

Automated Soil Monitoring for Seasonal Load Limits



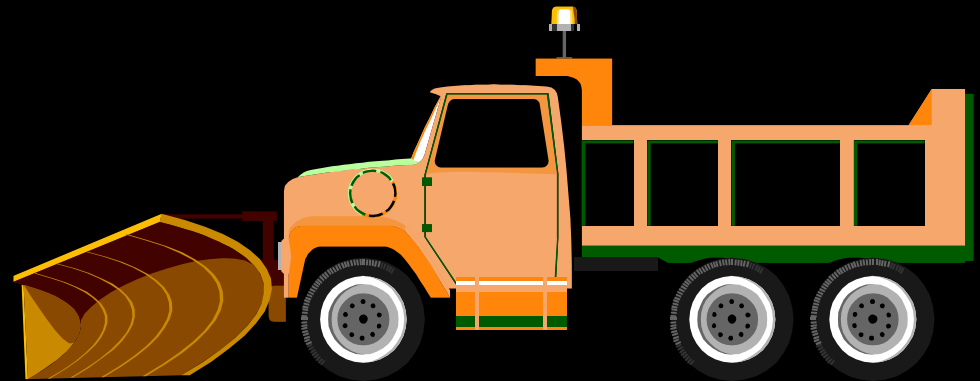
Greg Johnson

Minnesota Department of Transportation



Use of Frost Depth Information

- Ground Truth Verification for Proper Timing for:
 - Winter Load Increases
 - Spring Load Restrictions
- Our Primary Trigger is Based on Cumulative Air Temperature



