Subsurface Utility Engineering (SUE) and 3D Underground Utility Data in Microstation

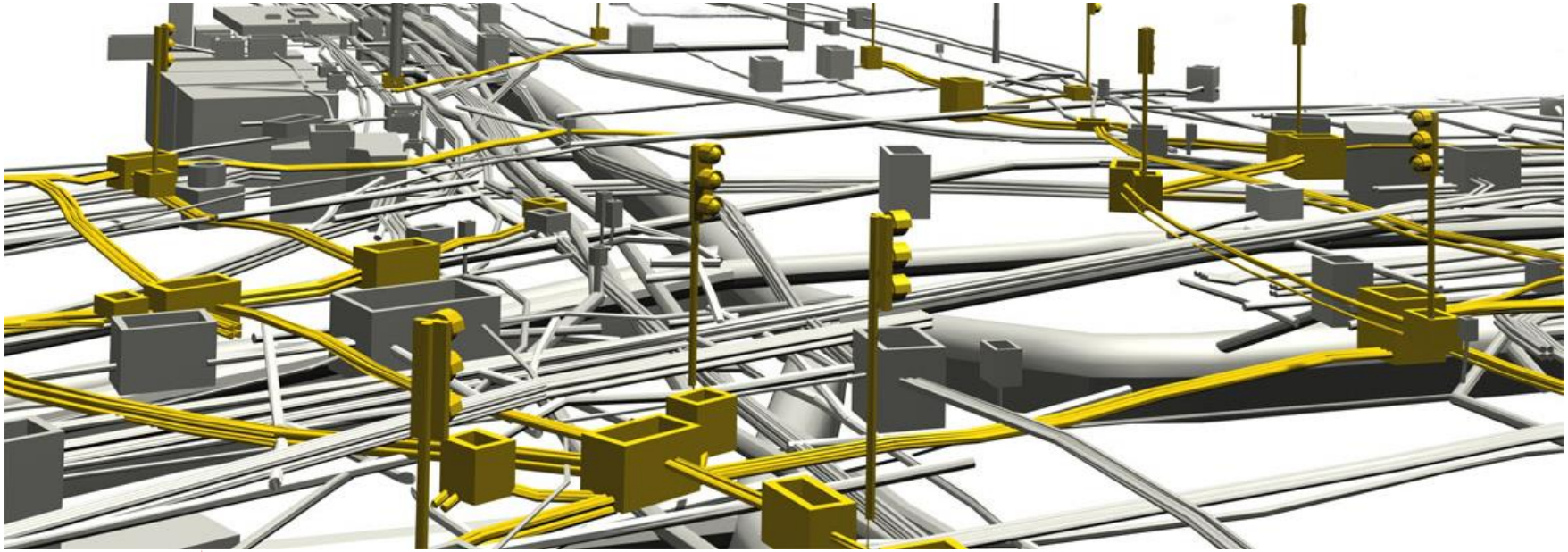
2014 Design Training Expo

The FDOT District 5 experience and the latest developments

Mark Pitchford, PSM
Carlo Pilia, CEng
CARDNO

What is “SUE?”

- Subsurface Utility ~~EXCAVATION~~?
- Subsurface Utility ~~EXPLORATION~~?
- SUBSURFACE UTILITY ENGINEERING



Subsurface Utility Engineering:

A branch of engineering practice that involves managing certain risks associated with utility mapping and appropriate quality levels, utility coordination, utility relocation design and coordination, utility condition assessment, communication of utility data to concerned parties, utility relocation cost estimates, implementation of utility accommodation policies, and utility design.

(CI/ASCE 38-02)

What do you do with “SUE?”

- “Do you ~~crack~~ a pipe?!!”
- “Do you ~~pothole~~ a pipe?!!”
- “Do you ~~sue~~ a pipe?!!”

What do you do with Subsurface Utility Engineering?

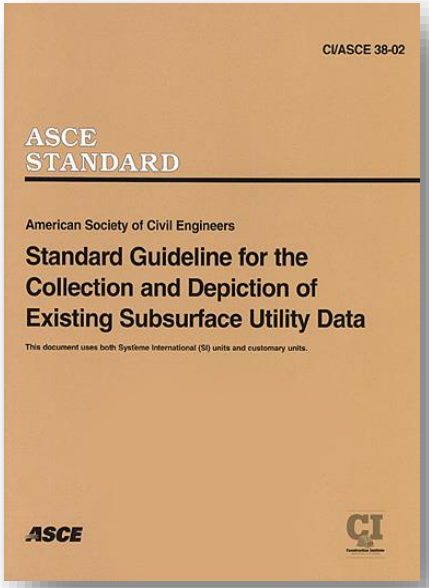
- **Collect, Gather, Interpret, Manage and Use Utility Information in Accordance with Standards (38-02).**

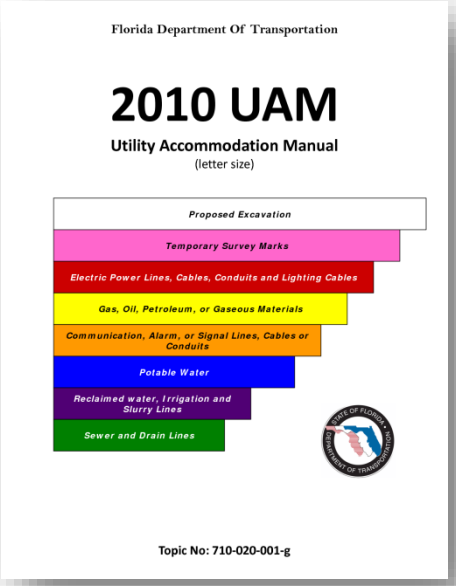
Utility information and reliability…
What is reliable?

David Butow US News & World Report

Utility information and reliability defined through four quality levels:

- Quality Level D
- Quality Level C
- Quality Level B
- Quality Level A





Utility information and reliability defined through four quality levels:

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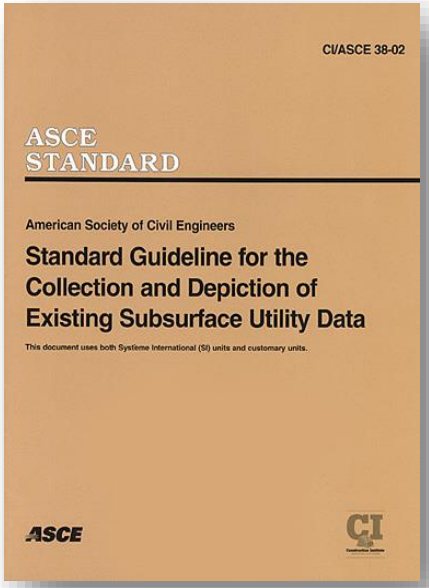
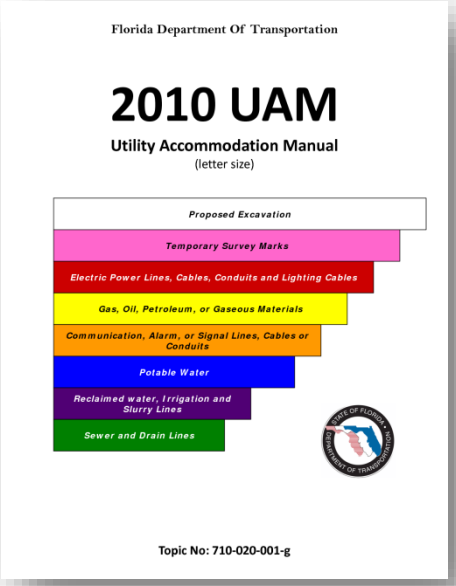
- Quality Level A

Depth information

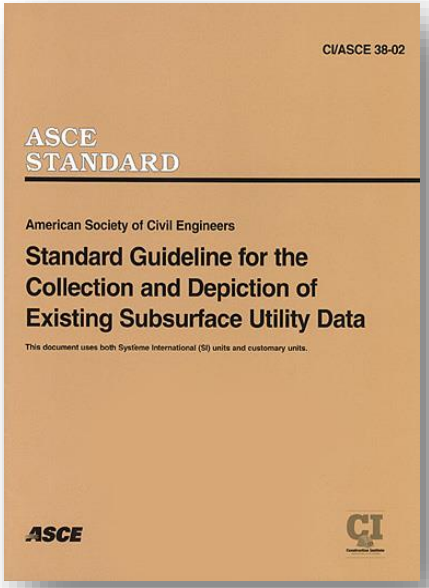




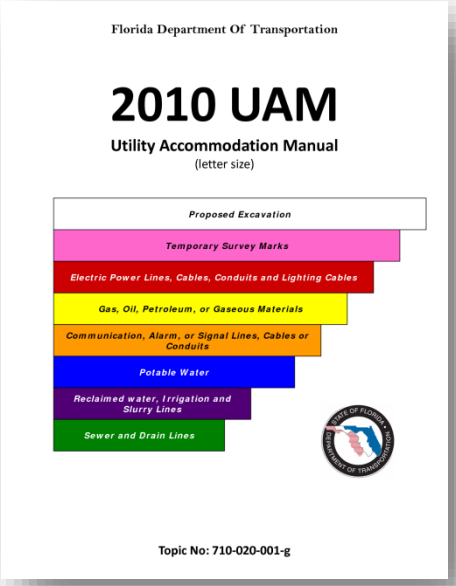
Quality Level B with depth information?

- **Hybrid: Quality Level B with depth qualifiers**

No Vertical Information



Limited Vertical Information



Why and how we obtain Quality Level B with depth information?

