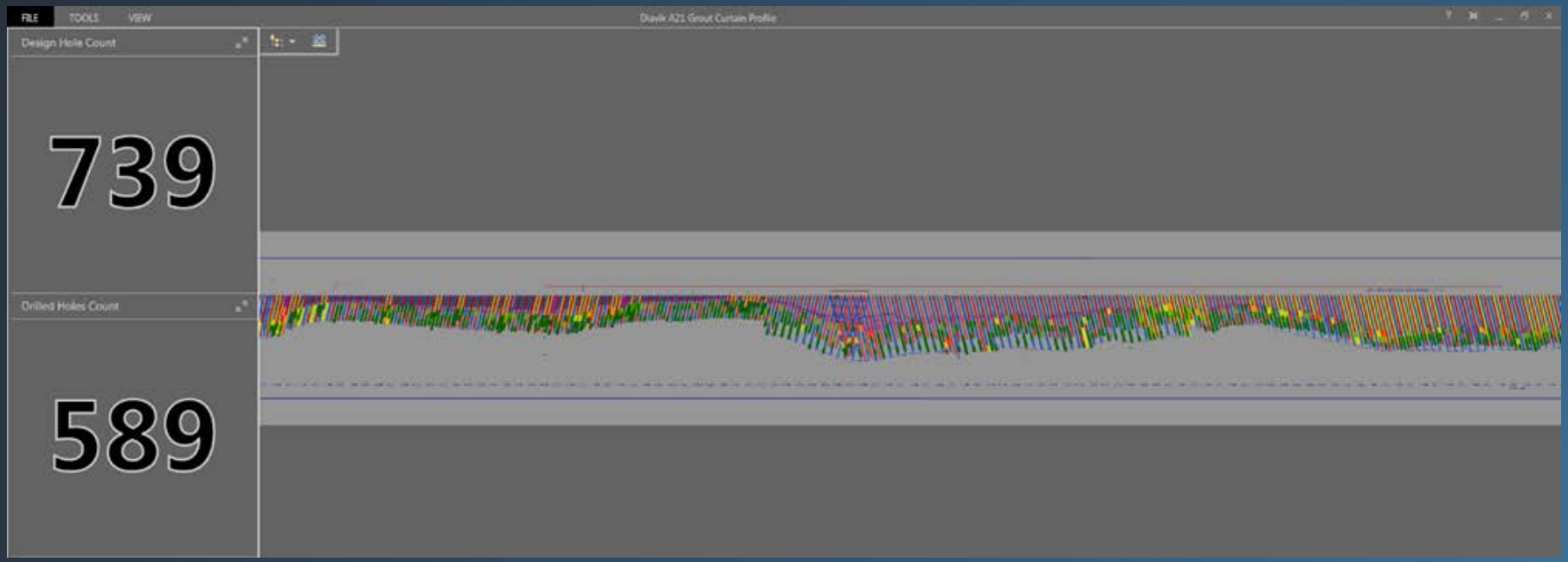


Reports and Data Sharing

- Reporting is typically done in tabular or spatial formats
- Both formats, singularly, limit data assessment in some way
- GIS is able to combine data types
  - Greatly decreases the time spent analysing complex construction data
- GIS is available through a web interface
  - Data sharing is fast, global, and can be regulated and controlled

Production

- Forecasting and logging construction progress are crucial in the civil contracting industry
- GIS has been used to communicate this information both in a written summary, and graphically

