From Release to Restoration

Cutting Through The Chaos

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Agenda

1. Backstory
2. Summarizing the Data
3. The Whole Picture
4. Moving Forward

Back Story

Back Story

Single motor vehicle incident releases 50,000 litres of diesel fuel

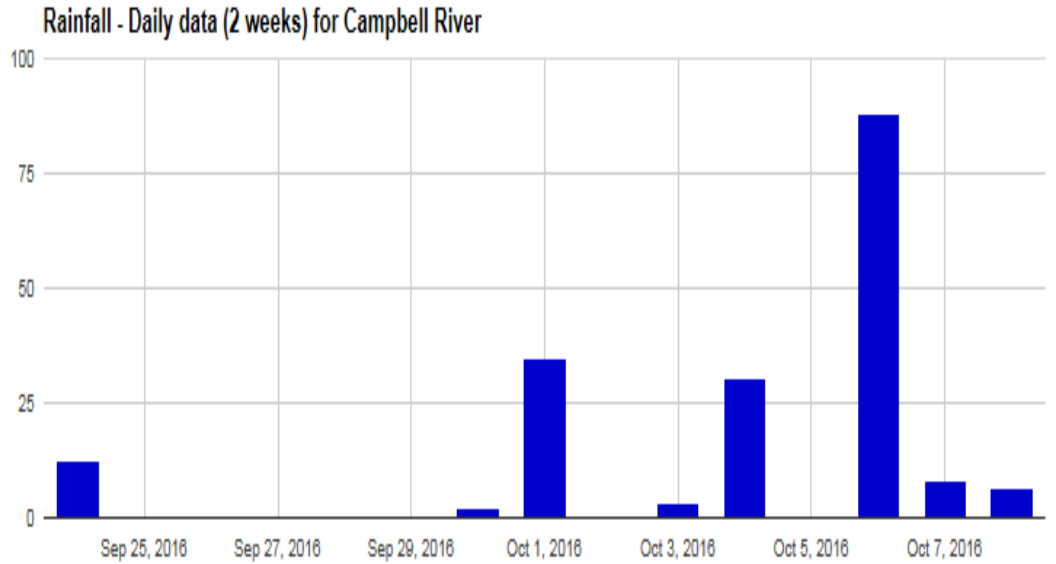
- Product released onto two separate properties
  - Ministry of Transportation & Infrastructure
  - Not for profit federally mandated conservation group
- Site was dry at the time of the release

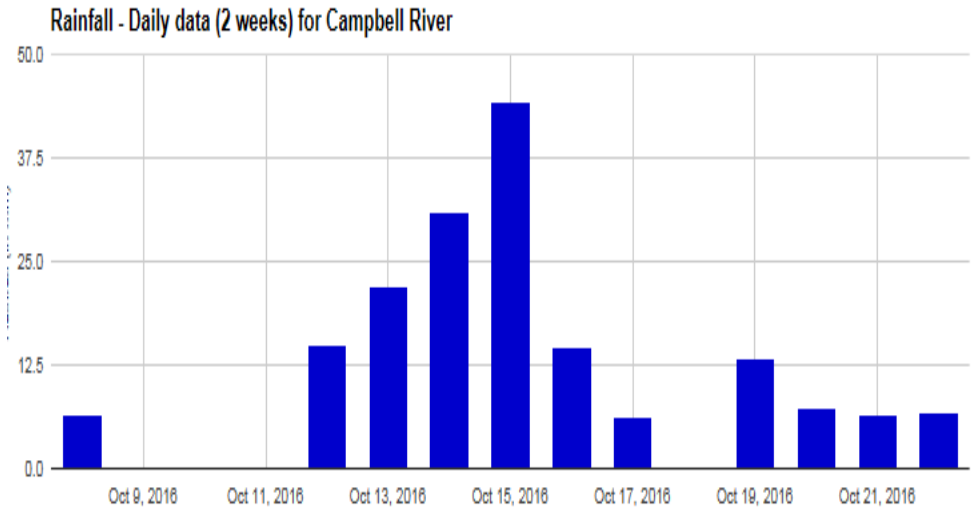
Back Story

- Site sensitivity analysis identified:
  - Presence of western toad
  - Ephemeral stream noted as spawning habitat for salmon
  - Wetland less than 1 km downstream
  - Residential homes and commercial businesses less than 1 km downstream
- Release location was at the base of a 45° slope 6 metres below the highway surface

RAIN!!!

- Initial excavation activities target saturated soils
- Wildlife management isolates the site
- Mobile laboratory established
- Permitting for water treatment and discharge





Environment and Climate Canada, 2017

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17,500,000 litres of water treated & released