- **Advancement in 3D design**
- **Improvements in surface geophysics**

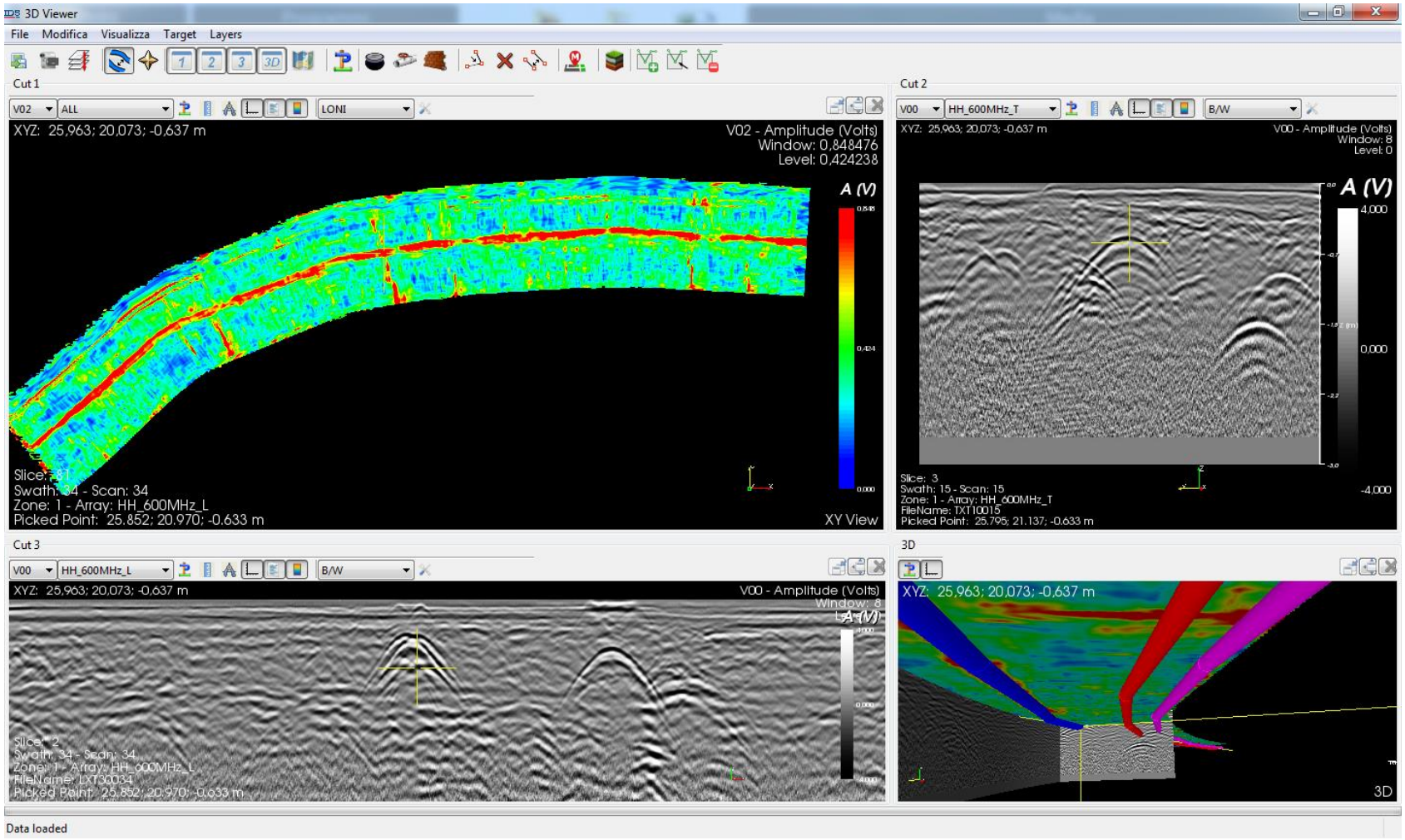
Radiodetection Ltd

2014 Design Training Expo

Radar Tomography (RT) – Benefits & Characteristics

- **Continuous data with post-processing and interpretation**
- **Calibration for depth readings**
- **Positioning (GPS, Total Station)**

RT – Benefits & Characteristics



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FDOT Central Office - 3D Radar Tomography Contract

TWO #1- District 5: SR46, Wekiva 7A

SR46 @ Lake Markham Rd

SR46 @ Orange Ave

Expectations

- Scan Areas with 3D Radar
- Support with Conventional Utility Mapping
- Obtain 3D Utility Information
- Horiz. & Vert. Accuracy ≤ 0.5ft
- UTEXRD01.dgn & UTVHRD01.dgn

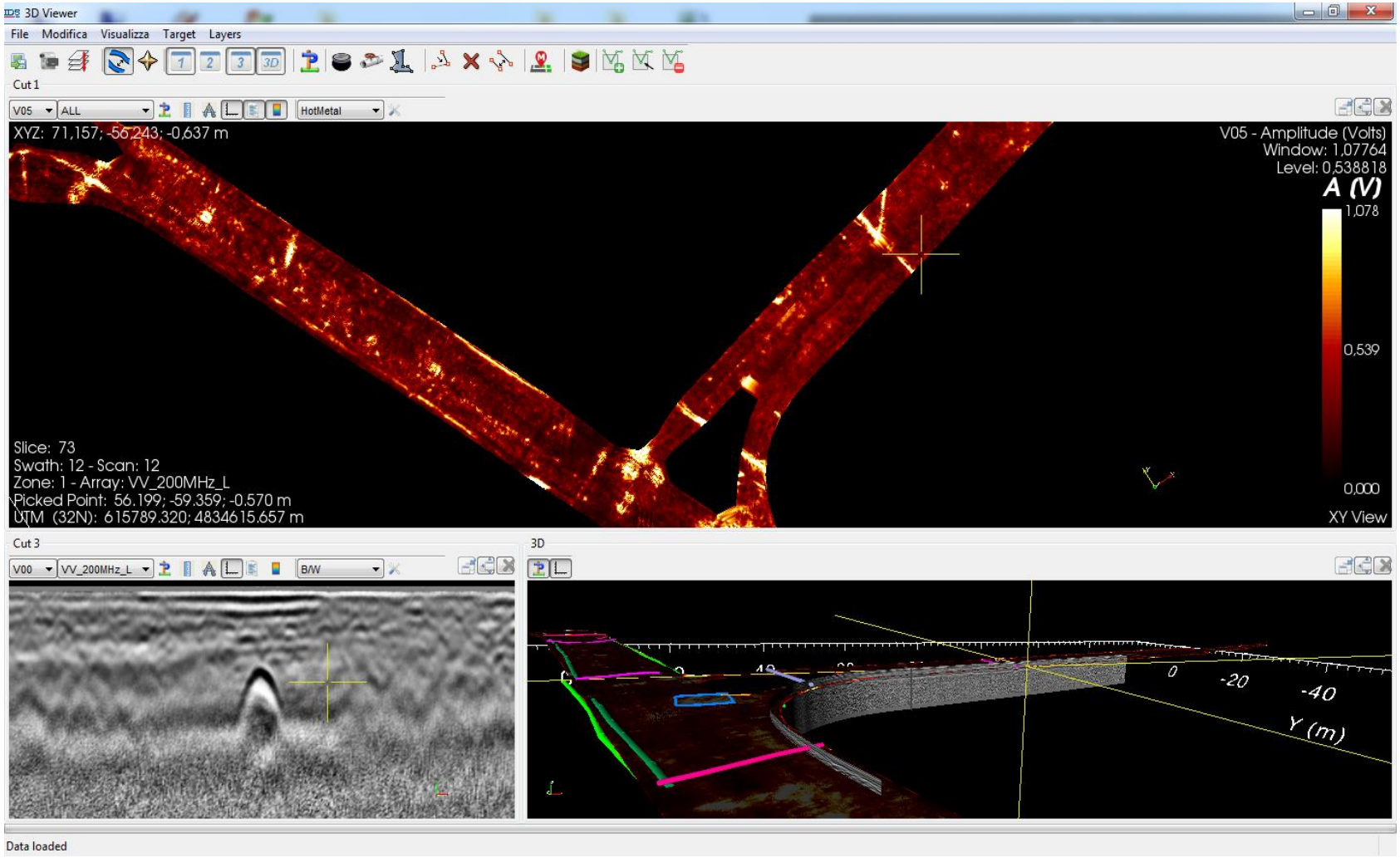
Process

- Obtain Utility Records
- Recover/Establish Project Horizontal and Vertical Control
- Scan Areas and Record Raw RT Data
- Complete Conventional Designating with EDE
- Complete Locating to assist in calibrating RT
- Survey
- Process and Prepare Deliverables

Depth information gathered from all available methods

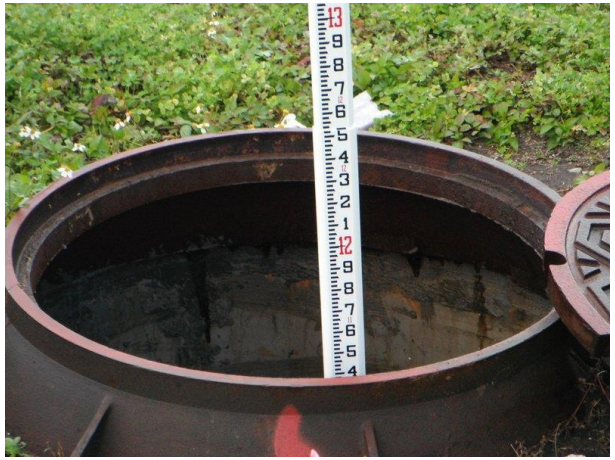
- Radar Tomography
- Electromagnetic Locators
- Direct Measurements
- CARDNO proprietary process to analyze, merge and produce reliable vertical data
- Elevations based on DTM

