Exponent®

Preliminary Magnetic Field and Thermal Analyses for New England Clean Power Link (NECPL) in Lake Champlain

Lake Symposium

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Modeling Scope

- Cable models based on TDI specifications
  - DC Magnetic Field
  - Thermal Gradients
- Environmental features
- Range of biotic exposures

PRELIMINARY MODELING – SUBJECT TO CHANGE

Distinctions Between DC and AC Magnetic Fields Associated with Electricity

Direct Current (DC)	Alternating Current (AC)
Static magnetic fields (0 Hz)	60- Hz magnetic fields - EMF
Present in natural environment	Associated with distribution and use of AC electricity
Non- or slowly-varying direction	Direction oscillates continuously with a cycle that repeats 60 times/sec
Does not induce voltages or currents in stationary conducting objects	Induces weak voltages and currents in stationary conducting objects
Sources – earth, permanent magnets, iron/steel, batteries	Sources – electric system – wires, equipment, motors, appliances, currents on water pipes

PRELIMINARY MODELING – SUBJECT TO CHANGE

Data Sources

This presentation reports Exponent's preliminary modeling results for magnetic field levels and thermal gradients associated with the NECPL transmission line.

These analyses are based upon design information and assumptions provided by TDI and HDR|DTA, which we have relied upon in our modeling.

PRELIMINARY MODELING – SUBJECT TO CHANGE

Cable System DC Magnetic Field Model

- Electrical Details
  - ±320 kV
  - Maximum Capacity: 1,000 MW (1563A)
- 135 mm outside conductor diameter
- Bipolar Configuration
  - 4-foot burial depth
  - Laying on lake floor

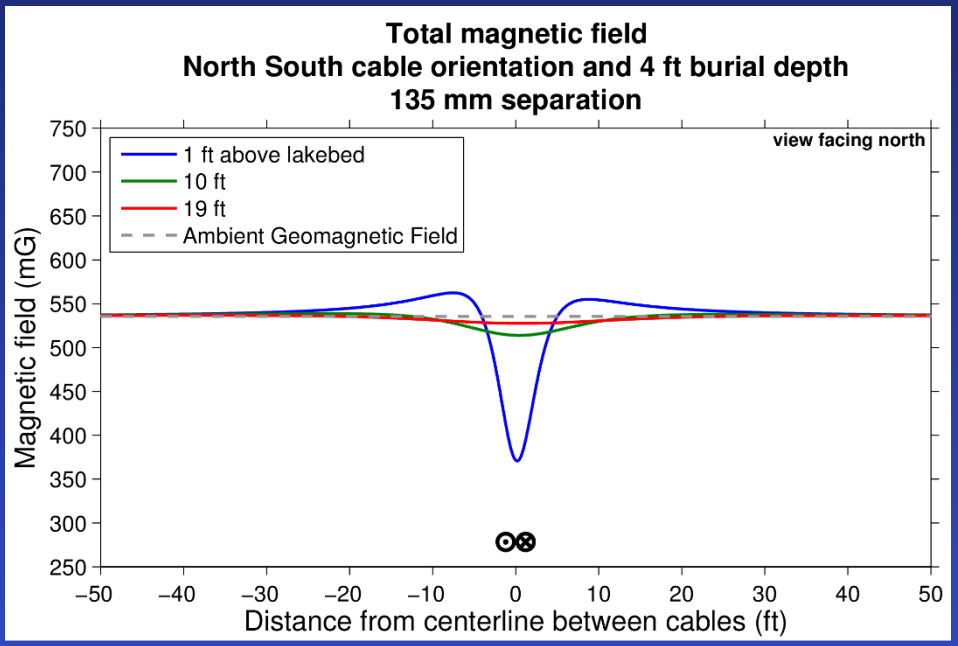
- Model
  - ±50 ft (x-direction)
  - Height 1, 10, 19 feet above lakebed (y-direction)
- Model Output
  - Combination of DC field with Earth's magnetic field
  - Compass deflection