+7,000 tonnes of impacted soil transported & barged off-island
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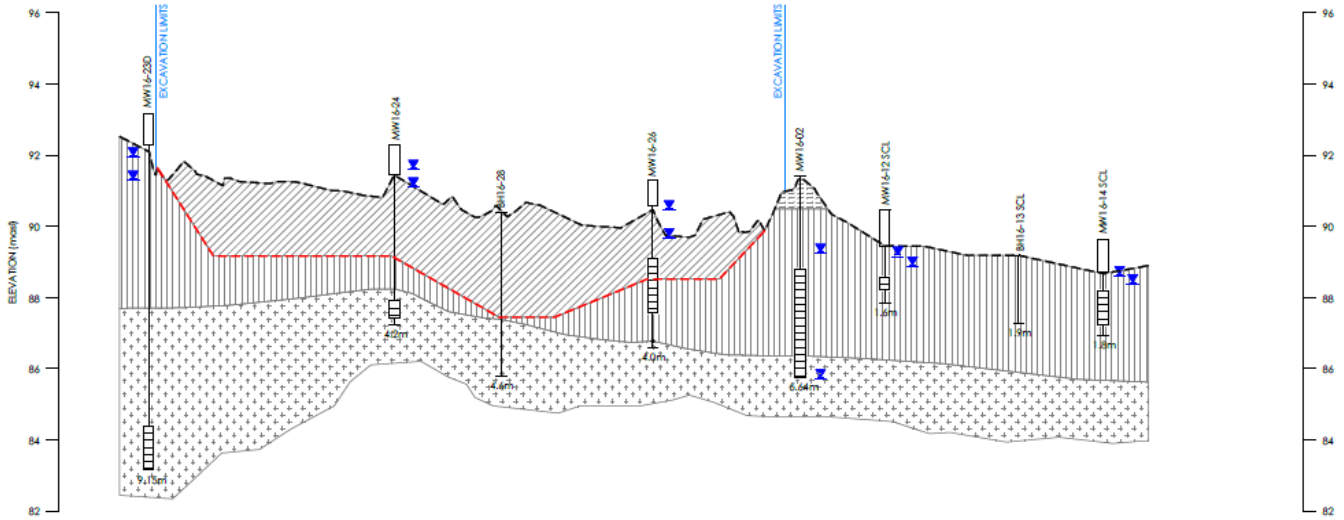
Back Story

Response Lessons Learned

- A Good Team Will Beat Bad Weather
- Engage Early
- Data Management Is Critical
- Logistics and Weather Can Be Cruel

Summarizing the Data

- Very useful, **IF** you know what you are looking at
- Stacks of data can be a lot to digest even for a seasoned technical expert
- Seeing in two dimensions isn't always the whole picture



Summarizing the Data

MONITOR WELL: MW16-01S

Project:
Client:
Location:
Number:
Field Investigator: R. HACHE
Contractor: BLUEMAX DRILLING INC

Drilling method: SONIC
Date started/completed: 10-Sep-2016 / 11-Sep-2016
Ground surface elevation: 92.93 m AMSL
Top of casing elevation: 93.02 m AMSL
Easting: 342639.635
Northing: 5521723.814

Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)
			Ground Surface	92.93
			FILL: Medium dense to very dense grey silt - trace gravel - moist	0.00
				90.80
			Loose to medium dense brown SAND and GRAVEL - moist	2.13
				89.88
			Light brown dense SILT - trace to some gravel - moist	3.05
				88.36
			SILTSTONE bedrock	4.57
				85.31
			End of Borehole	7.62

INSTALLATION DETAILS: Diagram / Description
- BENTONITE
- Groundwater Level: 3.86 m BGS
- SLOTTED SCREEN
- BENTONITE

Screen Interval: 3.00 - 6.20 m BGS
Sand Pack Interval: 2.80 - 6.20 m BGS
Well Seal Interval: 0.15 - 2.80 m BGS

