LRRB INV 828
Local Road Material Properties and Calibration for MnPAVE

TAP Meeting #2

August 17, 2006

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Minnesota Department of Transportation

http://www.dot.state.mn.us/app/MnPAVE/LRRB828.html

Work Plan Tasks

- Task 1: Survey of Local Road Officials
  - 75% complete
- Task 2: Model Selection
  - 100 % complete

Task 1: Survey of Local Road Officials

- Will be calibrated for local roads
  - Pavement information obtained by survey.
  - FWD and GPR testing as needed.
- Models for moisture, freezing & thawing effects from literature or research in progress.
- Models to predict base and soil moduli.

Task 1: Survey of Local Road Officials

- Updated contact information from 1998 Survey
- E-mailed new survey questions
- Conducted telephone interviews
- Entered new data into Access database
- Rated data quality and availability
- E-mailed follow-up surveys to cities and counties with high to medium data quality ratings

Survey Results

- 41 Counties Replied
  - 12 Have medium to high data quality
- 50 Cities Replied
  - 25 Have medium to high data quality
- Discussed data export capabilities with GoodPointe Technologies (ICON)

City Replies

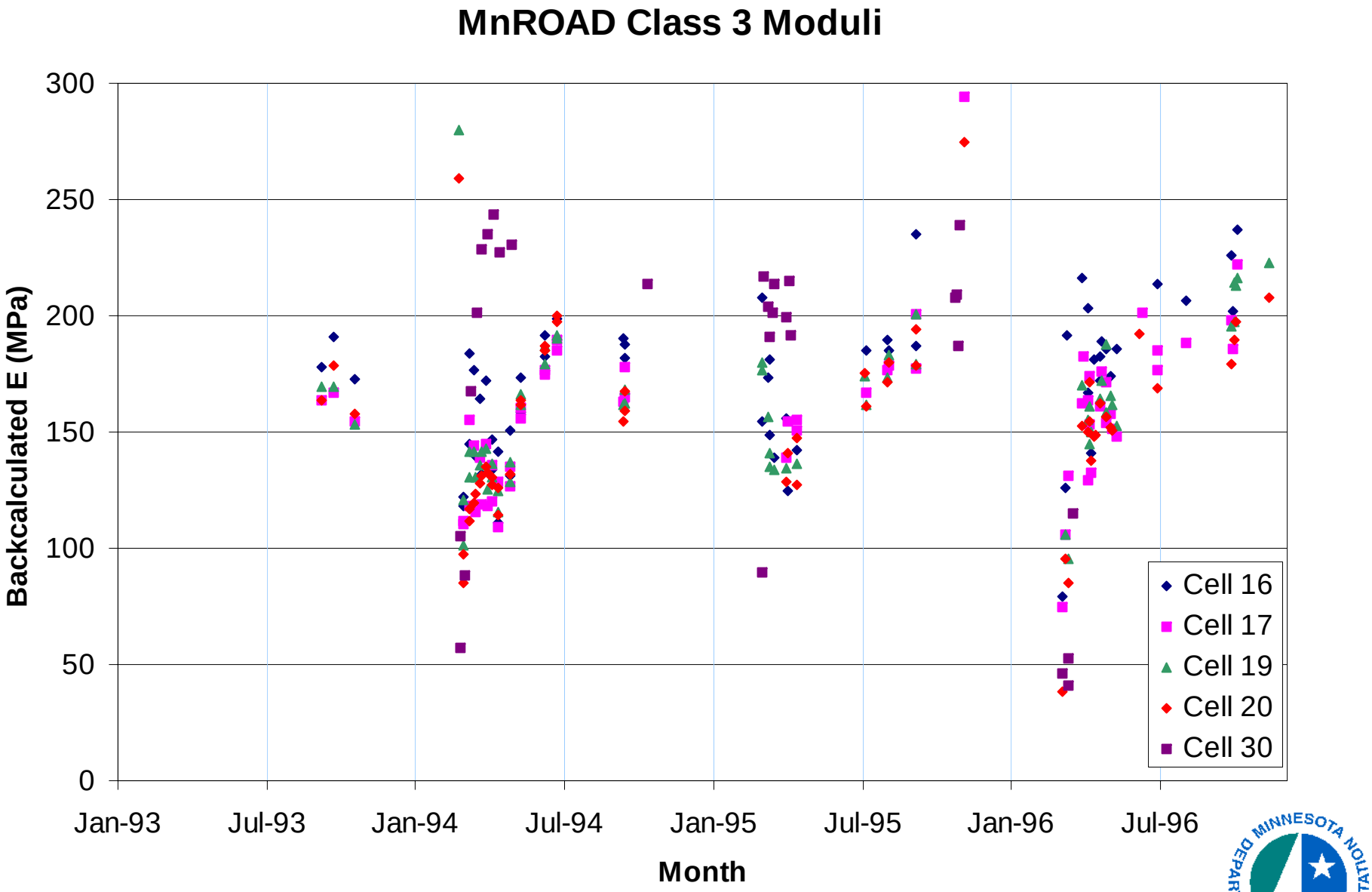
DataPriority	City	2006PMS	PMSNameEmail	RepliedPMSStart	LayerDa	GPRF
1	Eagan	same	1	19-Jun-06	☑	☑
1	Northfield	ICON	0	16-Aug-06	☑	☑
1	St. Cloud	same	0	16-Aug-06	☑	☐
2	Bloomington	same	1	30-Jun-06	☑	☐
2	Brooklyn Center		1	22-Jun-06	7/1/1950	☐	☐
2	Eden Prairie	same	0	28-Jun-06	☑	☑
2	Fridley	same	0	30-Jun-06	☑	☑
2	Hutchinson	same - ICON	0	19-Jul-06	☑	☑
2	Lino Lakes	Cartegraph	0	09-Aug-06	☑	☑
2	Mankato	same, APWA Paver	0	09-Aug-06	☑	☑
2	Mendota Heights	iWorqs, a web-based s	0	27-Jun-06	☑	☑
2	Minneapolis	same, Micro Paver	0	09-Aug-06	☑	☐
2	Monticello	ICON	0	05-Jul-06	☑	☐
2	Oakdale	none, using Arcview GI	3	27-Jun-06	☐	☐
2	Prior Lake	Pavement view	0	16-Aug-06	☐	☑