Progression of Frost Measuring Methods



Surface Characteristics



Frost Tube



Temperature/Resistance Probes

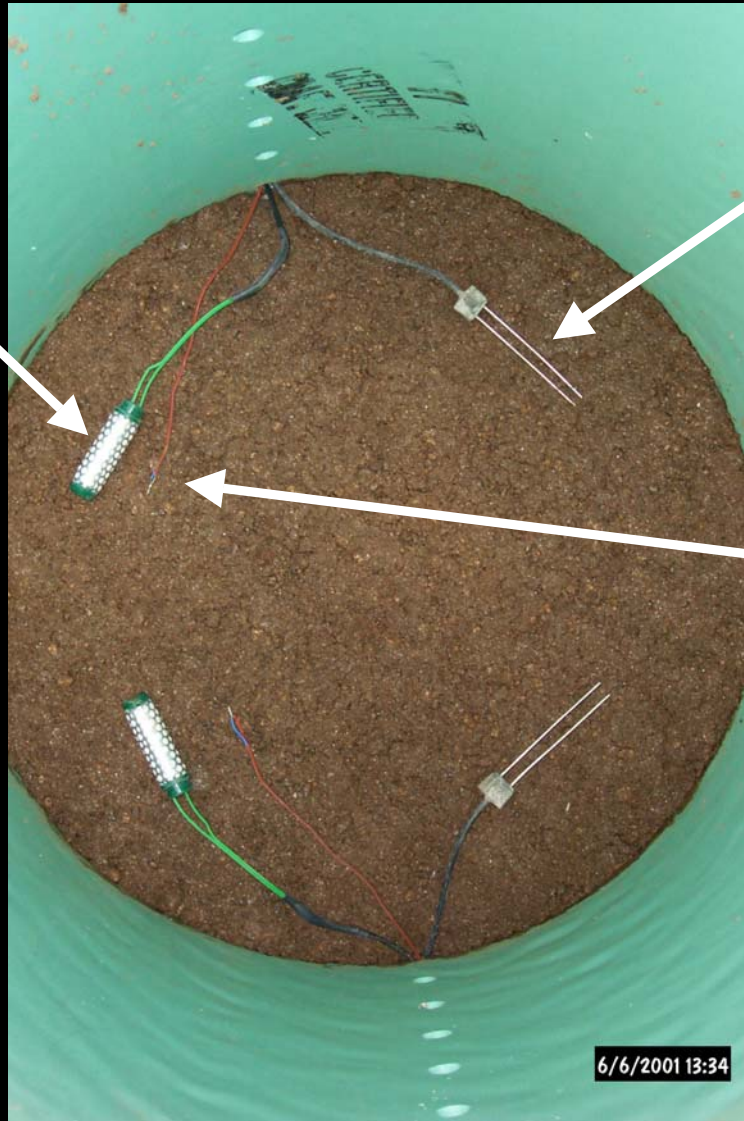


Laboratory Comparison of Sensors

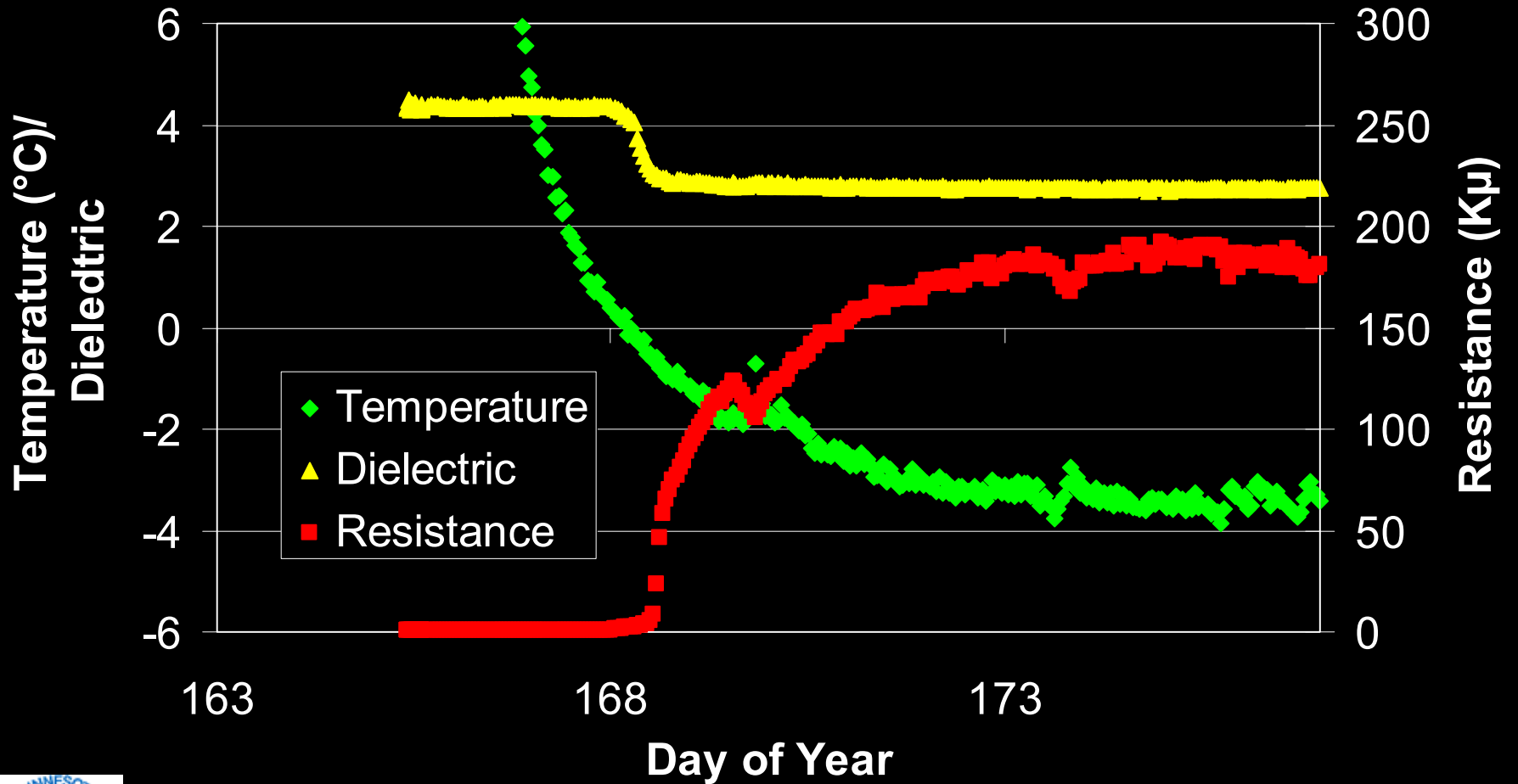
Resistance
Block

Time Domain
Reflectometer (TDR)