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
n/a - not available

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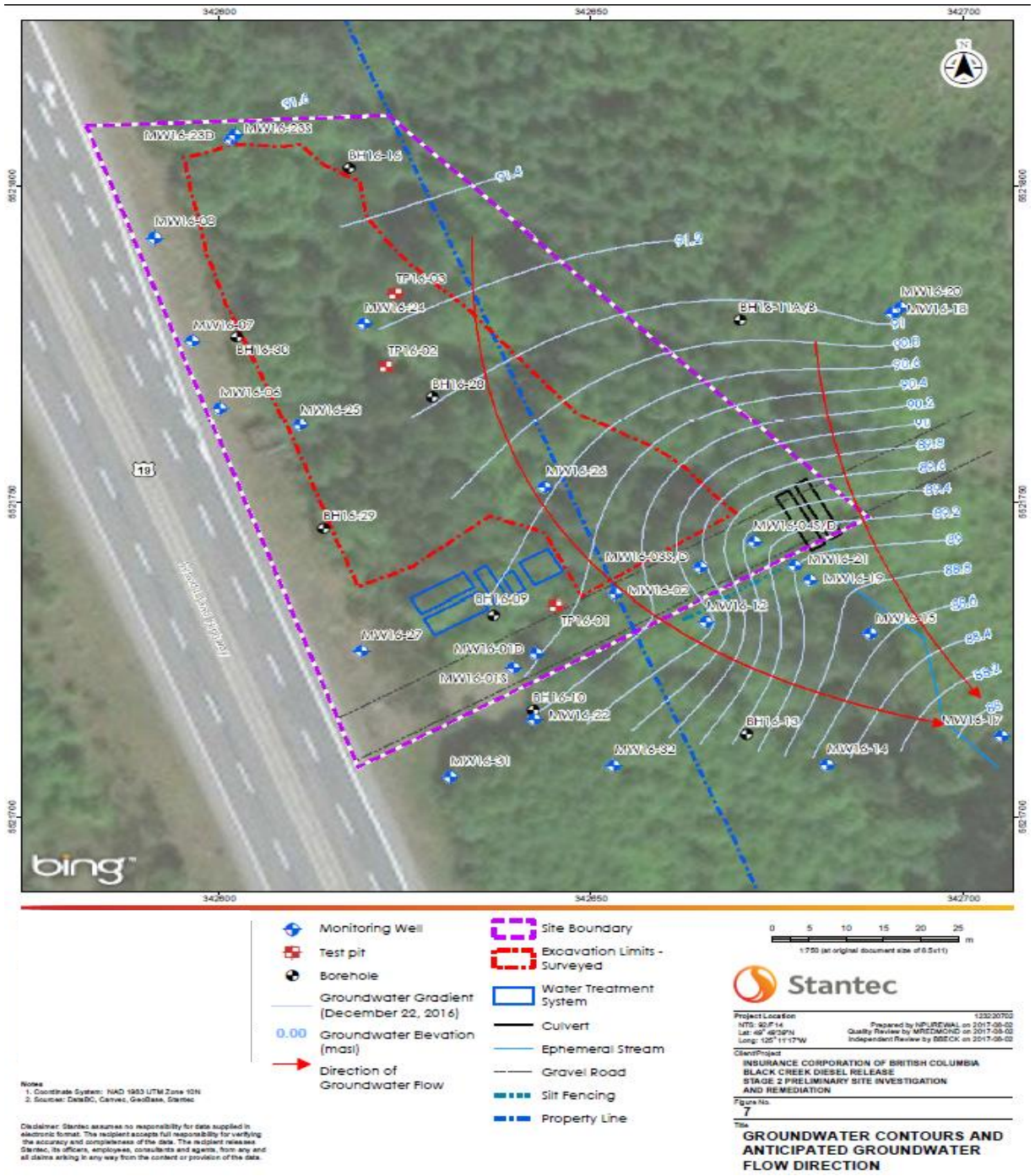
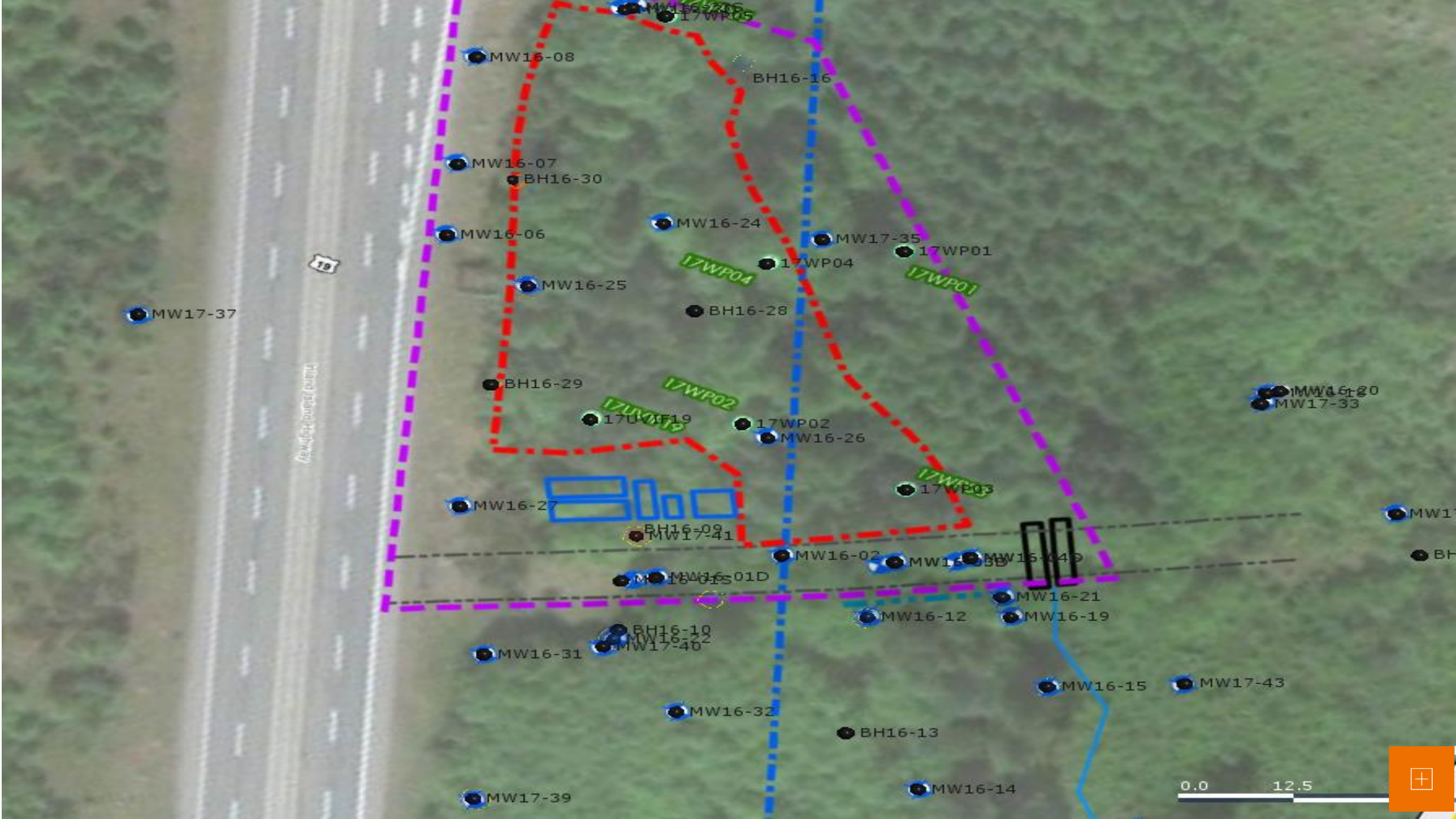
