

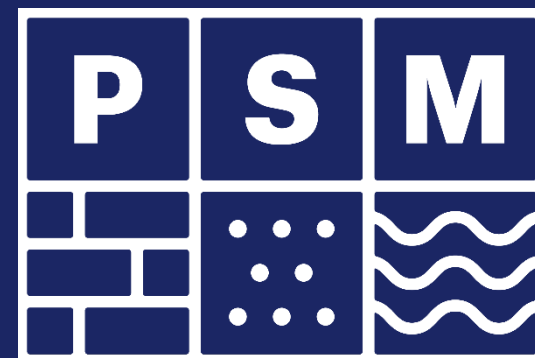
Appendix H

3D Stability Analysis



GPUG Subsidence Assessment

3D Numerical Analysis Results



GPUG 3D Numerical Analyses

The objective of this 3D numerical analysis is to assess surface subsidence and strains due to the proposed Golden Pont Underground Mining.

The analyses is undertaken in FLAC3D and incorporates the following:

- Latest OGC & PSM fault models
- Updated rock mass model
- Existing underground workings
- Proposed underground workings

Model Description

- The 3D numerical model was developed in FLAC3D version 9.0
- The model extent is about 2000 m (east-west, x-direction), about 2200 m (north-south, y-direction) and 1000 m (vertical, z-direction)
- The adopted mesh size for the zones is 2m at the boundary of the GPUG workings and 10m around fault surfaces
- Faults modelled as zones of class C material
- Strain softening incorporated to capture squeezing ground and progressive failure observed around underground openings.



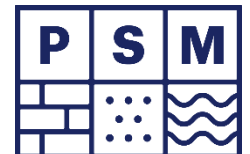
GPUG 3D Numerical Analyses

Model Staging

- **Phase 0 - Stress initialisation under gravity loading using the model geometry at the end of IM7/8 mining (Phase 0).**
- **Phase 1 - Excavation of the existing GPUG workings**
- **Phase 2 Excavation of the Proposed GPUG in 3 sub-substages**
 - Currently consented areas of CPUG
 - MP4 consent northern & western areas of the MP4 consent
 - M\$ consent eastern areas

Model Runs

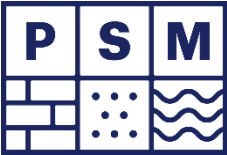
- **Base Case Analysis**
 - GPUG workings modelled in two phases (i.e. Phase 1 for the existing GPUG workings and Phase 2 for the proposed GPUG). Phase 1 results used to calibrate the model parameters
- **Stand off Case 1**
 - Scenario incorporating a standoff zone defined by a 30° draw angle from Deepdell Creek for mining within the proposed MP4 consent area. This scenario involves no mining within the standoff zone for the MP4 consent area but full extraction (including within the standoff zone) for the existing consent area.
- **Stand off Case 2**
 - Scenario incorporating partial extraction within the standoff zone for the MP4 consent area. This scenario involves mining of approximately one-third of the proposed GPUG stopes within the MP4 consent area (i.e. “hit-and-miss” extraction of one in three stopes within the 30° draw angle zone) but full extraction (including within the standoff zone) for the existing consent area.
- **Stand off Case 3**
 - Scenario incorporating no mining within the standoff zone for both the existing consent and MP4 consent areas.



Model Setup

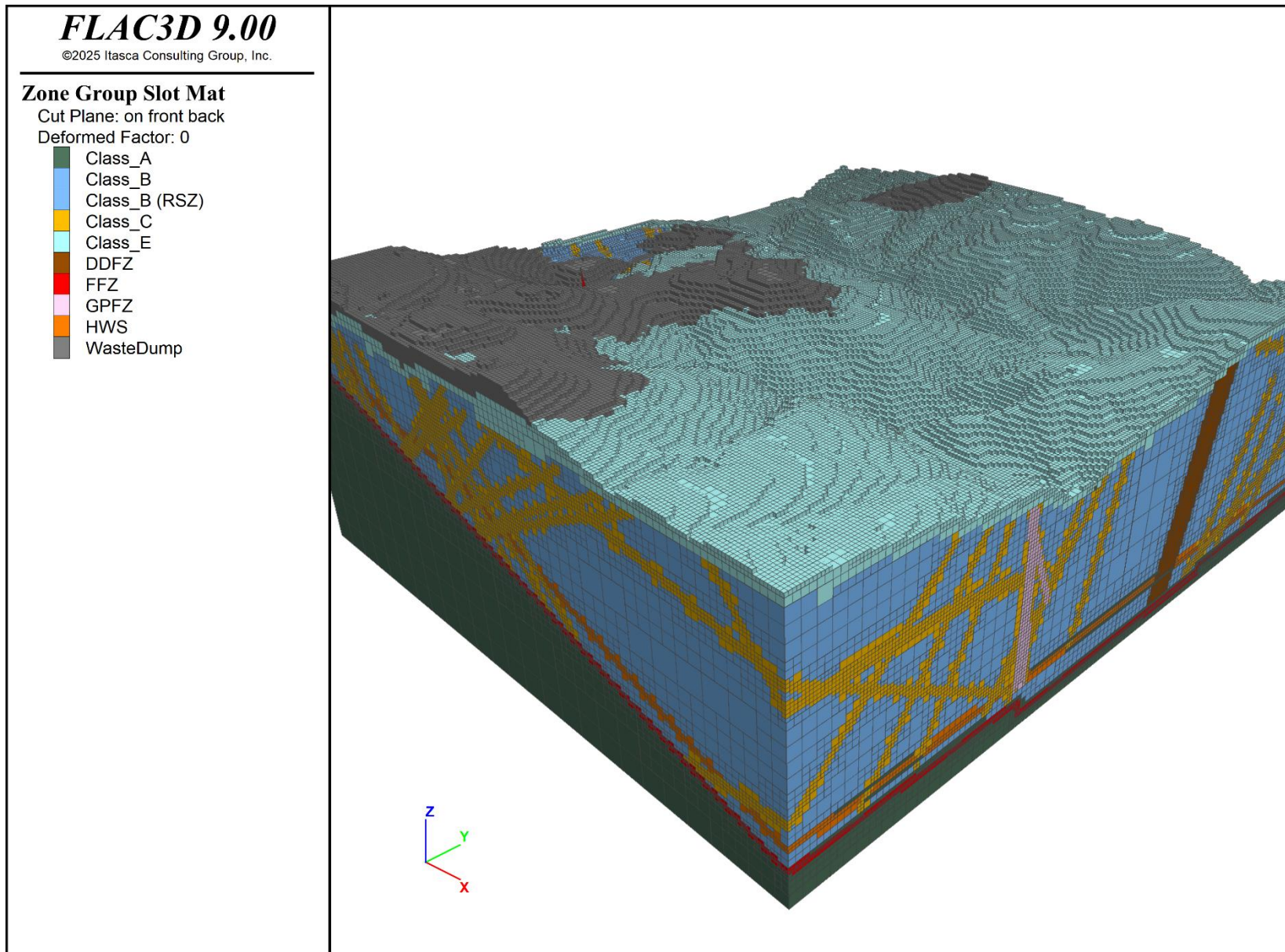
Model Parameters

Rock Mass Unit	Unit Weight (MN/m³)	UCS (MPa)	GSI	m _i	Mohr-Columb		Tensile strength (MPa)	Poisson's ratio	Rock mass modulus (MPa)
					Cohesion (kPa)	Friction Angle (°)			
Class A	27	40	65	12	NA		0.2	0.25	2000
Class B		40	55				0	0.25	1500
Class C	27	35	45				0	0.25	1000
DDFZ & GPFZ	25	NA			100	40	0	0.35	500
Class E /Weathered Zone	25				100	38	0	0.35	100
Waste Dump/Backfill	20				10	37	0	0.35	100