Depth Information from Different Data Sets



Depth Information from Different Data Sets

Depth Information from Different Data Sets

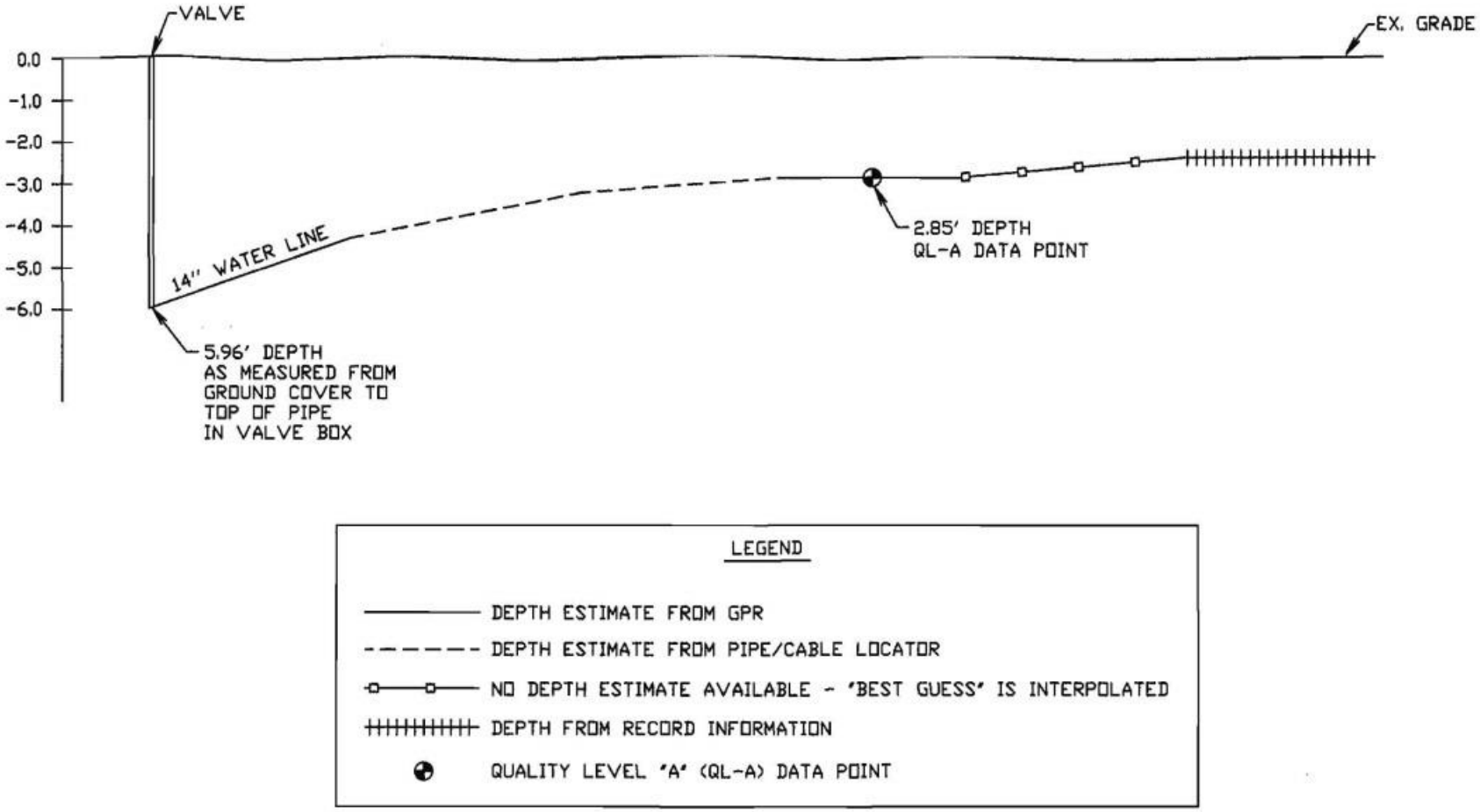


Survey Support

- Tie into existing project control
- 3D radar tomography uses point-to-point RTK GPS receiver to log horizontal positions
- Elevations based on existing DTM
- Standard surveying techniques for 3D position of designating and locating marks
- MS/Geopak for post processing and point/chain database management - PNEZD

Vertical Data Management

- Compare and analyze Z from different data sets



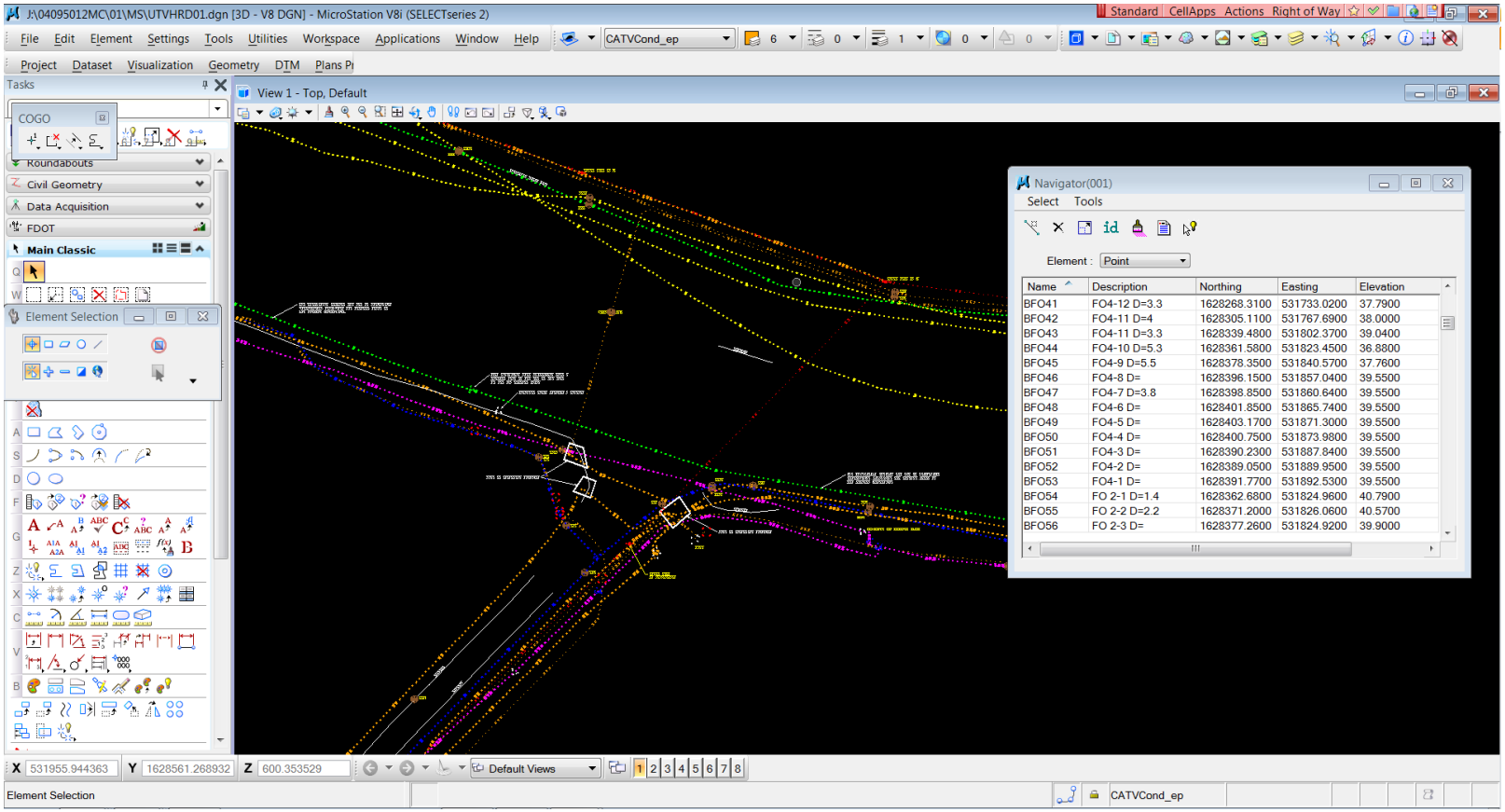
Vertical Data Management

- Compare and analyze Z from different data sets

RADAR TOMOGRAPHY CONTRACT - TWO 1 - DEPTH COMPARISON TABLE												
Point	TH#	Northing	Easting	Elevation	Depth/Cut (Feet)	Approximate Electronic Depth (Feet) EM Locator	Delta EM ED vs TH	Approximate Radar Depth (Feet) 3D RT (before correction)	Delta 3D RT ED vs TH	Abs Value of Delta EM ED vs TH	Abs Value of Delta 3D RT vs TH	Delta Comparison Best Value
CTH1	1	1628369.29	532098.29	42.11	4.93	N/A	N/A	4	0.93		0.93	N/A
CTH2	2	1628386.05	532100.87	42.34	4.80	N/A	N/A	4.2	0.60		0.6	N/A
CTH3	3	1628411.59	531864.74	43.61	3.50	N/A	N/A	3.7	-0.20		0.2	N/A
CTH4	4	1628218.19	531669.19	41.30	3.45	N/A	N/A	3.4	0.05		0.05	N/A
CTH5	5	1628396.69	531799.98	41.88	3.80	N/A	N/A	3.2	0.60		0.6	N/A
CTH6	6	1628442.94	531781.31	40.99	4.33	3.9	0.43	4.1	0.23	0.43	0.23	RT
CTH9	7	1628442.94	531781.31	40.99	4.07	3.9	0.17	4.1	-0.03	0.17	0.03	RT
CTH7	8	1628571.00	531490.66	42.30	2.41	1.5	0.91	2.2	0.21	0.91	0.21	RT
CTH8	9	1628571.77	531491.04	42.41	1.99	2	-0.01	2.4	-0.41	0.01	0.41	EM
DTH1	10	1628723.14	531556.16	39.14	2.06	3.8	-1.74	N/A	N/A	1.74		N/A
DTH6	11	1628705.16	531600.46	37.91	2.71	3.8	-1.09	2.7	0.01	1.09	0.01	RT
DTH7	12	1628649.89	531727.05	37.46	2.60	N/A	N/A	2.7	-0.10			N/A
DTH9	13	1628614.14	531815.27	38.13	2.97	N/A	N/A	2.5	0.47		0.47	N/A
DTH12	14	1628551.47	532022.08	38.44	2.93	N/A	N/A	N/A	N/A			N/A
DTH13	15	1628554.73	532022.40	38.38	3.76	3.5	0.26	2.5	1.26	0.26	1.26	EM
DTH10	16	1628541.01	531830.64	39.86	4.49	3.3	1.19	4.2	0.29	1.19	0.29	RT
DTH14	17	1628409.50	532005.49	43.73	4.27	4.5	-0.23	3.6	0.67	0.23	0.67	EM
DTH15	18	1628423.68	531926.16	43.76	3.46	4.5	-1.04	3.1	0.36	1.04	0.36	RT
DTH17	19	1628364.76	531812.38	42.35	3.81	N/A	N/A	3.6	0.21			N/A
DTH20	20	1628447.99	531797.27	42.36	8.17	12	-3.83	7.6	0.57	3.83	0.57	RT
DTH18	21	1628279.20	531697.03	40.71	1.60	N/A	N/A	1.2	0.40			N/A
DTH16	22	1628423.61	531898.69	43.66	4.29	N/A	N/A	3.9	0.39			N/A
EWM6	23	1628405.61	532004.13	43.65	6.05	N/A	N/A	5.3	0.75			N/A
ERW2	24	1628421.28	531898.45	43.61	9.50	9.5	0.00	N/A	N/A			N/A
ECSH1	25	1628618.75	531815.63	38.13	2.40	3.1	-0.70	2.4	0.00	0.7	0	RT
GCSH8	26	1628063.85	536485.35	53.33	2.50	2.7	-0.20	4.8	-2.30	0.2	2.3	EM
GCSH9	27	1628029.98	536619.59	53.85	6.00	N/A	N/A	5.1	0.90			N/A
GUNK2	28	1628235.93	536511.90	53.66	3.70	4.8	-1.10	2.8	0.90	1.1	0.9	RT
GCSH7	29	1628160.62	536670.79	55.88	3.90	5	-1.10	3.2	0.70	1.1	0.7	RT
GCSH10	30	1628026.74	536760.81	57.84	4.45	4.50	-0.05	N/A	N/A			N/A
GCSH12	31	1628024.20	536808.86	58.61	2.90	N/A	N/A	2.2	0.70			N/A
GCSH6	32	1628161.12	536808.72	57.30	3.10	3.5	-0.40	2.1	1.00	0.4	1	EM
GCSH5	33	1628162.52	536827.70	57.35	2.15	N/A	N/A	1.6	0.55			N/A
GCSH16	34	1627972.71	537036.84	57.47	3.55	4	-0.45	2.7	0.85	0.45	0.85	EM
GCSH13	35	1628009.67	537034.38	60.72	5.60	6.2	-0.60	3.2	2.40	0.6	2.4	EM
GCSH20	36	1628005.68	537314.11	61.87	4.55	N/A	N/A	3	1.55			N/A
GCSH14	37	1628016.38	537081.49	61.28	6.00	N/A	N/A	4	2.00			N/A
GCSH4	38	1628142.24	537107.00	59.18	2.35	3.5	-1.15	1.6	0.75	1.15	0.75	RT
GUNK17	39	1628152.80	537170.47	59.94	4.10	N/A	N/A	2.1	2.00			N/A

