Hitting the Target: Modeling against Subsurface Strata

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Bentley Advancing Infrastructure

Where to get Subsurface Strata

- GIS Systems that have verified geologic layers may be available
- If the layers are uniform and of known thickness and not highly deformed, offsetting the existing ground is a possibility
- Boring data base using gINT Civil Tools
  - The density of the borings have to be enough to build a well triangulated terrain
    - Borings in a straight line will not triangulate for a useful terrain

gINT Civil Tools At-A-Glance

gINT Database

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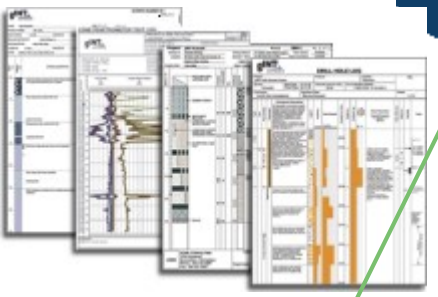
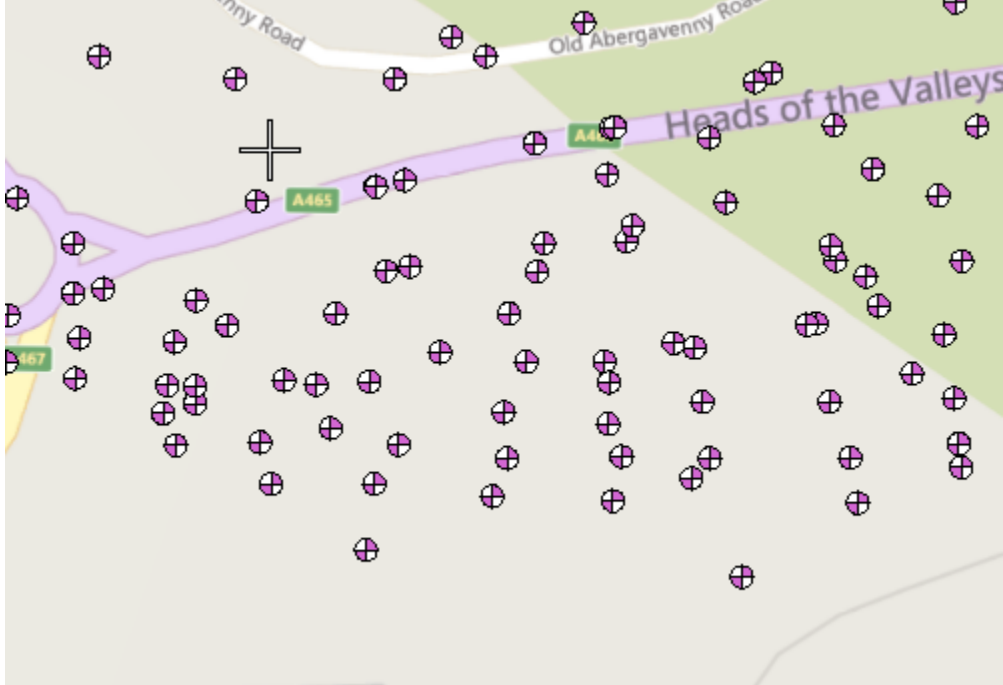
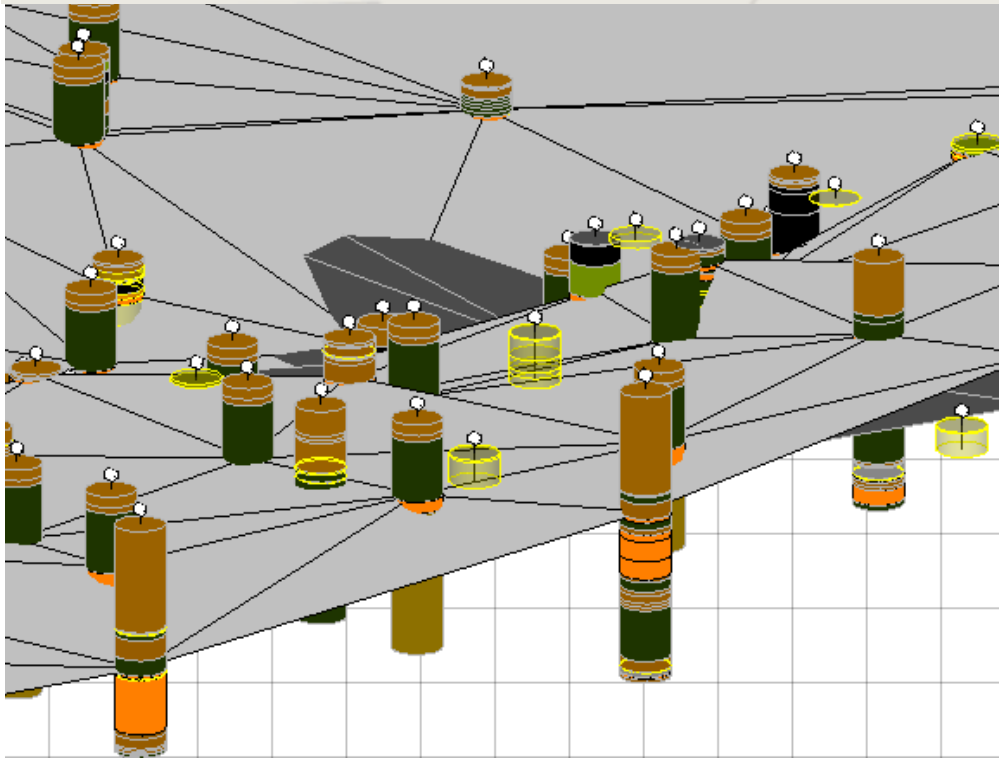


gINT

OpenRoads Geotechnical Workflow





OpenRoads Designer Geotechnical Workflow

- Open an existing gINT Database
- Connect to the database
- Review the borings
- Display the borings in 3D
- Export the terrains of Interest