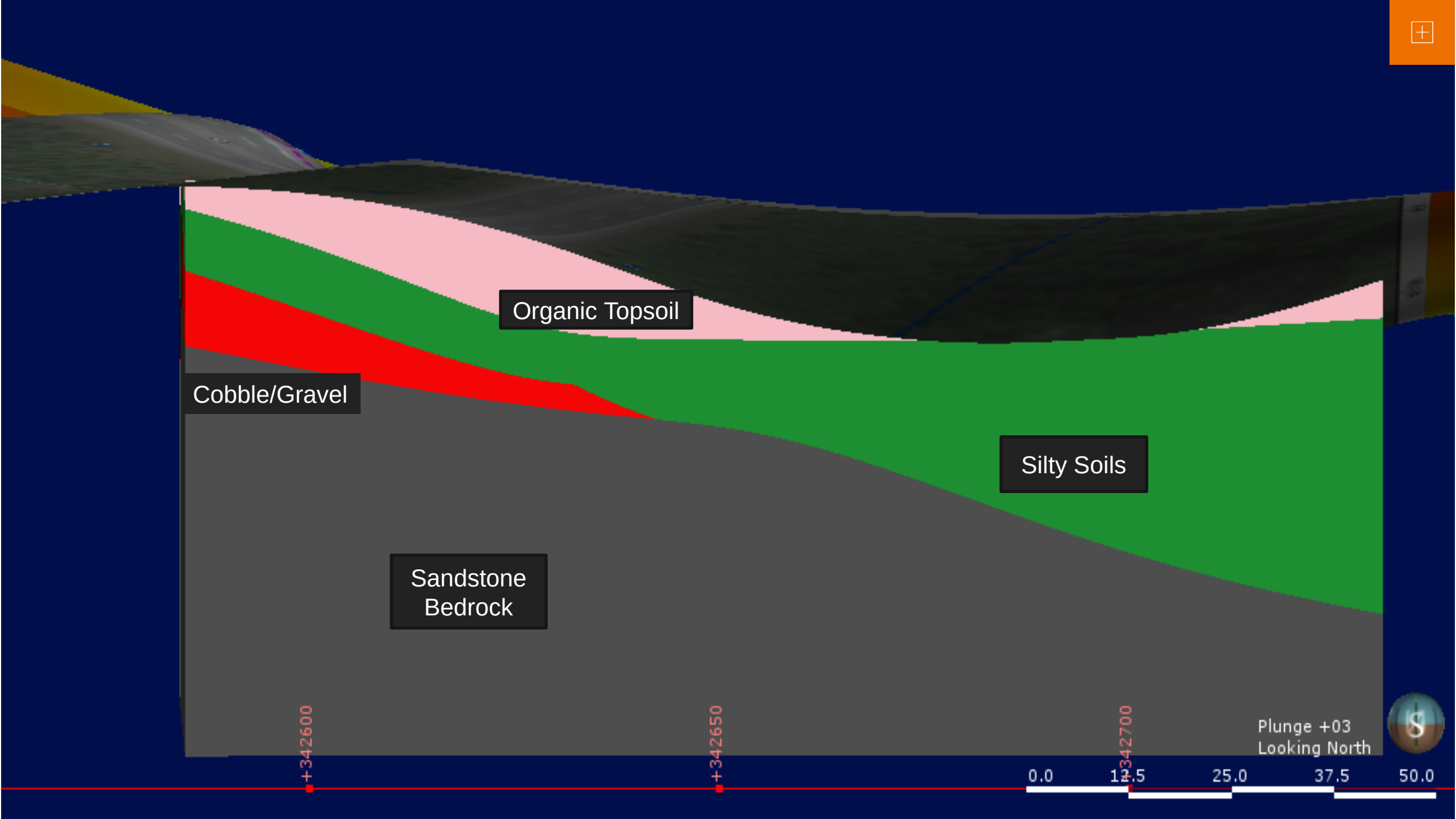
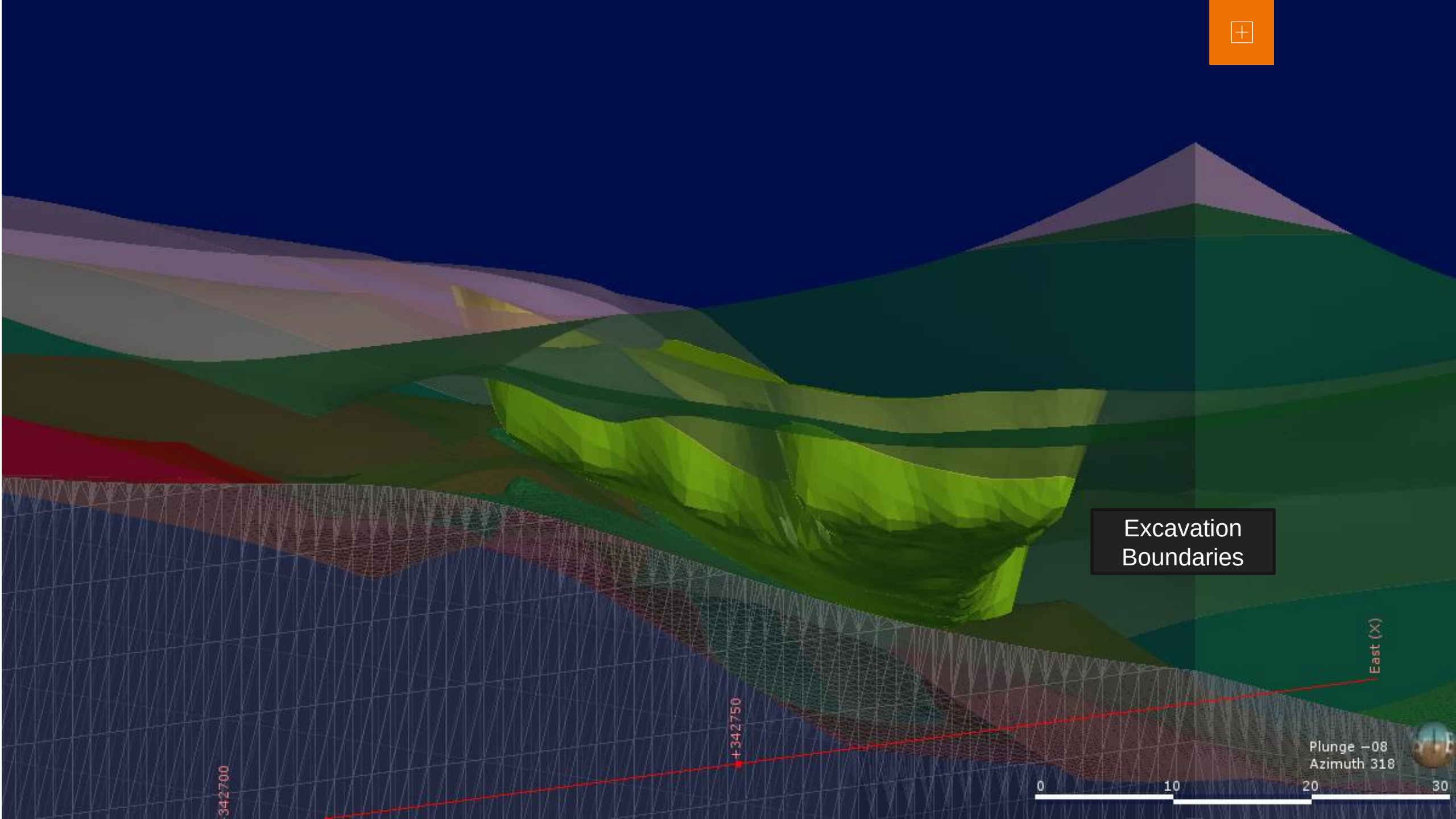
Drawn By/Checked By:

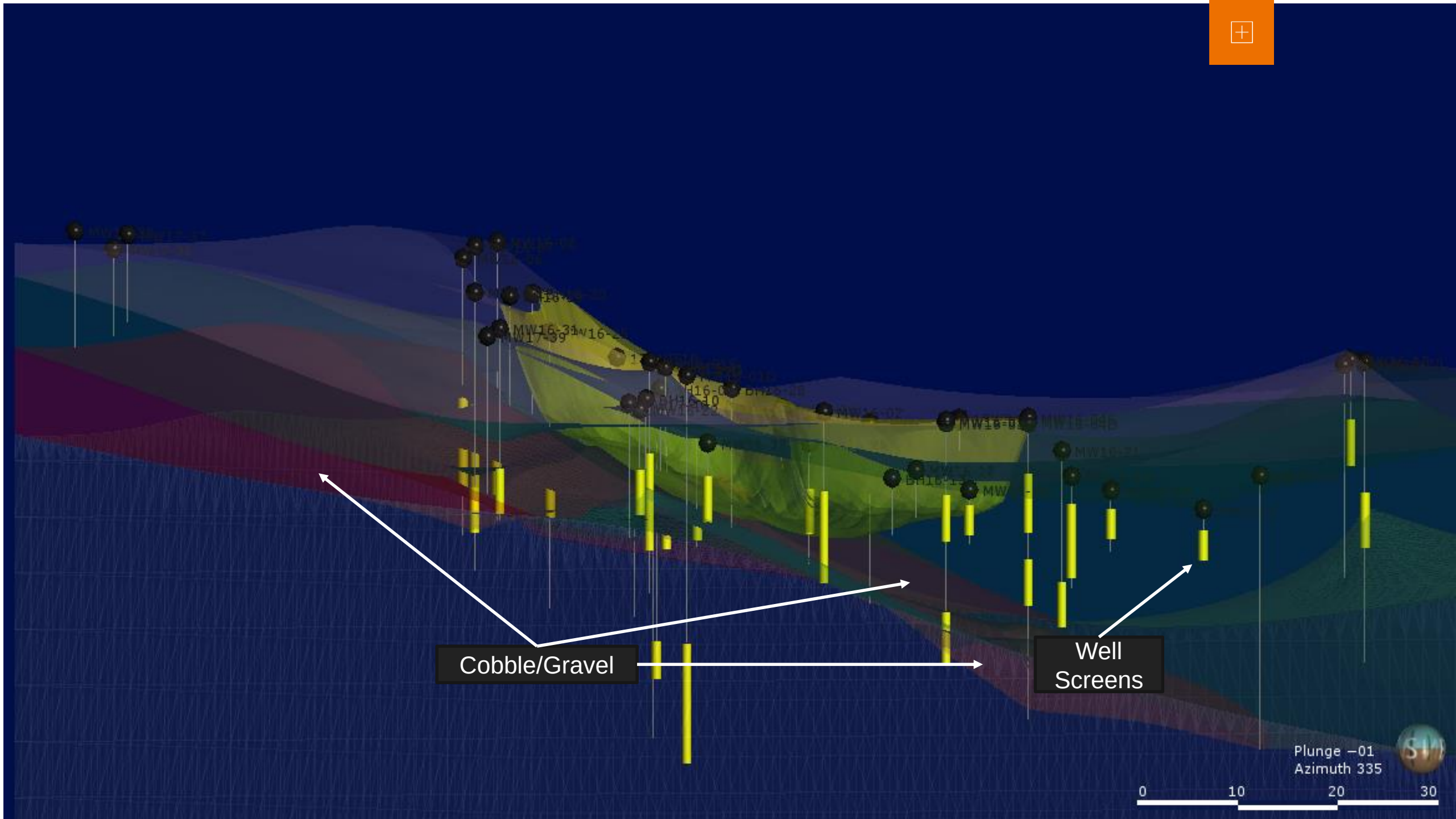
Sheet 1 of 1

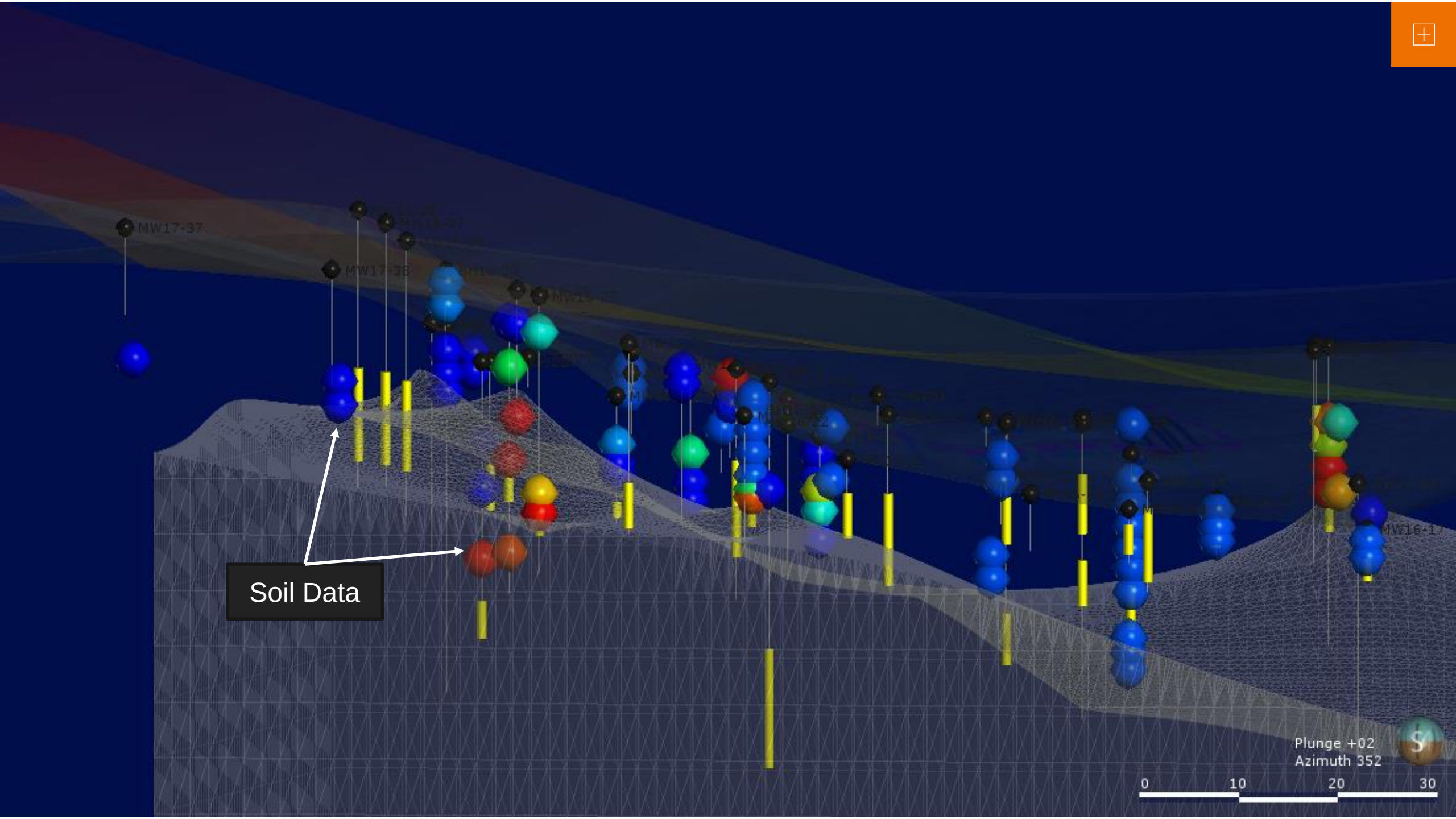


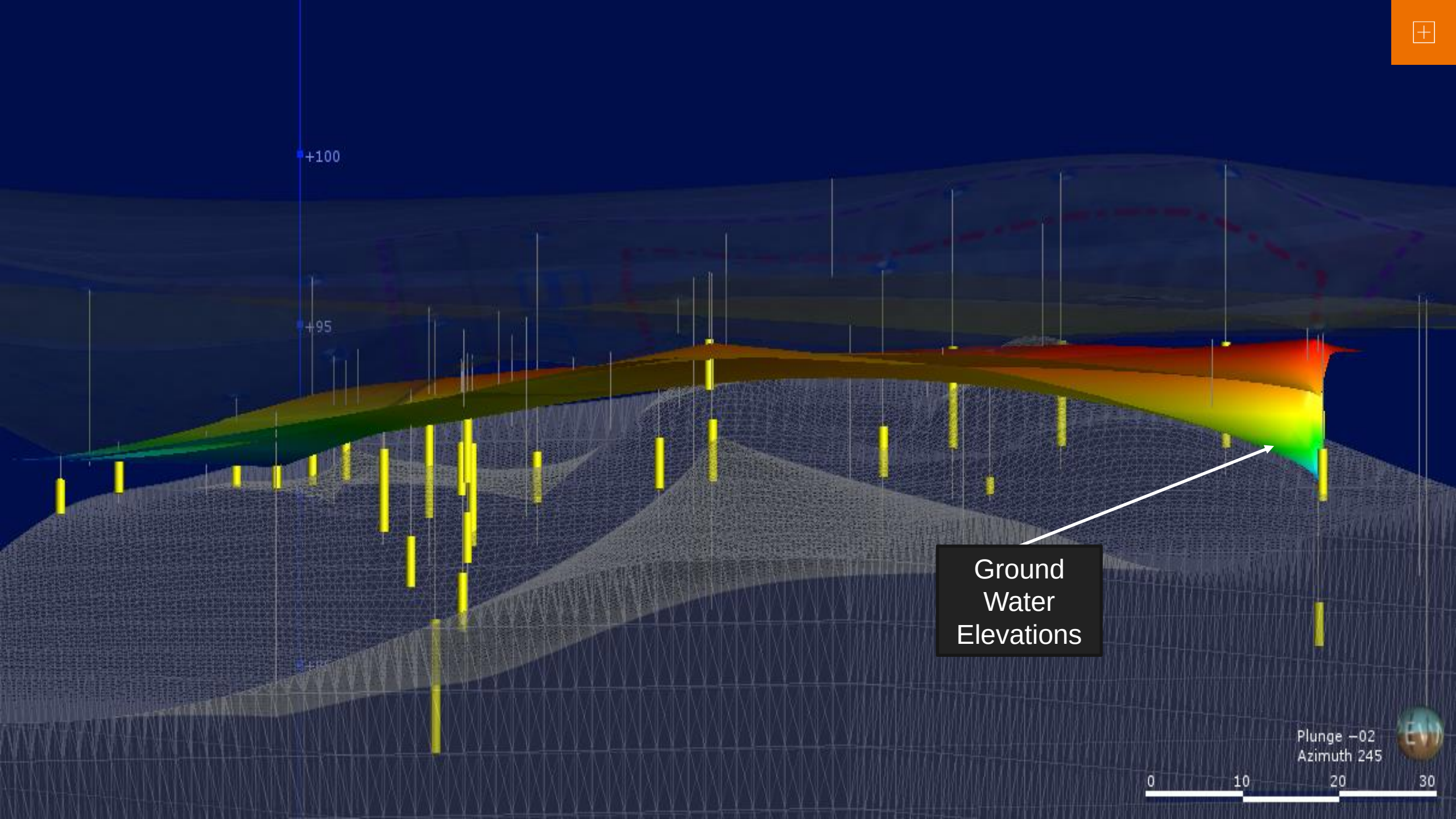

MW16-08
BH16-16
MW16-07
BH16-30
MW16-24
MW16-06
MW17-35
17WP01
17WP04
MW16-25
MW17-37
BH16-28
BH16-29
17WP02
MW16-26
MW16-27
17WP03
BH16-09
MW17-41
MW16-02
MW16-21
MW16-12
MW16-19
BH16-10
MW17-40
MW16-31
MW16-15
MW17-43
MW16-32
BH16-13
MW16-14
MW17-39
MW17-33
0.0
12.5


Organic Topsoil
Cobble/Gravel
Silty Soils
Sandstone Bedrock
+342600
+342650
+342700
Plunge +03
Looking North
0.0
12.5
25.0
37.5
50.0