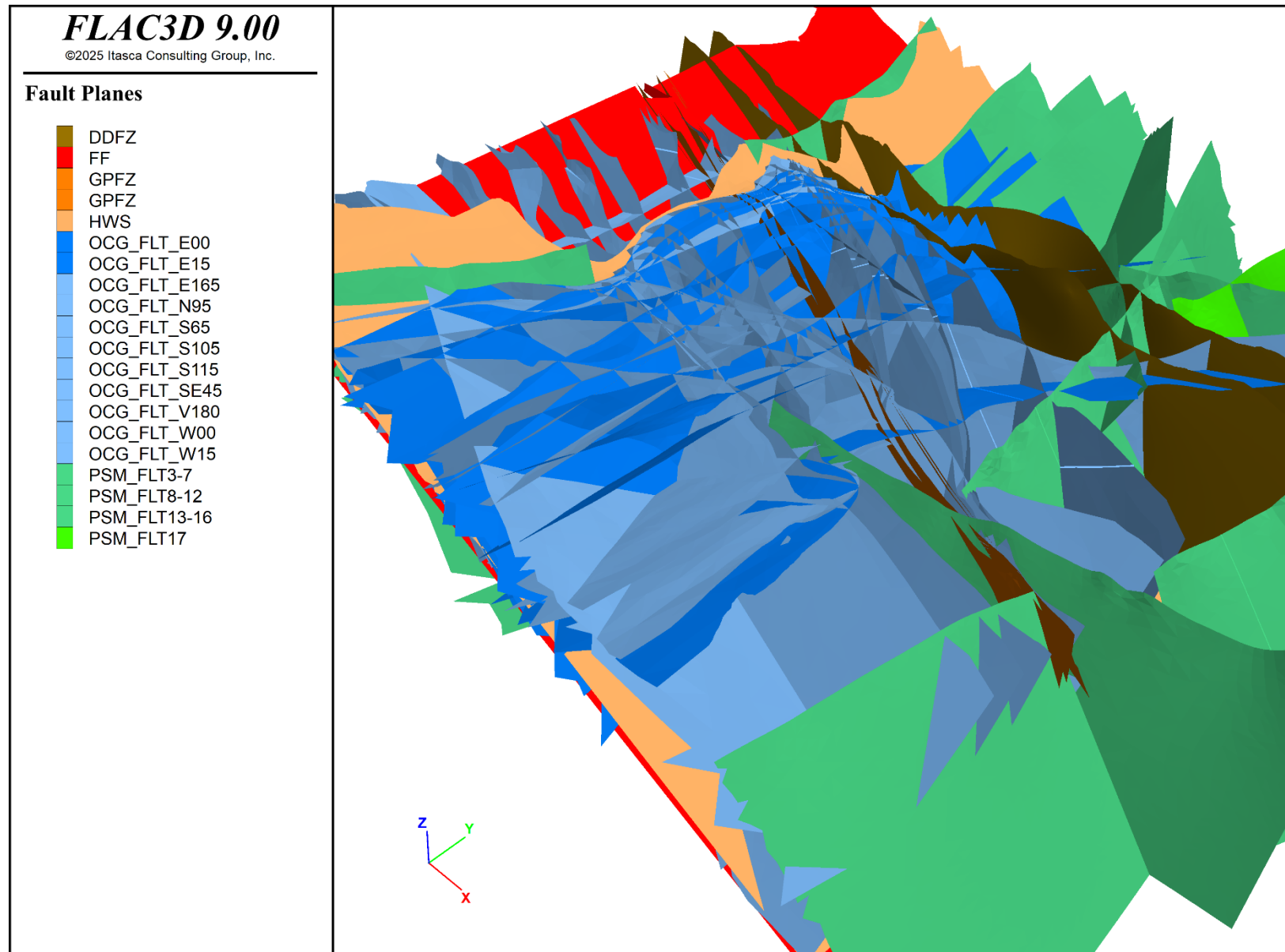
Model Setup

Rock mass units



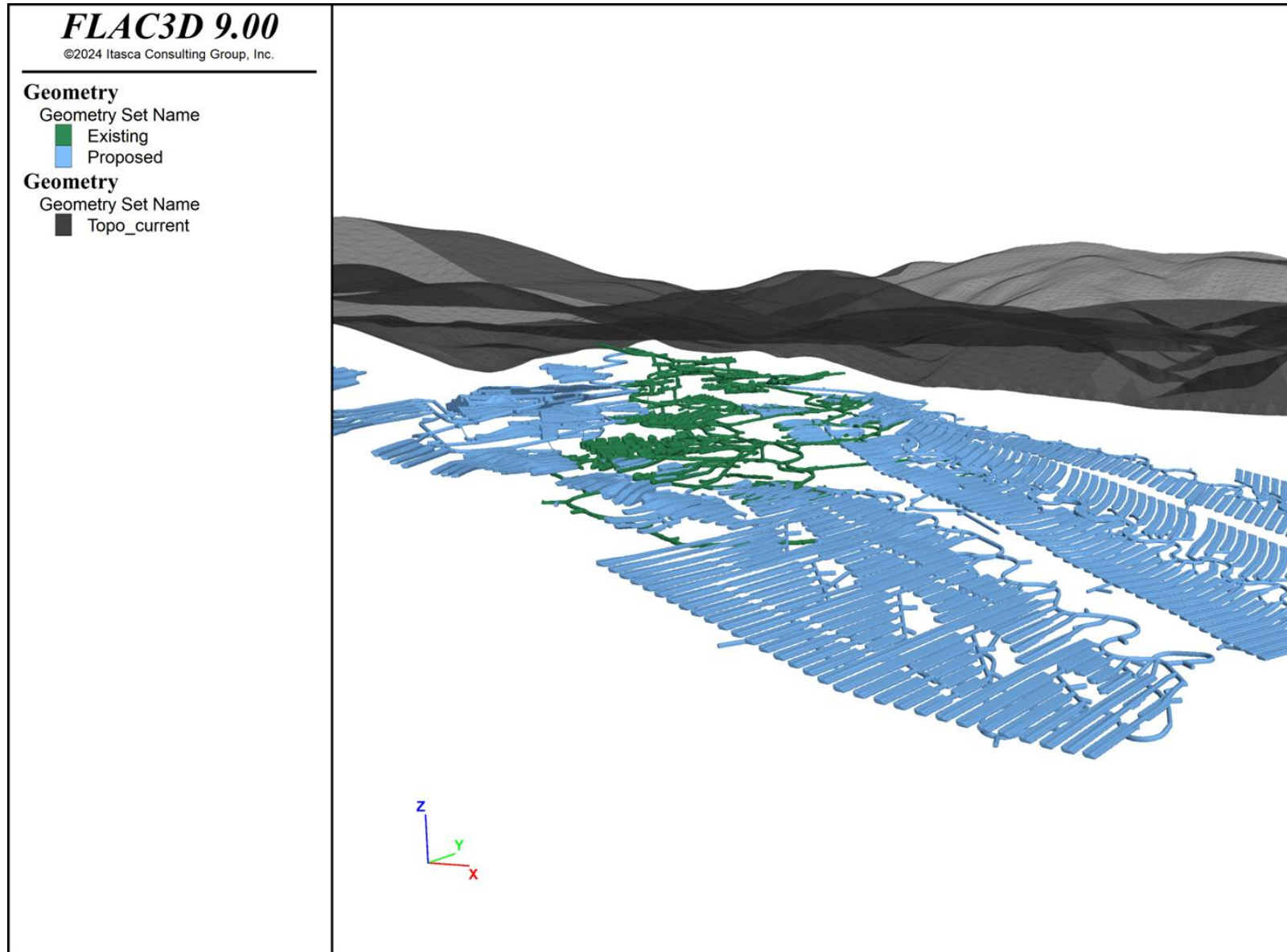
Model Set-up

Modelled Faults



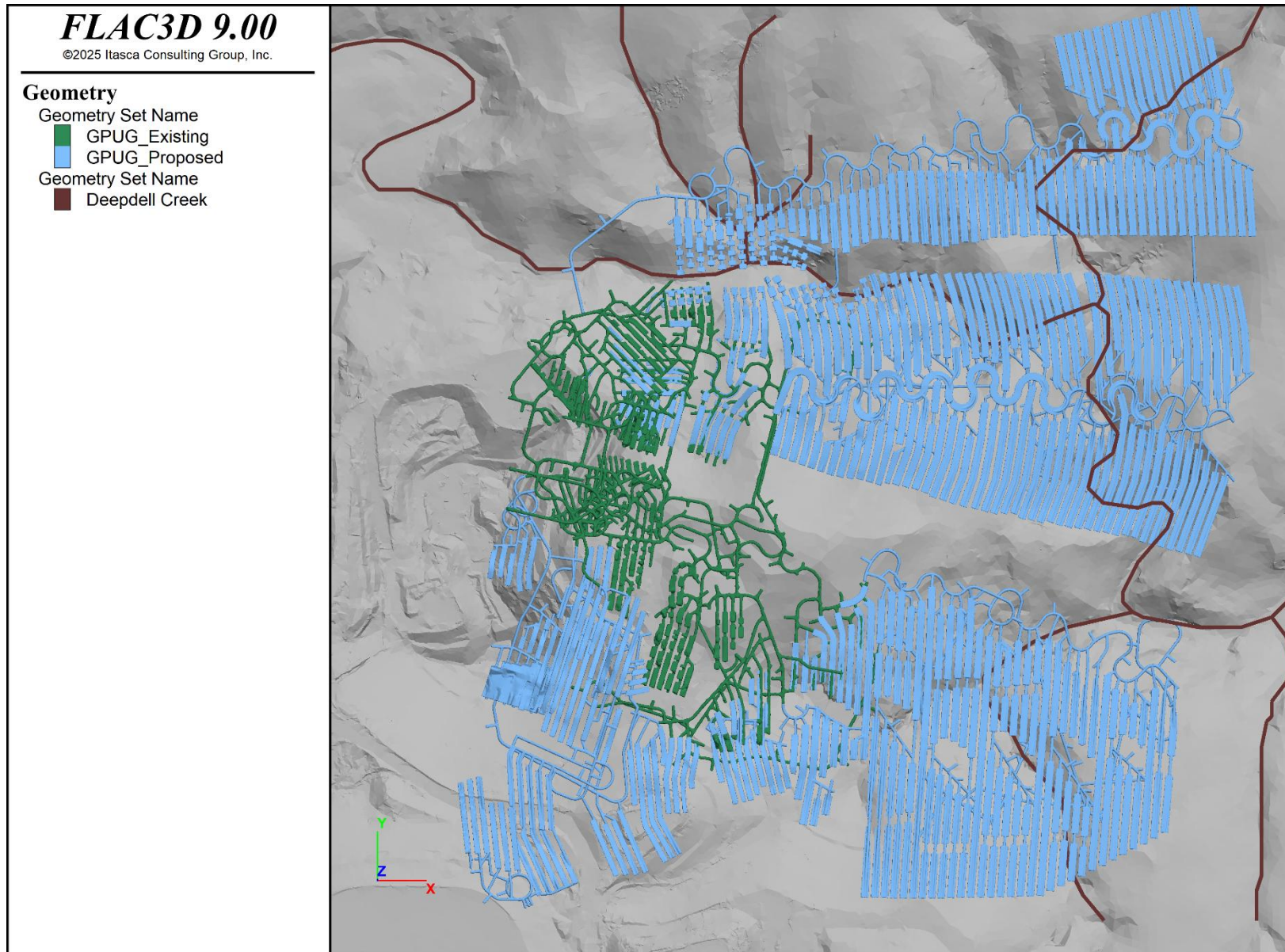
Model Set-up

GPUG - existing & proposed workings



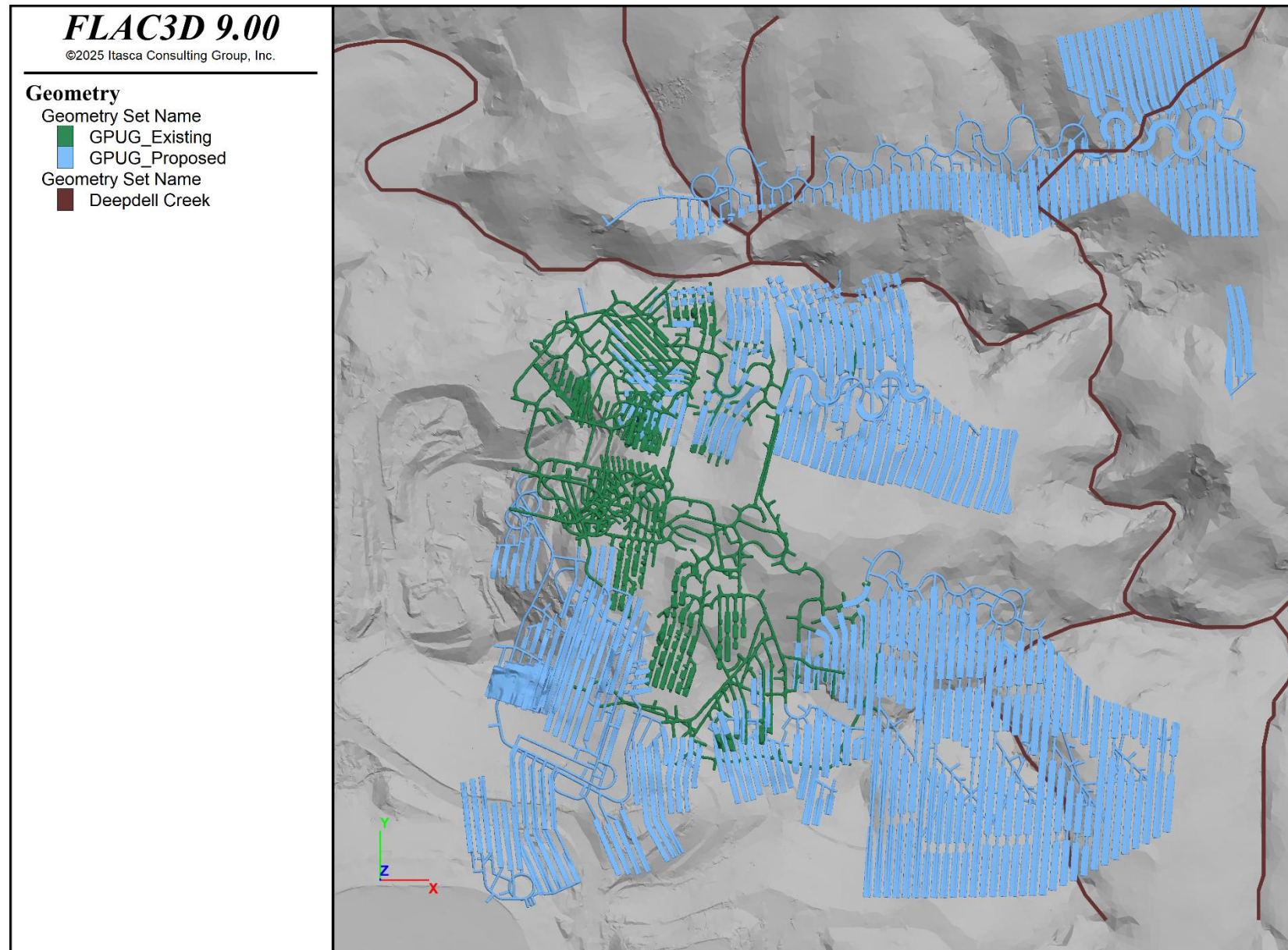
Model Set-up

Base Case existing & proposed GPUG workings



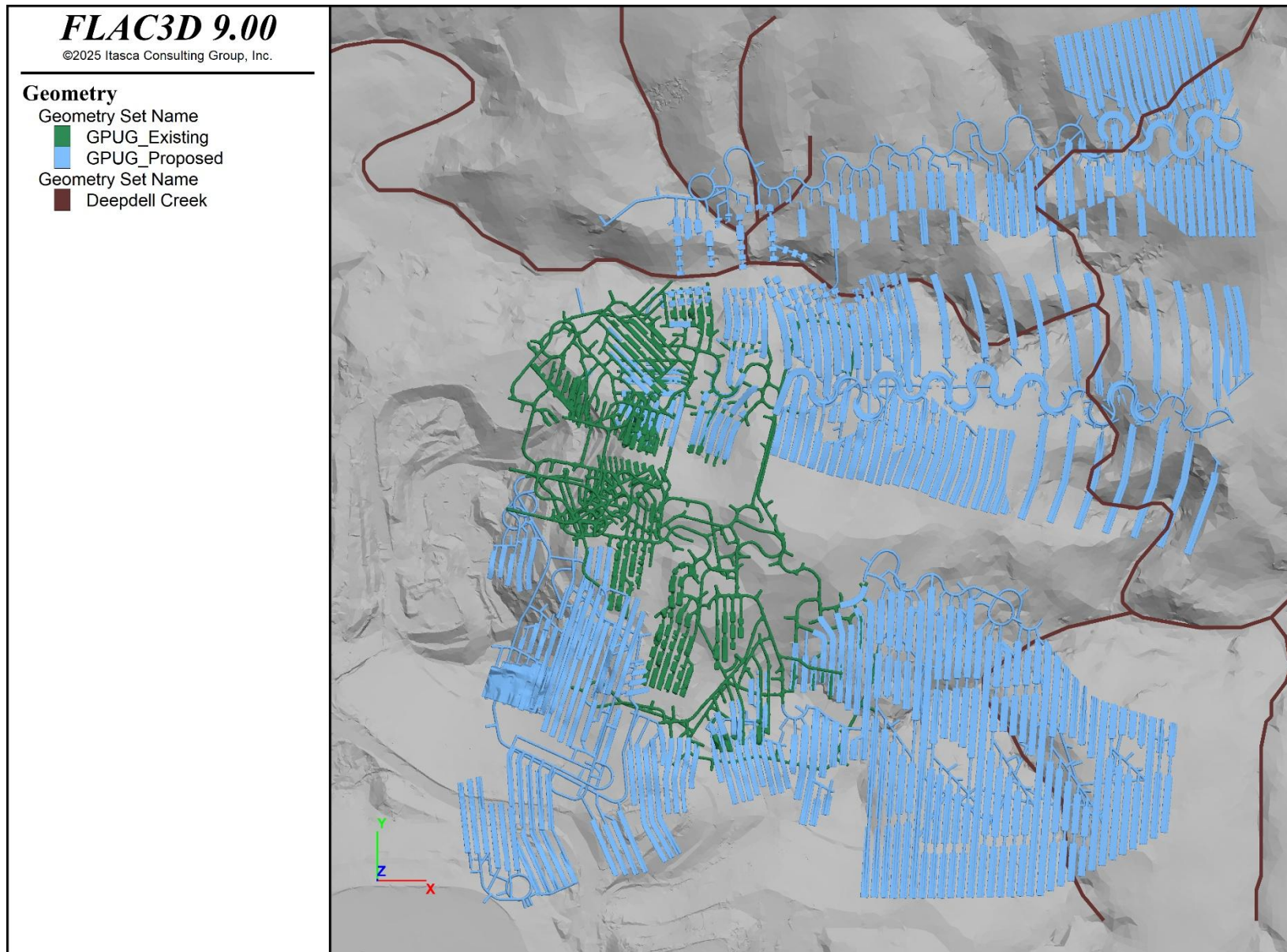
Model Set-up

Standoff Case 1



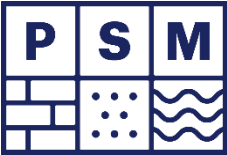
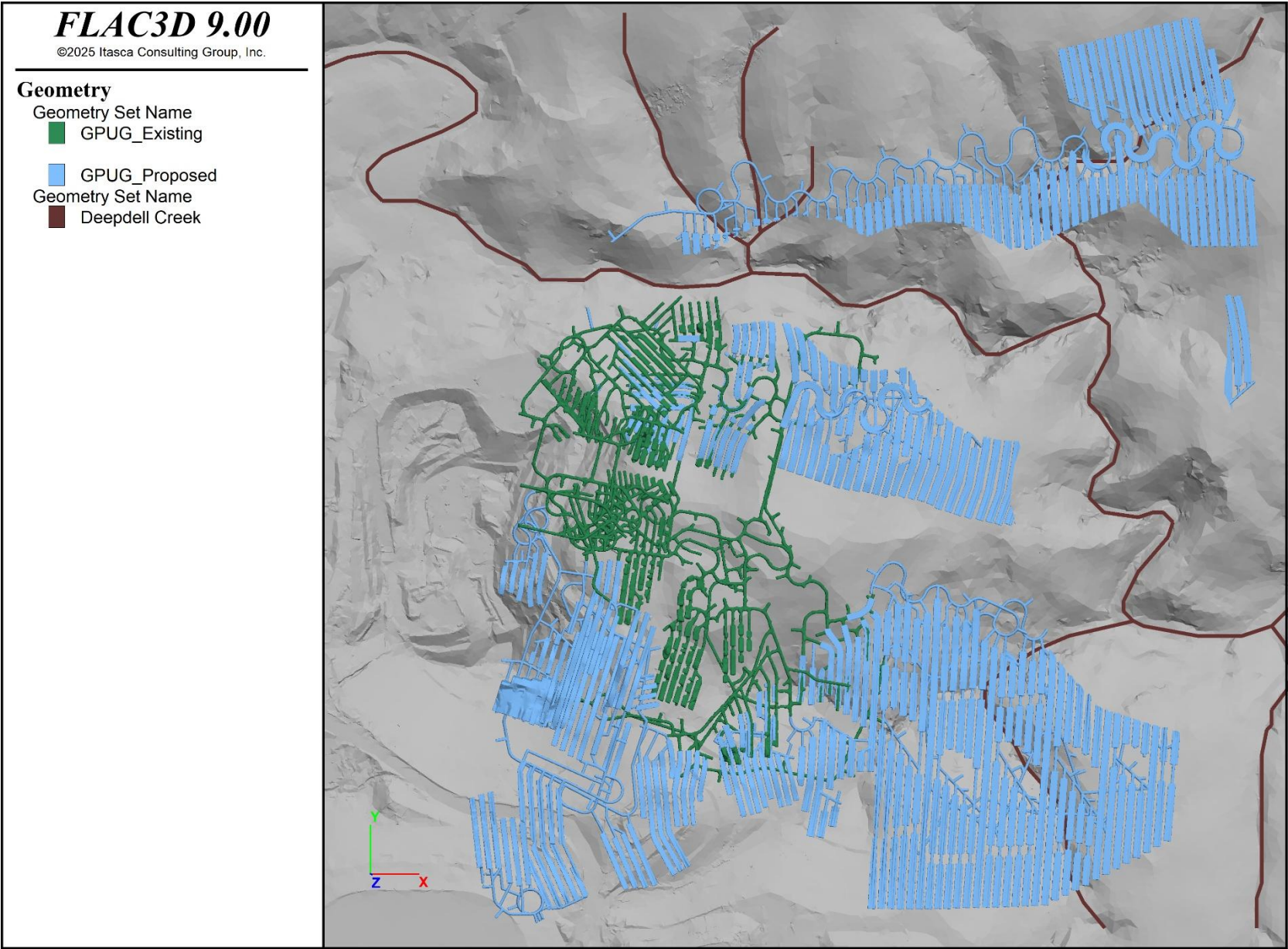
Model Set-up

Standoff Case 2



Model Set-up

Standoff Case 3



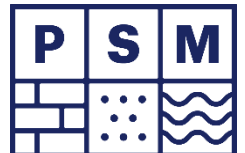
Presentation of Results

Phases include:

- Phase 1: Completion of the existing GPUG (Base Case only)
- Phase 2: Completion of the proposed GPUG (Base Case & Standoff Cases)

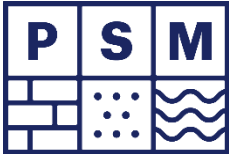
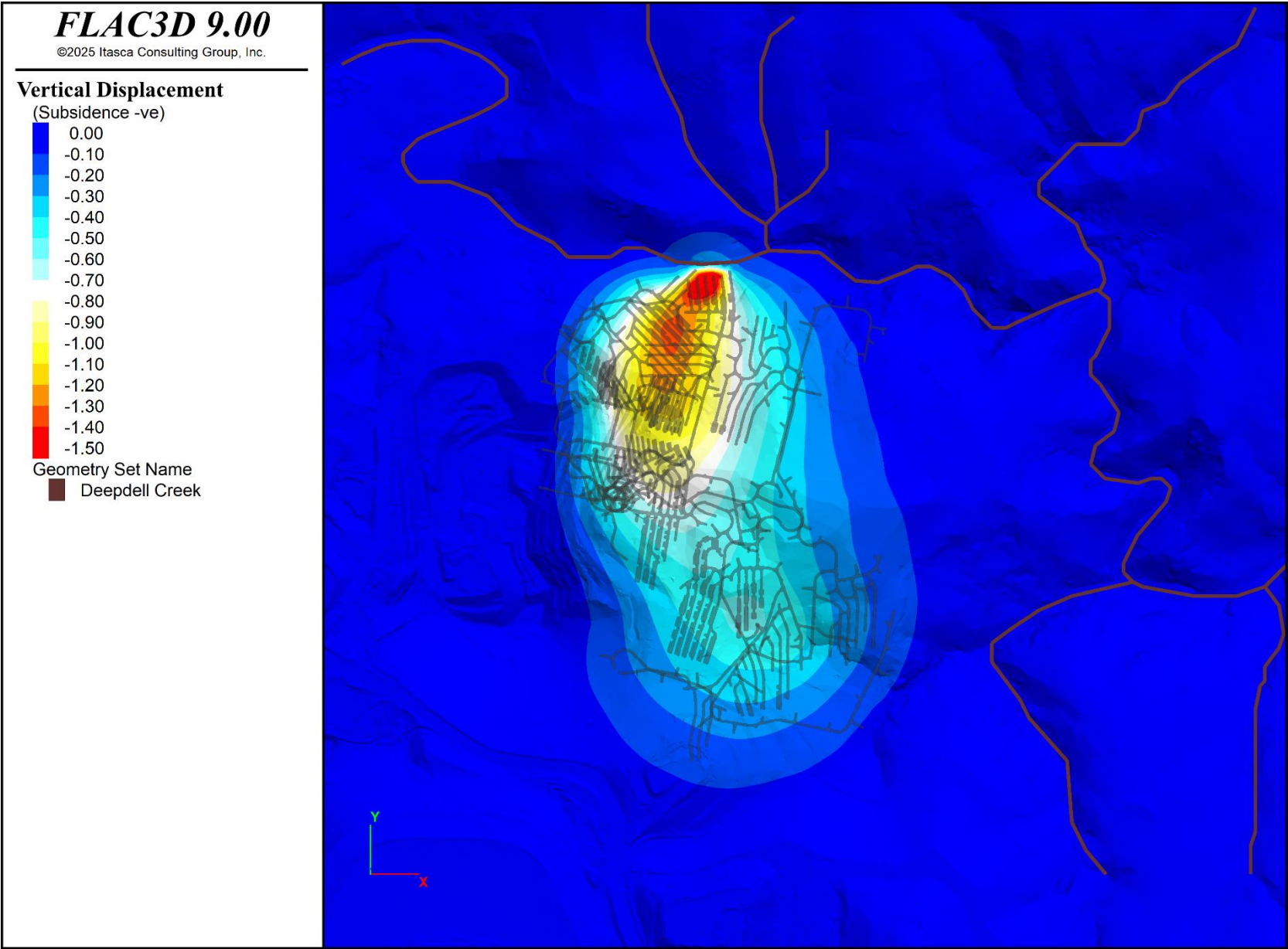
The following plots are presented as plan views of :

- Vertical displacement at the ground surface
- N-S & E-W Horizontal displacements at the ground surface
- Maximum tensile strain at the ground surface
- Horizontal strain at the ground surface
- Trace of vertical displacement along Deepdell Creek
- Trace of maximum tensile strain along Deepdell Creek



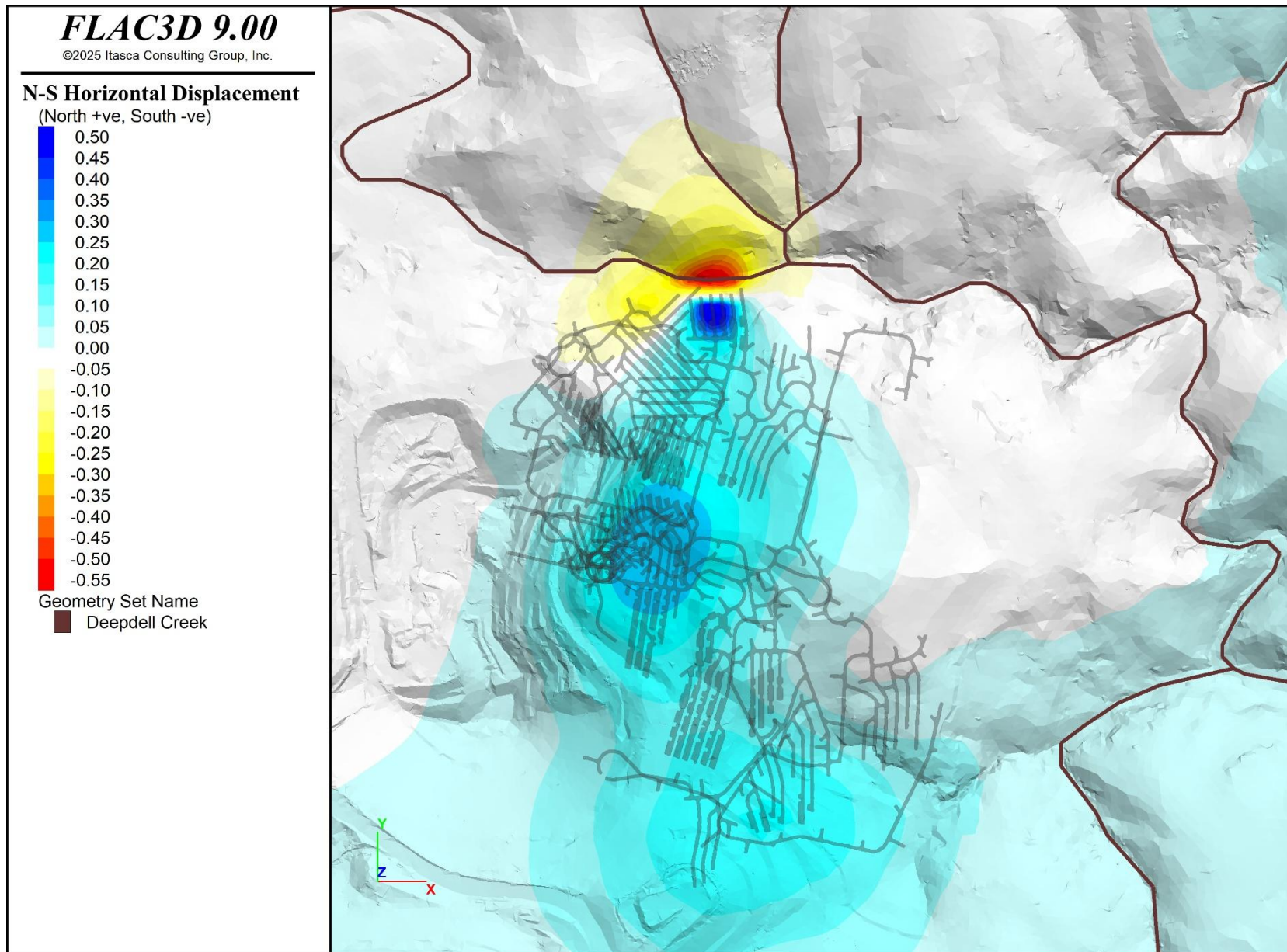
Base Case Phase 1 (Existing GPUG)