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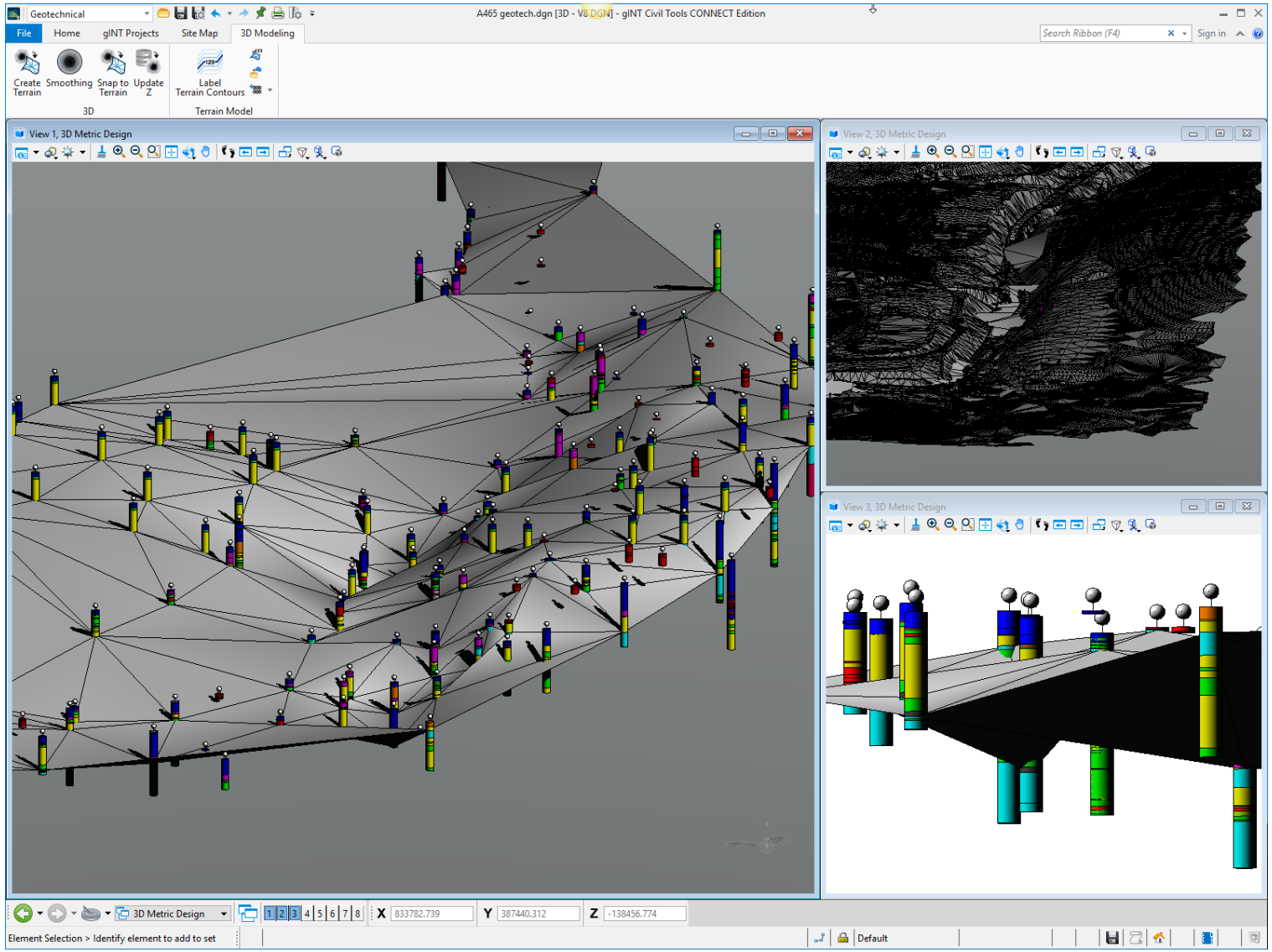
OpenRoads Designer Geotechnical workflow = gINT Civil Tools

- Native Read / Write of gINT Projects
- Subsurface interpretation
- Export terrain for use in Civil design process