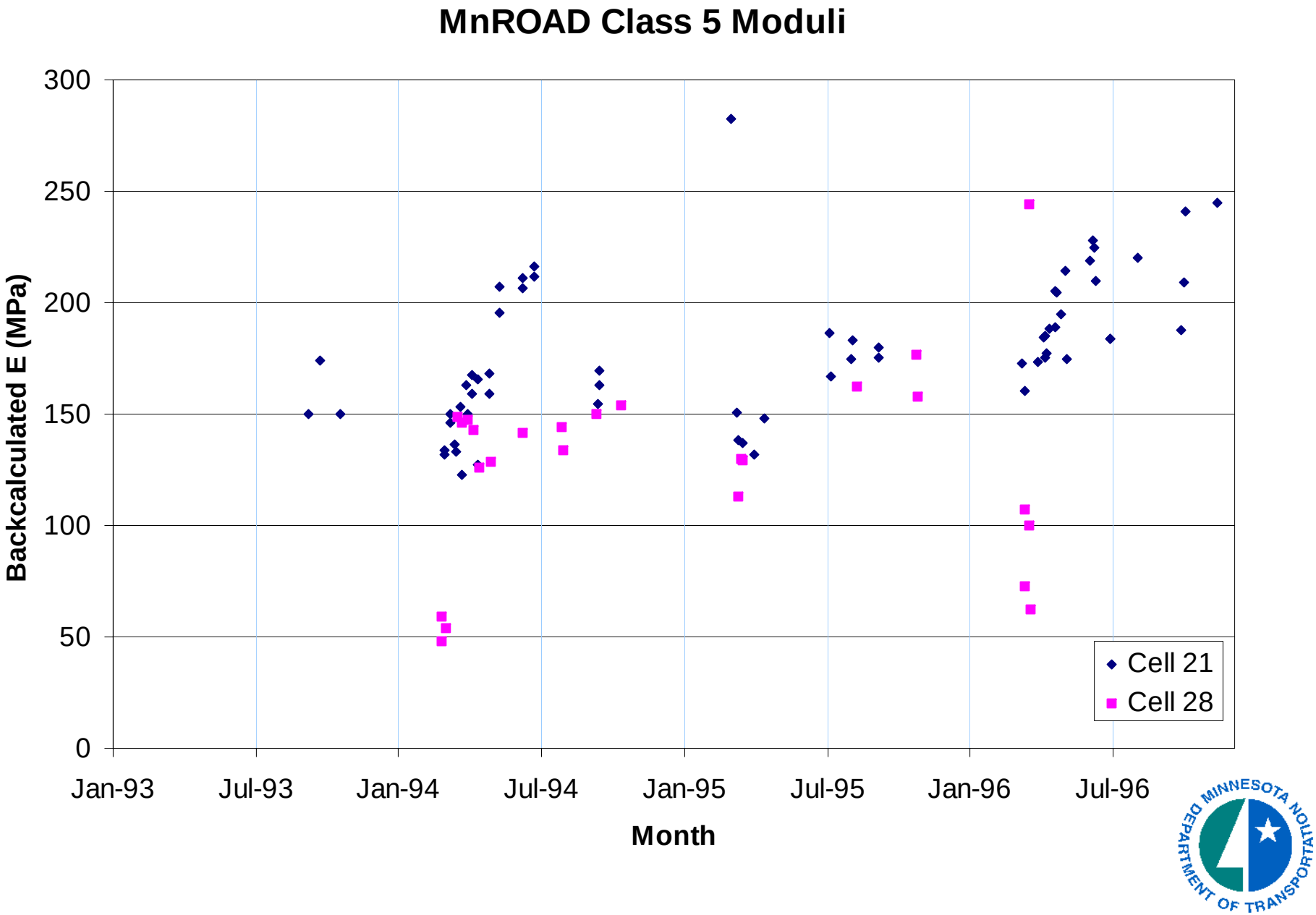
County Replies

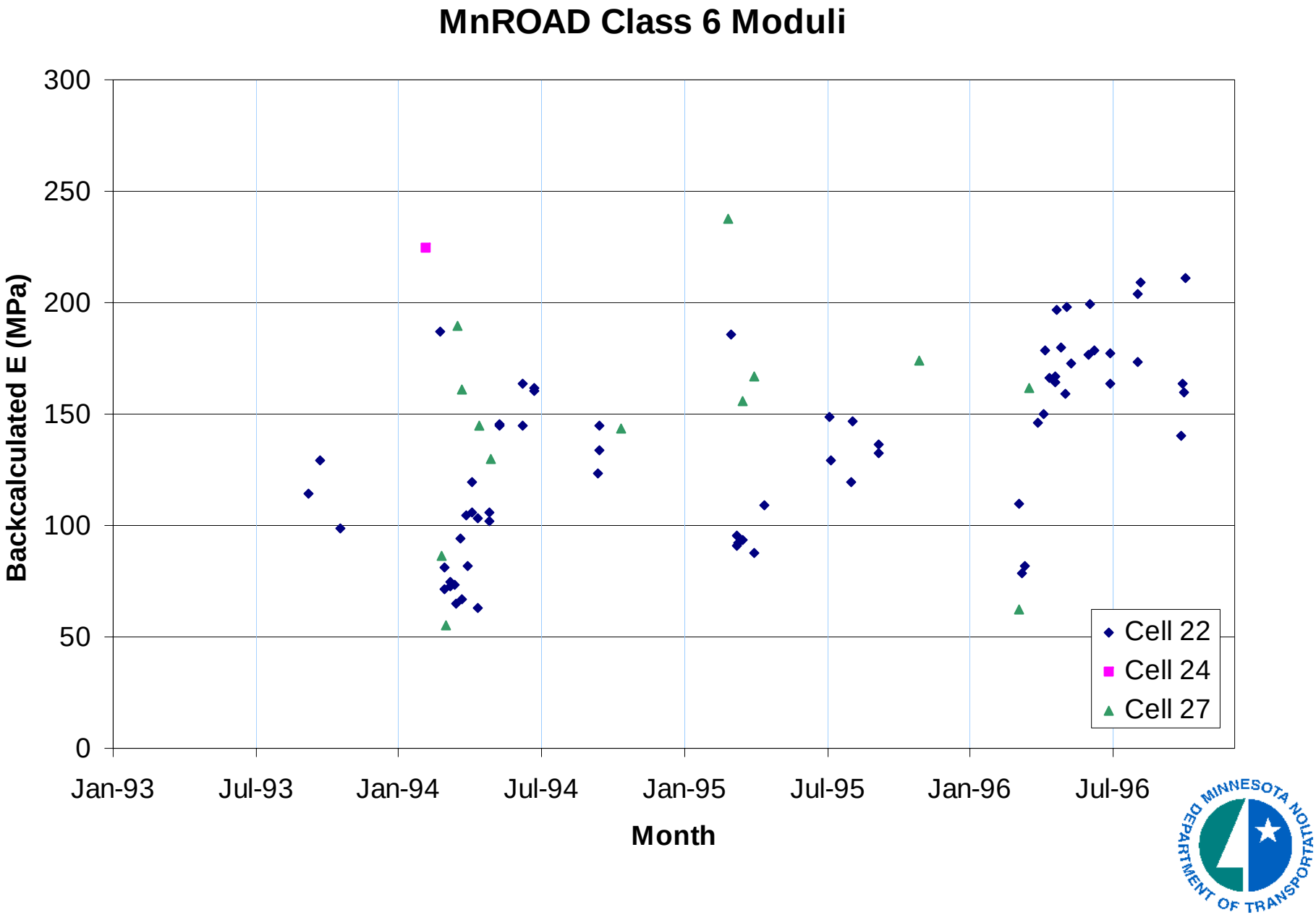
DataPriority	County	2006PMS	PMSName	mailReplied	PMSStart	LayerDat	GPRFW
1	Clearwater		0	6/16/2006		☑	☑
1	Dakota	ICON and Access da	0	7/18/2006		☑	☑
1	Olmsted		0	6/30/2006		☑	☐
2	Isanti	Mn/DOT Pave Tech	0	8/9/2006		☐	☑
2	Mille Lacs		1	6/27/2006	7/1/2006	☑	☑
2	Morrison	none, Mn/DOT collec	0	6/26/2006		☑	☑
2	Polk		0	6/27/2006		☑	☑
2	Rock	MicroPaver	0	8/16/2006		☑	☐
2	Roseau	Cartegraph	0	6/20/2006		☑	☑
2	Scott		3	6/23/2006	7/1/1980	☑	☑
2	Washington		1	7/3/2006		☑	☑
2	Wright	same	1	8/16/2006		☑	☐
3	Chippewa	none	0	6/28/2006		☐	☐
3	Goodhue	none	0	6/27/2006		☐	☐
3	Itasca	none, manual syste	0	8/9/2006		☐	☐