Planview: Vertical Displacement



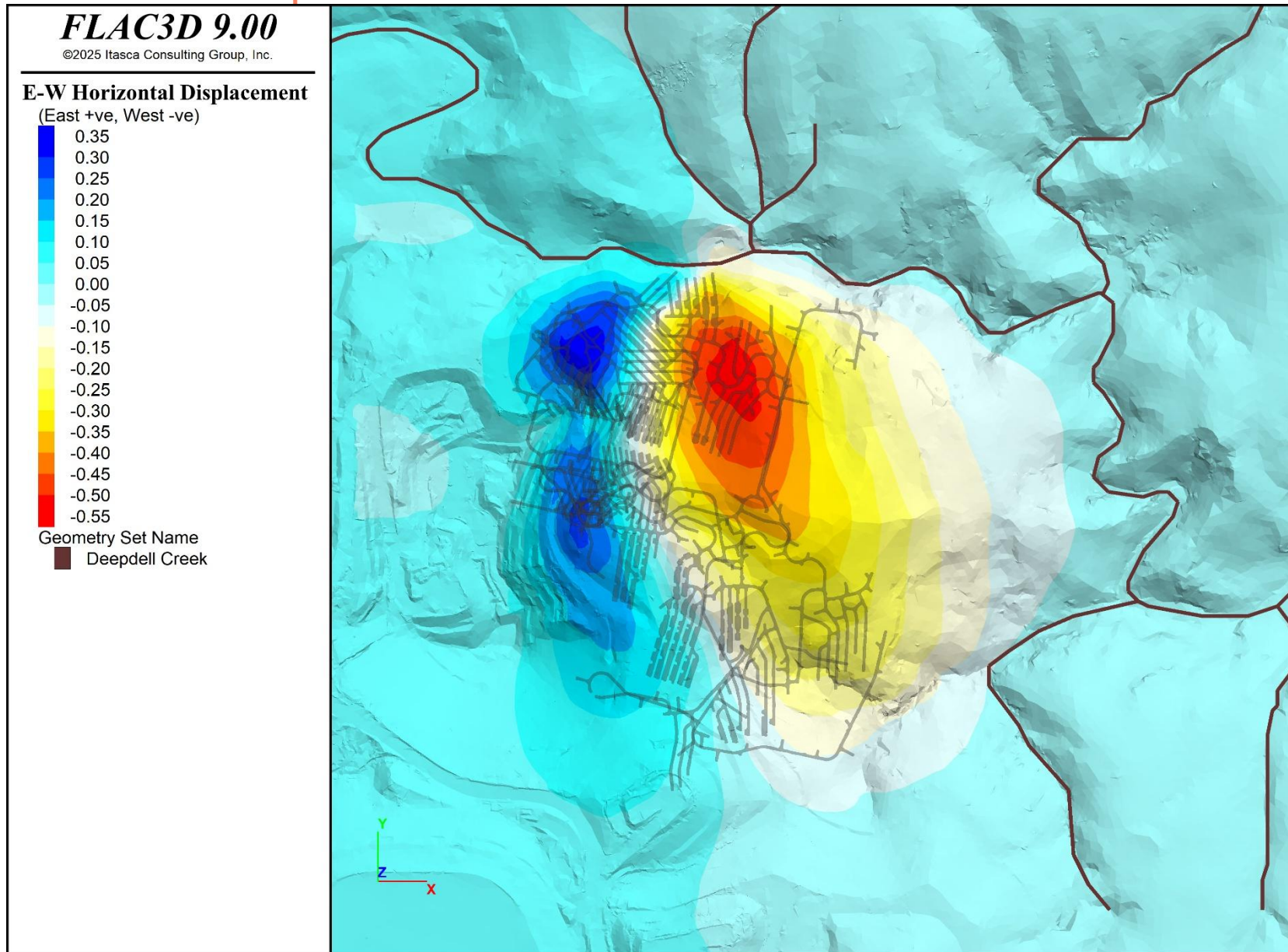
Base Case Phase 1 (Existing GPUG)

Planview: N-S Horizontal Displacement



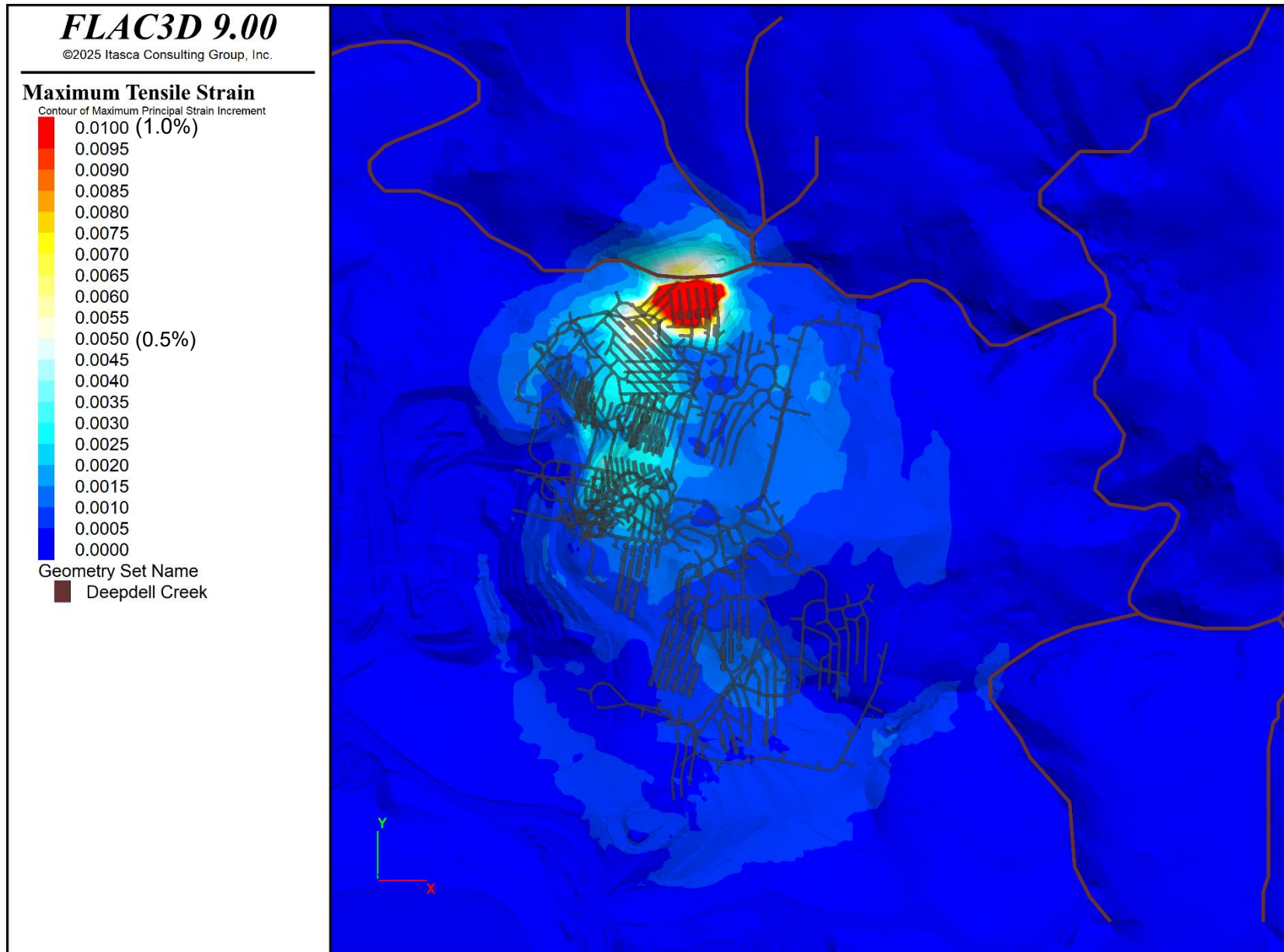
Base Case Phase 1 (Existing GPUG)

Planview: E-W Horizontal Displacement



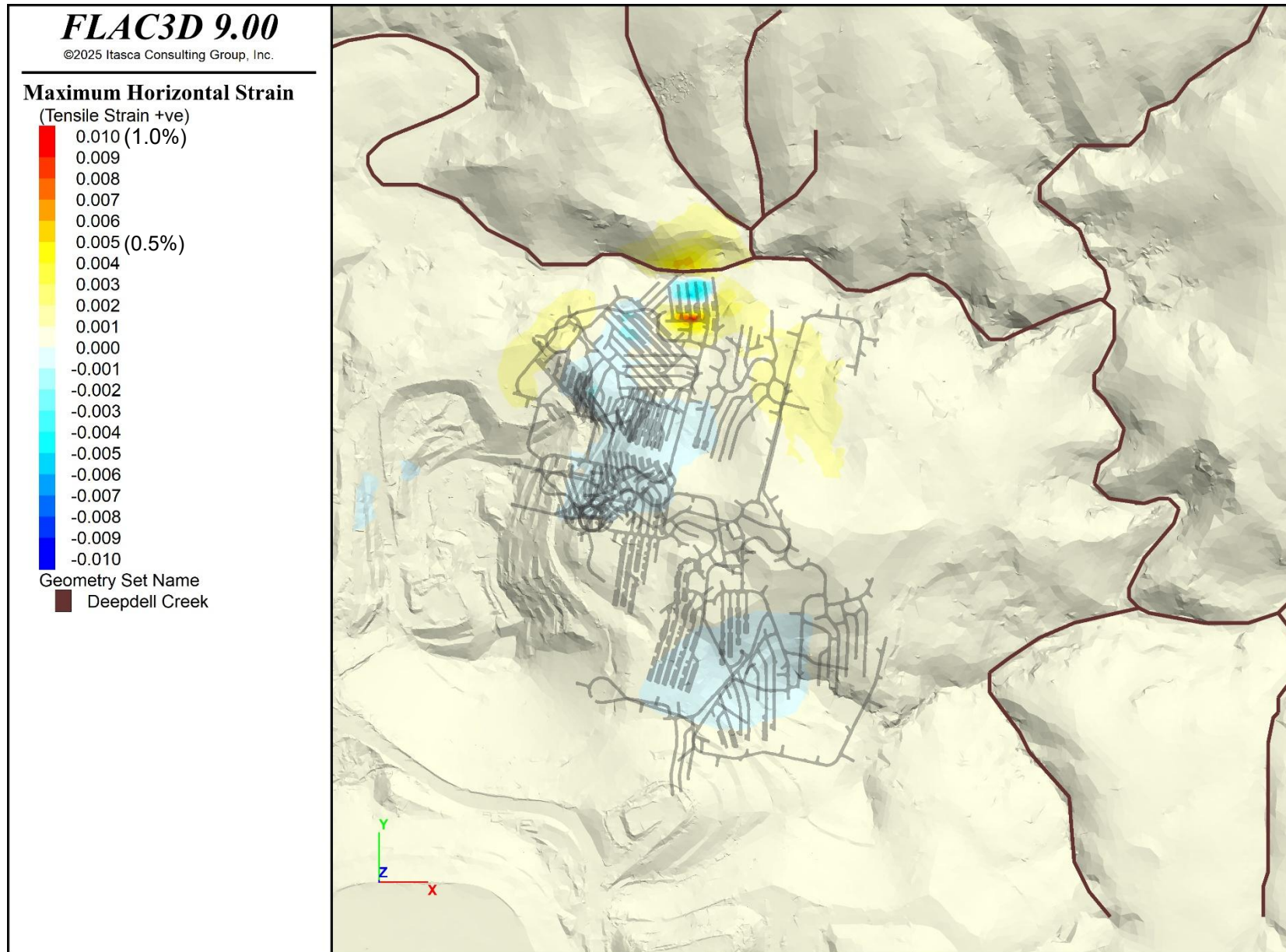
Base Case Phase 1 (Existing GPUG)

Planview: Maximum Tensile Strain



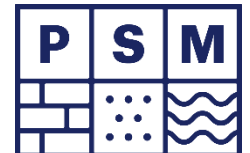
Base Case Phase 1 (Existing GPUG)

Planview: Horizontal Strain



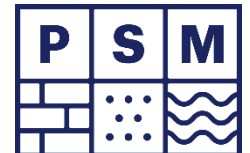
Base Case Phase 1 (Existing GPUG)

Deepdell Creek - Vertical Displacement



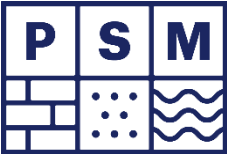
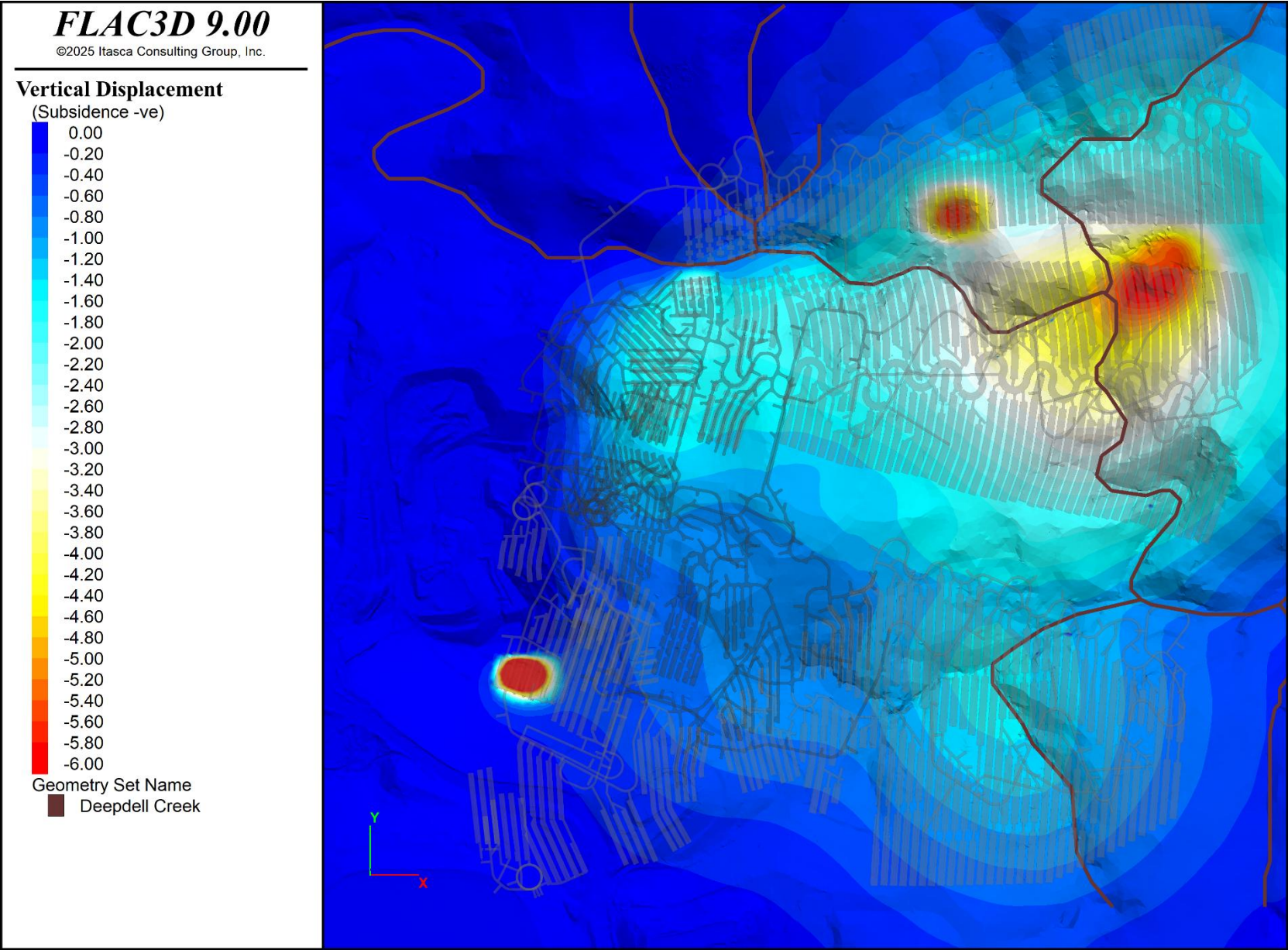
Base Case Phase 1 (Existing GPUG)

Deepdell Creek - Maximum Tensile Strain



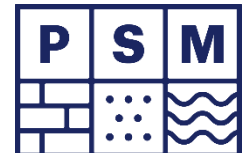
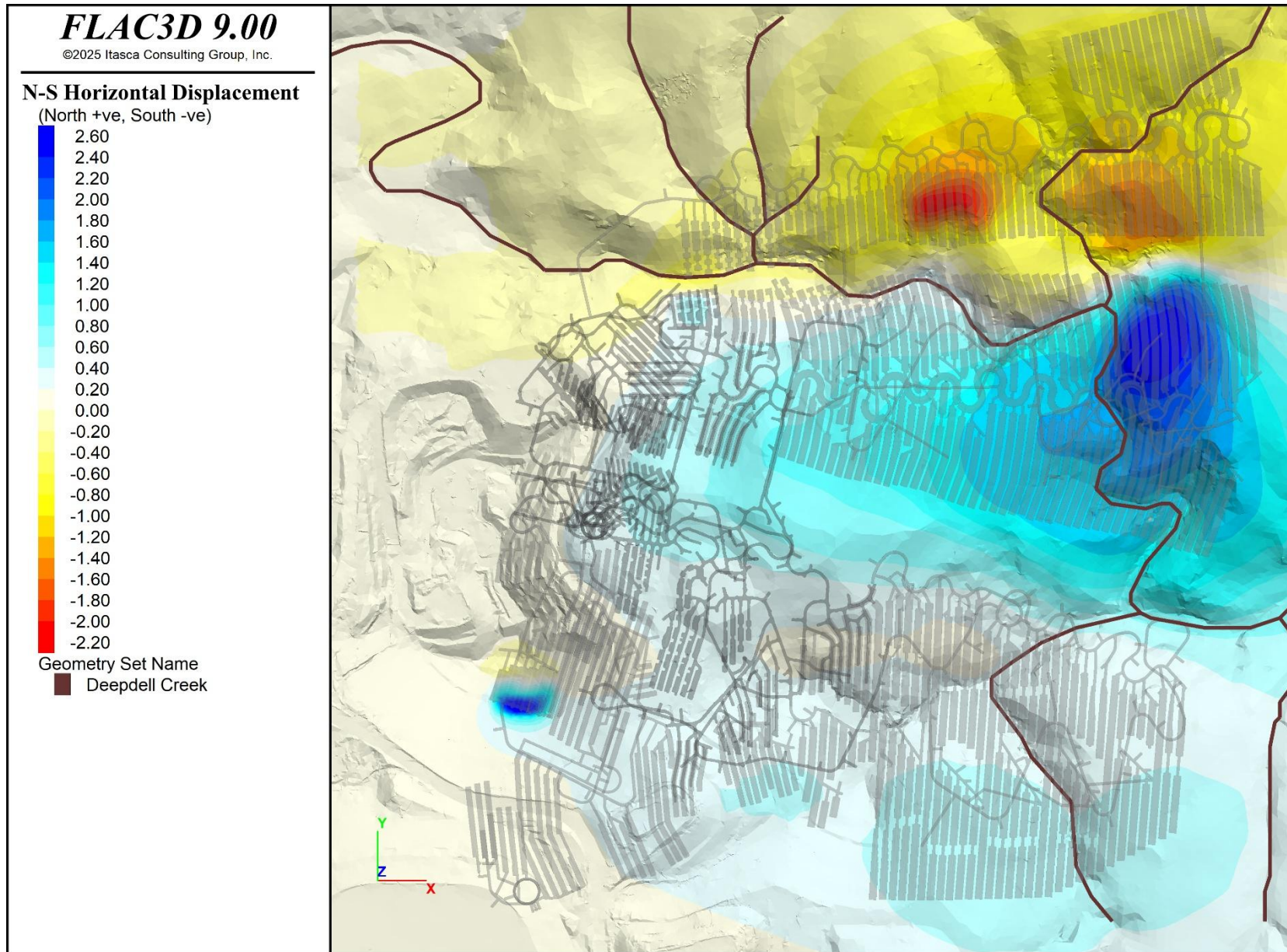
Base Case Phase 2 (Proposed GPUG)