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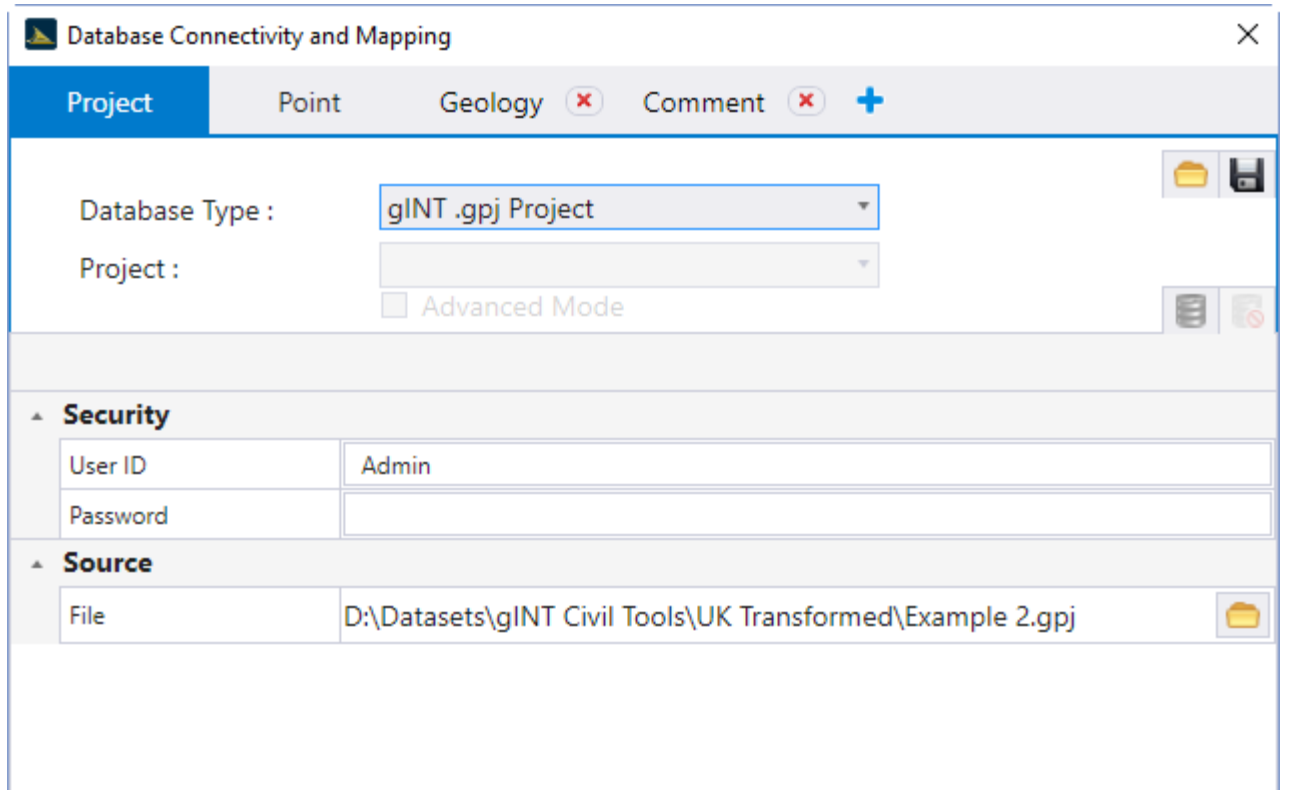
Native Read/Write of gINT Projects

- Direct access to any gINT Access and SQL Server
- Mapping between gINT schema and gINT Civil Tool
- Settings saved in DGN file and DGN Library, and can be shared



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Native Read/Write of gINT Projects

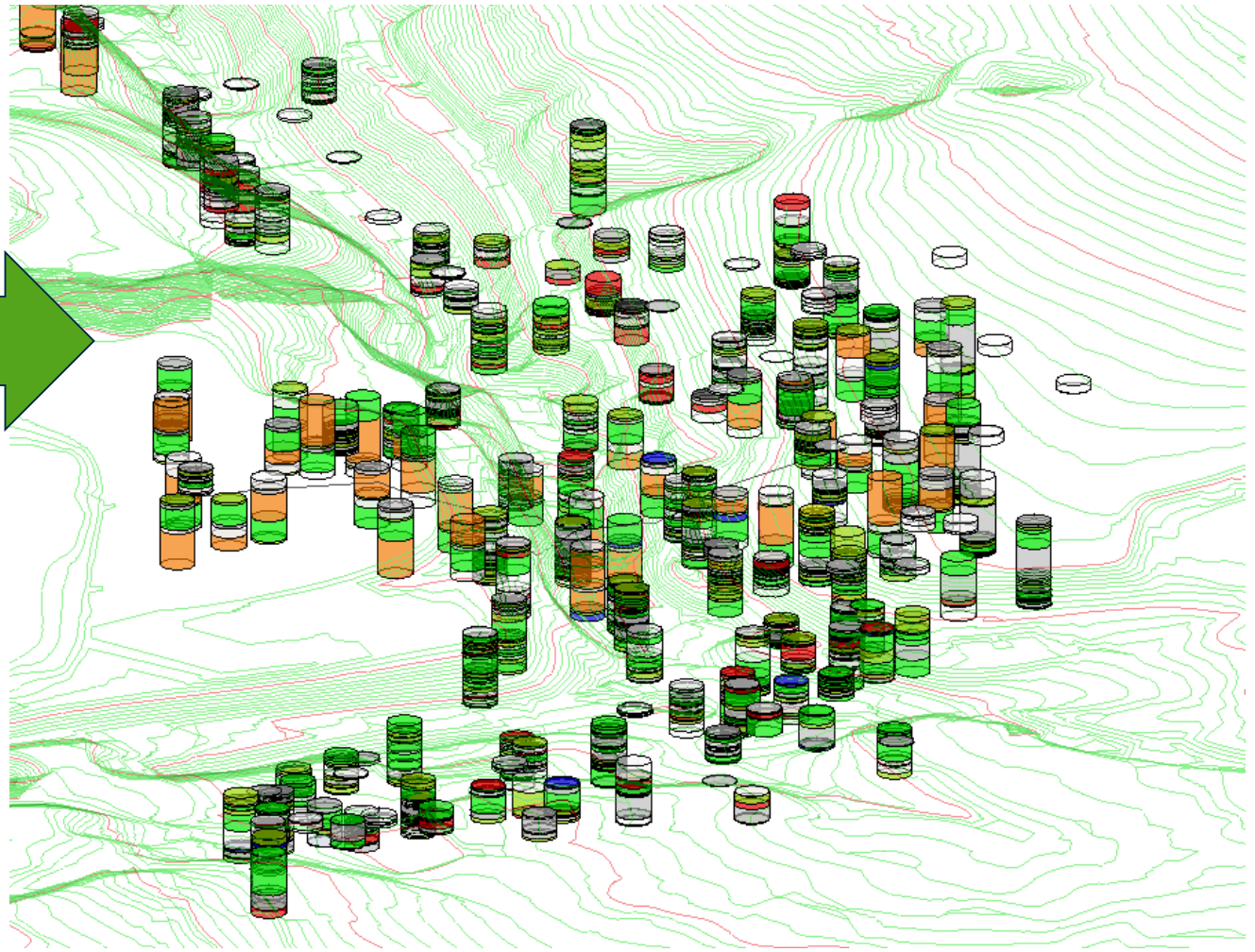
INPUT | OUTPUT | DATA DESIGN | REPORT DESIGN | SYMBOL DESIGN | DRAWINGS | UTILITIES