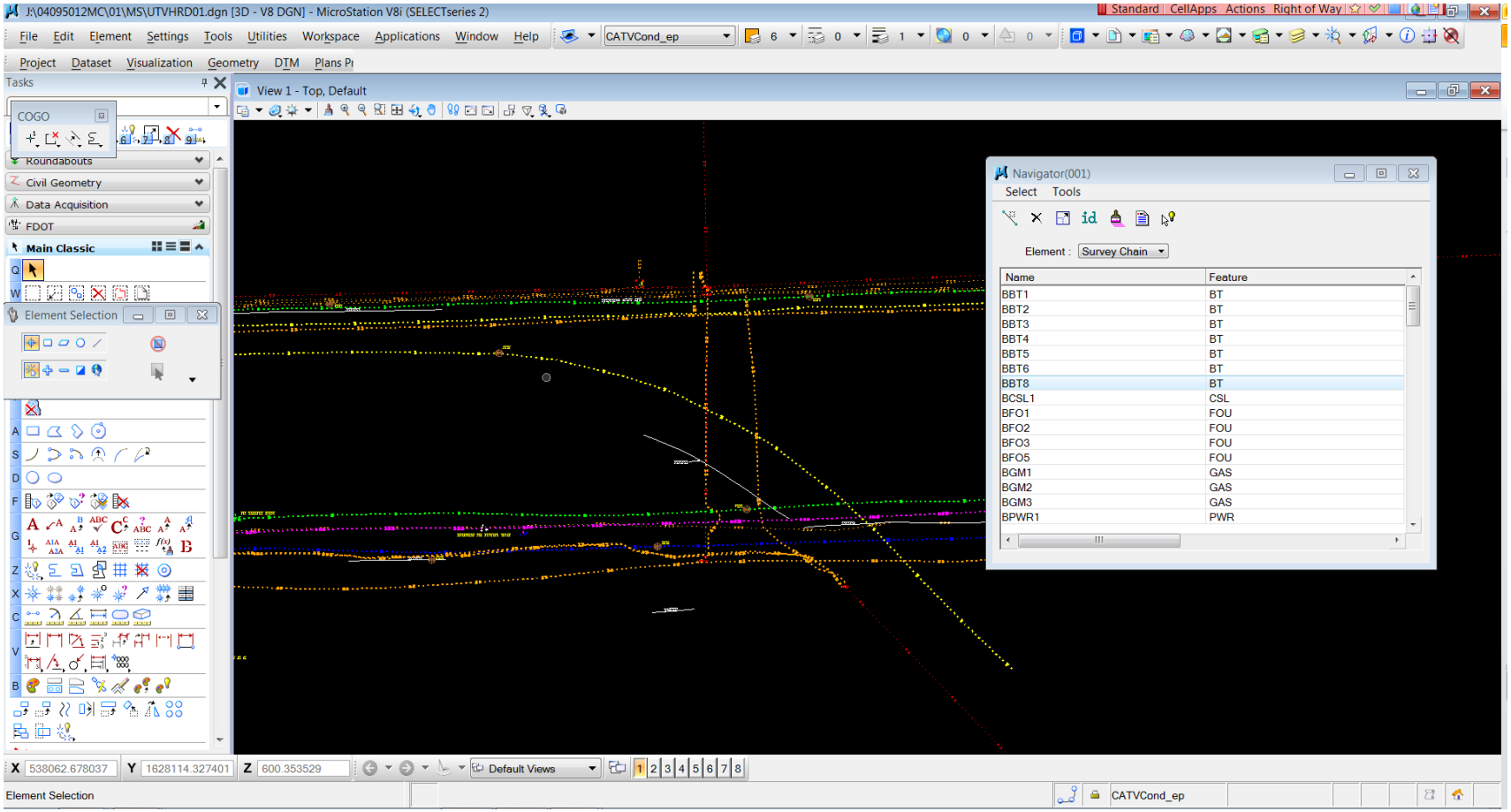
Export and Preparation of 2D and 3D DGN

- Microstation V8i and Geopak (points)



Export and Preparation of 2D and 3D DGN

- Microstation V8i and Geopak (chains)