Planview: Vertical Displacement



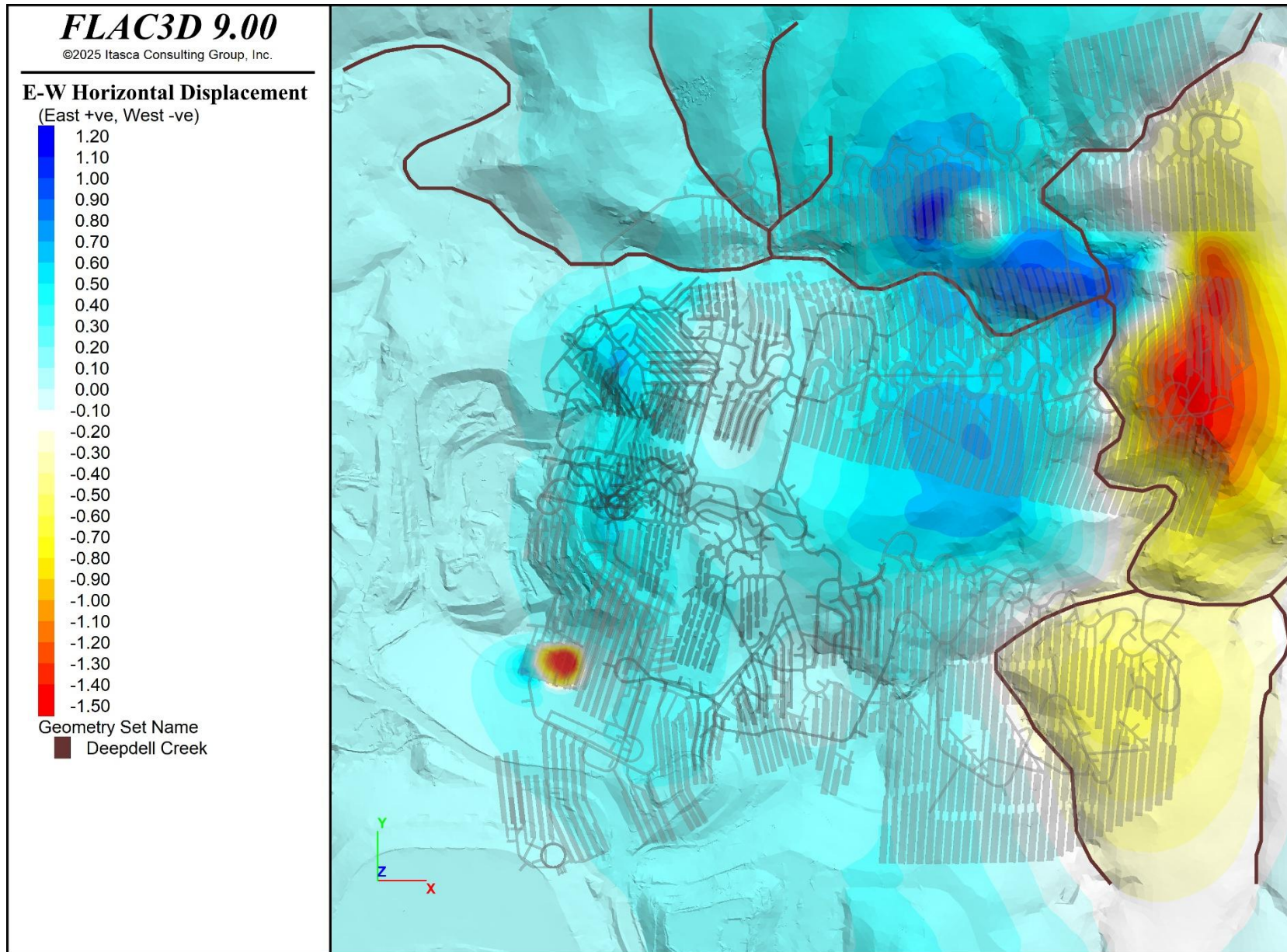
Base Case Phase 2 (Proposed GPUG)

Planview: N-S Horizontal Displacement



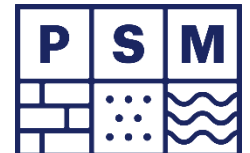
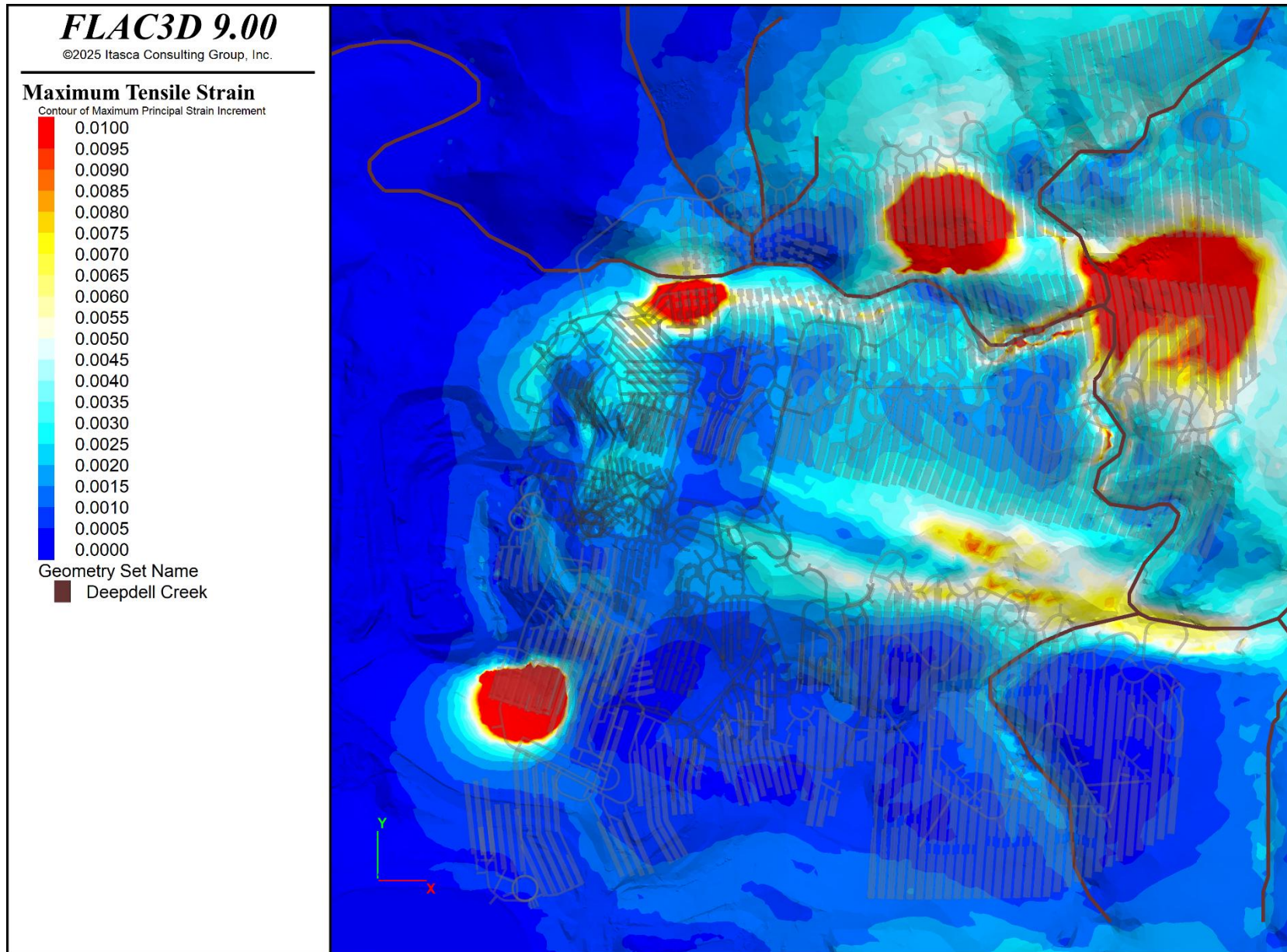
Base Case Phase 2 (Proposed GPUG)

Planview: E-W Horizontal Displacement



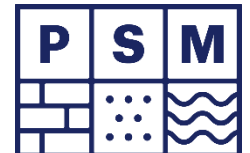
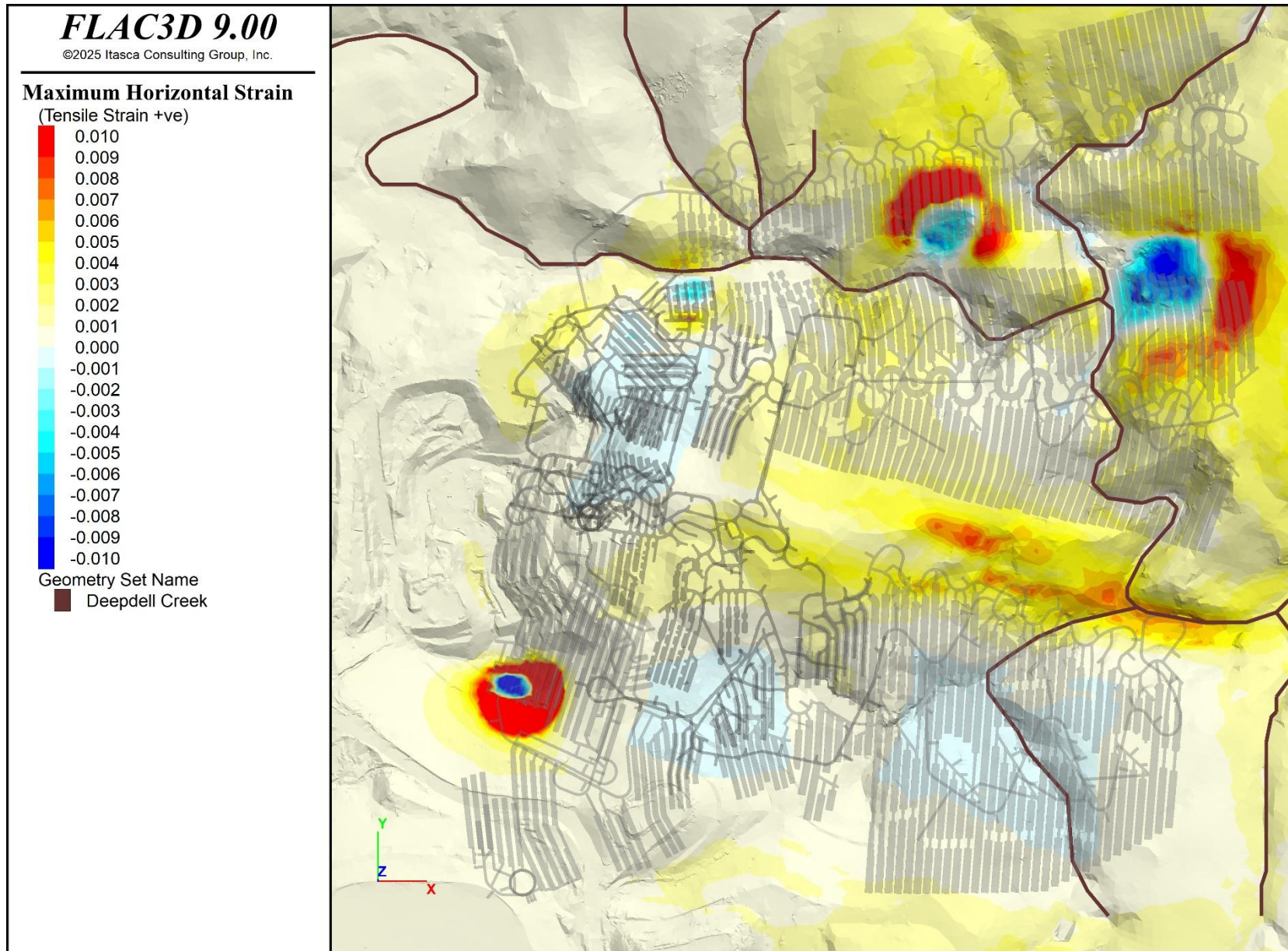
Base Case Phase 2 (Proposed GPUG)

Planview: Maximum Tensile Strain



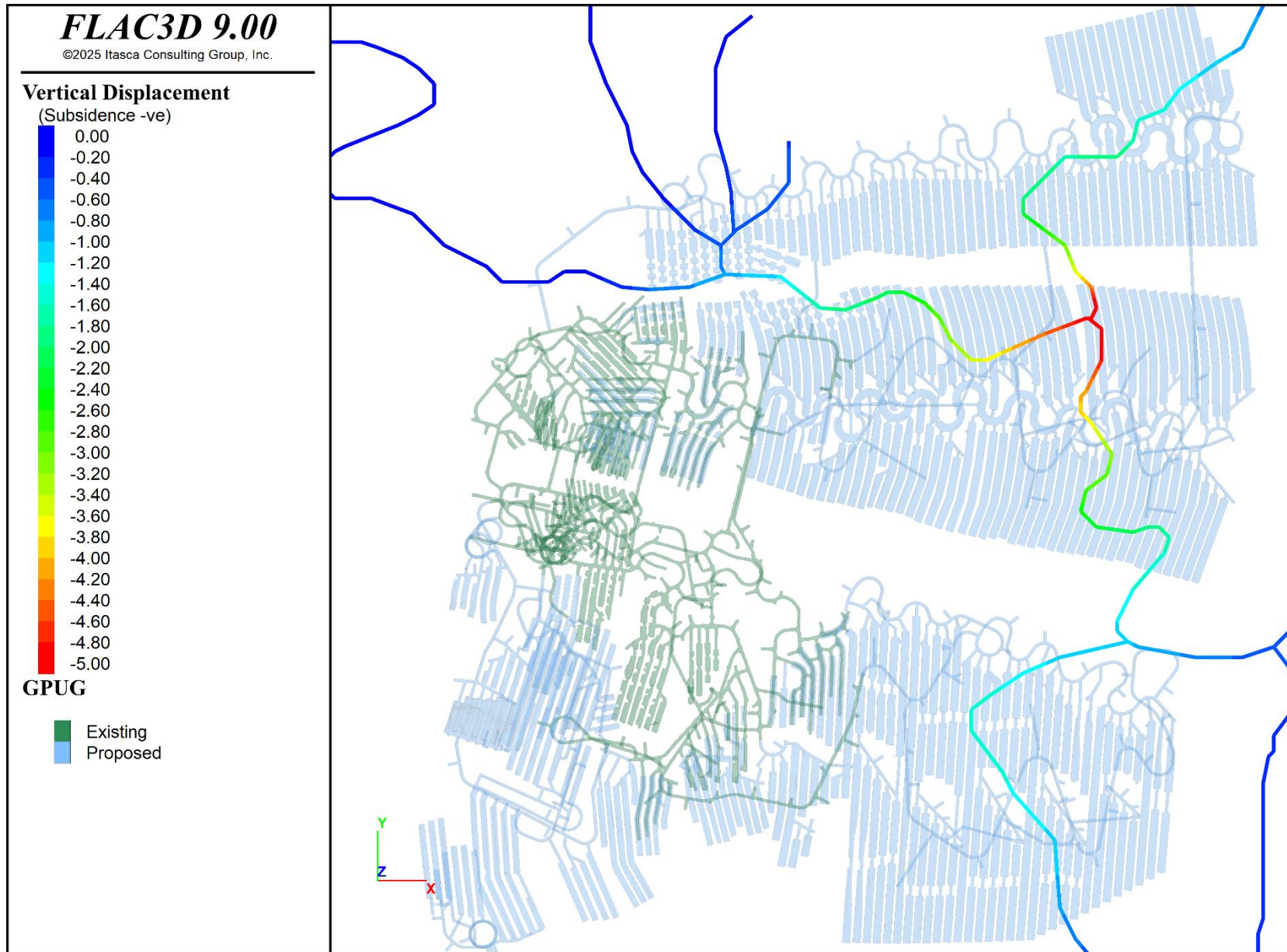
Base Case Phase 2 (Proposed GPUG)

Planview: Horizontal Strain



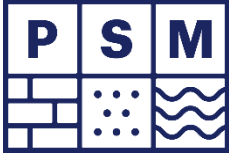
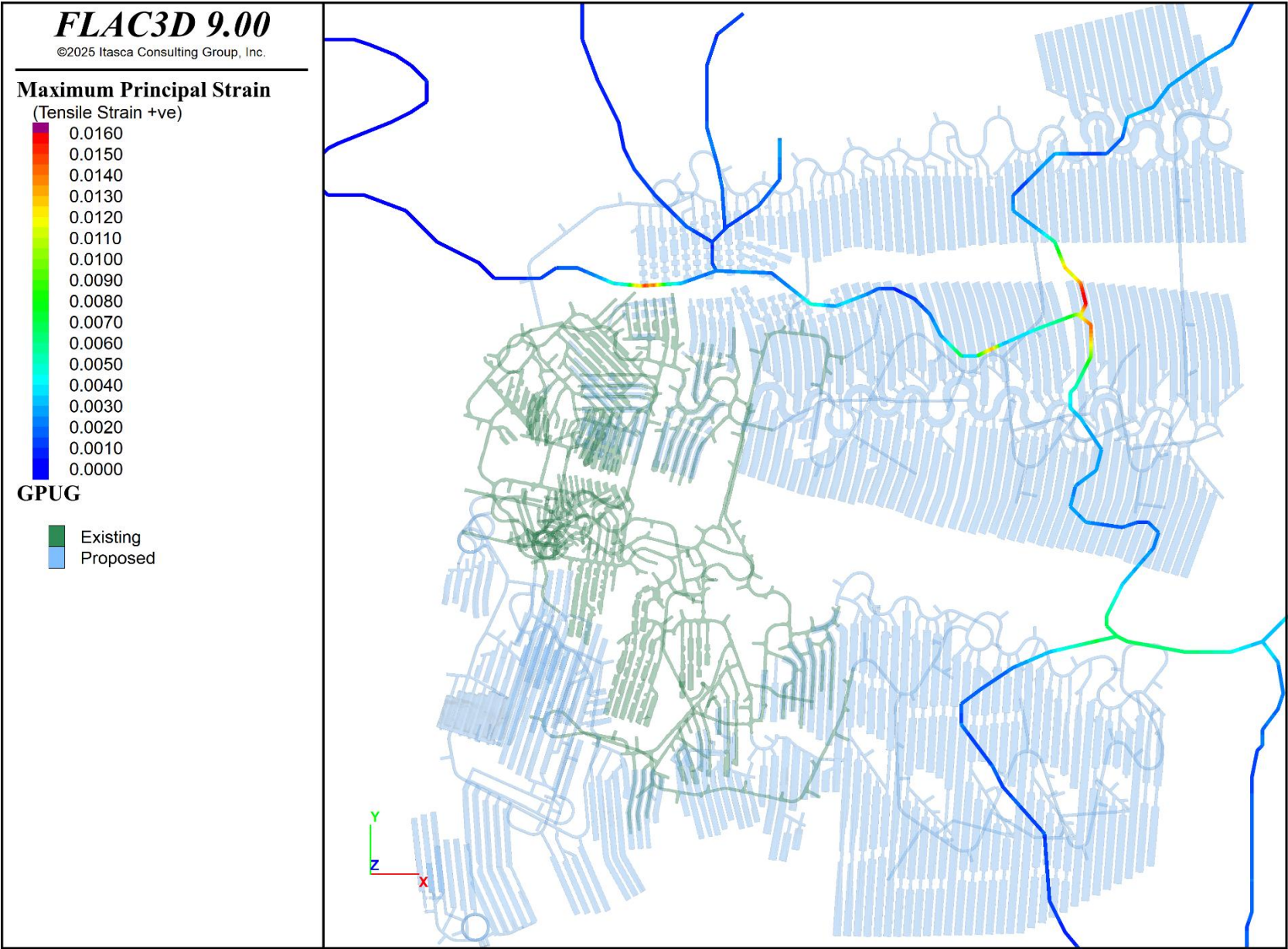
Base Case Phase 2 (Proposed GPUG)

Deepdell Creek - Vertical Displacement



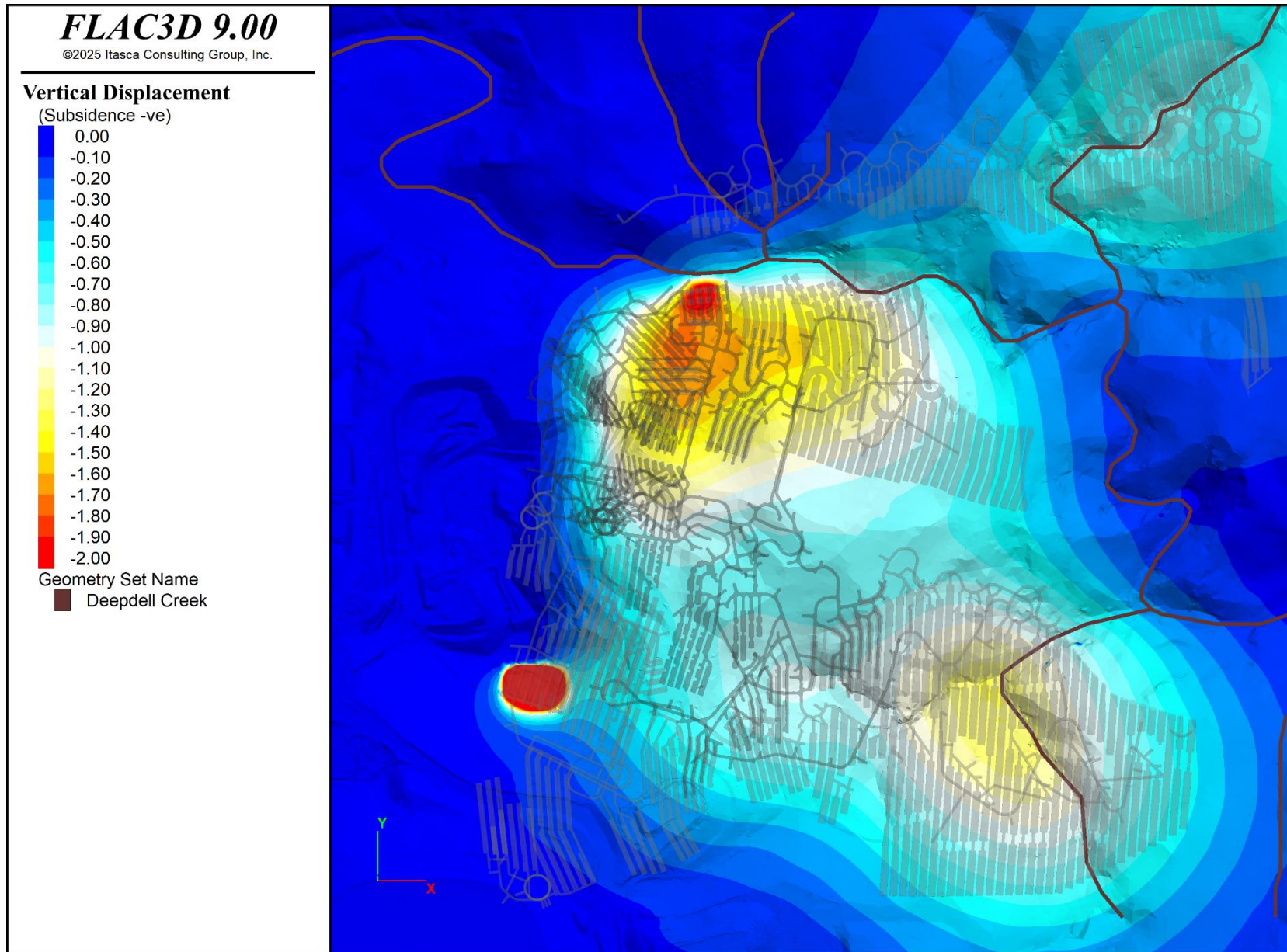
Base Case Phase 2 (Proposed GPUG)