Main Group | Rock Coring | Depth Doc | Field Testing | Monitoring | Lab | Time Remarks | AGS | Site Map | Surfac

Project | Hole | Samples | Strata Main | Strata Soil | Strata Rock | Strata Details | Backfill

[Main Group]

Hole ID	Type	Date Started (dd/mm/yyyy)	Date Completed (dd/mm/yyyy)	Local X (m)	Local Y (m)	Local Z (m)	Final Depth (m)
BH1	RC	12/9/2011	12/9/2011	29563.92	12283.04	334.2633719	10.00
BH2	RC	11/22/1996	11/25/1996	31754.11	12625.37	203.5020308	20.10
BH3	CP	10/6/1996	10/6/1996	31757.99	12642.53	207.7561265	2.80
BH4	RC	11/27/1996	11/29/1996	31757.99	12642.53	207.7561265	30.10
BH5	CP+RC	11/17/1996	11/20/1996	31744.84	12617.09	202.8952942	25.65
BH6	CP	10/6/1996	10/6/1996	31733.05	12635.47	211.3060849	1.64
BH7	RC	11/11/1996	11/14/1996	31733.05	12635.47	211.3060849	
BH8	RC	11/14/1996	11/16/1996	31717.71	12602.48	203.9171226	
BH9	RC	10/29/1996	11/1/1996	31709.33	12623.46	214.3831528	
BH10	RC	11/8/1996	11/13/1996	31687.82	12587.65	207.7122538	
BH11	CP+RC	10/4/1996	10/23/1996	31671.69	12614.08	226.7977796	20.40
BH12	RC	11/4/1996	11/7/1996	31655.64	12575.90	223.0101711	25.20
BH13	RC	10/15/1996	10/17/1996	31645.74	12595.36	229.8863434	12.50
BH14	RC	10/23/1996	10/28/1996	31645.74	12595.36	229.8863434	20.00
BH15	RC	10/30/1996	11/3/1996	31628.77	12566.66	226.8168399	25.50
BH16	CP	10/7/1996	10/7/1996	31614.31	12586.22	234.1574465	2.10
BH17	RC	11/16/1996	11/21/1996	31614.31	12586.22	234.1574465	20.00
BH18	RC	10/22/1996	10/28/1996	31602.95	12561.89	230.2289278	29.85
BH19	CP+RC	10/3/1996	10/20/1996	31593.54	12571.26	236.0963212	25.60
BH20	RC	10/10/1996	10/16/1996	31572.02	12555.91	237.0019073	20.00
BH21	CP+RC	10/4/1996	10/18/1996	31539.99	12518.19	232.2687919	30.10
BH22	RC	10/18/1996	10/20/1996	31510.21	12508.89	241.9942571	20.20



Direct read of gINT Projects minimizes using old data and reduces opportunity for data entry errors