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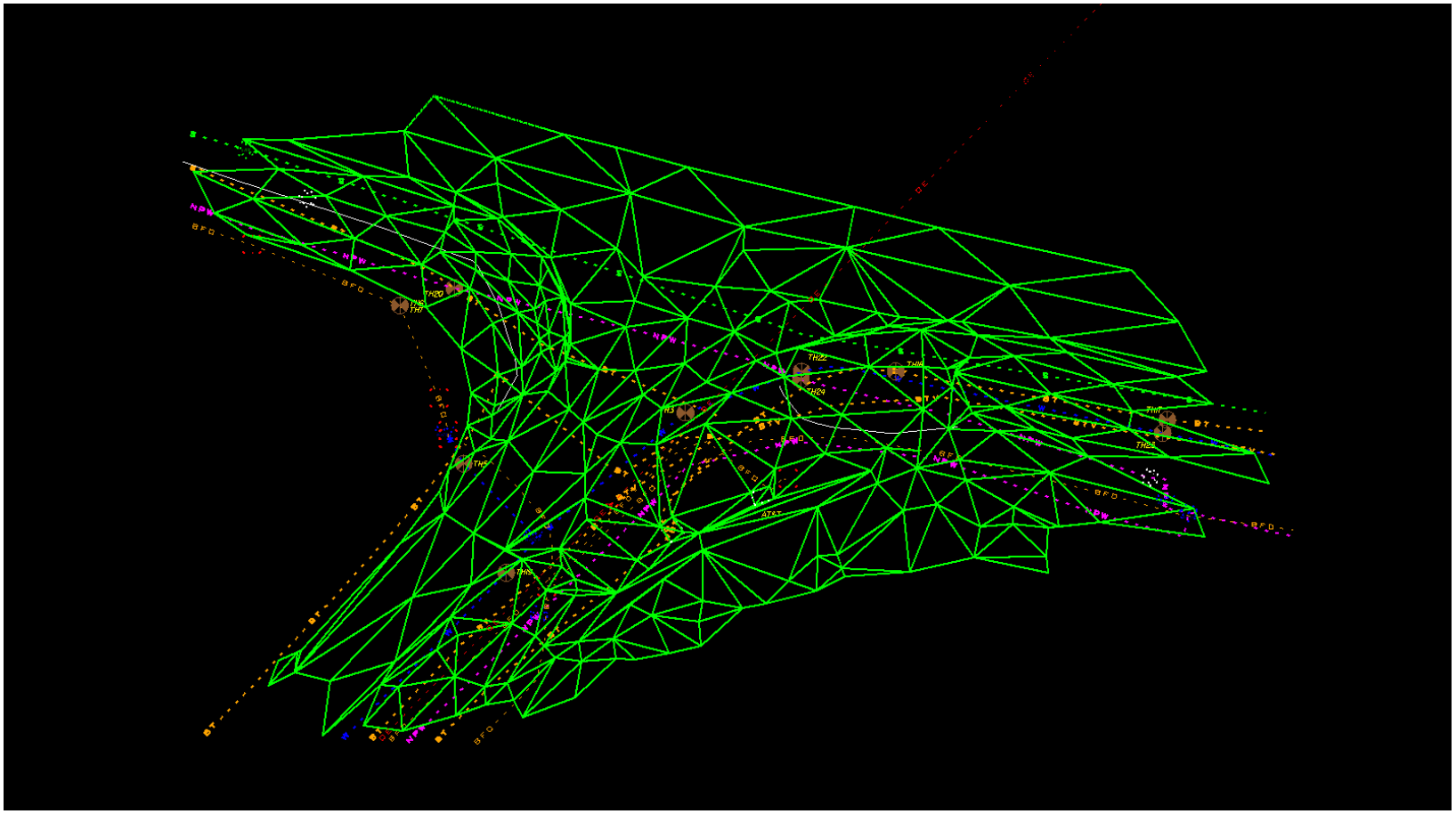
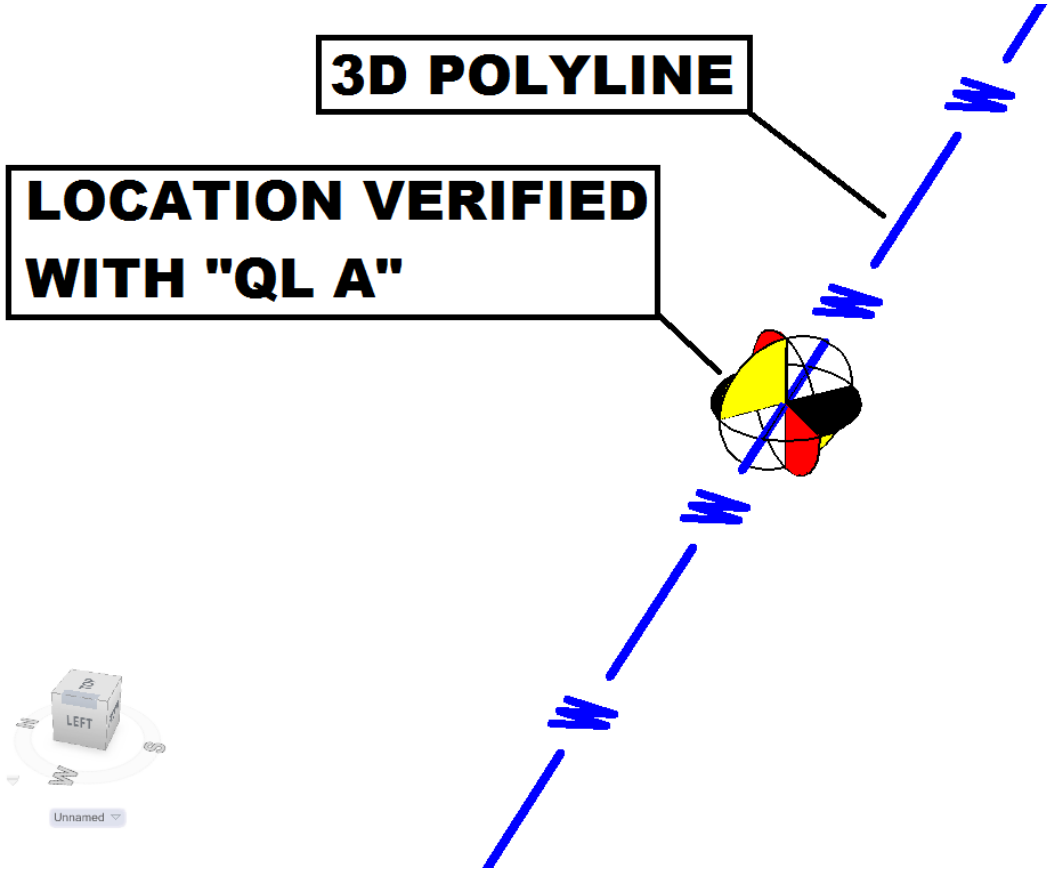
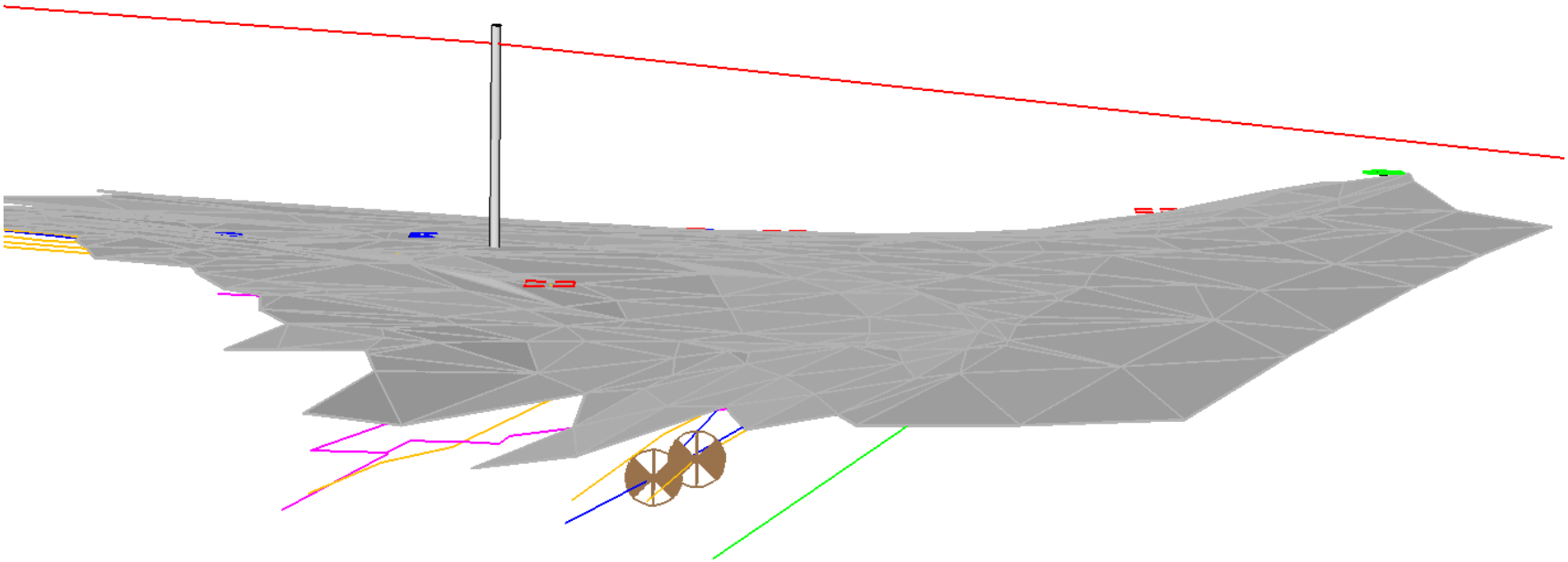
Export and Preparation of 2D and 3D DGN



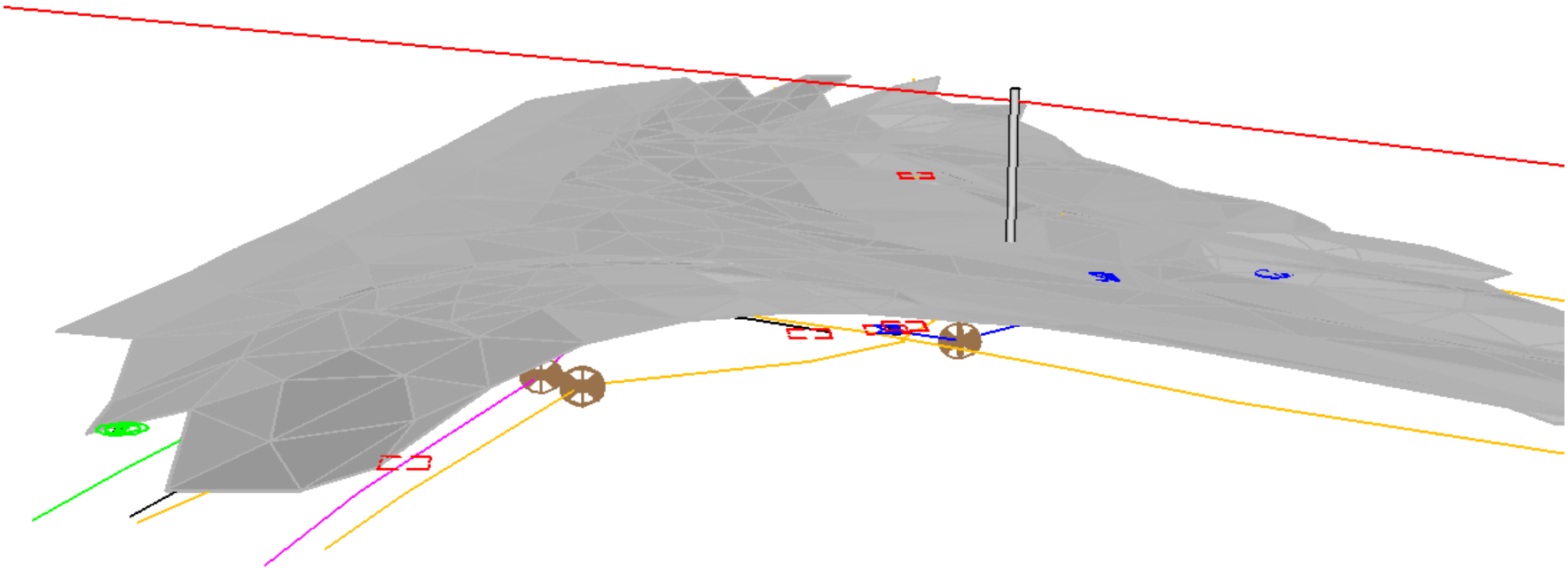
Quality Level B with depth qualifiers & Quality Level A at critical locations