Deepdell Creek - Maximum Tensile Strain



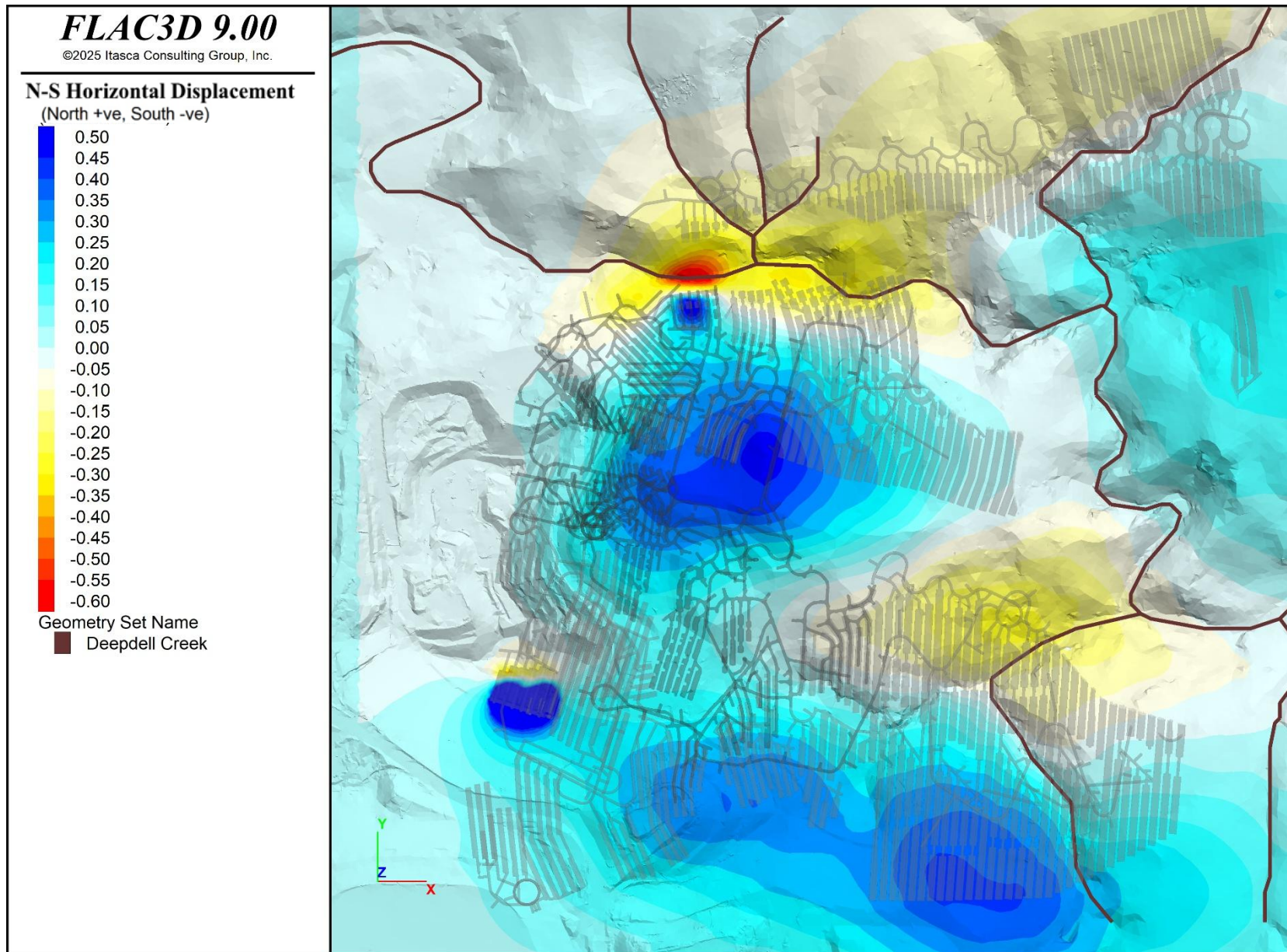
Standoff Case 1

Planview: Vertical Displacement



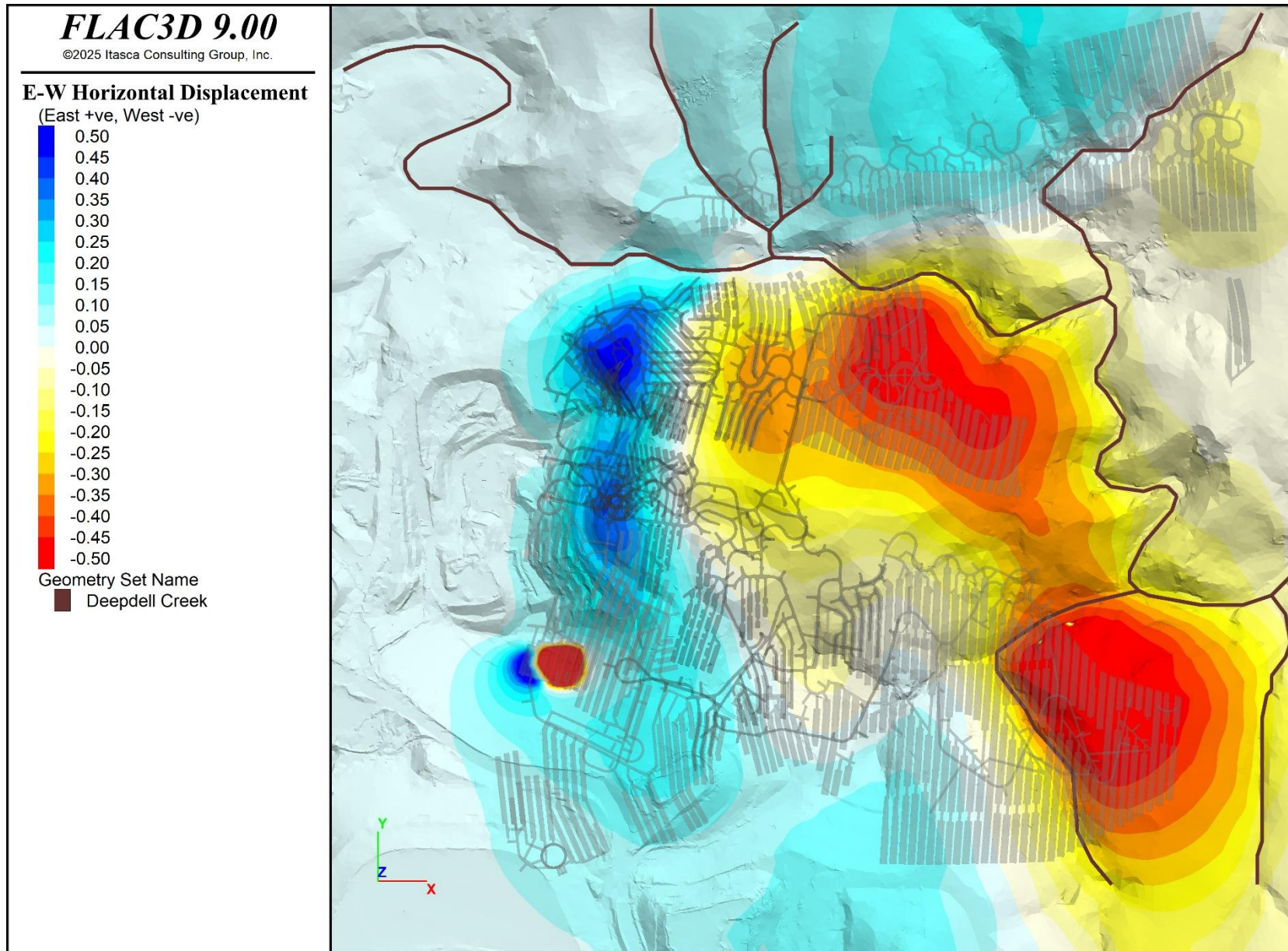
Standoff Case 1

Planview: N-S Horizontal Displacement



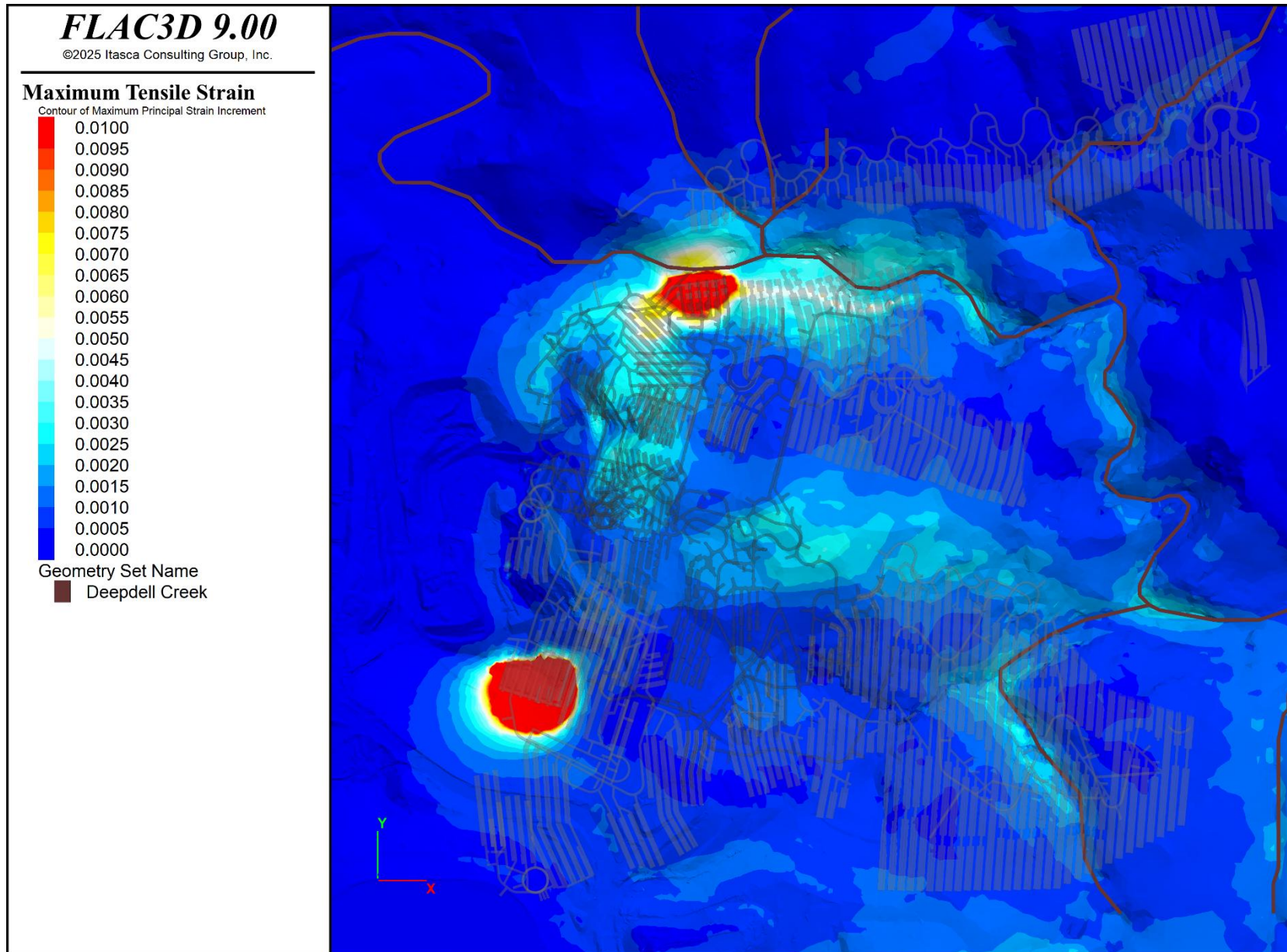
Standoff Case 1

Planview: E-W Horizontal Displacement



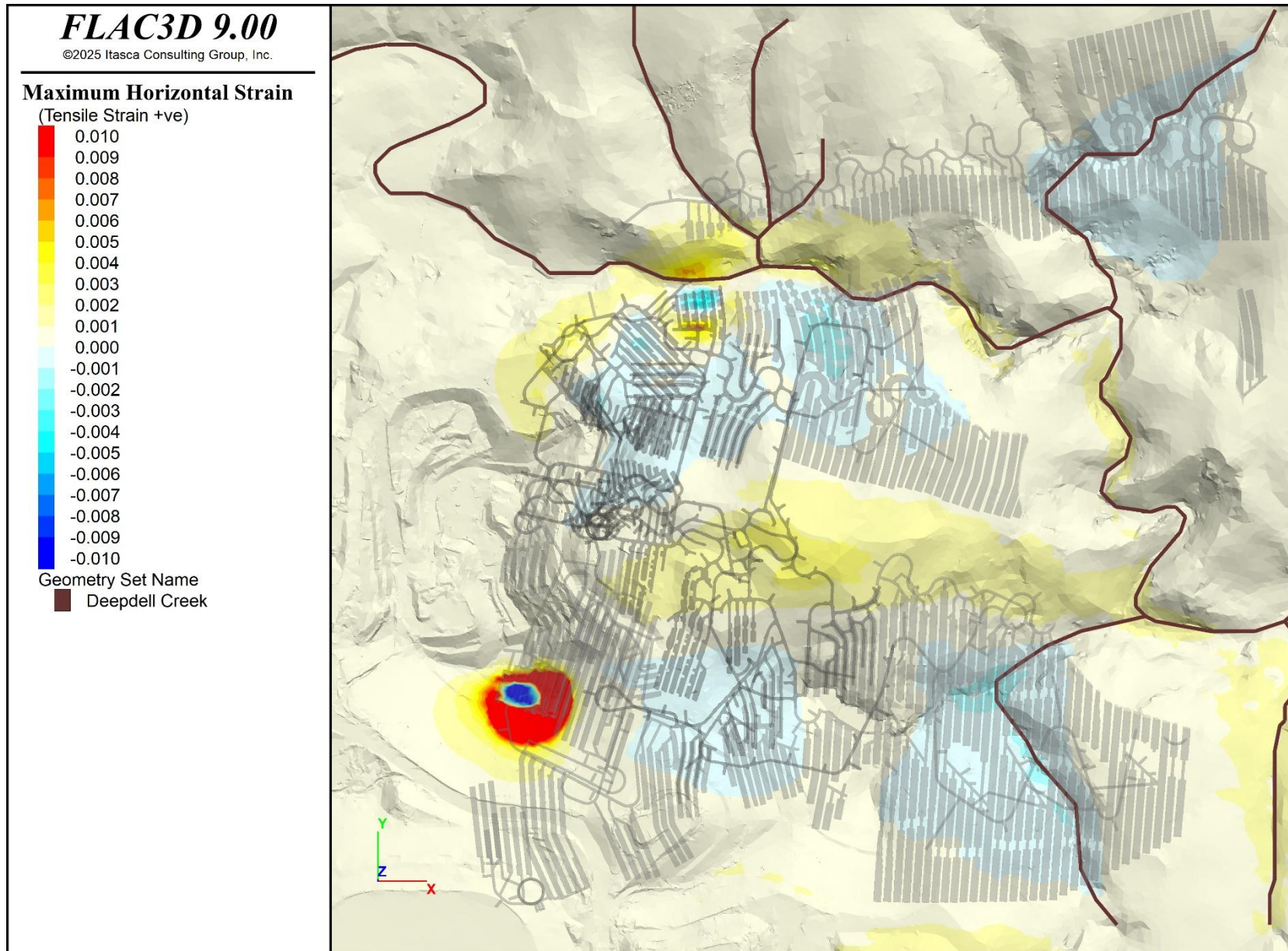
Standoff Case 1

Planview: Maximum Tensile Strain



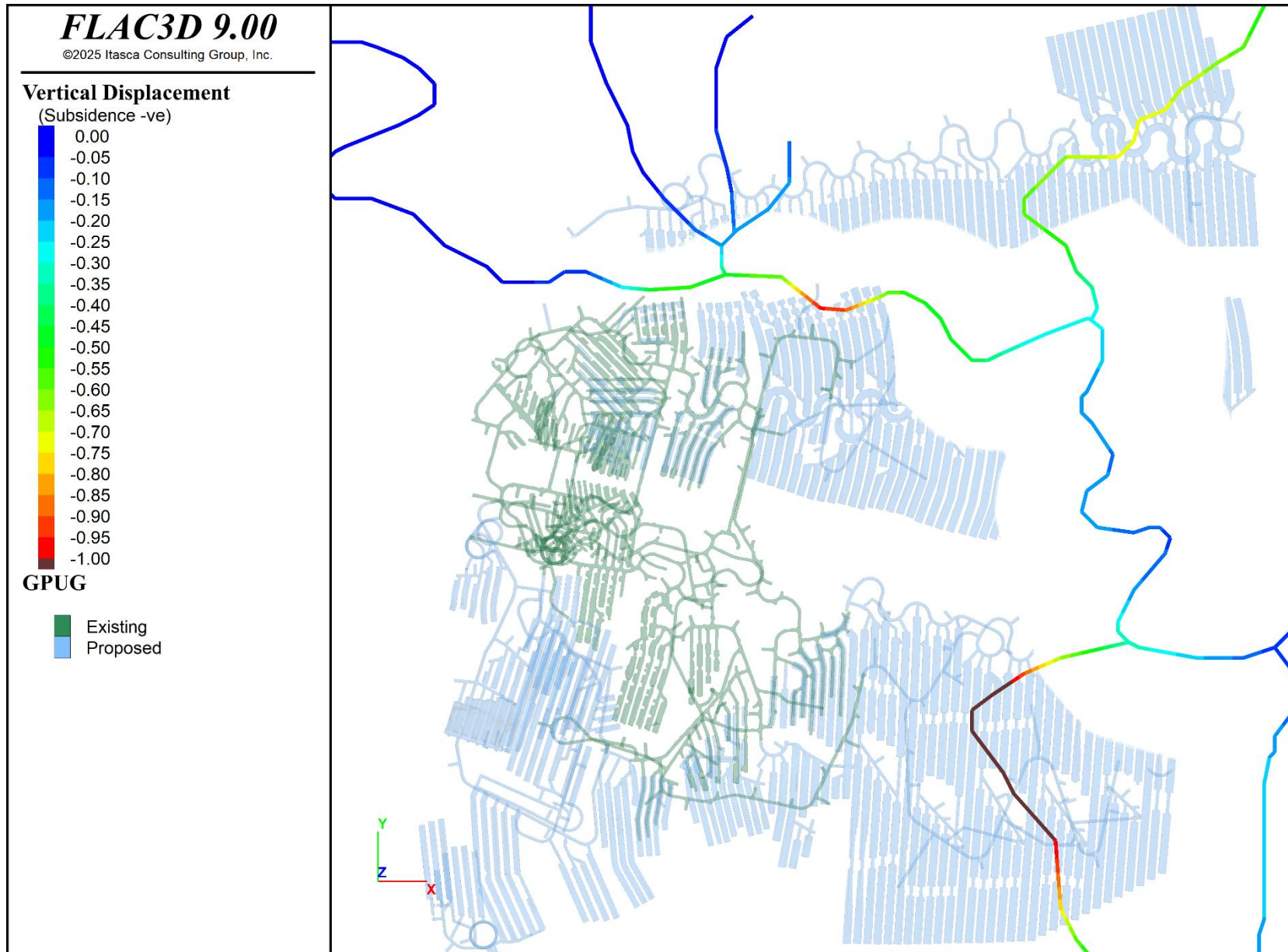
Standoff Case 1

Planview: Horizontal Strain



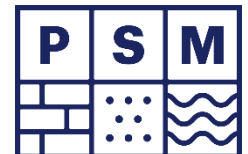
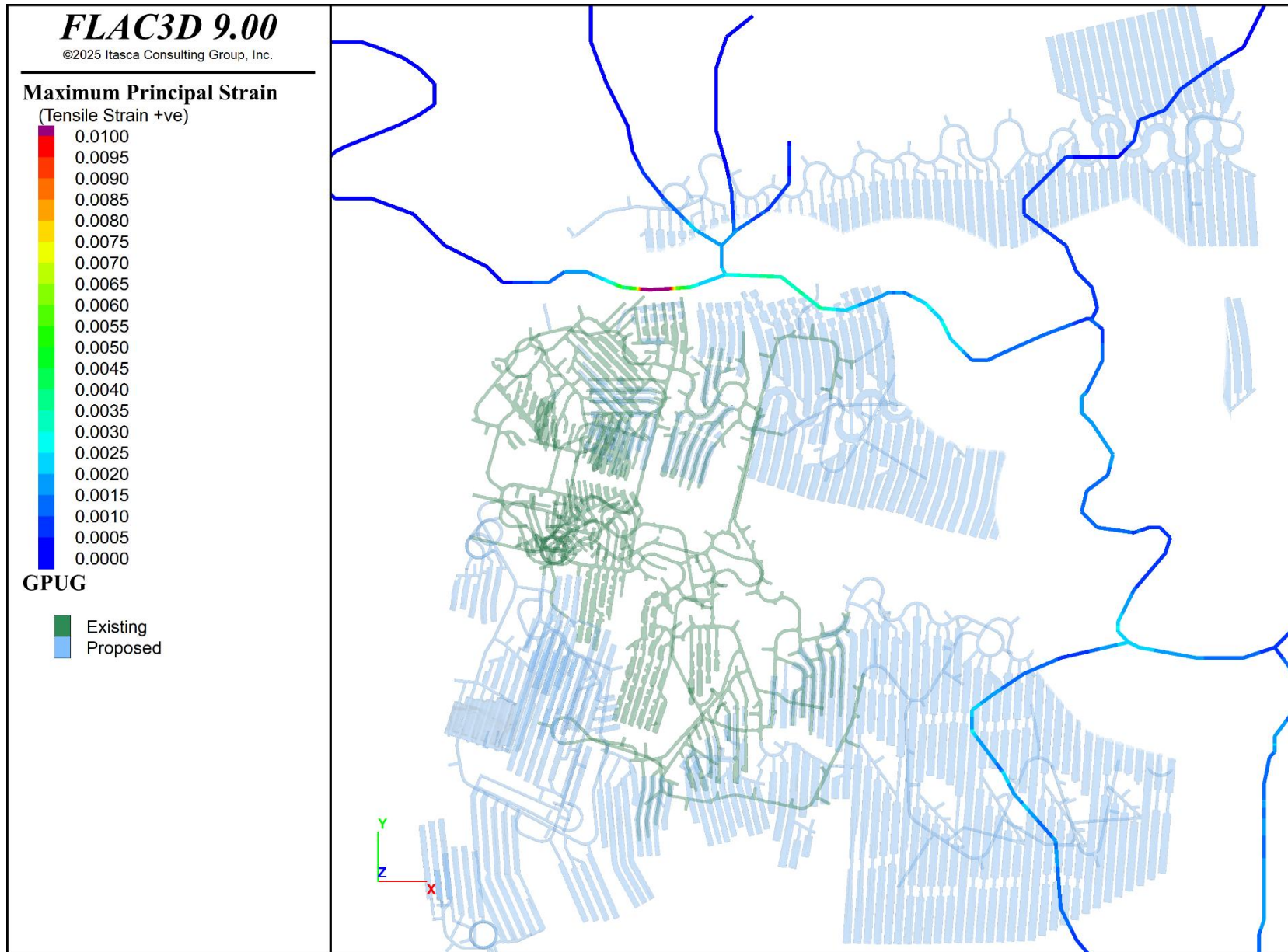
Standoff Case 1