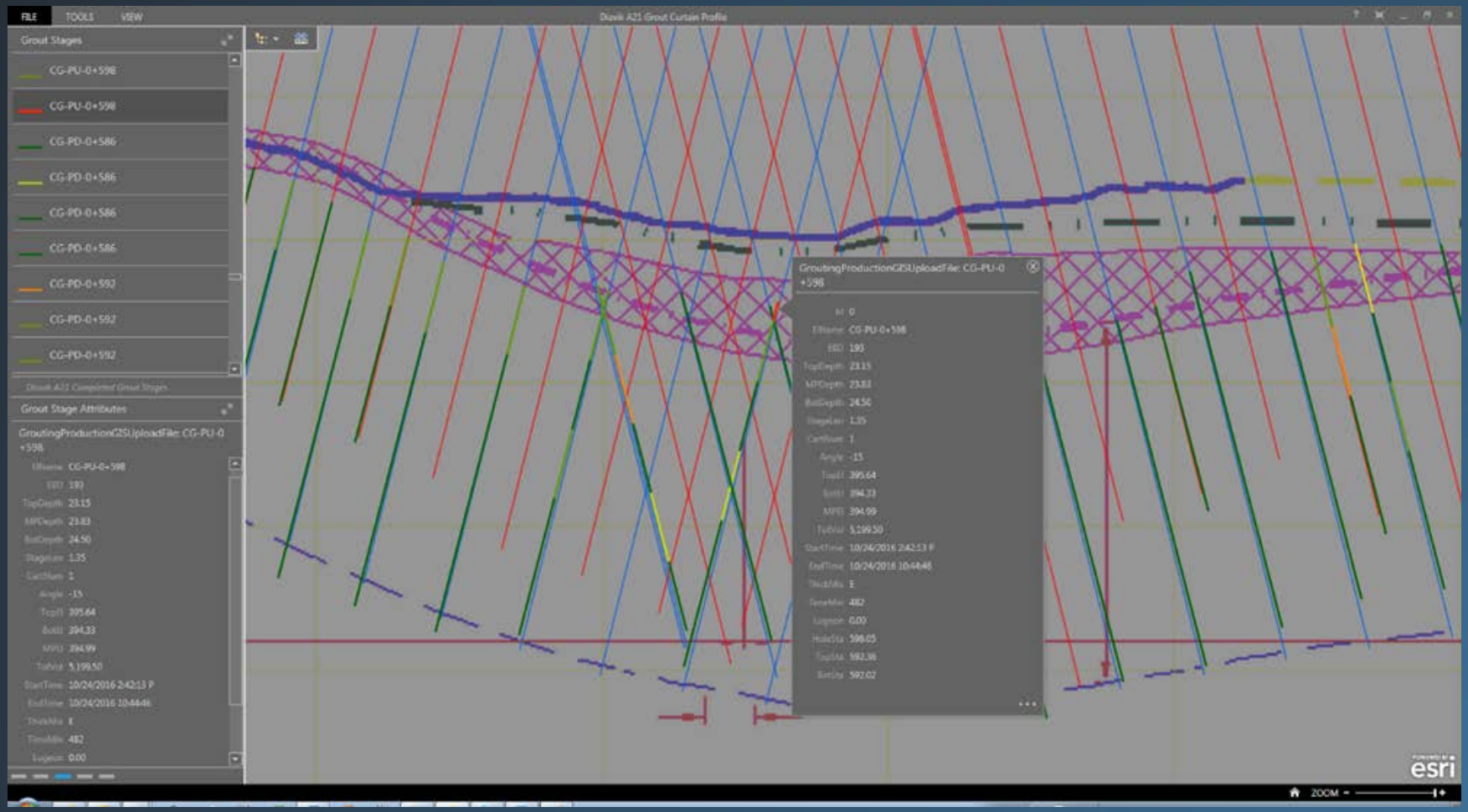


Engineering

- Multiple engineering parties are often involved
- Engineers are concerned with the design and assessment of constructed objects
  - Looking for patterns, trends, structural anomalies
- 3D orbiting programs with overlapping spatial and numerical data can result in skewed conclusions
  - GIS can decrease visual data confusion
- ArcGIS Online provides a suite of toolsets for engineering analysis

Engineering

Typical ArcGIS engineering tool used for identifying patterns in the data using a color symbology.



Why Use GIS?