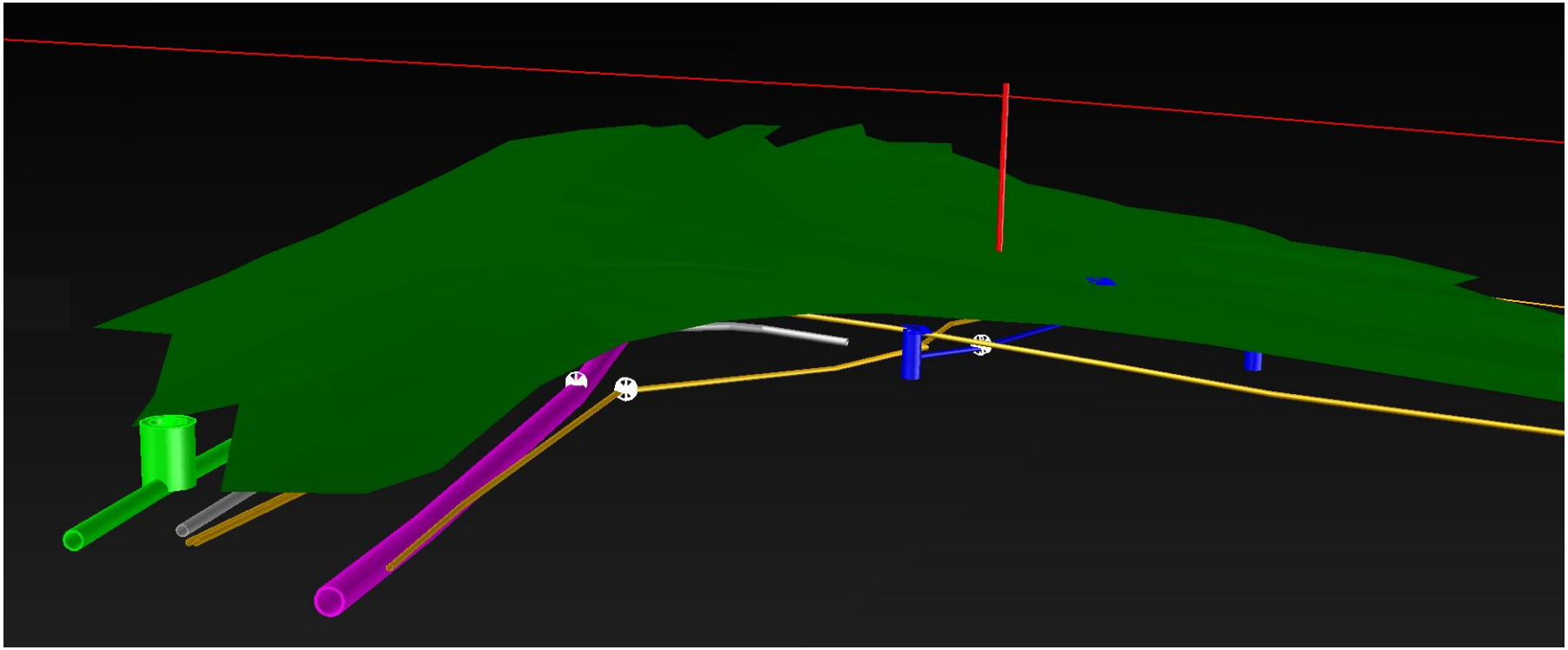
UTVHRD01.dgn



UTVHRD01.dgn as per FDOT standards, but…

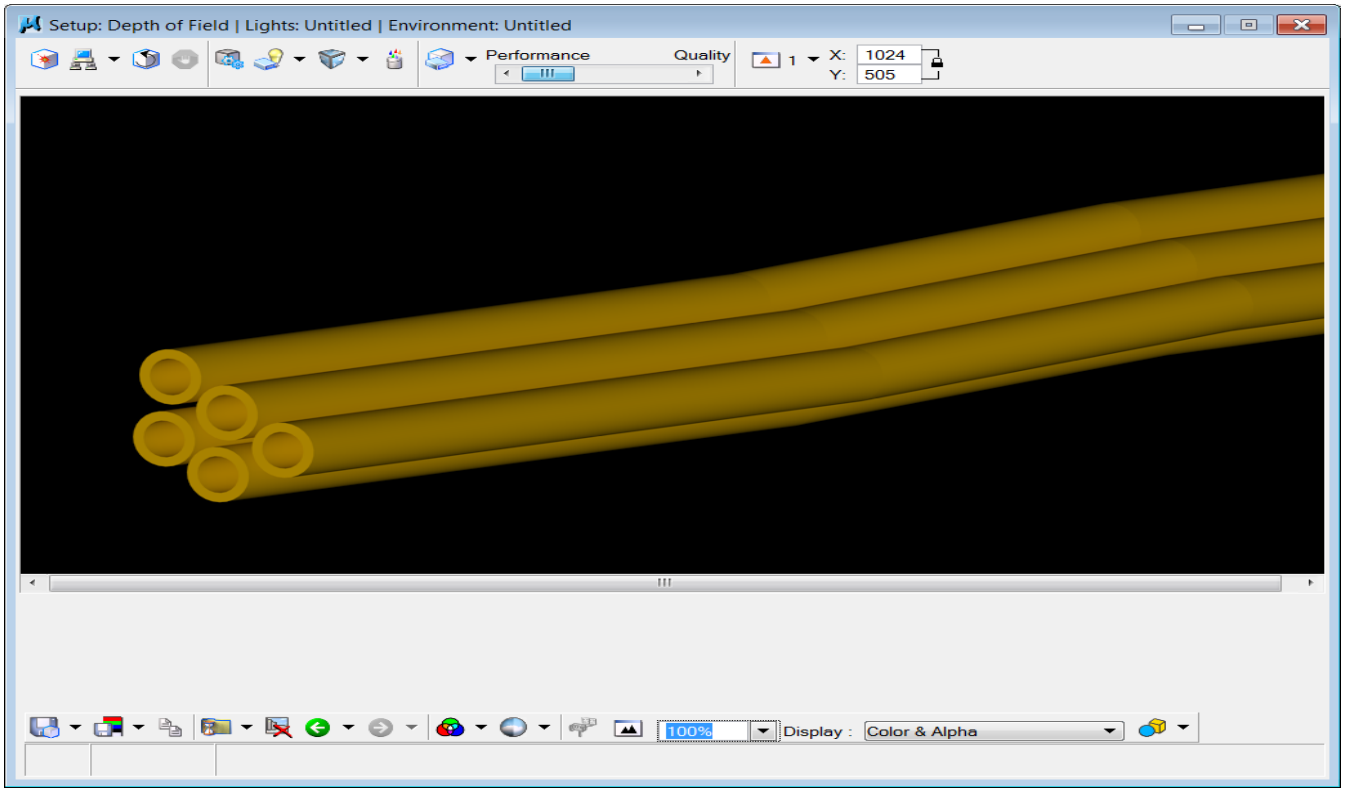


UTVHRD01.dgn to 3D Render/Model



UTVHRD01.dgn to 3D Render/Model

- Create solids extruding along <u>survey chains</u>
- Change solid display to “surfaces”
- Use visualization tools for lighting and shading



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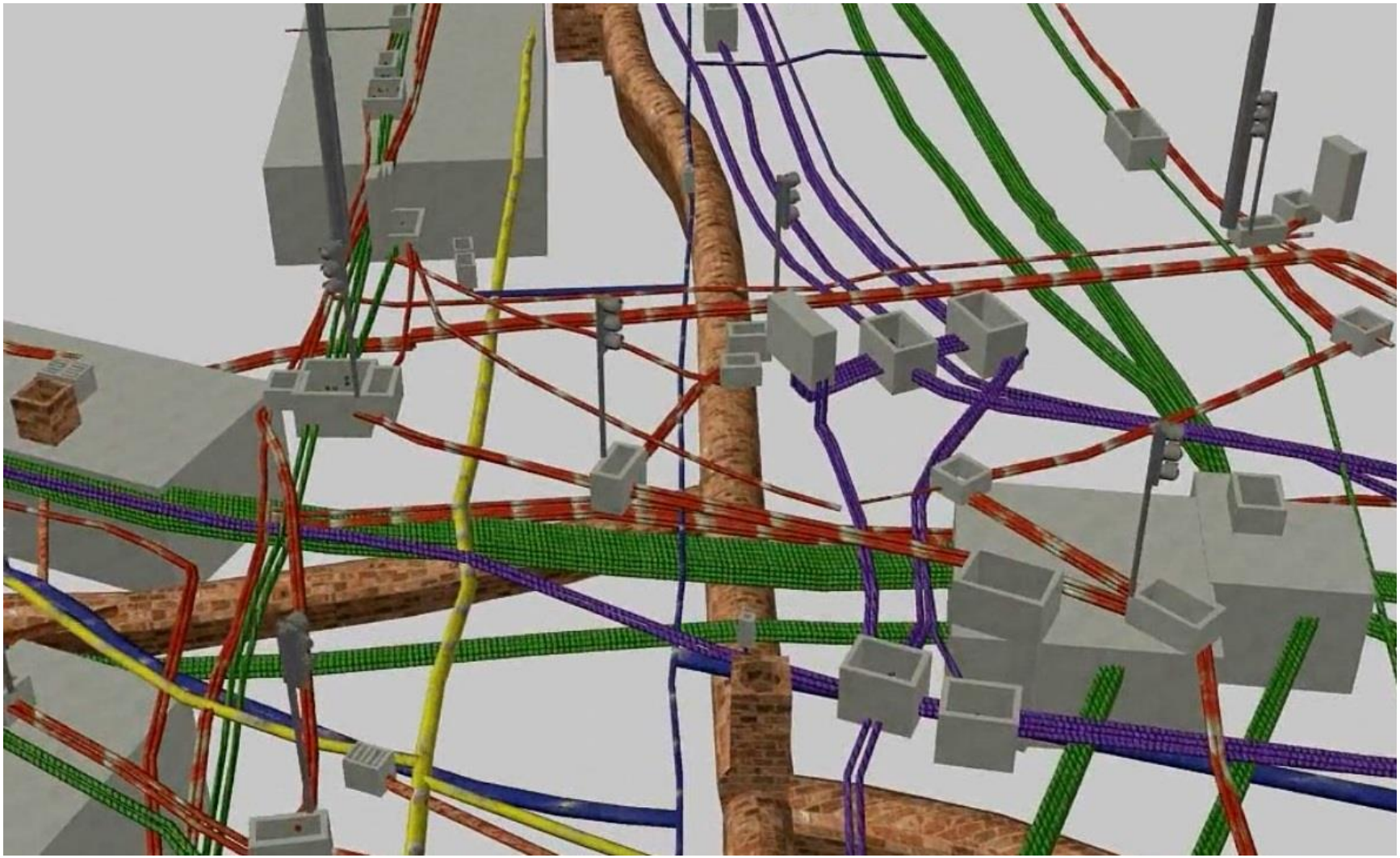
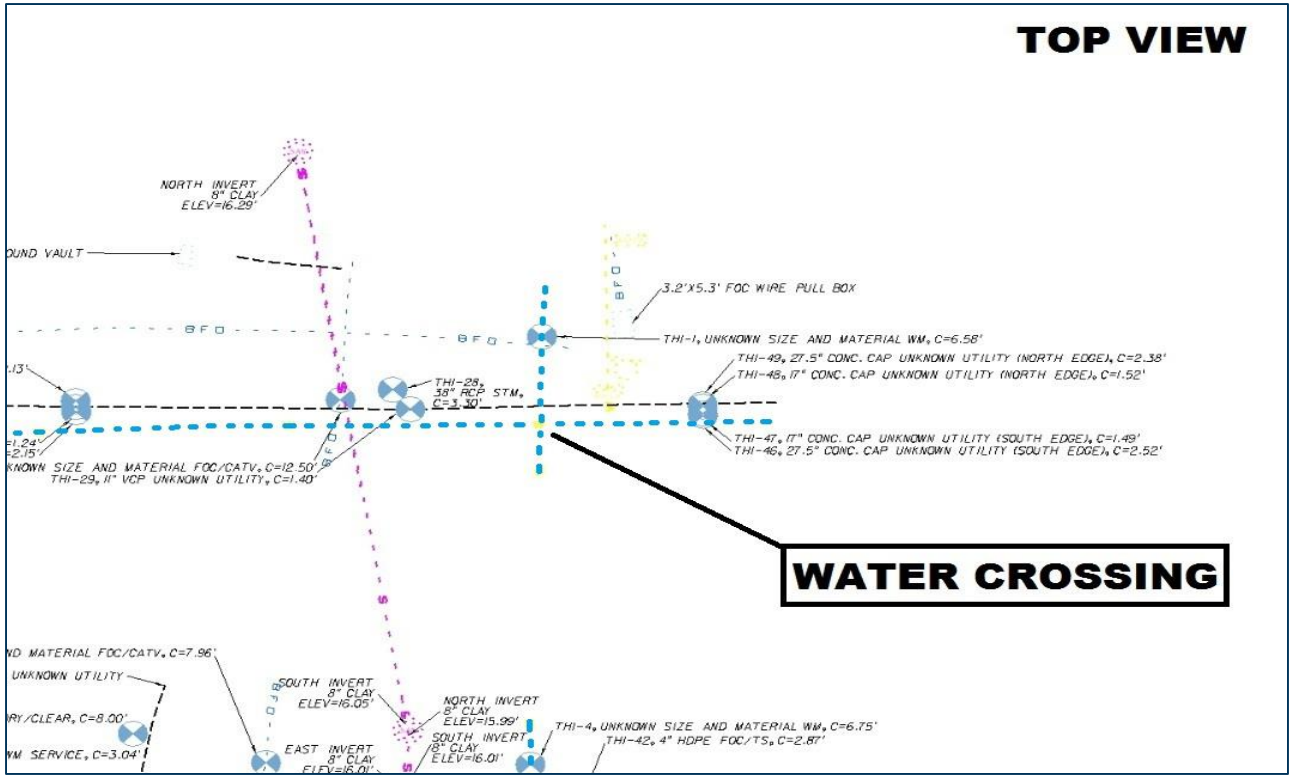
Assign materials, sizes, textures…