Deepdell Creek - Vertical Displacement



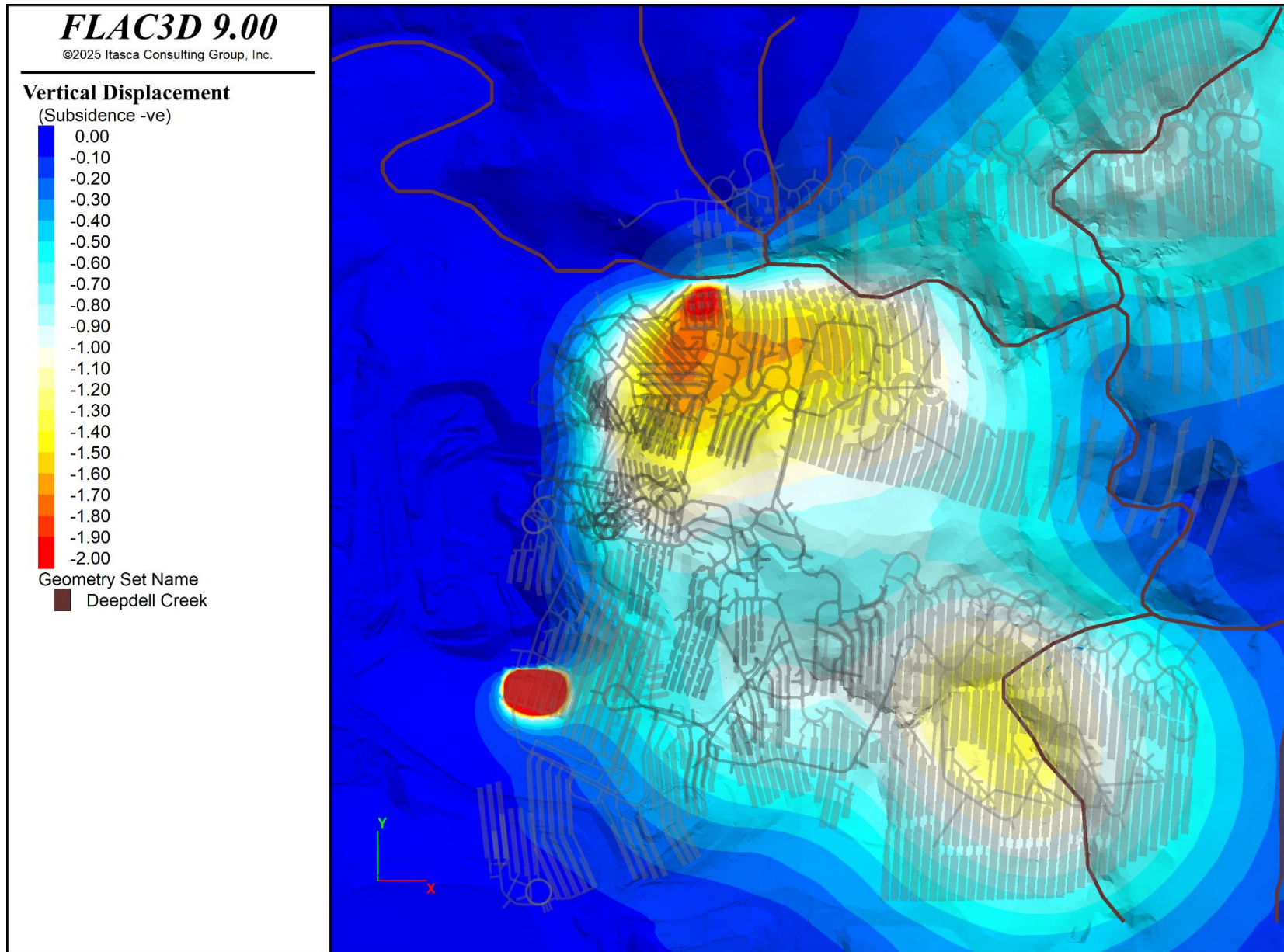
Standoff Case 1

Deepdell Creek - Maximum Tensile Strain



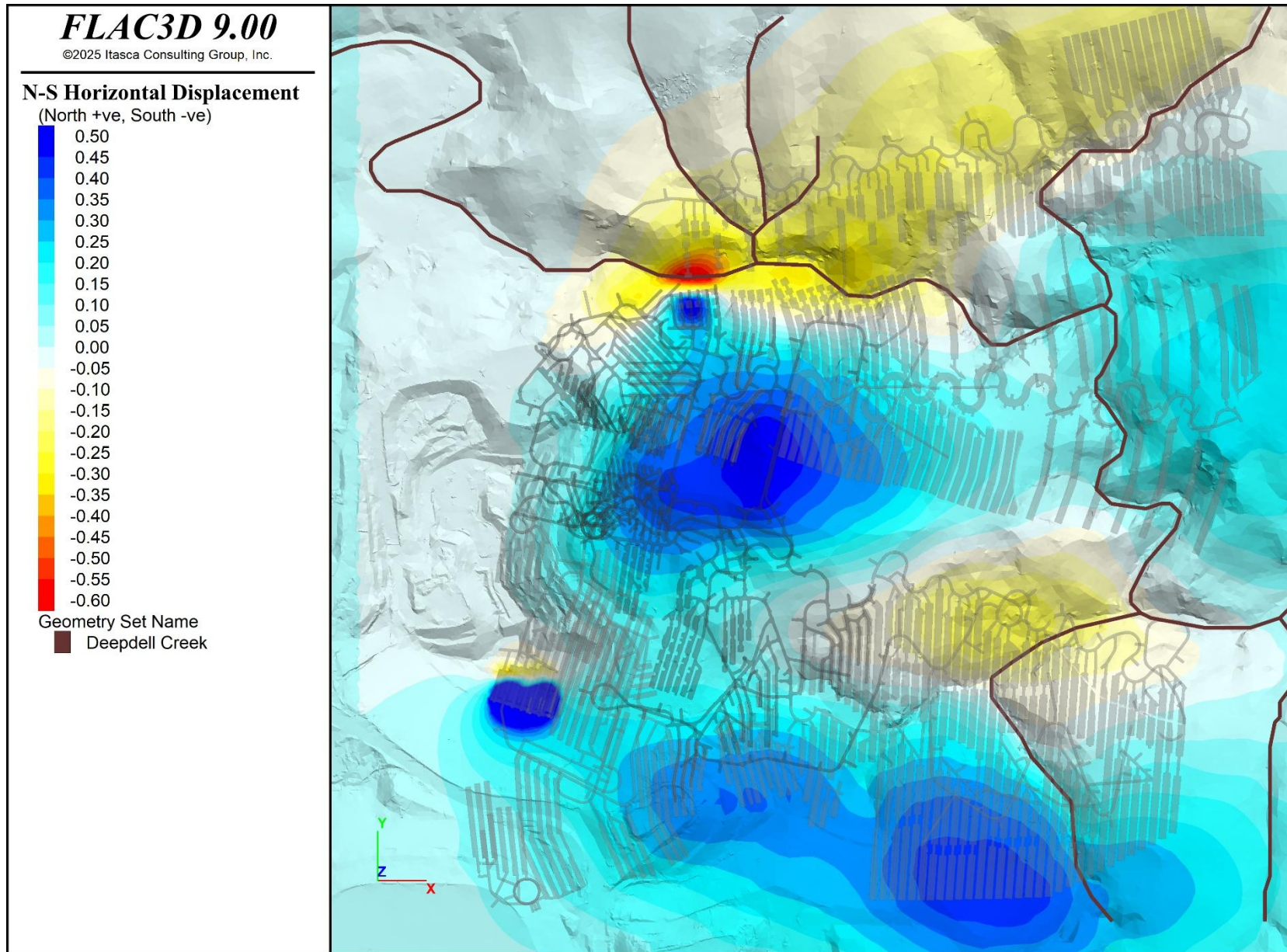
Standoff Case 1

Planview: Vertical Displacement



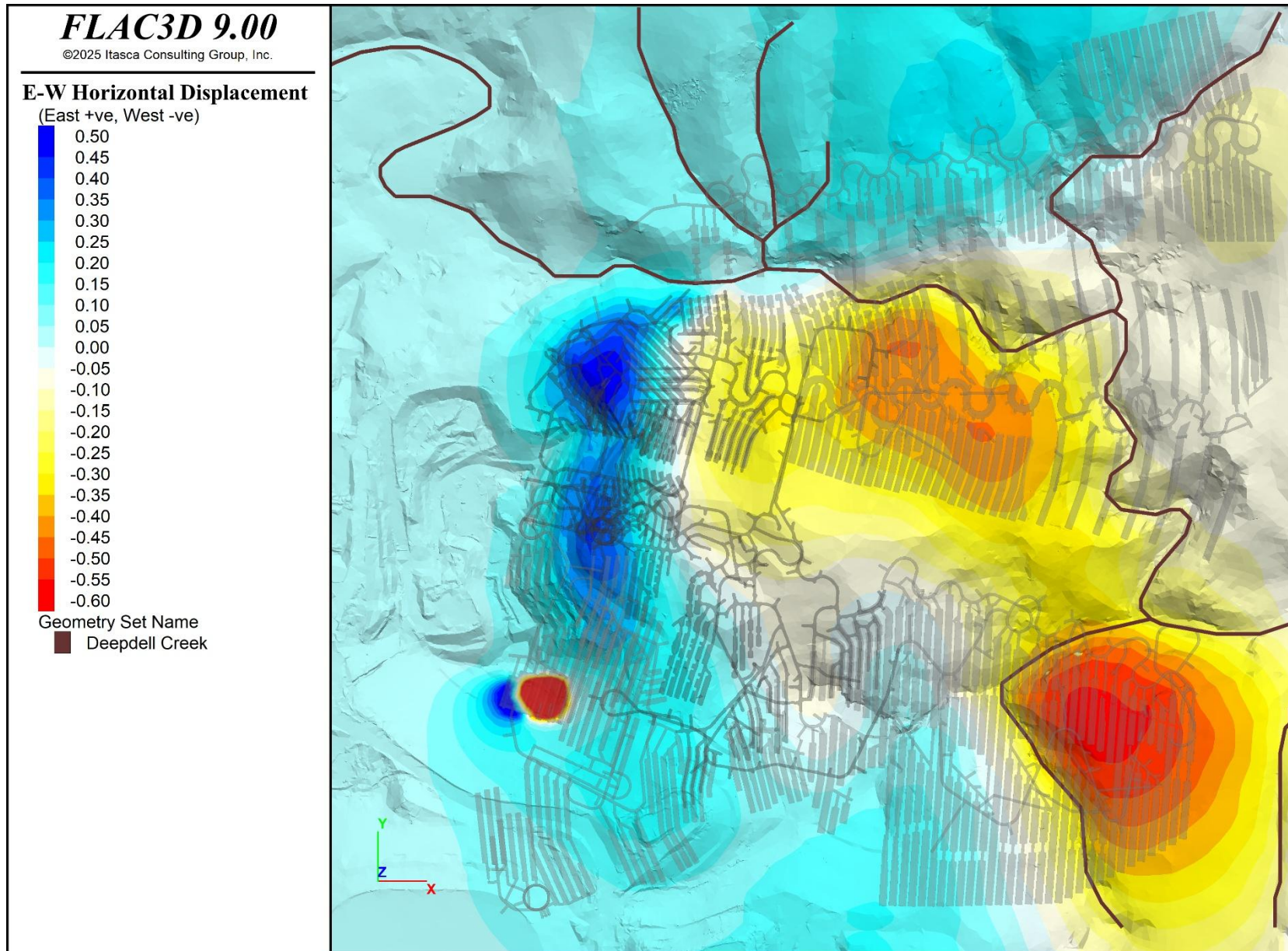
Standoff Case 2

Planview: N-S Horizontal Displacement



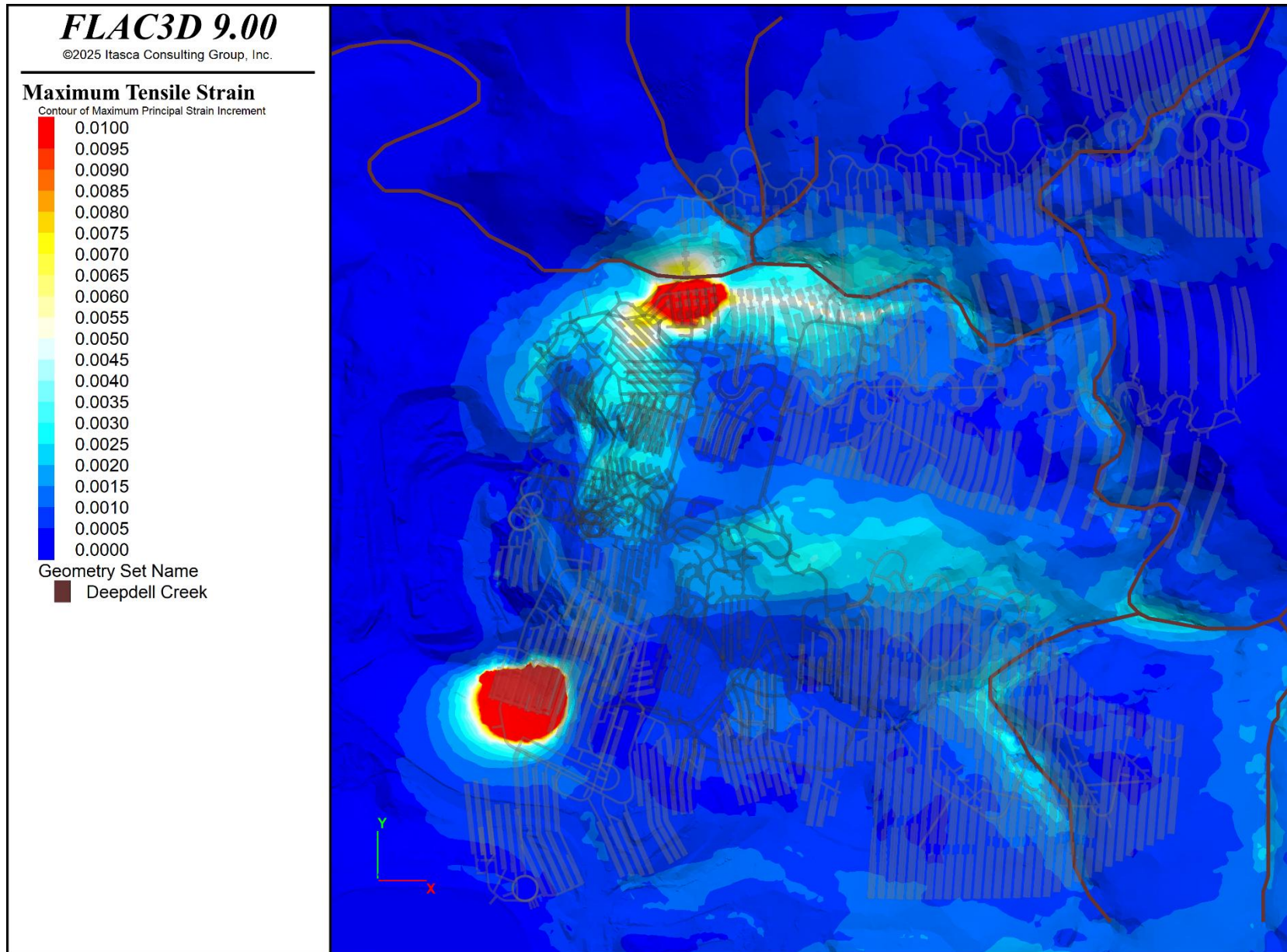
Standoff Case 2

Planview: E-W Horizontal Displacement



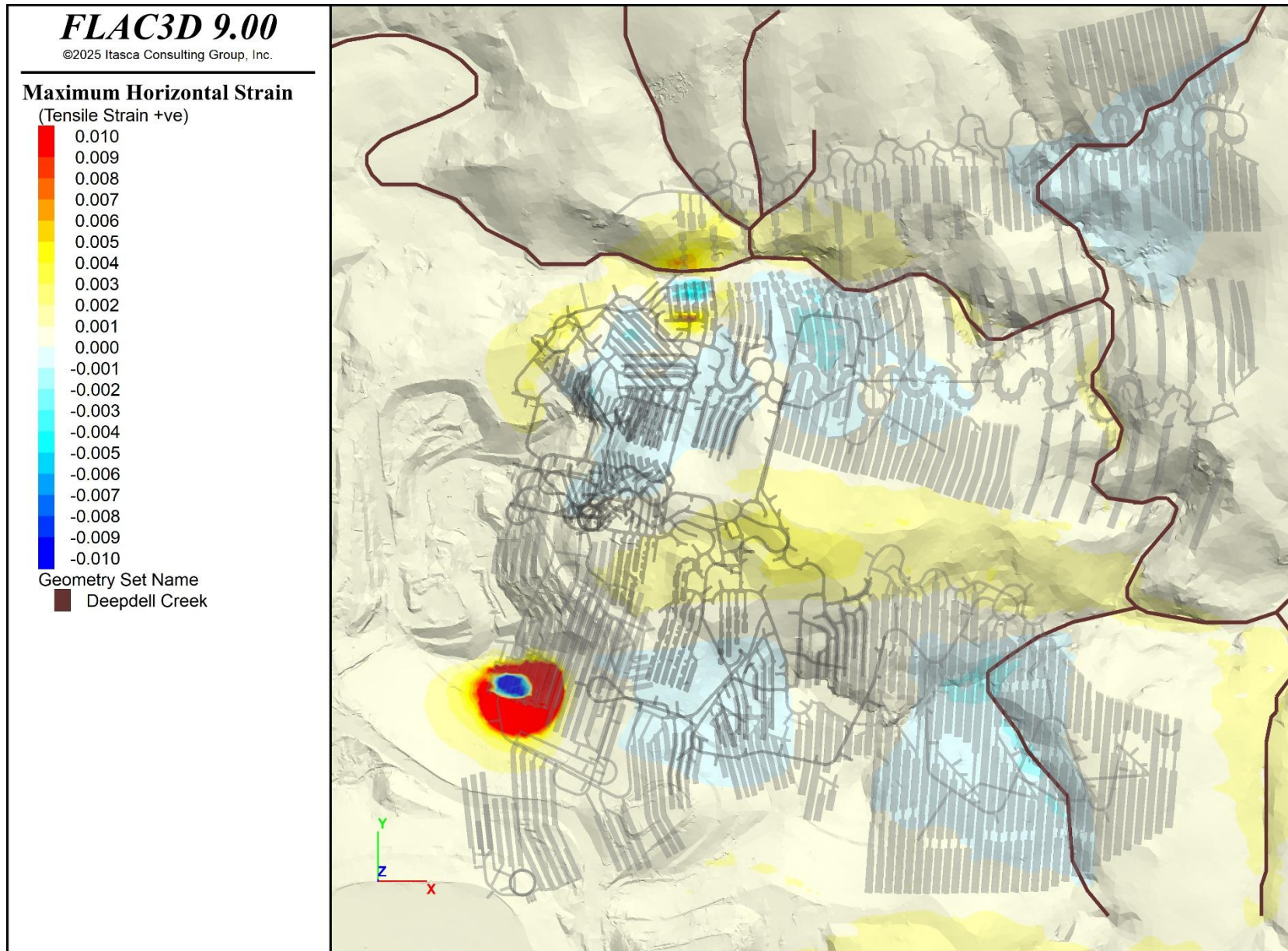
Standoff Case 2

Planview: Maximum Tensile Strain



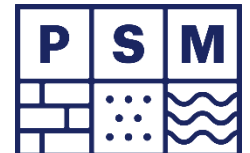
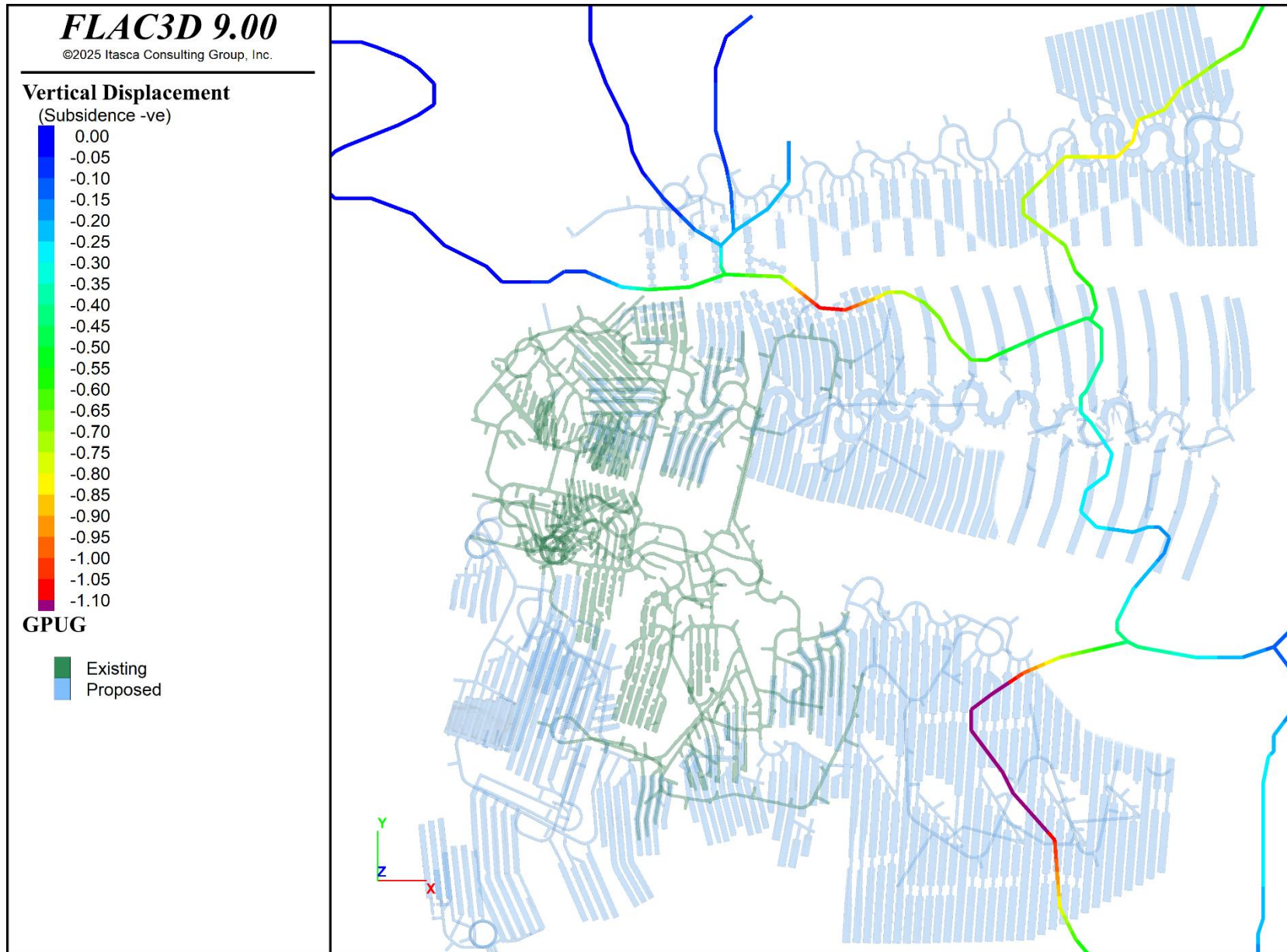
Standoff Case 2

Planview: Horizontal Strain



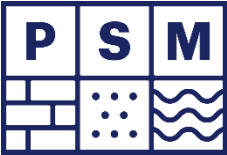
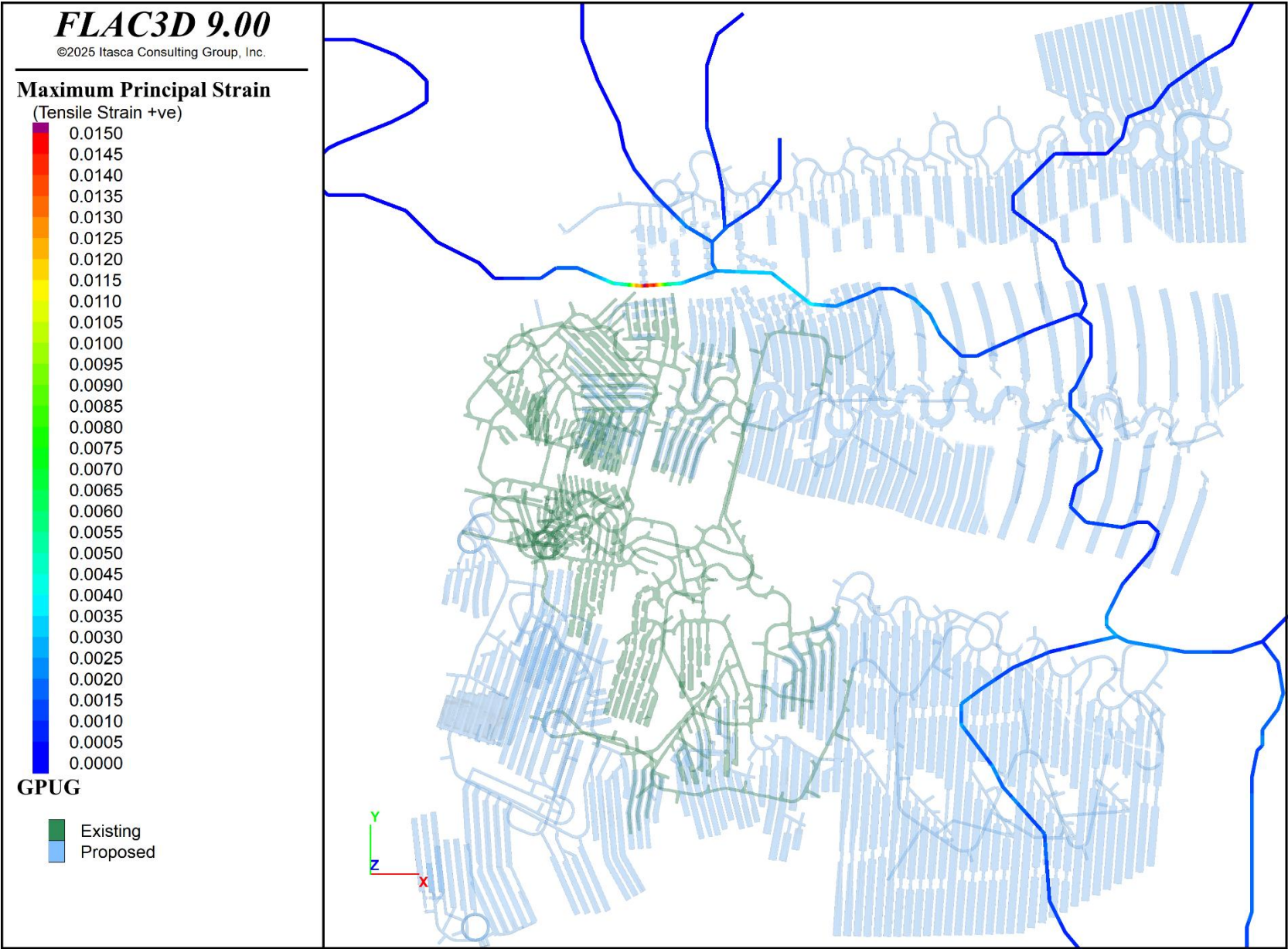
Standoff Case 2