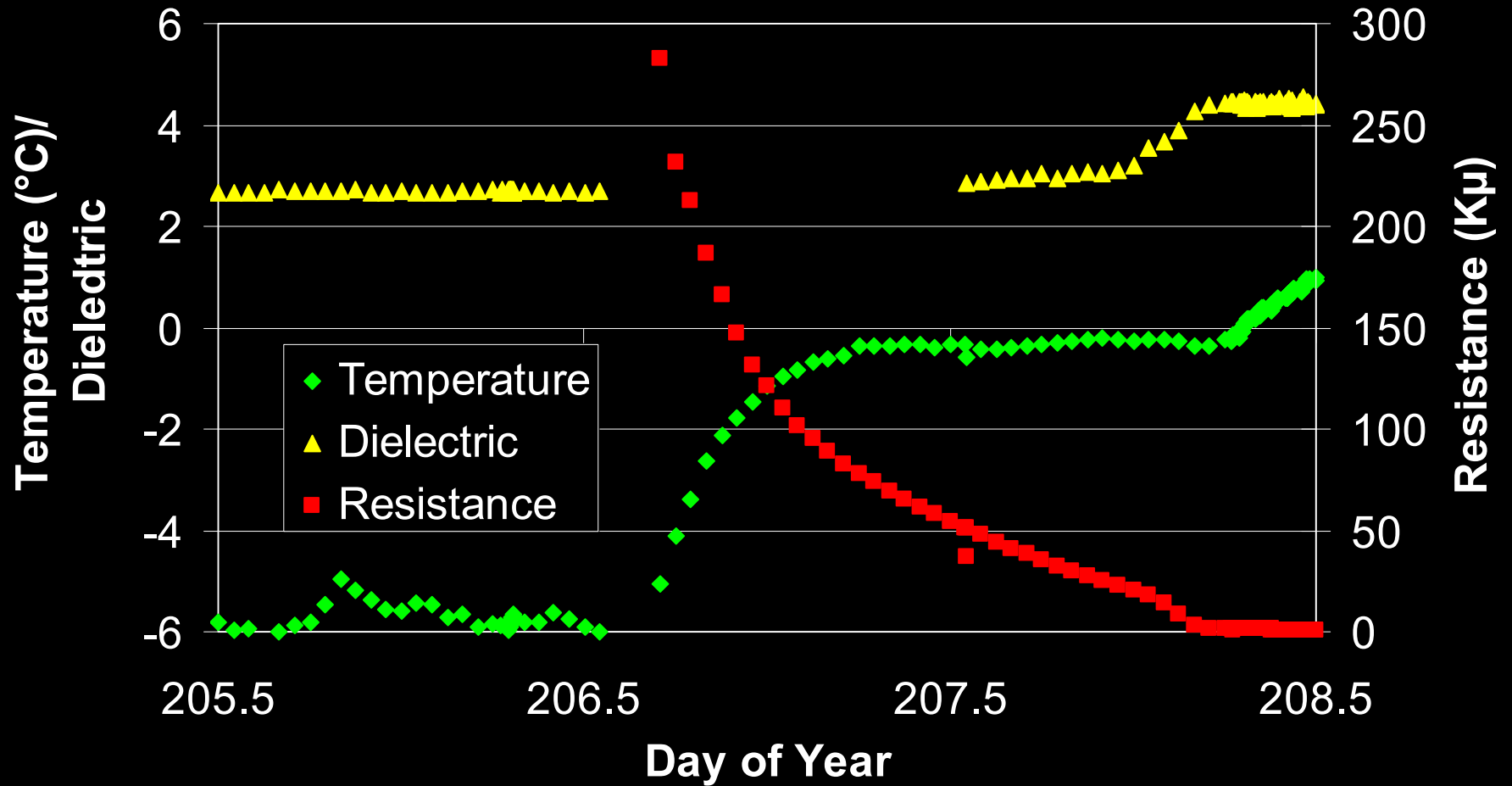
Thermocouple



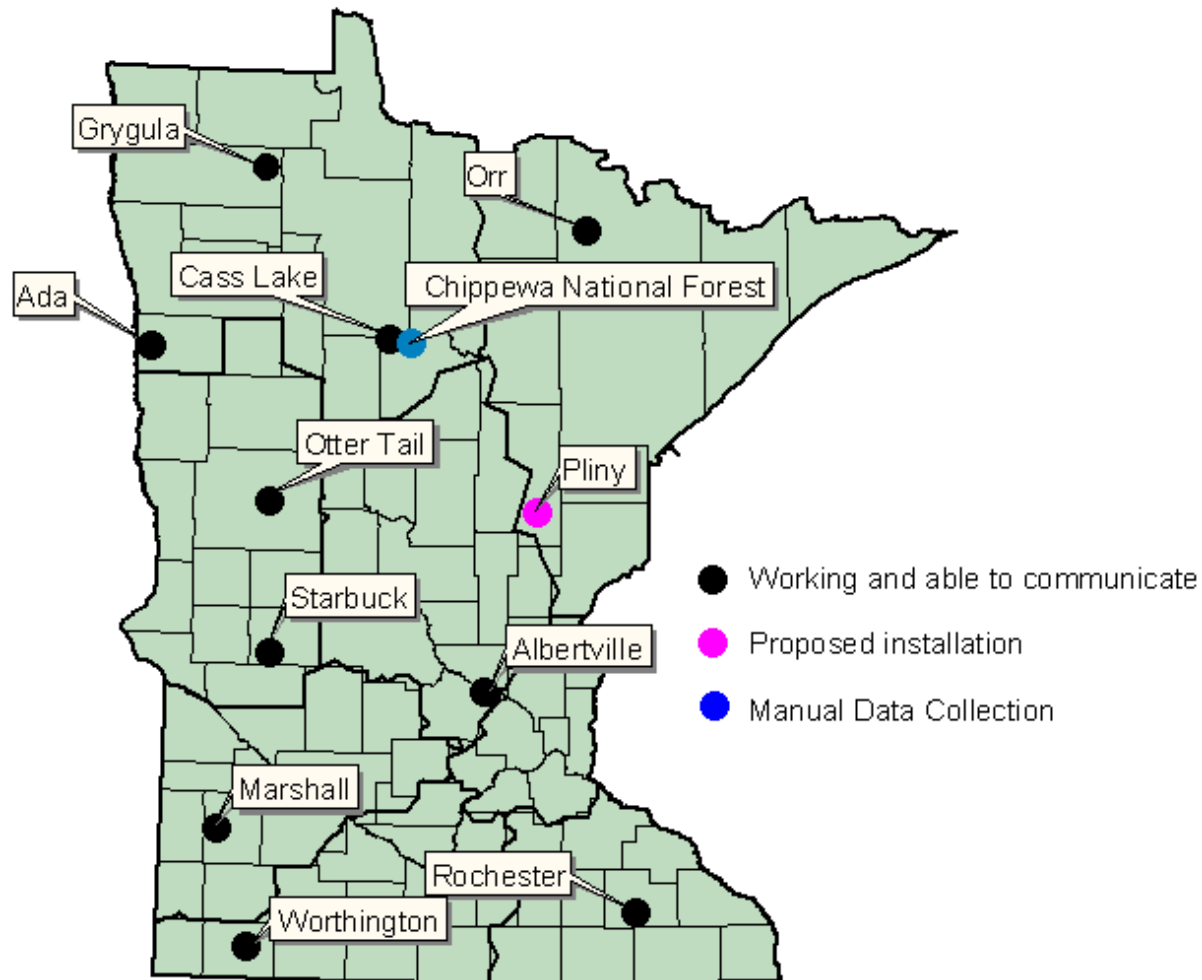
Freezing Curve - Sensor Comparison

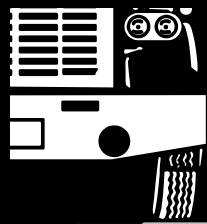