The Decision to Use ArcGIS

A better option for subsurface construction

- Ability to represent data as spatial objects
- Ability to embed attribute data
- Ease of access, mobile device access
- Availability of ArcGIS Online and the Operations Dashboard
- No need for special software skills, AutoCAD training

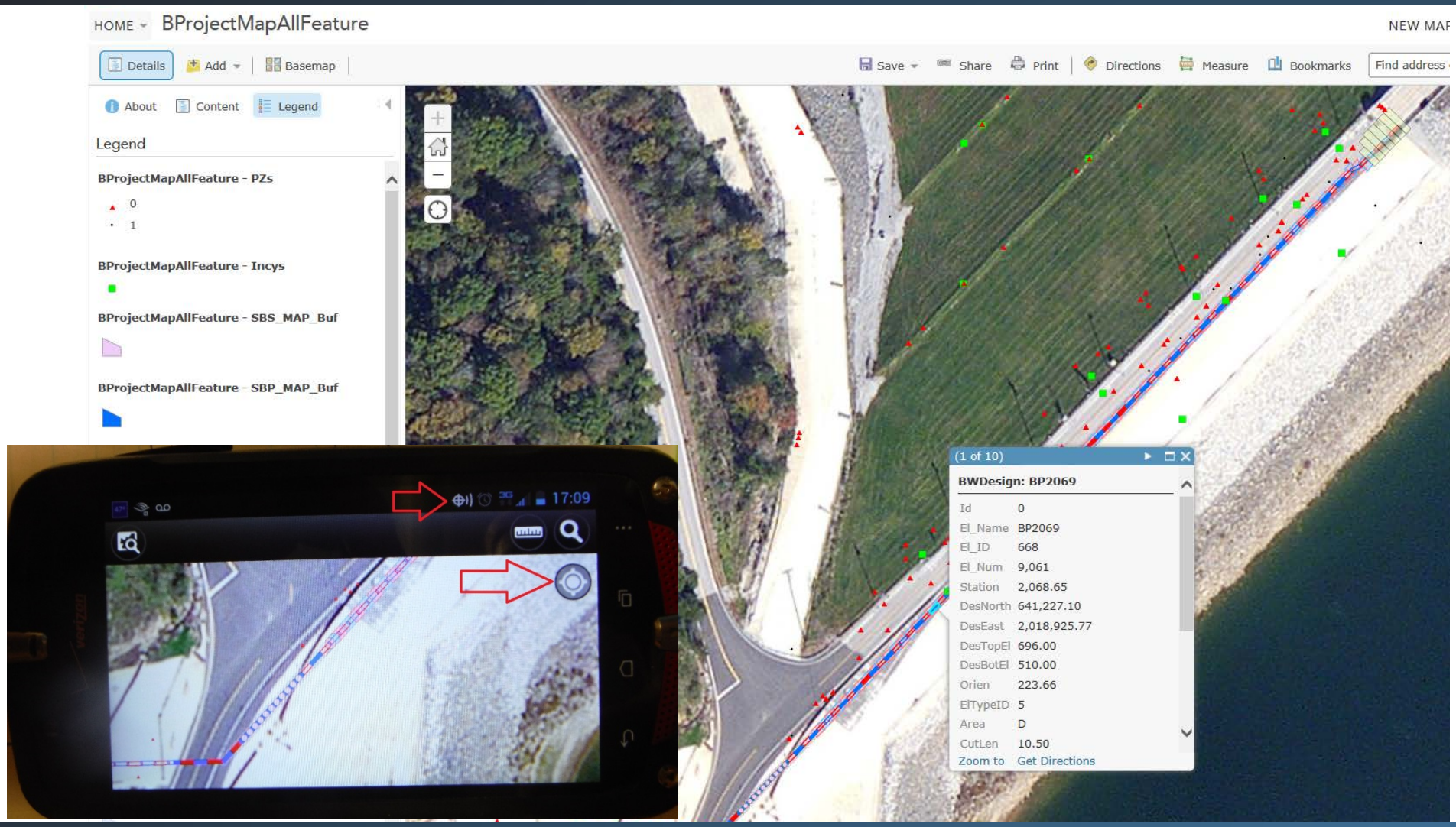
Attribute Data Embedded in Spatial Objects