…as far as the utility info X,Y,Z is reliable

Benefits During Design:

- **Elevations throughout the project**
- **Continuous 3D representation**
- **Less potential conflicts**



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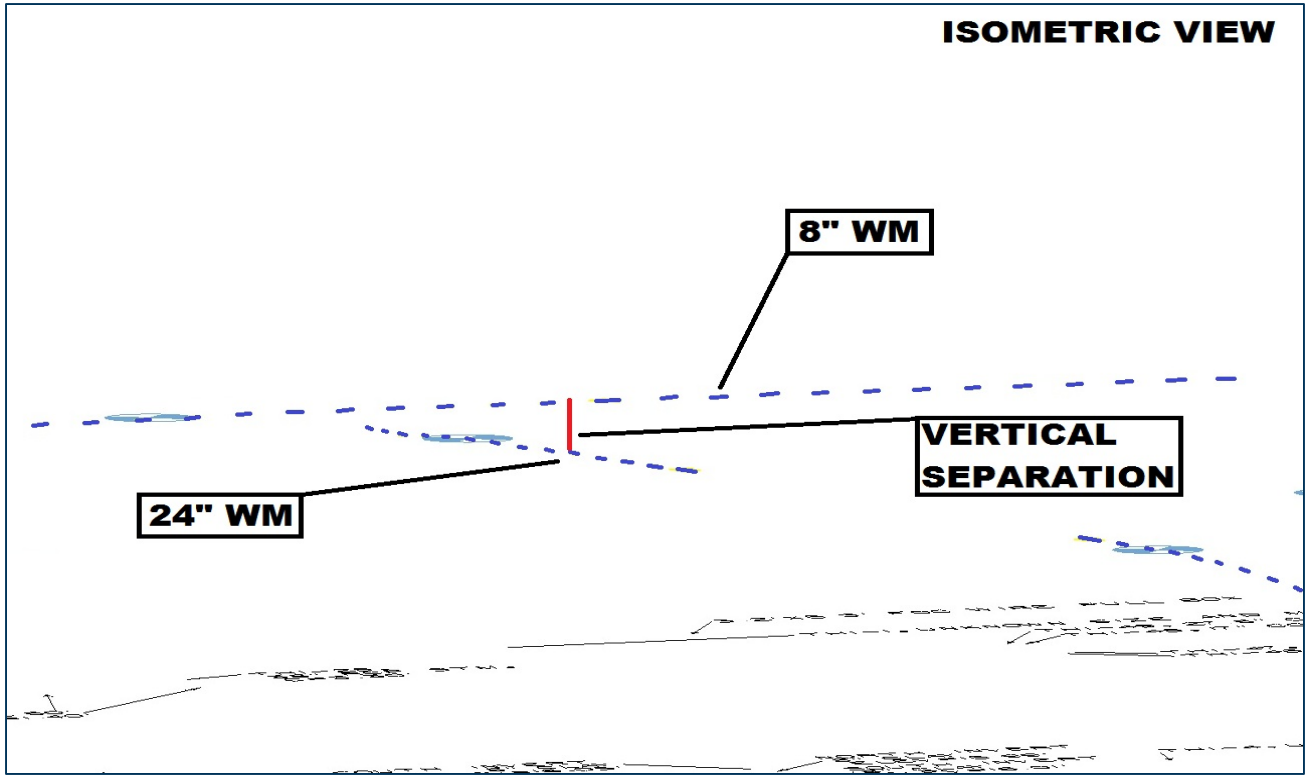


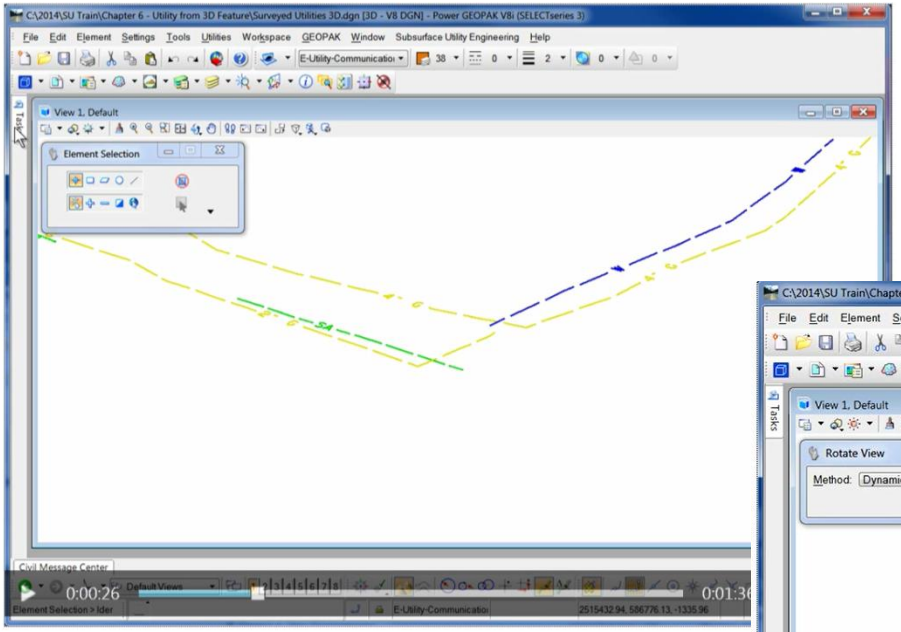
Latest Developments:

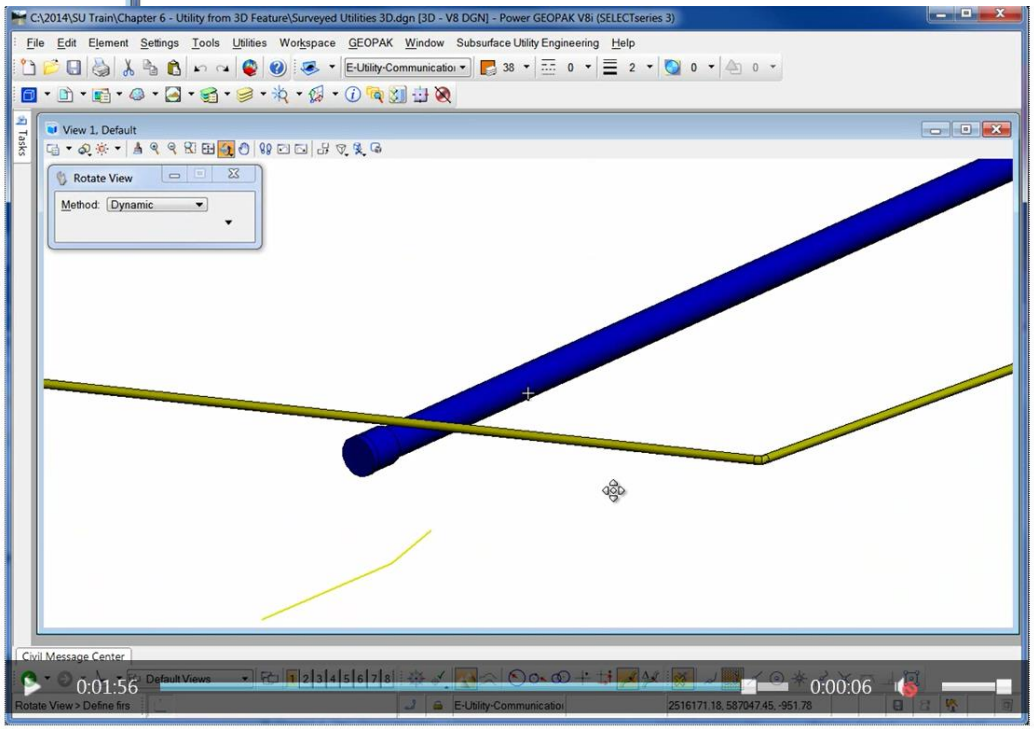
Bentley Subsurface Utility Engineering for Civil Engineering

- **Built on OpenRoads technology – works on SS3**
- **Builds 3D utility models from whatever information is available – automated utility network model creation**
- **Maintains relationship between CAD and GIS utility source**
- **Enables clash detection as conflict features: reportable, searchable and editable.**

Bentley SUE for Civil Engineering:

Creates utilities from 3D graphic sources





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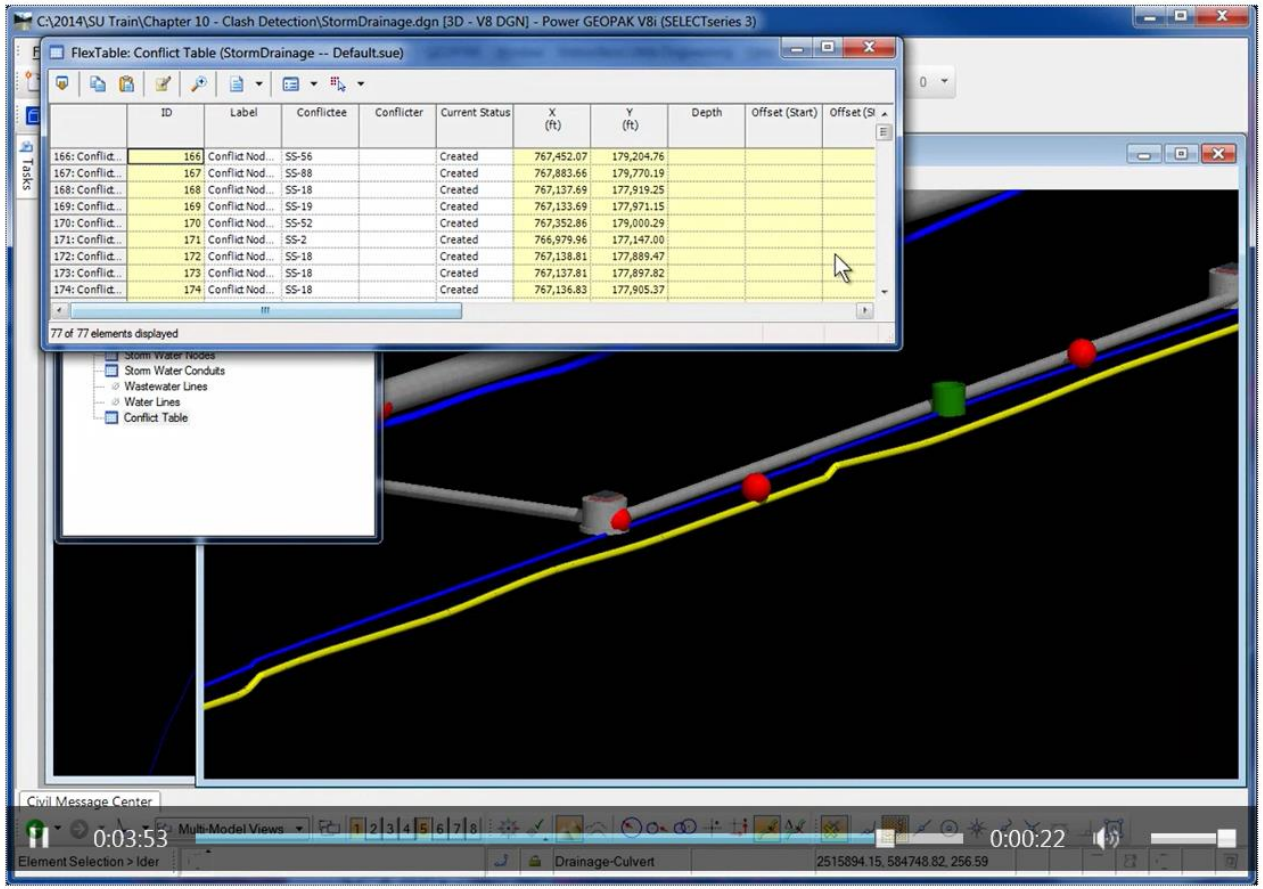
Bentley SUE for Civil Engineering:

Clash detection between elements



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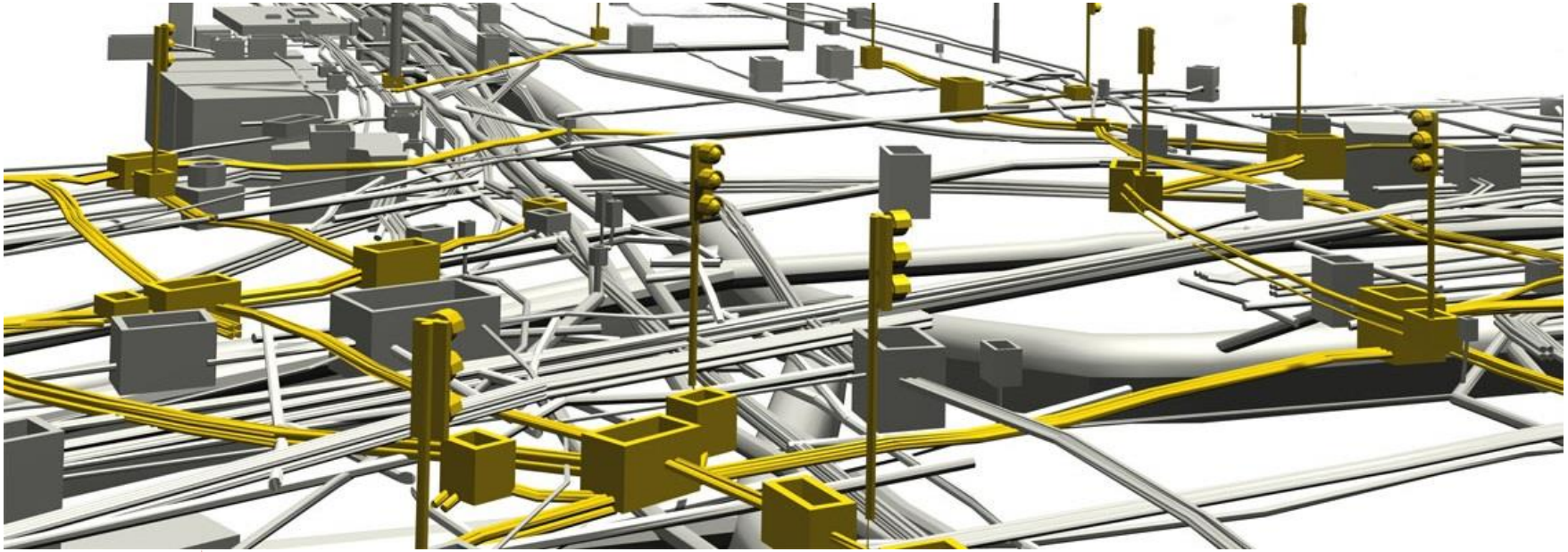
Conclusions:

Subsurface Utility Engineering, utility quality levels and reliability

Improvements in surface geophysics and 3D GPR

FDOT 3D RT contract – DGN and modeling



Conclusions:

When it comes to 3D, choose the RIGHT project!

Special Thanks:

FDOT Central Office

FDOT District 5

Cardno 3D TEAM
(Daryl Thie, PLS
Matt LaLuzerne, PSM
Adam Berry, SI)

Underground
Imaging
Technology

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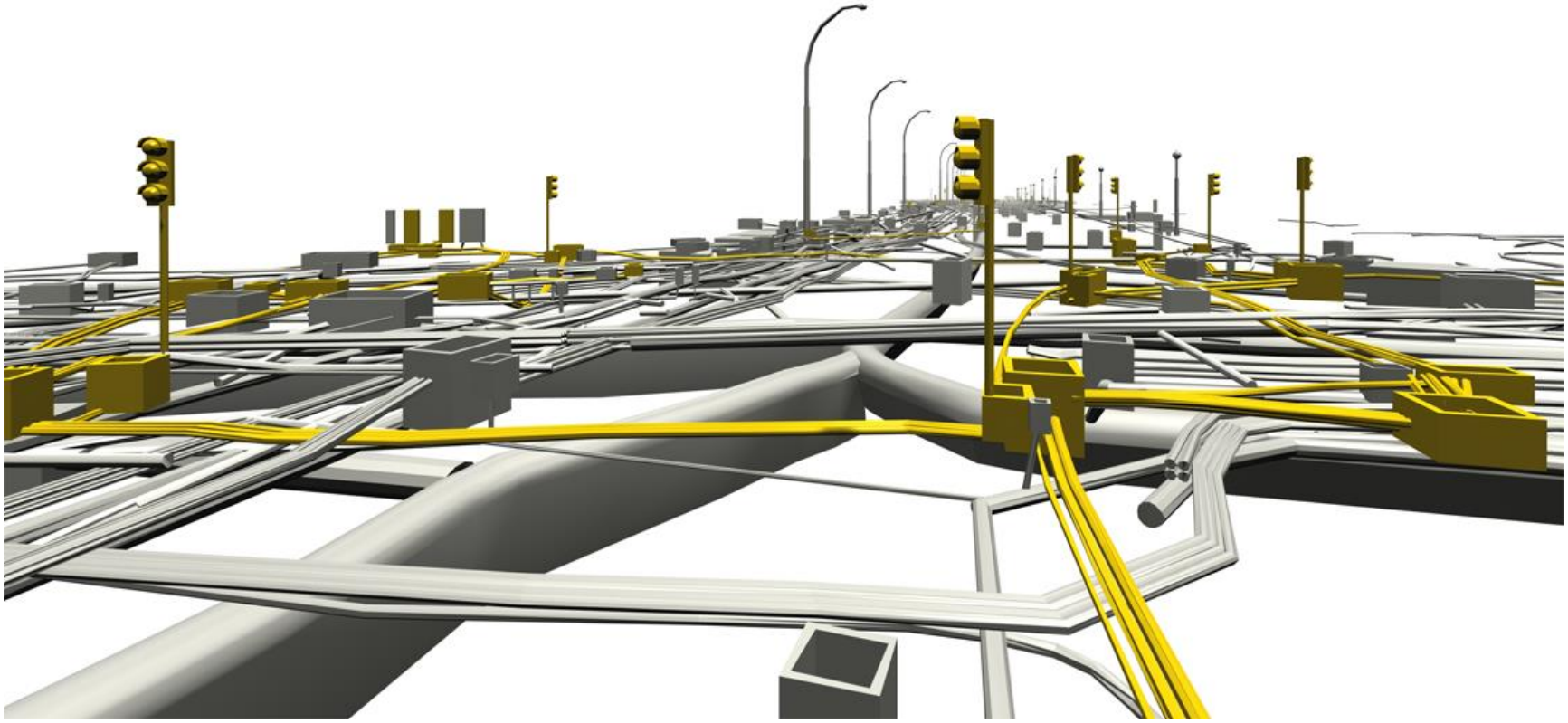
THANK YOU !



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