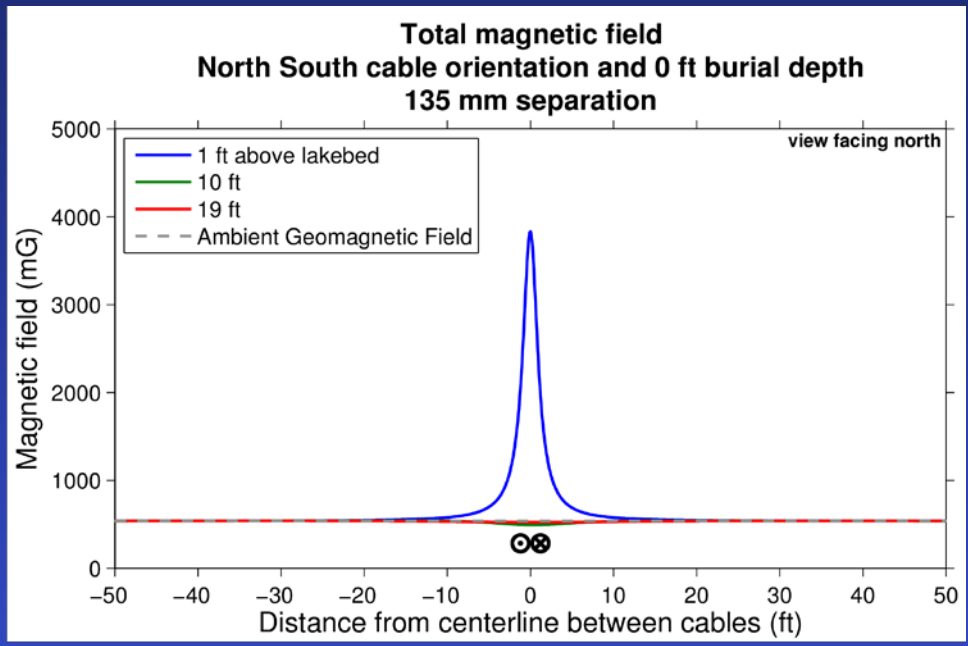
Component	Geomagnetic field (in nanotesla [nT] and mG)		
Northern component	18345.4 nT	=	183.45 mG
Eastern component	-4694.3 nT	=	-4.69 mG
Downward component	50084.0 nT	=	500.84 mG
Total field			535.44 mG

PRELIMINARY MODELING – SUBJECT TO CHANGE

DC Magnetic Field

- 4-foot Burial Depth
- 0-foot Burial Depth





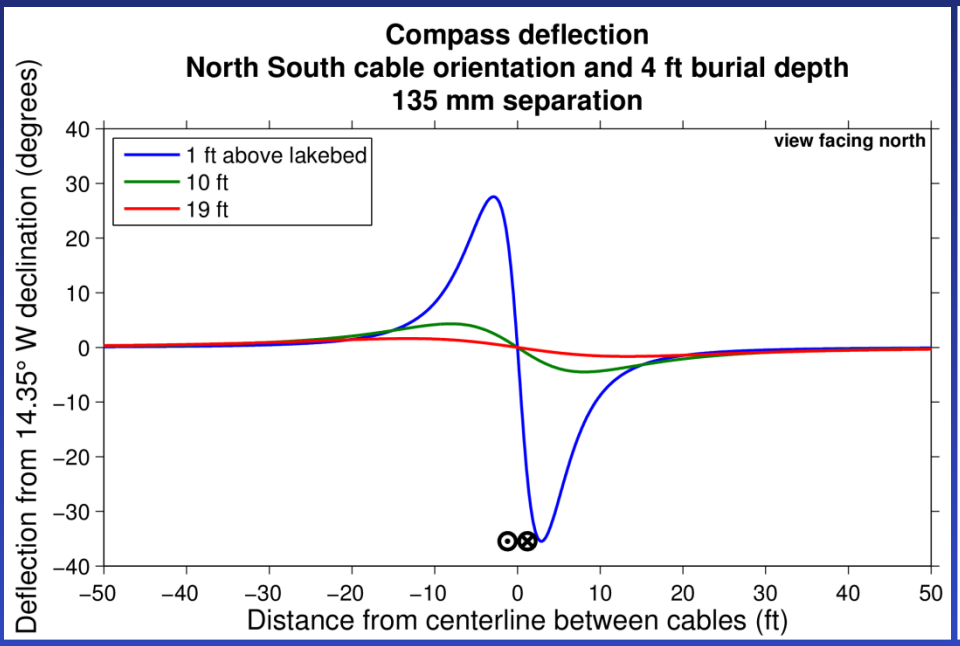
- ✓ Maximum change at 1 ft above lakebed):
  - 42.8 mG (8% of ambient field) at 10 feet from cable
- ✓ Max change at 19 ft above lakebed:
  - 11.8 mG (~2% of ambient field)