- ArcGIS objects are based on two components
  - The shape itself
  - The attribute information embedded in the shape

- Objects with embedded data can be combined with external descriptive information

Ease of Access, Mobile Device Use

- ArcGIS Online is available on a PC, Mobile device, etc.
  - In-field data availability for Field Engineers and Superintendents
- Mobile GPS for field locations of objects
  - User can locate specific elements in the field as they go: instruments, wells, etc.
- Center Hill Dam and Pine Creek Dam success
  - ArcGIS Online Mobile and ArcGIS Collector used extensively


HOME
BProjectMapAllFeature
NEW MAP
Details
Add
Basemap
Save
Share
Print
Directions
Measure
Bookmarks
Find address
About
Content
Legend
Legend
BProjectMapAllFeature - PZs
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17:09
(1 of 10)
BWDesign: BP2069
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DesEast 2,018,925.77
DesTopEl 696.00
DesBotEl 510.00
Orien 223.66
ElTypeID 5
Area D
CutLen 10.50
Zoom to
Get Directions

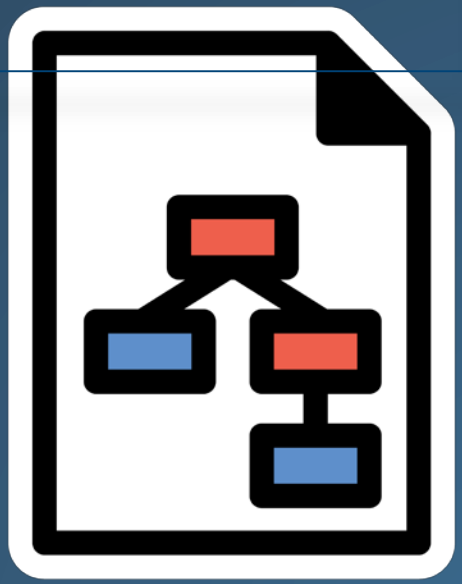
ArcGIS Online and Operations Dashboard

- Simplicity of access in a connected world
- Operations Dashboard contains simplified GIS tools for inexperienced users
- Ability to control the uploading and organization is crucial
  - The end user has access to the information for assessment only
  - Engineers control data input and organization for accuracy

No Advanced Software Skills or Programs

- When information is centralized, it is more organized and controlled
- AutoCAD can be tricky
  - Good modelling tool, but difficult for spatial/numerical interpretation together
  - Specialized program knowledge required
- SQL can be difficult to learn
  - Data engineers are trained in its use and can customize the information
- Operations Dashboard is an easy, viable a field solution

Data Workflow Improvements



Data Querying, Processing and Uploading

- BProject uses Microsoft SQL Server
  - Simple process of publishing the updated shapefiles to established layers in ArcGIS Online, through ArcGIS desktop