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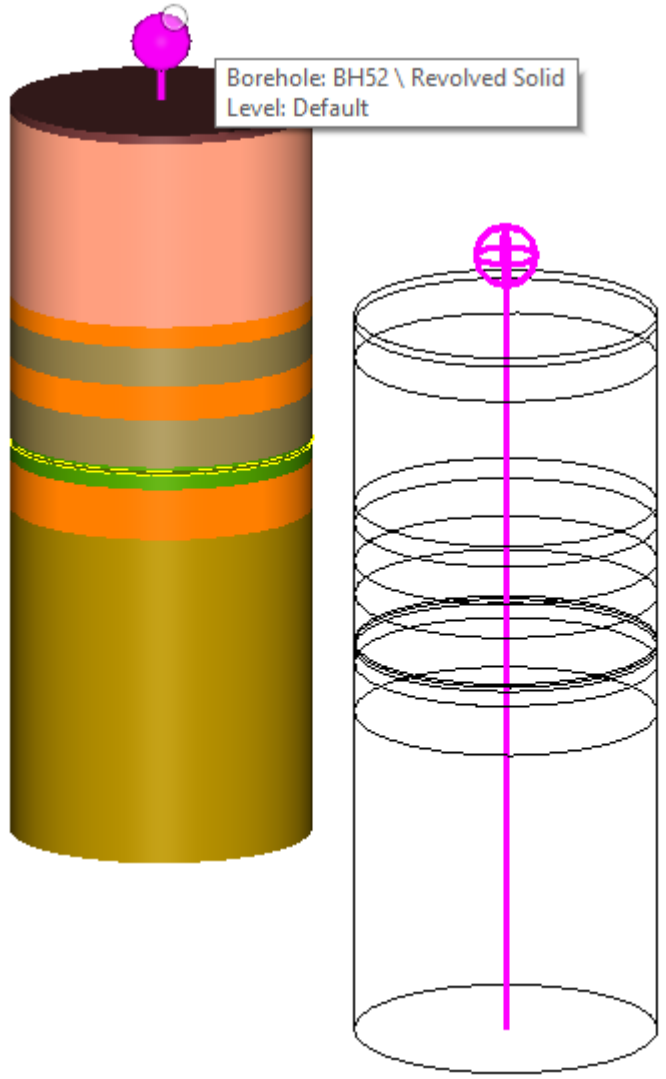
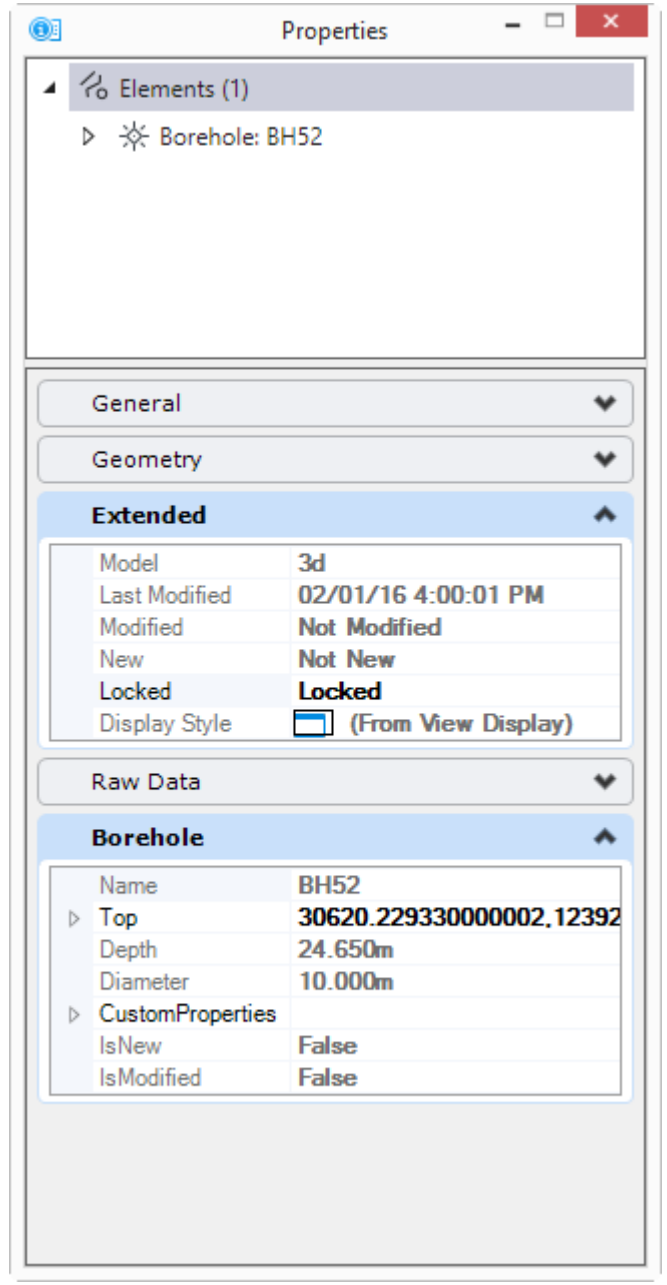
Subsurface data model : PointID