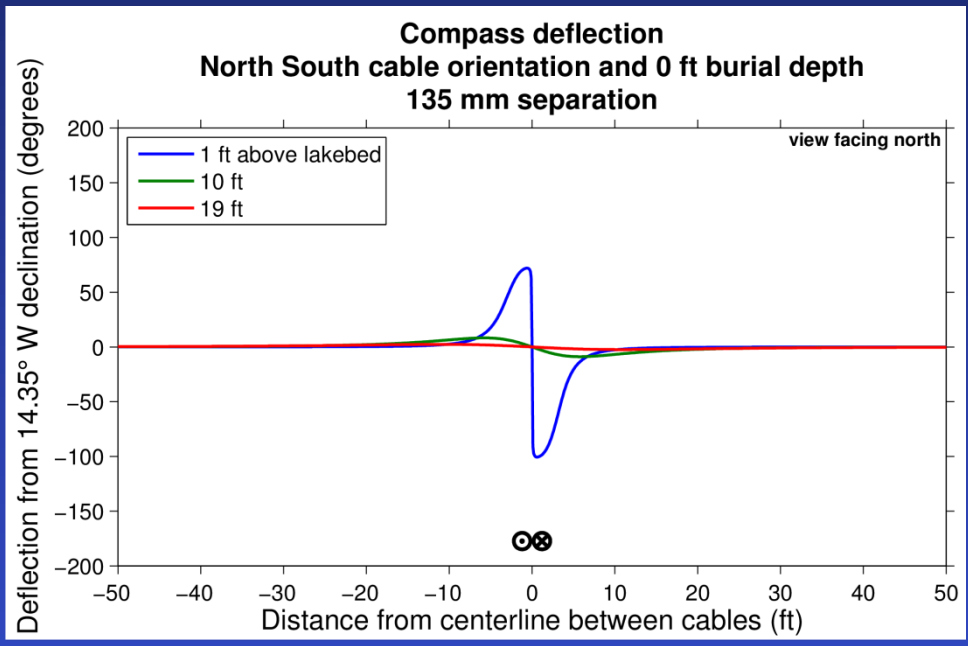
*Note differing y-axis limits

PRELIMINARY MODELING – SUBJECT TO CHANGE

Compass Deflection

- 4-foot Burial Depth
- 0-foot Burial Depth





✓ Max compass deflection at 19’ above lakebed: 1.6-2.4 degrees

✓ Compass deflection largely restricted to ± 10 ft from cable

PRELIMINARY MODELING – SUBJECT TO CHANGE

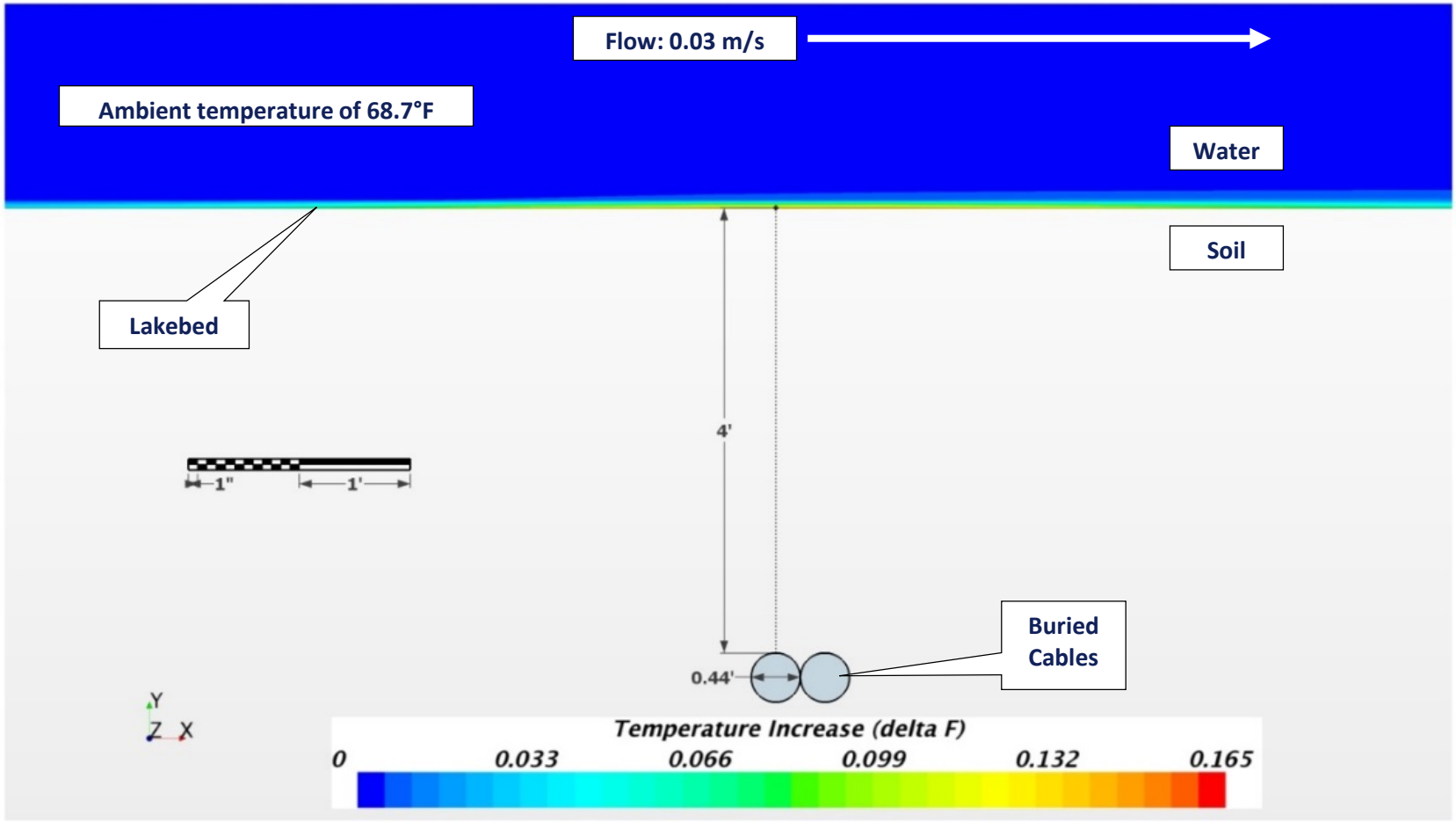
*Note differing y-axis limits

DC Cable System Model (Thermal Gradients)

Conditions	Case 1	Case 2
Burial Depth (to top of cable)	4 feet	N/A (on lakebed)
Soil Type	Clay/Silt	
Heat Load	23.3 W/m per cable	
Ambient Temperature	68.7°F (20.4°C)	46.4°F (8°C)
Water Flow	0.03 m/s	0.001 m/s
Water Depth	10 feet	150 feet
Cable Diameter	135 mm	
Water Quality Standard	+1°F	