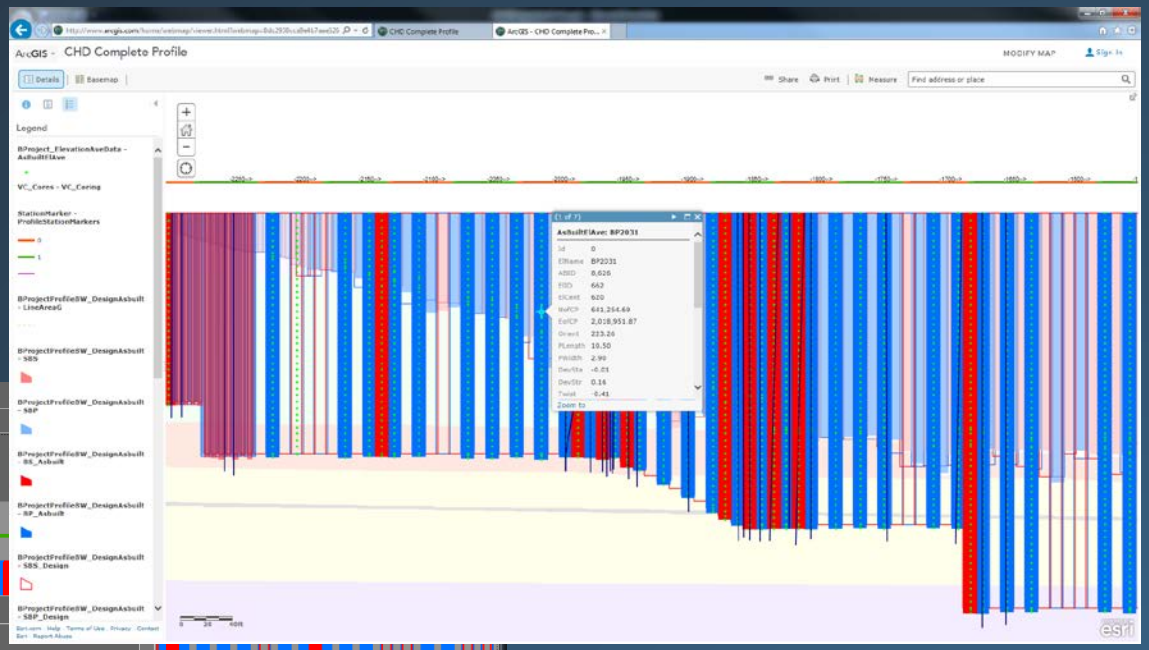
- Shapefiles versus other recent ArcGIS data structures
  - Considered “primitive”, though more useful in isolated work environments
  - Shift by shift updating

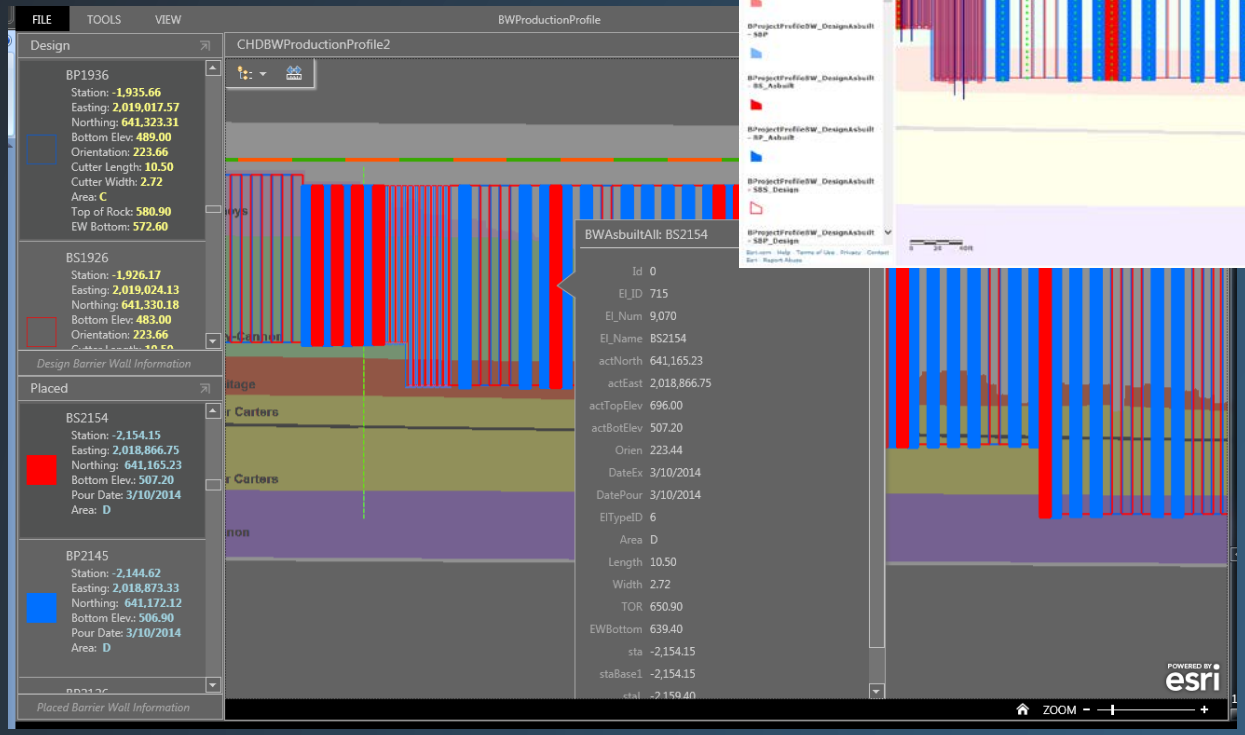
- Other options include using an Esri geodatabase

```
import arcpy
import copy

row, rows, field, fields = None, None, None, None

fc = "D:\Diavik\GIS_Upload_Files\GroutingProductionGISUploadFile.txt"
MyShapeFile = fc.replace(".txt",".shp")

rows = arcpy.SearchCursor(fc)
fields = arcpy.ListFields(fc, None, "All")

i = 0
AttributeDataT = [None] * 2
AttributeDataB = [None] * 2
AttributeDataRC = [None] * 20  #<-----------   Change this too!!!s
TotalAttributeData = []
TotalAttributeData2 = []
TotalAttributeData3 = []
```