Thawing Curve - Sensor Comparison

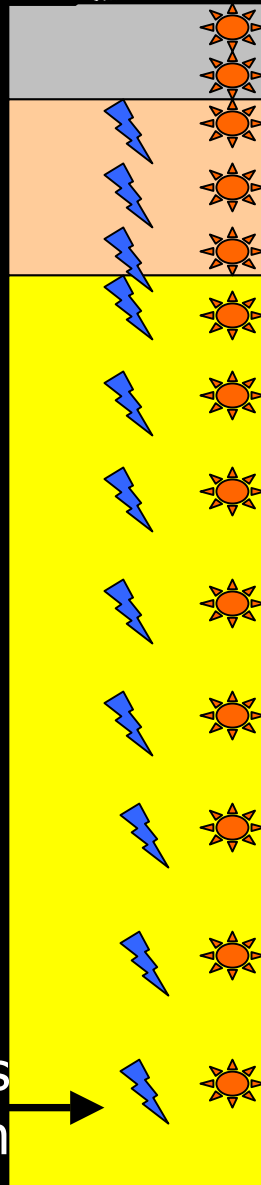


MnDOT Frost Monitoring Sites

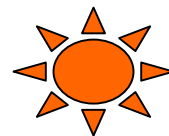




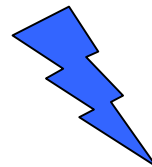
HMA
Base
Subgrade



96 inches
2400 mm



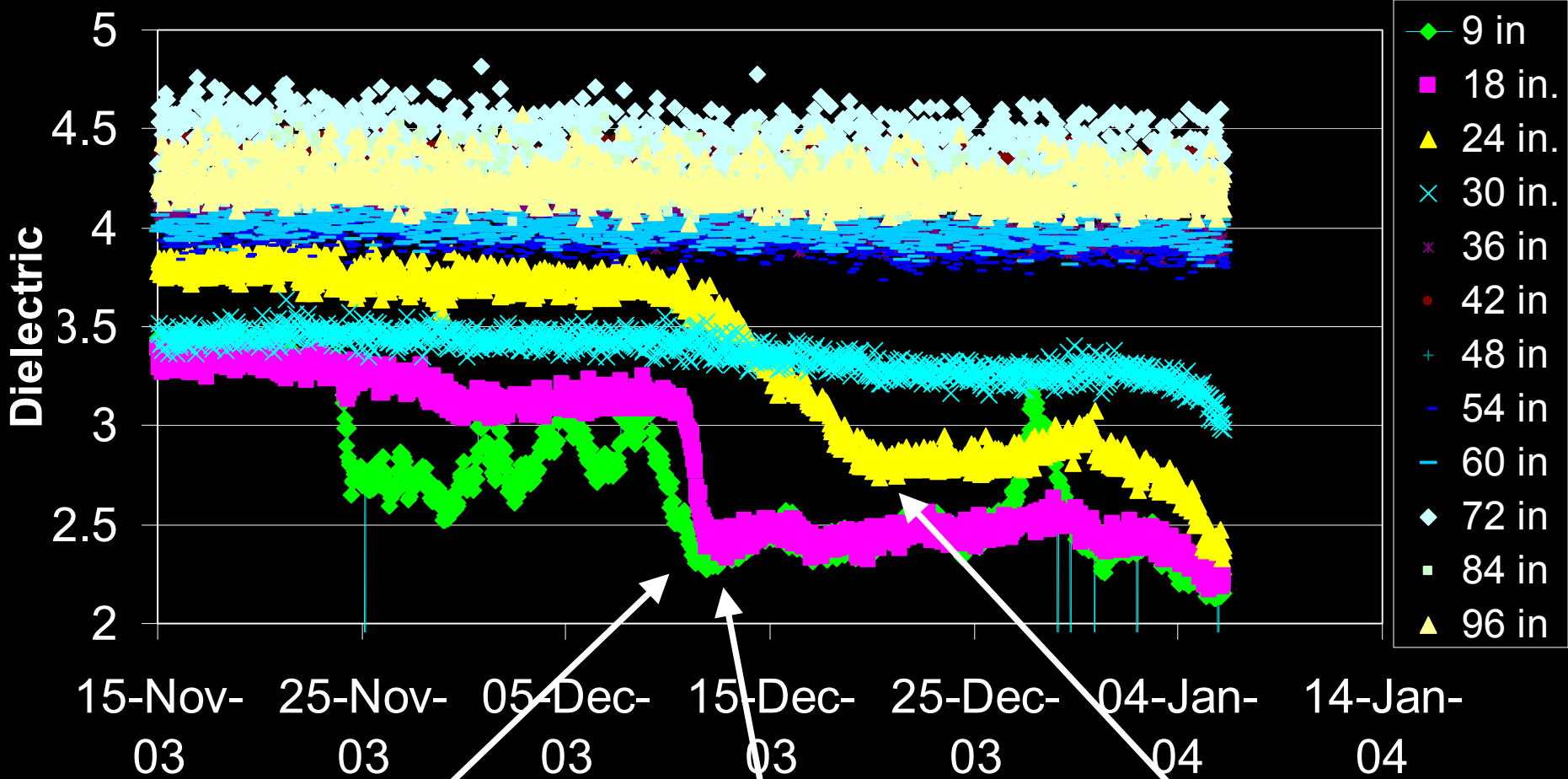
Thermocouple



Time Domain
Reflectometer (TDR)