Deepdell Creek - Vertical Displacement



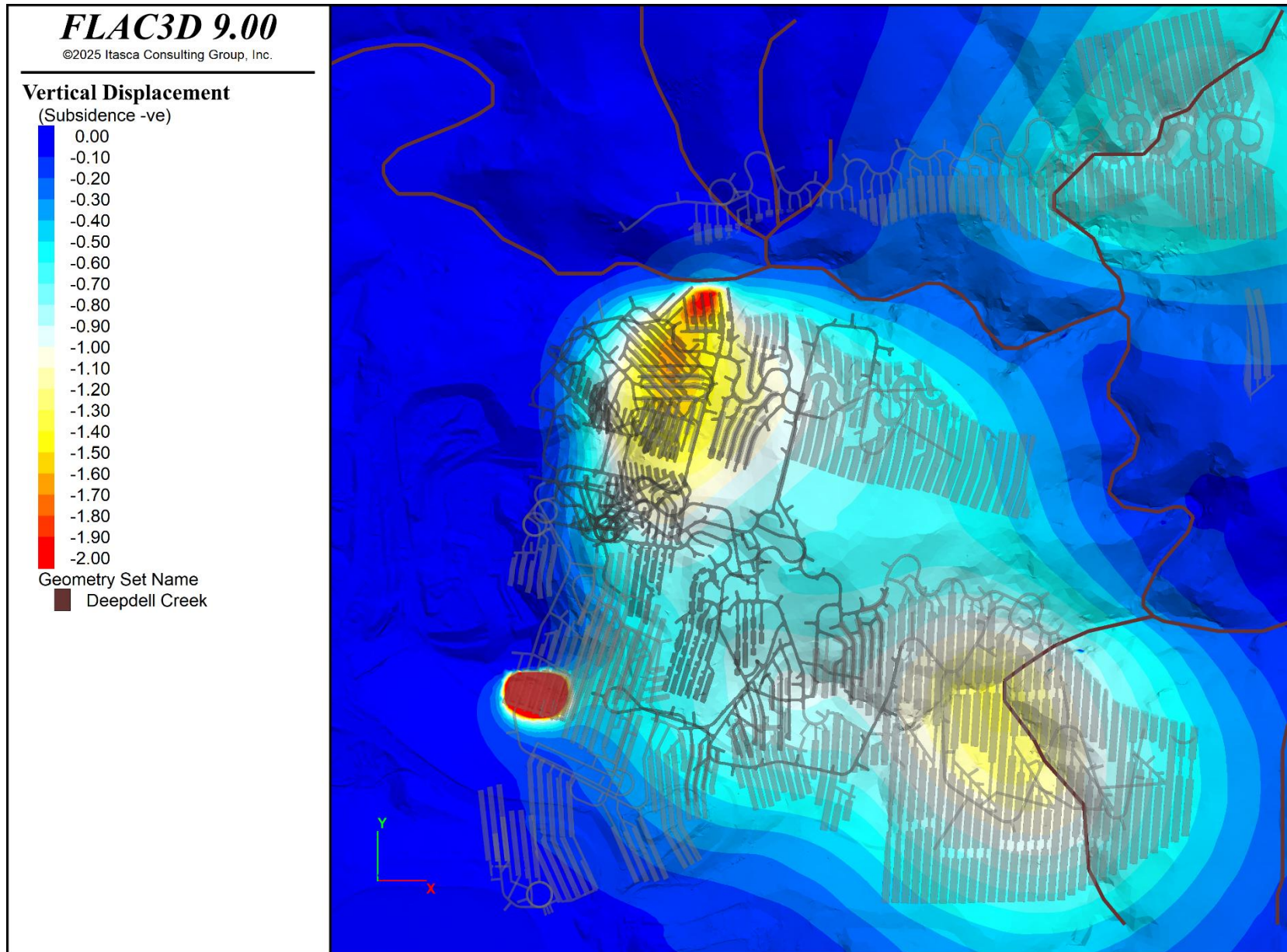
Standoff Case 2

Deepdell Creek - Maximum Tensile Strain



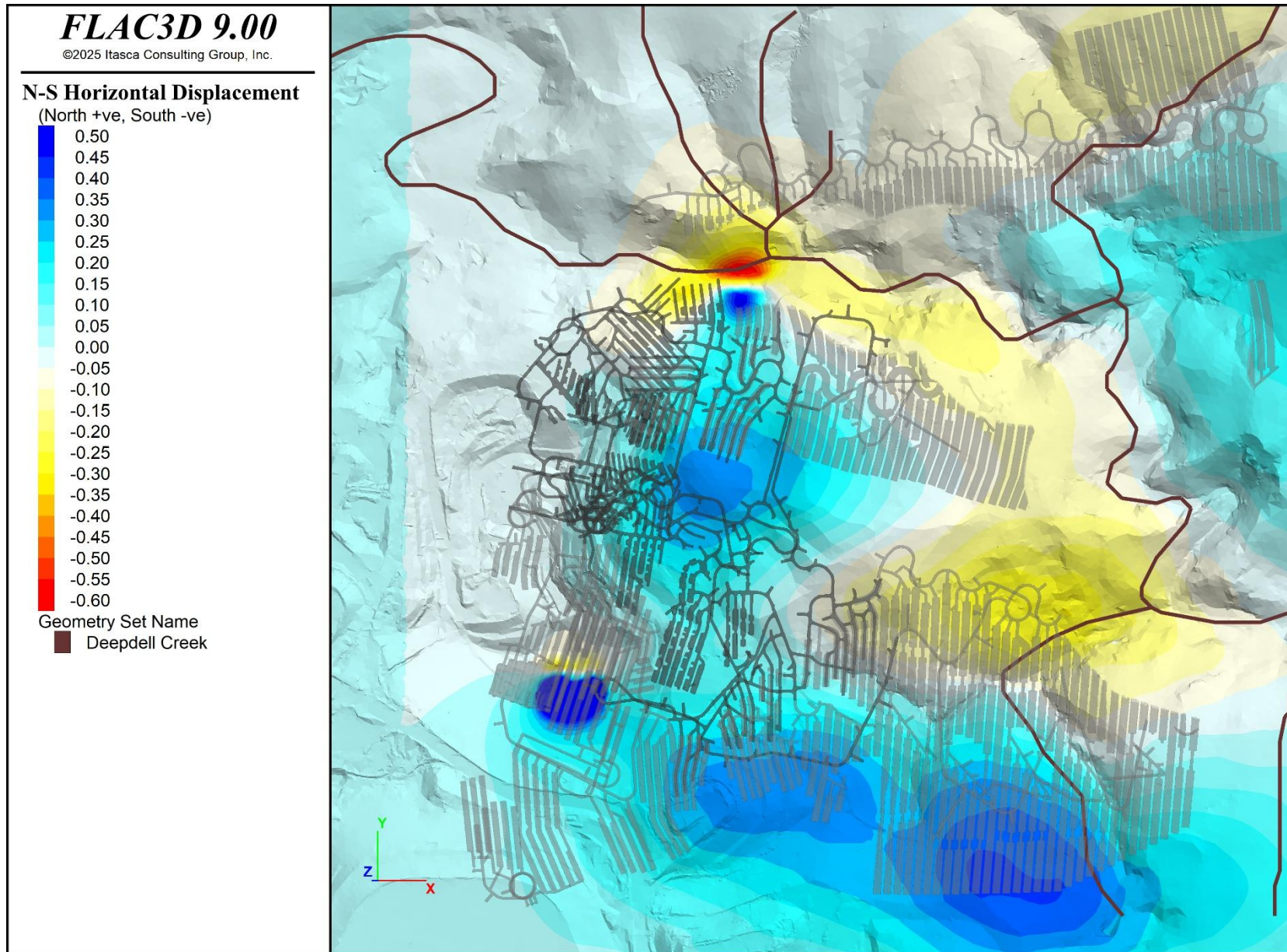
Standoff Case 3

Planview: Vertical Displacement



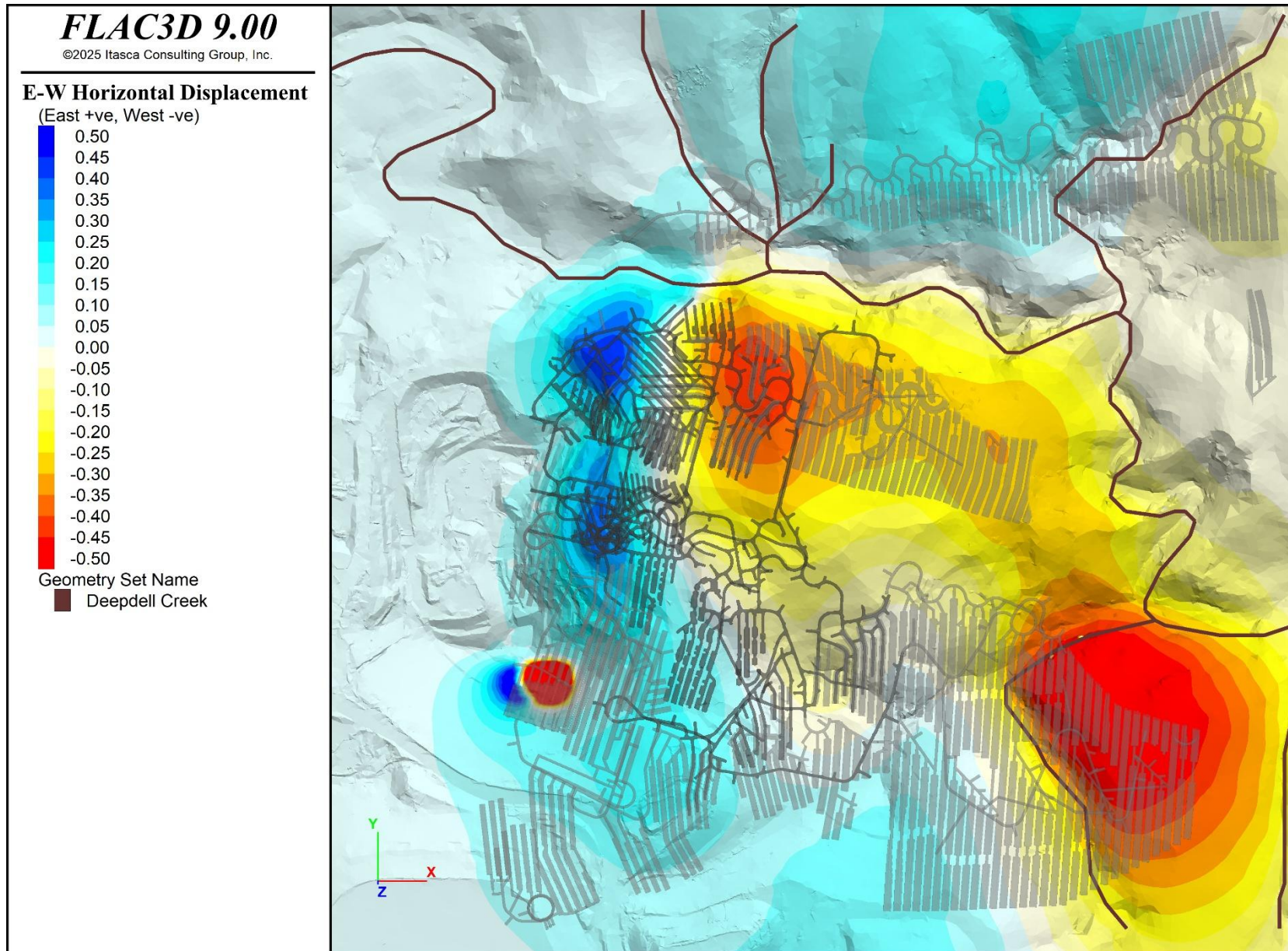
Standoff Case 3

Planview: N-S Horizontal Displacement



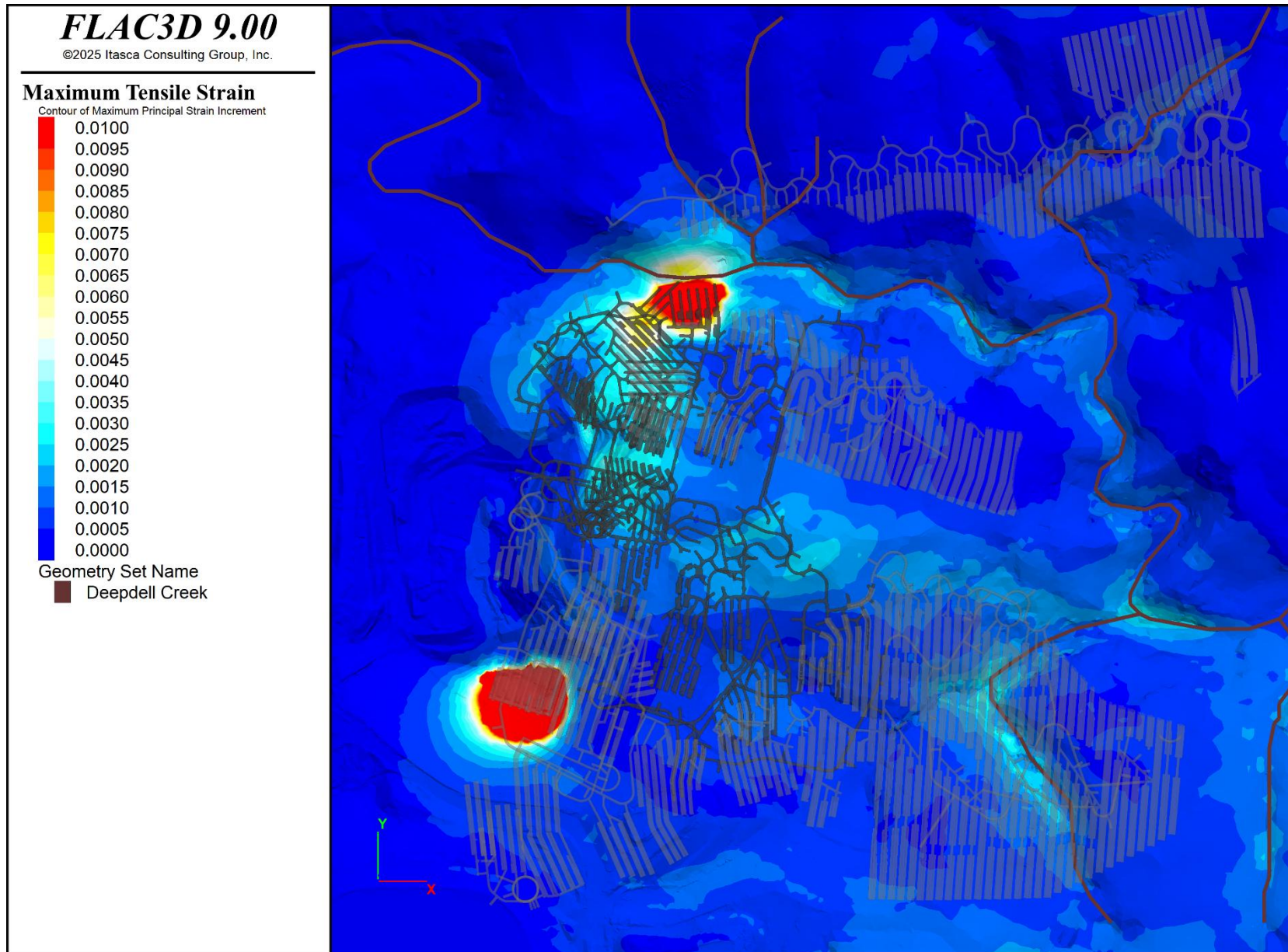
Standoff Case 3

Planview: E-W Horizontal Displacement



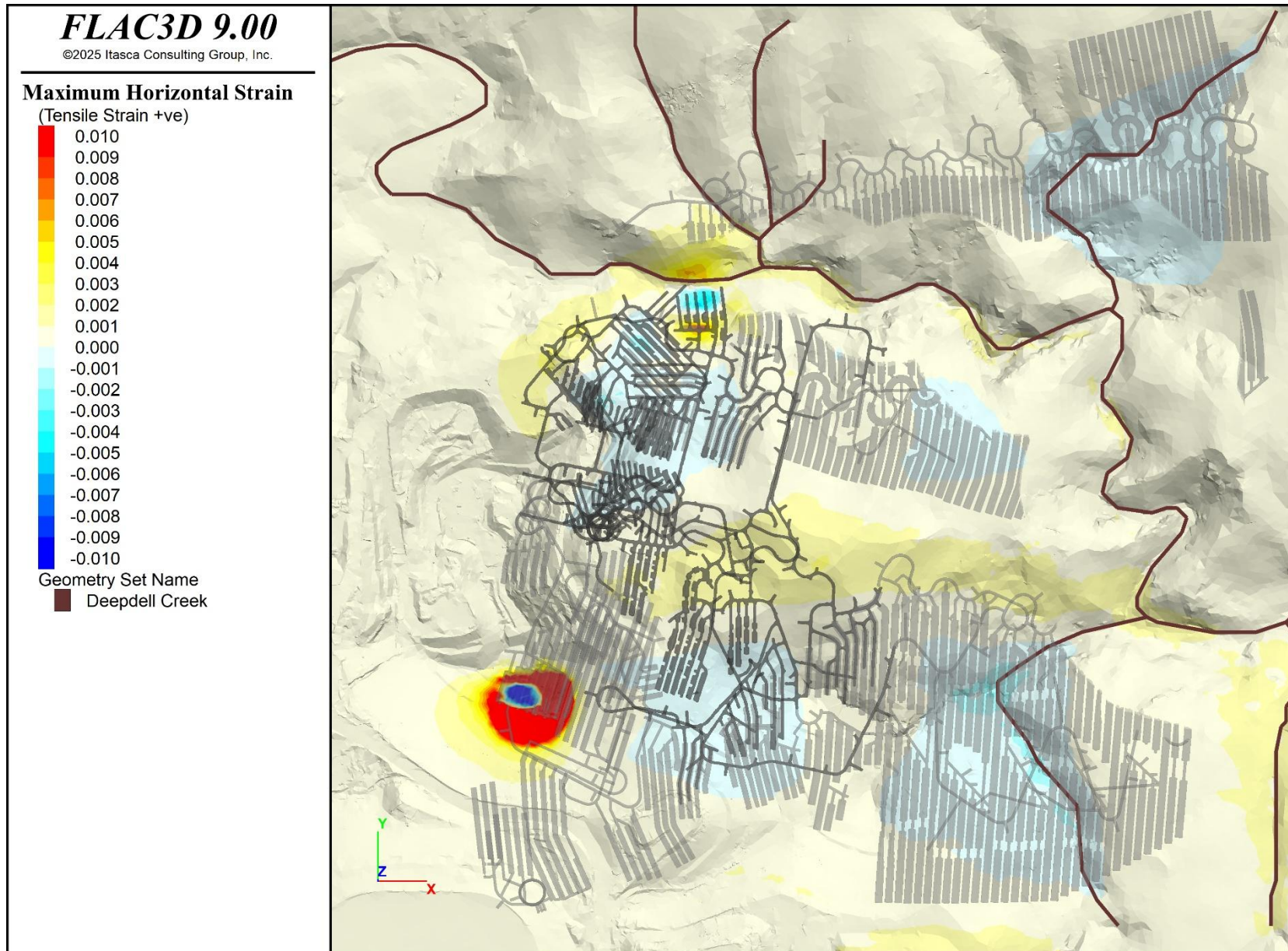
Standoff Case 3

Planview: Maximum Tensile Strain



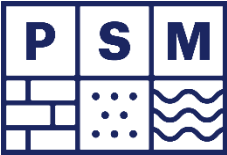
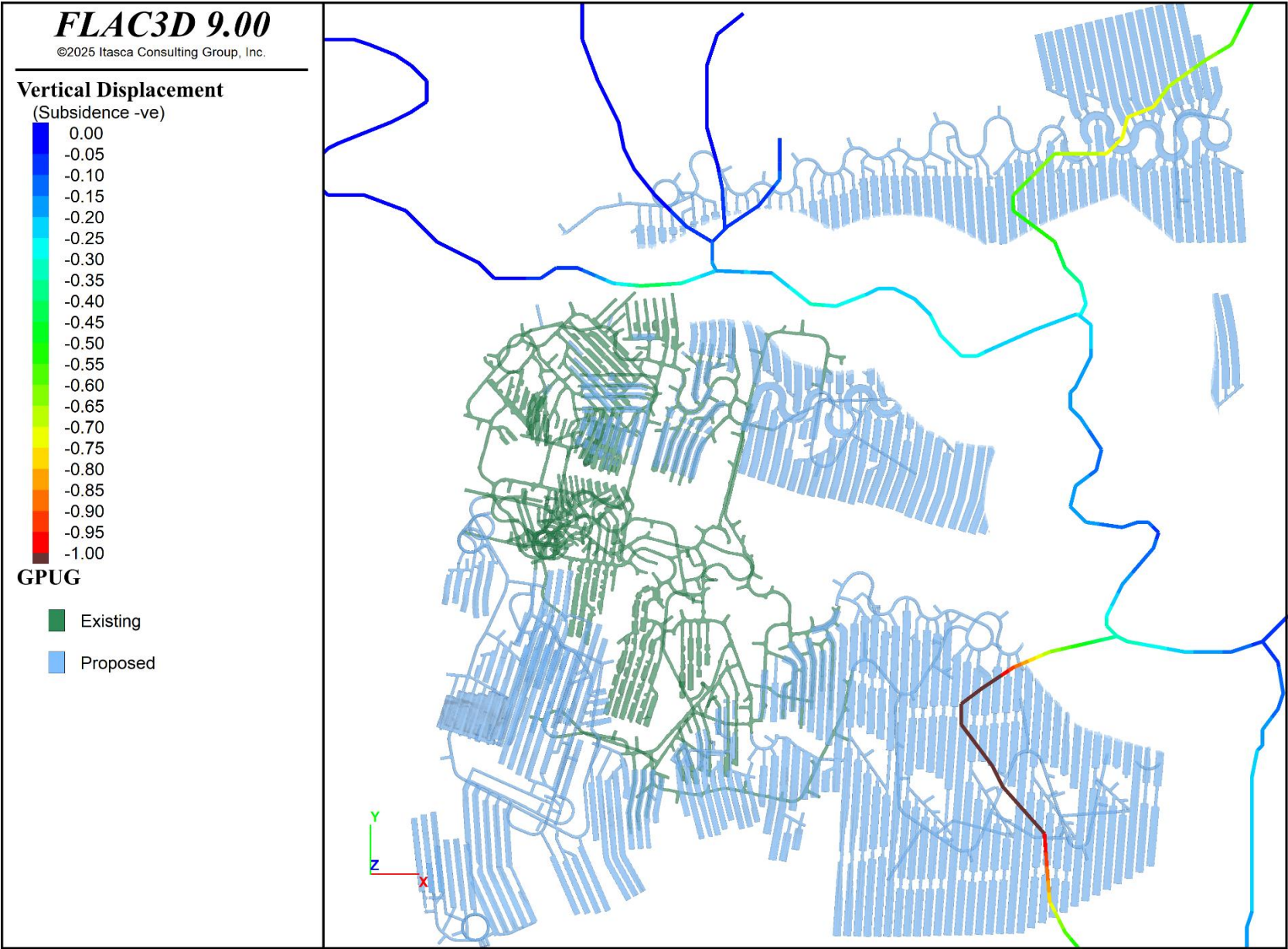
Standoff Case 3

Planview: Horizontal Strain



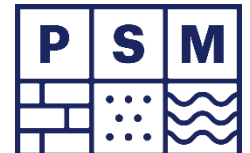
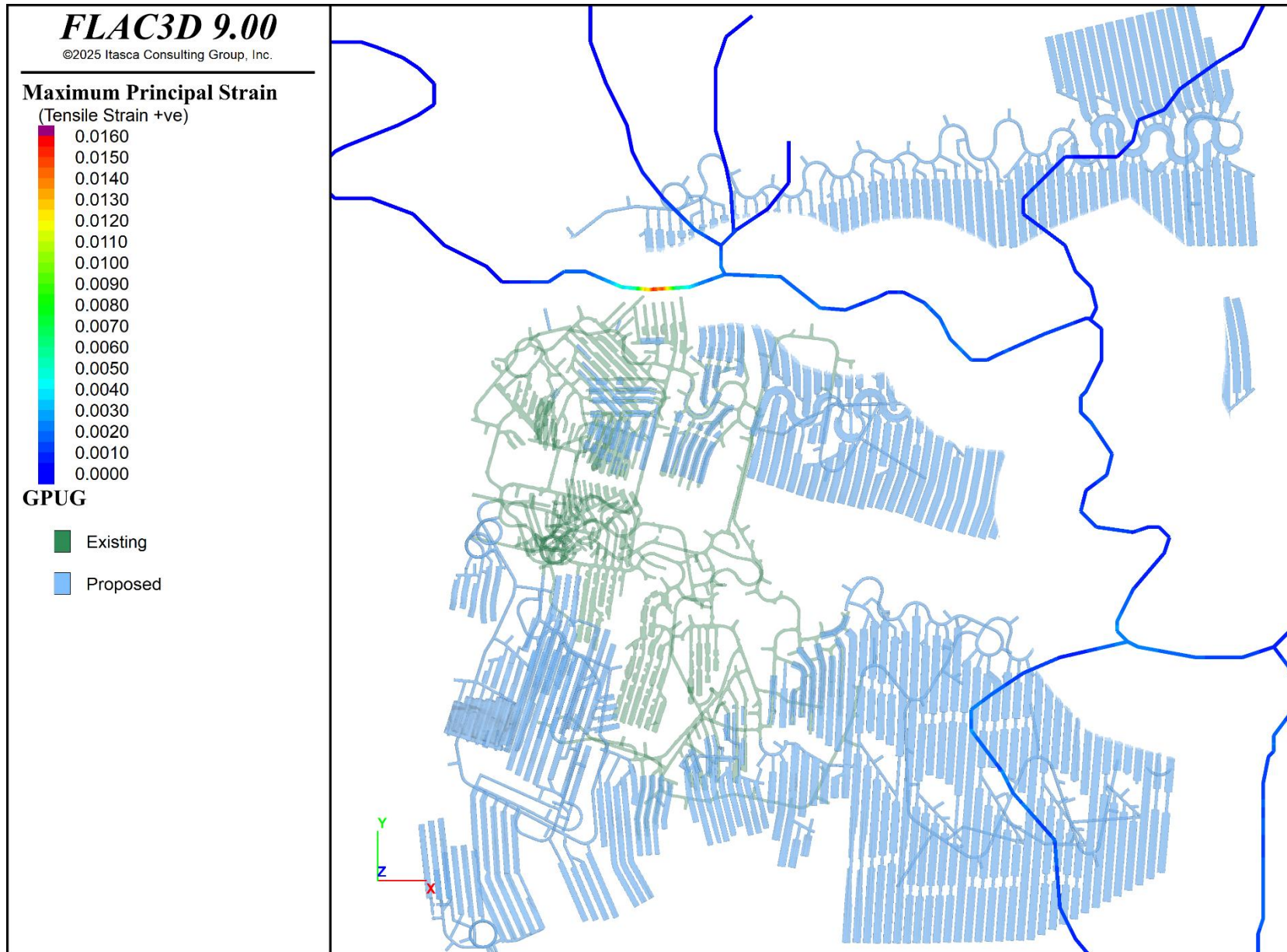
Standoff Case 3

Deepdell Creek - Vertical Displacement



Standoff Case 3

Deepdell Creek - Maximum Tensile Strain



Summary

- **The results for the base case scenarios indicate:**
 - Maximum subsidence of up to 5 m at the eastern end of Deepdell Creek
 - Maximum tensile strain of up to 1.5% (15 mm/m) in localised section of Deepdell Creek, though the maximum tensile strain is typically <0.5% (5 mm/m) along most of the Deepdell Creek alignment
 - Horizontal tensile strain typically <0.5% (5 mm/m) along the entire Deepdell Creek alignment
 - Valley closure of up to 3 m along N-S direction and 2m along E-W direction (valley closure is assessed as the net inward horizontal displacement between the opposite sides of the Deepdell Creek valley)
 - Potential for chimney type failure in shallow cover areas at the southern end of the Golden Point open pit.
- **The results for the Standoff Case 1 (i.e. existing consent fully extracted but no extraction within the standoff zone for the MP4 consent area) indicate:**
 - Maximum subsidence of up to 1 m at Deepdell Creek above the existing consent area
 - Maximum subsidence of <0.5 m at Deepdell Creek for the proposed MP4 consent area
 - Maximum tensile strain along Deepdell Creek is typically <0.5% (5 mm/m) along the Deepdell Creek alignment
 - Valley closure of up to 0.25 m was predicted along the proposed GPUG workings for the existing and MP4 consent areas
- **The results for the Standoff Case 2 (i.e. existing consent fully extracted but partial extraction within the standoff zone for the MP4 consent area) indicate:**
 - Maximum subsidence of up to 1.1 m at Deepdell Creek above the existing consent area
 - Maximum subsidence of <0.5 m at Deepdell Creek for the proposed MP4 consent area
 - Maximum tensile strain along Deepdell Creek is typically <0.5% (5 mm/m) along the Deepdell Creek alignment
 - Valley closure of up to 0.25 m was predicted along the proposed GPUG workings for the existing and MP4 consent areas
- **The results for the Standoff Case 3 (i.e. no extraction within the standoff zone for the existing consent and MP4 consent areas) indicate:**
 - Maximum subsidence of 0.35 m at Deepdell Creek
 - Maximum tensile strain along Deepdell Creek is typically <0.25% (2.5 mm/m) along the Deepdell Creek alignment
 - Valley closure of up to 0.1 m was predicted along the proposed GPUG workings for the existing and MP4 consent areas