Center Hill Dam Profile View

Viewed in ArcGIS Online

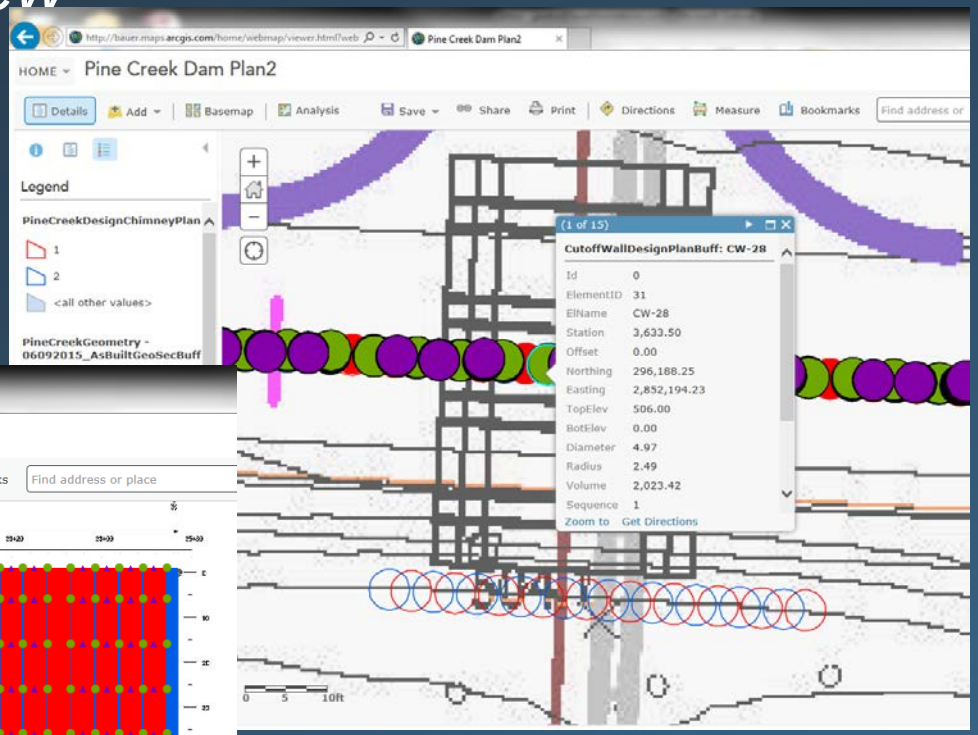


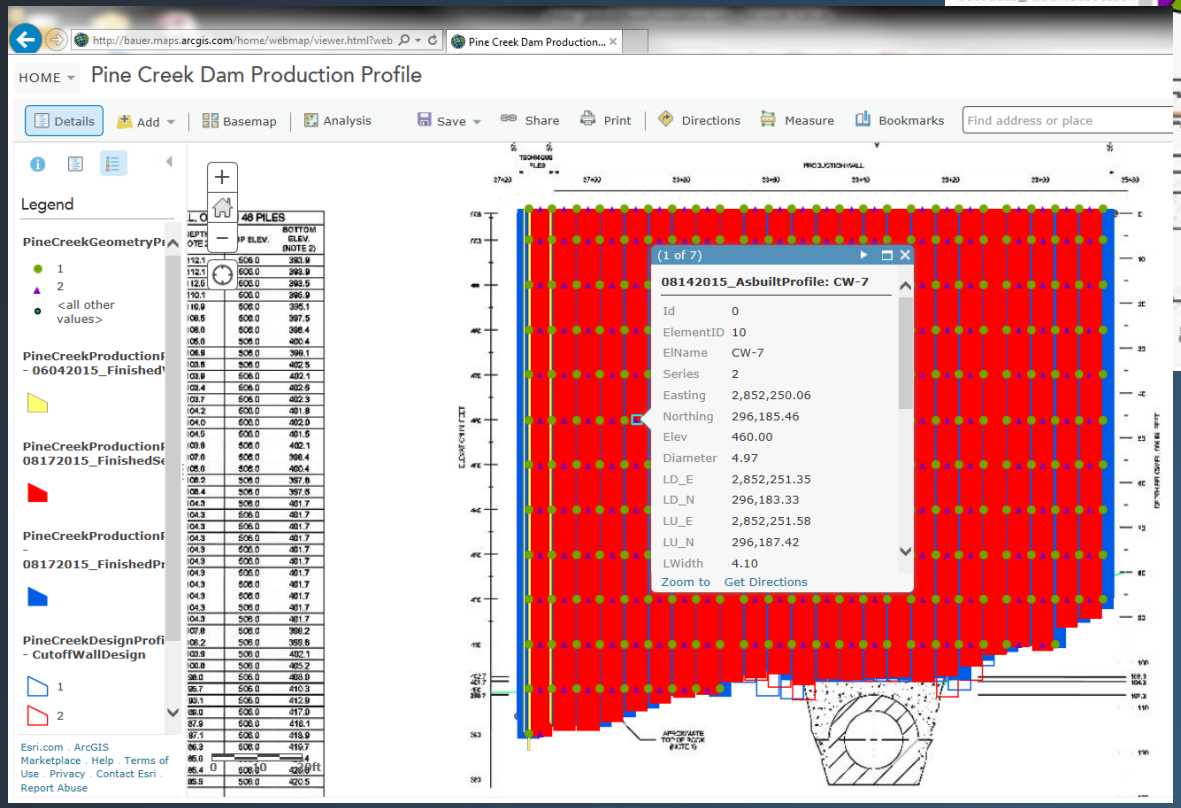


Viewed in Operations Dashboard

Pine Creek Dam Profile View

Plan view with georeferenced design drawing as basemap

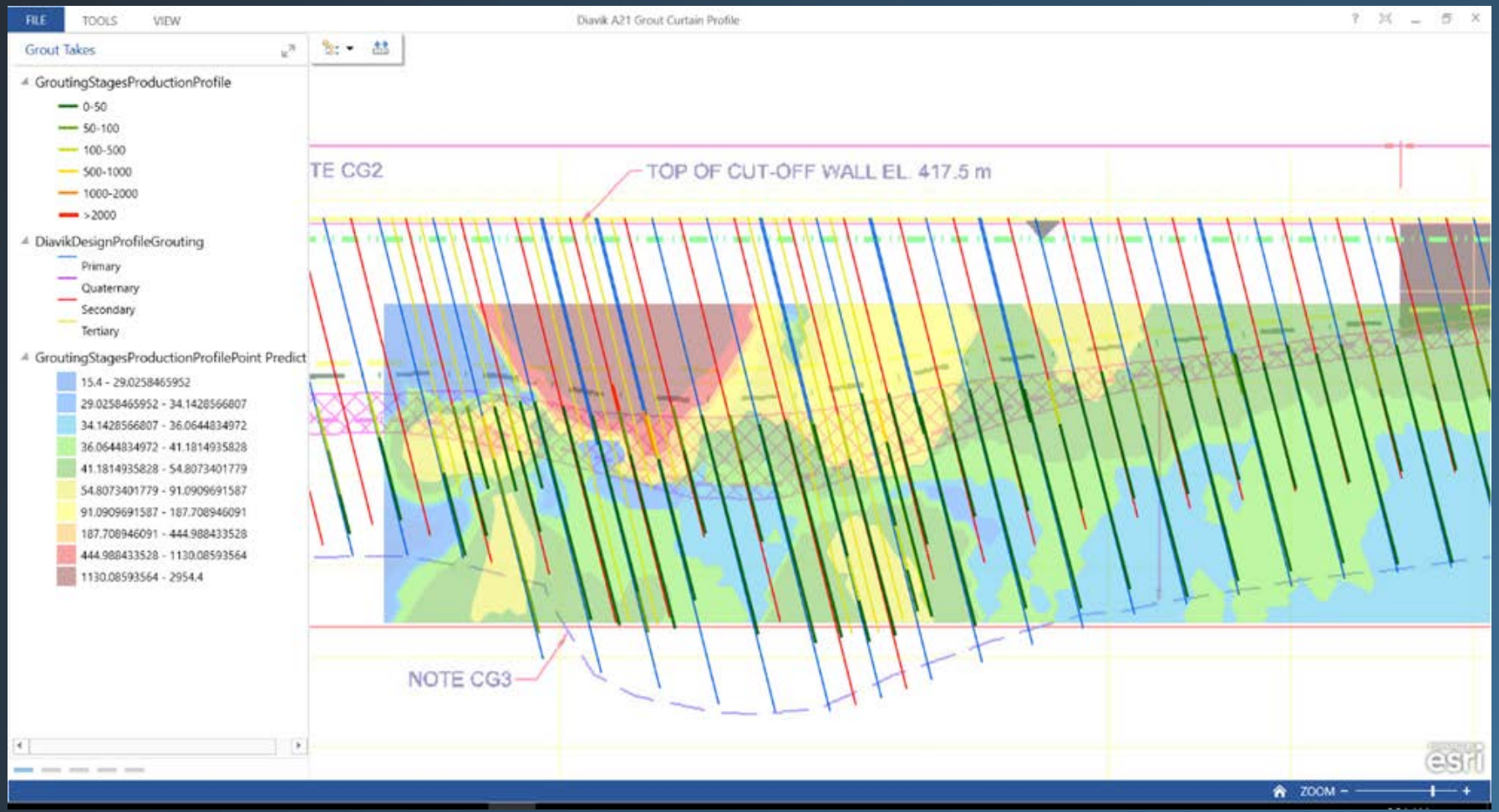




Profile view of cutoff wall with georeferenced basemap

Diavik A21 Dike Profile View

Profile of the Diavik A21 grout curtain with hole, stage and color contour map showing permeability trends. Contour map was generated using ArcGIS spatial analysis tools.



Questions?

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