Pope Co. (MN29) Dielectric



Frozen Soil at:

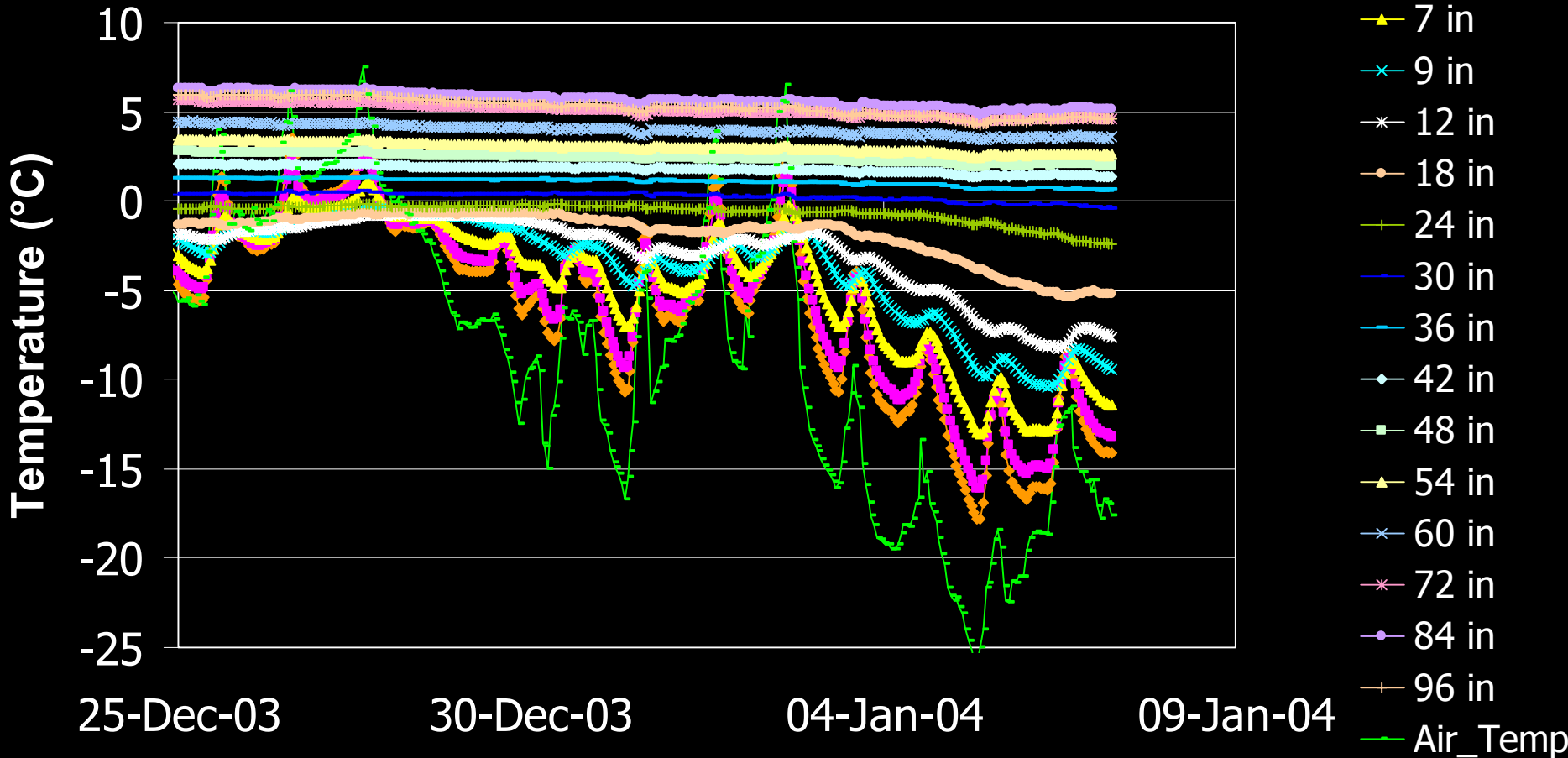
9 in. (225 mm)