Hole ID	Type	Date Started (dd/mm/yyyy)	Date Completed (dd/mm/yyyy)	Local X (m)	Local Y (m)	Local Z (m)	Final Depth (m)
BH37	RC	10/1/1996	10/2/1996	31149.12	12398.80	237.3349670	10.25
BH38	RC	1/23/1997	1/26/1997	31099.25	12422.11	245.0492368	20.00
BH39	RC	1/27/1997	1/29/1997	31023.99	12422.26	262.1024753	25.00
BH40	CP+RC	11/29/1996	12/4/1996	31010.68	12372.64	272.7349314	15.00
BH41	RC	12/5/1996	12/5/1996	30970.56	12373.69	272.9574418	3.31
BH42	RC	12/5/1996	12/12/1996	30970.56	12373.69	272.9574418	15.00
BH43	RC	9/24/1996	9/30/1996	30891.65	12432.63	269.9964031	25.10
BH44	CP	9/24/1996	9/25/1996	30837.01	12436.47	275.1481336	1.30
BH45	CP	9/25/1996	9/25/1996	30837.01	12436.47	275.1481336	3.38
BH46	RC	10/2/1996	10/3/1996	30837.01	12436.47	275.1481336	9.46
BH47	RC	1/15/1997	1/20/1997	30837.01	12436.47	275.1481336	35.00
BH48	CP+RC	9/23/1996	9/26/1996	30869.96	12367.26	297.8937829	15.10
BH49	RC	10/1/1996	10/2/1996	30809.01	12377.77	292.3013887	10.00
BH50	CP+RC	12/9/1996	1/14/1997	30744.12	12412.70	270.4929268	30.35
BH52	CP+RC	12/4/1996	1/8/1997	30620.23	12392.58	296.3300577	24.65
BH54	RC	10/8/1996	10/16/1996	30532.20	12350.90	292.7634905	30.15
BH55	CP+RC	9/20/1996	10/21/1996	30511.81	12345.30	289.4038521	20.80
BH56	CP+RC	9/22/1996	10/14/1996	30471.00	12334.85	293.3918984	35.00
BH57	CP+RC	9/21/1996	10/20/1996	30436.65	12324.26	292.2586770	30.00
BH58	CP+RC	9/26/1996	10/23/1996	30416.30	12332.16	303.3694834	20.31
BH59	RC	10/29/1996	11/2/1996	30385.25	12311.07	301.4364342	25.14





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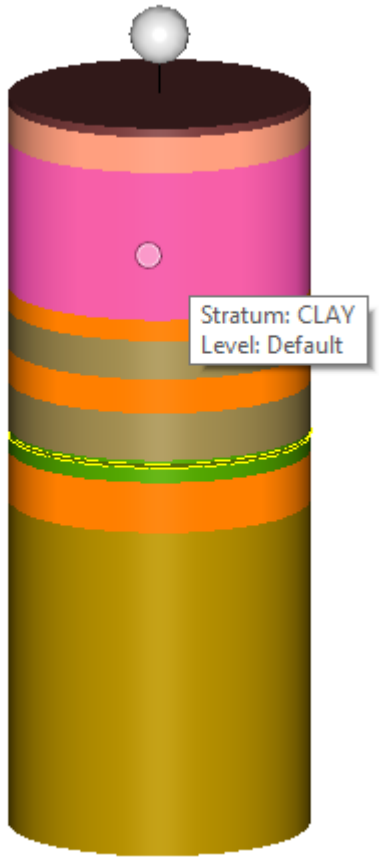
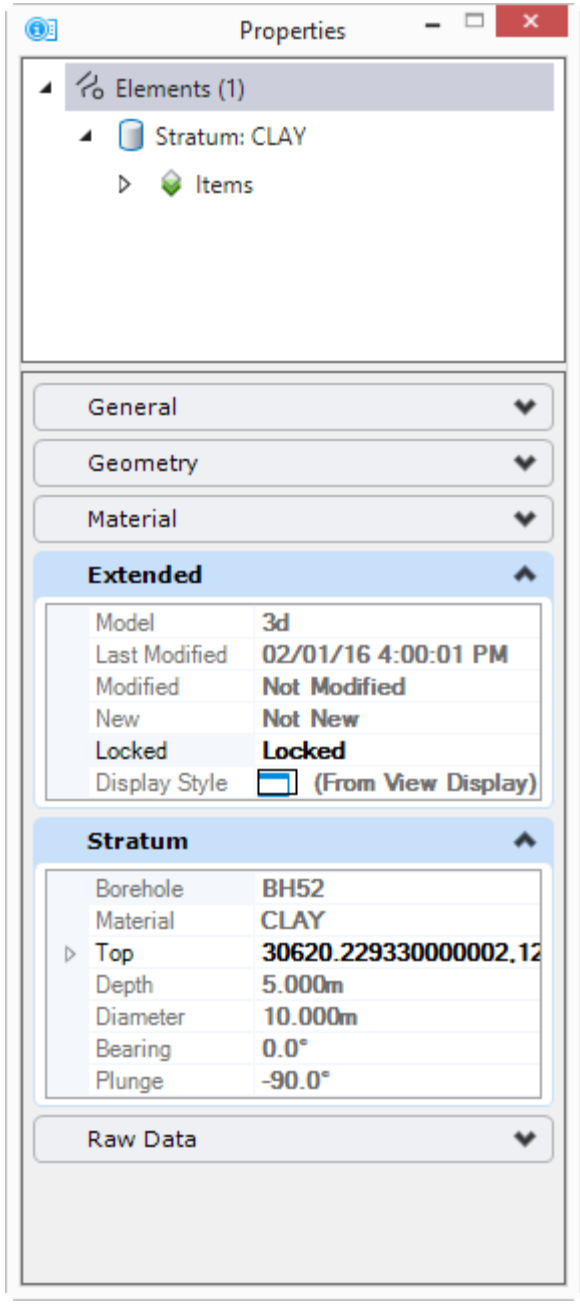
Subsurface data model : Top-Bottom