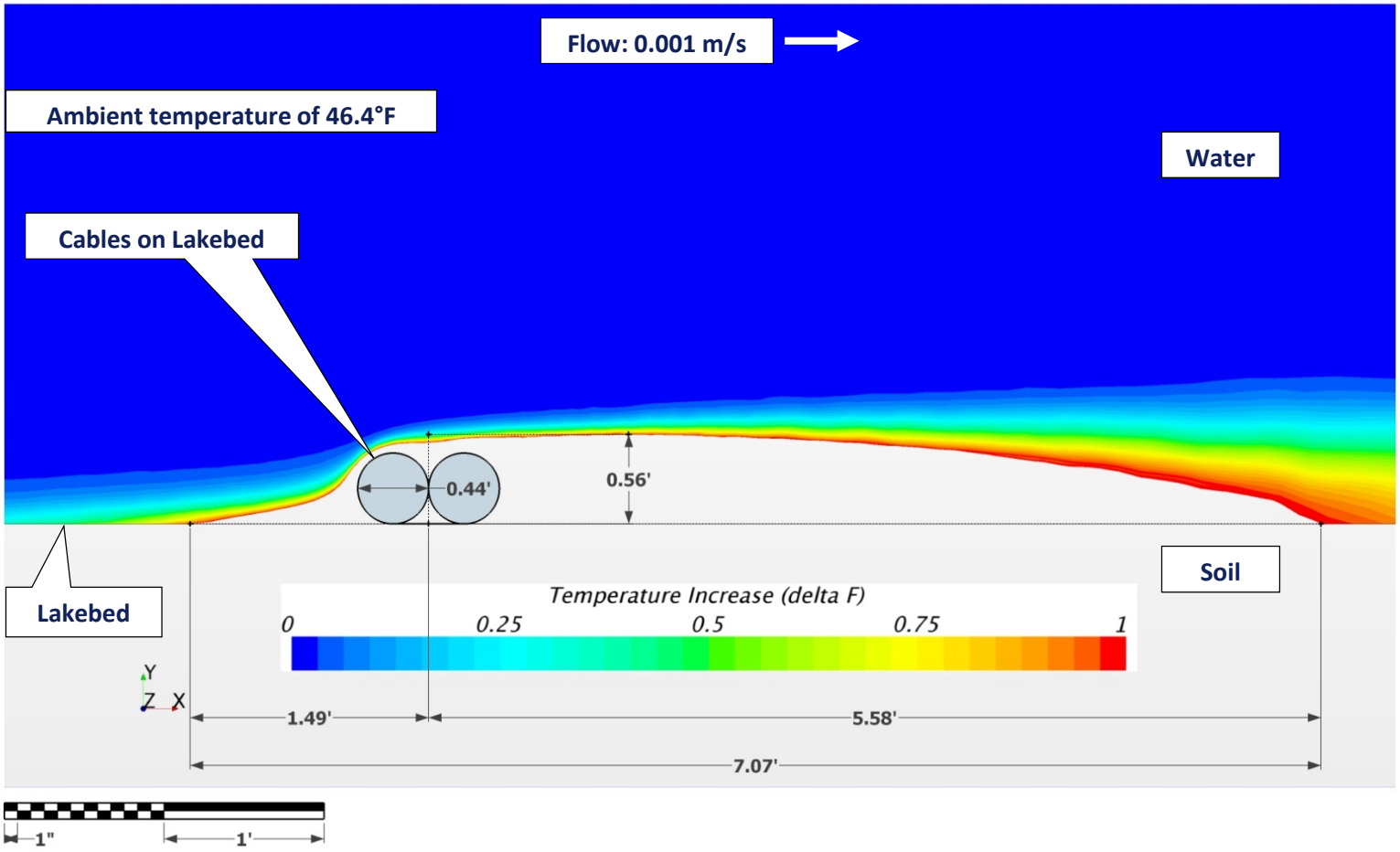
PRELIMINARY MODELING – SUBJECT TO CHANGE

Case 1: maximum water temperature increase of 0.165°F (Ambient =68.7 °F)



PRELIMINARY MODELING – SUBJECT TO CHANGE

Case 2: boundaries for a 1°F temperature increase (Ambient =46.4 °F)



PRELIMINARY MODELING – SUBJECT TO CHANGE

Summary of Thermal Results

- Insignificant water temperature rise for buried cables (<0.165°F)
- For cables resting on lakebed: temperature rise remains below prescribed limits of 1°F in the entire water domain except for small region of limited extent (< 10 ft from cables)

PRELIMINARY MODELING – SUBJECT TO CHANGE

Work-in-Progress

- Modeling of additional magnetic field and thermal gradient cases
- Assessment of potential relevance of magnetic fields and thermal gradient to Lake Champlain marine environment and organisms
  - Realistic exposure scenarios
  - Fish and other biota in Lake Champlain

PRELIMINARY MODELING – SUBJECT TO CHANGE