18 in. (460 mm)

24 in. (610 mm)

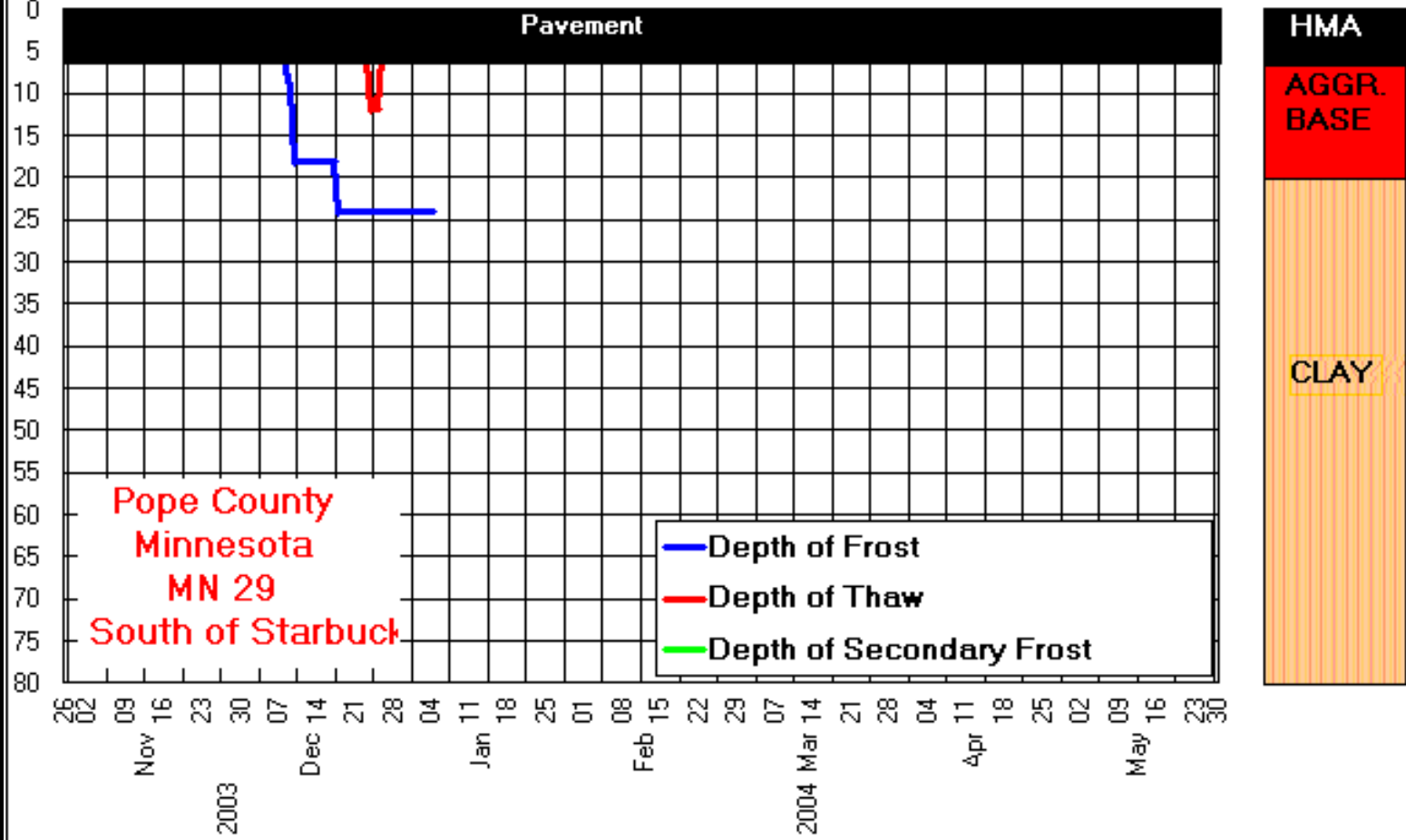


Pope Co. (MN 29) Soil Temperatures



Frozen Soil Profile

Depth Below Pavement Surface (inches)



Conclusions

- Soil temperature & dielectric properties can be used to determine the zone of frozen soil.
- Automated system provides continuous data to provide prediction and confirmation of the 3 day notice given to changes in winter load limits.

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