Top (m)	Base (m)	Description	Legend
0.00	0.30	TOPSOIL **	TOPSOIL
0.30	1.50	Soft to firm yellow and orange brown and grey mottled slightly sandy (fine) silty CLAY with occasional angular fine to medium gravel.	CLAY si sa gr co
1.50	6.50	Very stiff dark brown mottled grey slightly sandy (fine to coarse) silty CLAY with some to much angular to subangular fine to coarse gravel and cobbles of sandstone and quartzite.	CLAY si sa gr co
6.50	7.20	Grey fine and medium grained very thinly to thinly bedded slightly weathered SANDSTONE,strong to very strong. Prominent discontinuities: 1) Bedding fractures: subhorizontal (5? to 15?) planar,rough,clean,orange brown stained. 2) Subvertical (70? to	SANDSTONE
7.20	8.50	Grey thinly to medium bedded slightly weathered CONGLOMERATE,strong to very strong comprising subangular to subrounded up to coarse gravel sized clasts of quartz with a little to some matrix of fine to coarse grained sandstone. Prominent discontinuities: 1) Bedding	CONGLOMERATE
8.50	9.65	Grey brown fine to medium grained medium bedded slightly weathered SANDSTONE,strong and very strong. Prominent discontinuities: 1) Bedding fractures: 15? to 20?,planar,rough,clean,slightly orange brown stained. 2) Very closely to closely	SANDSTONE
9.65	11.25	Grey thinly to medium bedded slightly weathered CONGLOMERATE,strong to very strong comprising subangular to subrounded up to coarse gravel sized clasts of predominantly quartz with a little to some matrix of fine to coarse grained sandstone. Prominent	CONGLOMERATE
11.25	11.35	Grey slightly weathered SILTSTONE,weak to predominantly moderately weak with very closely to closely spaced randomly orientated and subhorizontal (0? to 20?) planar and irregular,smooth,clean discontinuities.	SILTSTONE
11.35	11.50	AZCL	Unknown
11.50	12.00		SILTSTONE
12.00	13.70	Grey fine to medium grained thinly to thickly bedded slightly weathered SANDSTONE,strong to extremely strong. Prominent discontinuities: 1) Bedding fractures: subhorizontal (5? to 20?) planar and irregular,rough,clean. 2) Subvertical (70? to 80?) irregular,rough,locally	SANDSTONE
13.70	24.65	Grey fine to medium grained thinly to thickly bedded slightly to moderately weathered crystalline LIMESTONE,strong to very strong with occasional sand to coarse gravel sized voids (occasionally infilled with quartz and calcite mineralisation). Locally discoloured brown	LIMESTONE





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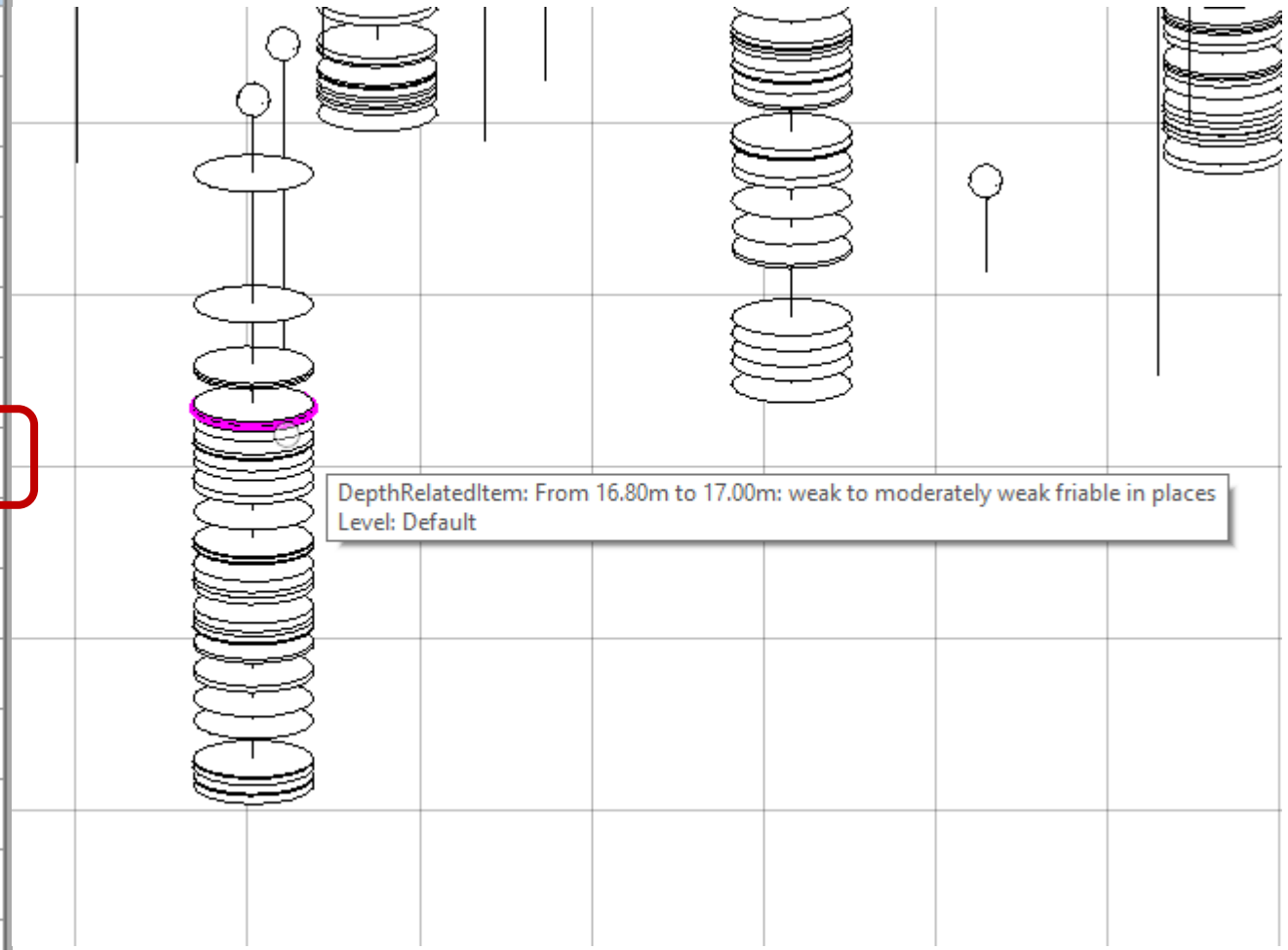
Subsurface data model : Depth Only