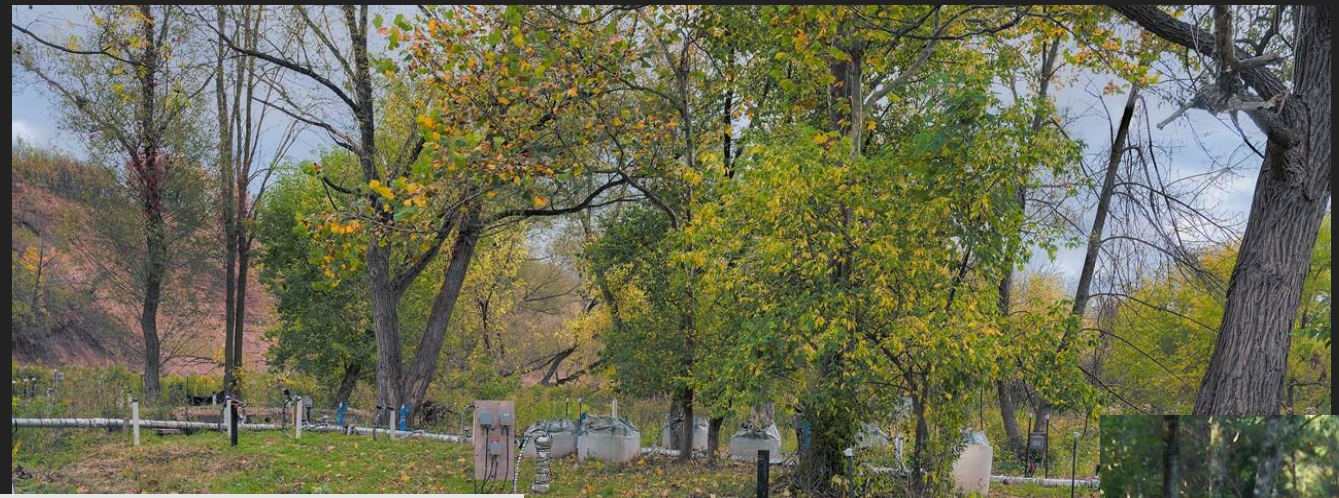

Excavation Boundaries
East (X)
+342750
342700
Plunge −08
Azimuth 318
0
10
20
30


Cobble/Gravel
Well Screens
Plunge −01
Azimuth 335
0
10
20
30


Soil Data
Plunge +02
Azimuth 352
0
10
20
30


+100
+95
Ground
Water
Elevations
Plunge −02
Azimuth 245
0
10
20
30

Moving Forward



	A	B	C	D	E	F	G	H	I	J	K	L
10	F1-BTEX											
11												
12					General Statistics							
13				Total Number of Observations		159			Number of Distinct Observations			27
14				Number of Detects		29			Number of Non-Detects			130
15				Number of Distinct Detects		26			Number of Distinct Non-Detects			2
16				Minimum Detect		15			Minimum Non-Detect			10
17				Maximum Detect		740			Maximum Non-Detect			17
18				Variance Detects		38608			Percent Non-Detects			81.76%
19				Mean Detects		184.1			SD Detects			196.5
20				Median Detects		110			CV Detects			1.067
21				Skewness Detects		1.515			Kurtosis Detects			1.437
22				Mean of Logged Detects		4.655			SD of Logged Detects			1.134
23												
24					Normal GOF Test on Detects Only							
25				Shapiro Wilk Test Statistic		0.79			Shapiro Wilk GOF Test			
26				5% Shapiro Wilk Critical Value		0.926			Detected Data Not Normal at 5% Significance Level			
27				Lilliefors Test Statistic		0.233			Lilliefors GOF Test			
28				5% Lilliefors Critical Value		0.165			Detected Data Not Normal at 5% Significance Level			
29					Detected Data Not Normal at 5% Significance Level							
30												
31					Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs							
32				Mean		41.76			Standard Error of Mean			8.587
33				SD		106.4			95% KM (BCA) UCL			57.22
34				95% KM (t) UCL		55.97			95% KM (Percentile Bootstrap) UCL			57.09
35				95% KM (z) UCL		55.89			95% KM Bootstrap t UCL			60.73
36				90% KM Chebyshev UCL		67.52			95% KM Chebyshev UCL			79.19
37				97.5% KM Chebyshev UCL		95.39			99% KM Chebyshev UCL			127.2
38												
39					Gamma GOF Tests on Detected Observations Only							
40				A-D Test Statistic		0.456			Anderson-Darling GOF Test			
41				5% A-D Critical Value		0.774	Detected data appear Gamma Distributed at 5% Significance Leve					
42				K-S Test Statistic		0.102			Kolmogrov-Smirnoff GOF			
43				5% K-S Critical Value		0.167	Detected data appear Gamma Distributed at 5% Significance Leve					
44					Detected data appear Gamma Distributed at 5% Significance Level							
45												
46					Gamma Statistics on Detected Data Only							
47				k hat (MLE)		1.027			k star (bias corrected MLE)			0.944
48				Theta hat (MLE)		179.3			Theta star (bias corrected MLE)			195.1
49				nu hat (MLE)		59.56			nu star (bias corrected)			54.73
50				MLE Mean (bias corrected)		184.1			MLE Sd (bias corrected)			189.6
51												
52					Gamma Kaplan-Meier (KM) Statistics							
53				k hat (KM)		0.154			nu hat (KM)			48.99
54				Approximate Chi Square Value (48.99, α)		33.92			Adjusted Chi Square Value (48.99, β)			33.81
55				95% Gamma Approximate KM-UCL (use when n>=50)		60.31			95% Gamma Adjusted KM-UCL (use when n<50)			60.52
56												
57					Gamma ROS Statistics using Imputed Non-Detects							
58					GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs							
59					GROS may not be used when kstar of detected data is small such as < 0.1							
60					For such situations, GROS method tends to yield inflated values of UCLs and BTVs							

Credits

- **Joseph Riddell**, P.Geo

3-D CSM Production

- **Tanya Shanoff,** M.Sc, P.Geo

Senior Hydrogeologist

- **Chris Gill**, B.A.(Env), LEED AP, EP

Client Manager

"Every now and then one paints a picture that seems to have opened a door and serves as a stepping stone to other things"

- Pablo Picasso