Depth (m)	Base (m)	Remark
2.5		From 2.5m: Samples recovered as angular fine to coarse gravel and cobbles of siltstone and fine grained sandstone with some grey brown mottled silty
10.5		At 10.50m: recovered as grey silty gravel
14.22		From 14.22m to 14.52m: 80? to 90? planar,irregular,rough,closed,iron stained joint perpendicular to main joint set
14.4		From 14.40m to 14.57m: fine to medium grained sandstone with occasional interlaminations of sandy siltstone
14.57		From 14.57m to 15.00m: with occasional thin sandy laminae
16.55		From 16.55m to 16.60m: ironstone nodule
16.8		From 16.80m to 17.00m: weak to moderately weak friable in places
17.16		From 17.16m to 17.25m: ironstone nodule
17.75		From 17.75m to 18.00m: slightly weathered,clay smearing along bedding fractures
18.55		From 18.55m to 18.65m: with some coarse gravel size ironstone nodules
18.82		From 18.82m to 18.85m: with some medium gravel size ironstone nodules
18.93		From 18.93m to 19.98m: 75? planar,smooth,closed joint
19.6		From 19.60m to 19.70m: with coarse gravel size ironstone nodules
20.15		From 20.15m to 20.28m: 45?,planar,rough,closed to slightly open (<1mm) joint with a slight clay smearing in places and slight iron staining



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Reporting of Geotechnical Data

- Loading boreholes in gINT Civil Tools
  - gINT Civil Tools available in
    - OpenRoads Designer Connect Edition (CE)
      - Access from the Geotechnical Workflow
    - gINT Civil Tools Professional Plus
      - Available to all gINT Professional Plus Connect Edition users
  - Connecting to a gINT Project
  - Loading boreholes and lithology (soil and rock) in 3D context
  - Annotating boreholes and lithology
  - Links to gINT reports (boreholes logs)

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Connecting to a gINT Project

- Let’s take a look…

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Create Terrains from 3D Borings

- Have the lithology table configured
- Have a 3D model open and active
- Query the borings
- Select 3D Modeling > 3D > Create Terrain
- Once created assign an OpenRoads Terrain feature
  - Required for OpenRoads to target the terrain

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Create Terrains from 3D Borings

- Let’s see how that works…
- We’ll look at both gINT and the geotechnical workflow in OpenRoads Designer

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OpenRoads Modeling Workflow Objectives

- Review the reference files
- Understand how to configure a template to target Subsurface strata
- Accessing the Geotechnical Subsurface Strata in the corridor
- Review the cross sections
- Generate volumes including the Subsurface Strata

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What files are required? Review the reference files

- 2D file containing the Geometry
- Existing Terrain 3D File
- 3D file containing the Substrata
- 2D file containing the corridor

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Review the reference files

- Let’s look at those references and the process

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How to target Subsurface Strata

- Use End Conditions Solution bundles
- Set up targets for specific strata
- Determine the appropriate priority
- Test the end condition solution before added to the project template

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End Condition Review

- I love templates so let’s see how we can make one to target substrata terrains.

Create the corridor

- Build a new corridor that has access to the substrata with an end condition bundle
- Process the corridor and verify the results by reviewing the 3D model

Create Dynamic Cross Sections

- Select the corridor
- From the context sensitive pop up select Corridor Views > Open Cross section Model
  - Or Select Corridors > Review > Dynamic Sections
- Provide left and right offsets
- Provide interval
- Review the sections

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Review the Dynamic Cross Sections and End Area Volumes

- Without doubt dynamic cross sections are the best way of reviewing corridor solutions…so here goes…

Earthworks Cut and Fill Volumes

- It’s great to report on cut and fill volumes.
- But what about the cost of cutting through rock?
- If we can quantify how much rock cut we have we can know the cost.

Review the Dynamic cross sections and End Area Volumes

- OpenRoads Designer has many civil analysis tools.
- Cut and fill volumes is getting more powerful.
- Reporting on named boundaries gets us the numbers we require.
- Getting used to this…let's take a look!

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Additional Information

- Defining Template End Conditions
- QuickStart for OpenRoads Designer Corridor Modeling
- Creating and Manipulating the Corridor
- https://learn.bentley.com/app/Public/ViewLearningPathDetails?lpId=110831
- QuickStart using gINT Civil Tools
- http://learn.bentley.com/app/Public/ViewLearningPathWithMasterCourseExpanded?lpId=111600&mcId=102599
- Bentley Communities gINT Forum
- https://communities.bentley.com/products/geotechnical1/f/gint-forum#pi25960=1

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Questions?

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