Model Selection

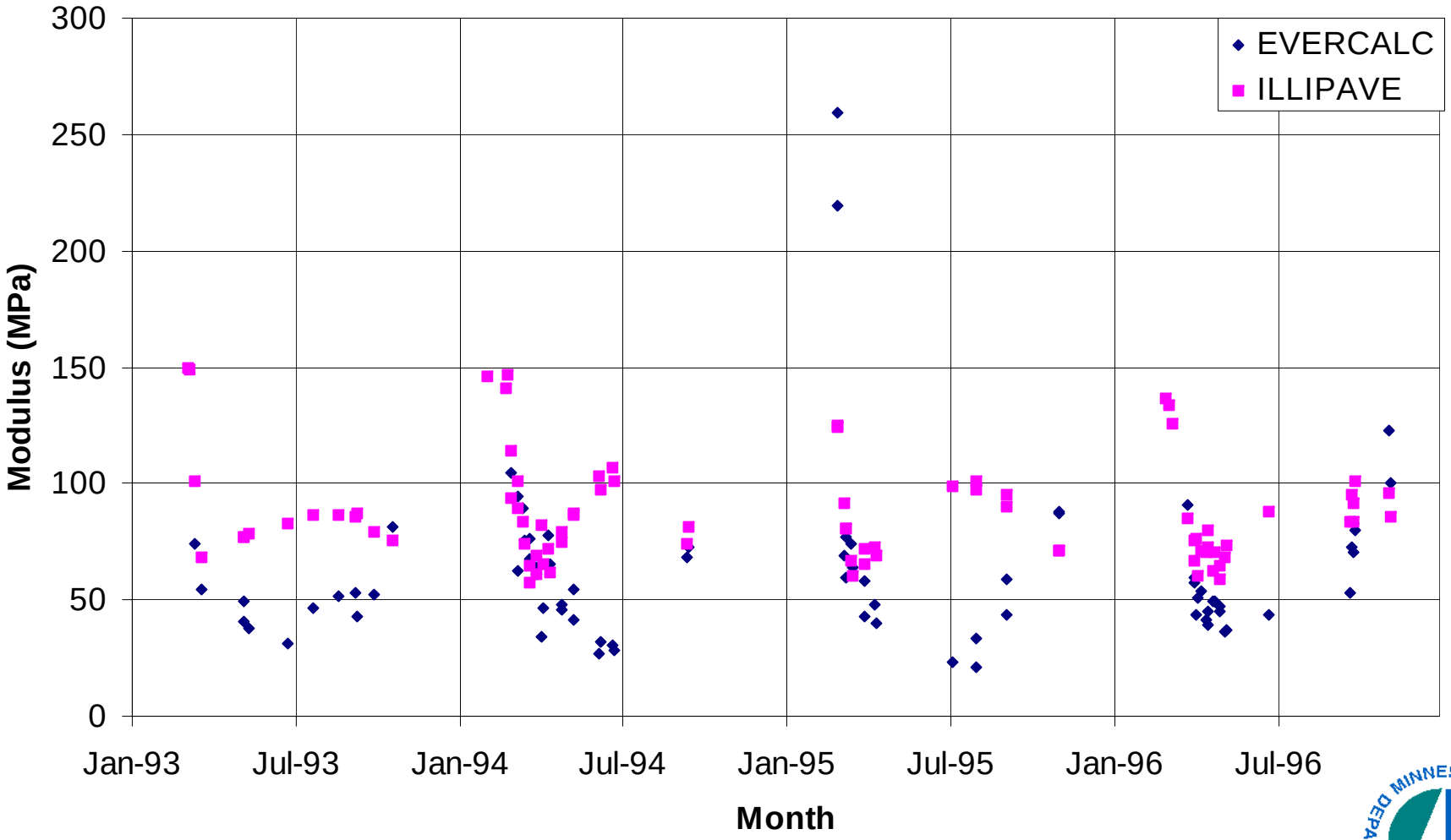
- FWD Backcalculation
  - Aggregate Base: EVERCALC backcalculation of MnROAD data
  - Soil: ILLIPAVE equations on statewide data (validated with MnROAD data)
- Seasonal Adjusment Factors


MnROAD Class 3 Moduli
Backcalculated E (MPa)
300
250
200
150
100
50
0
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Month
Cell 16
Cell 17
Cell 19
Cell 20
Cell 30

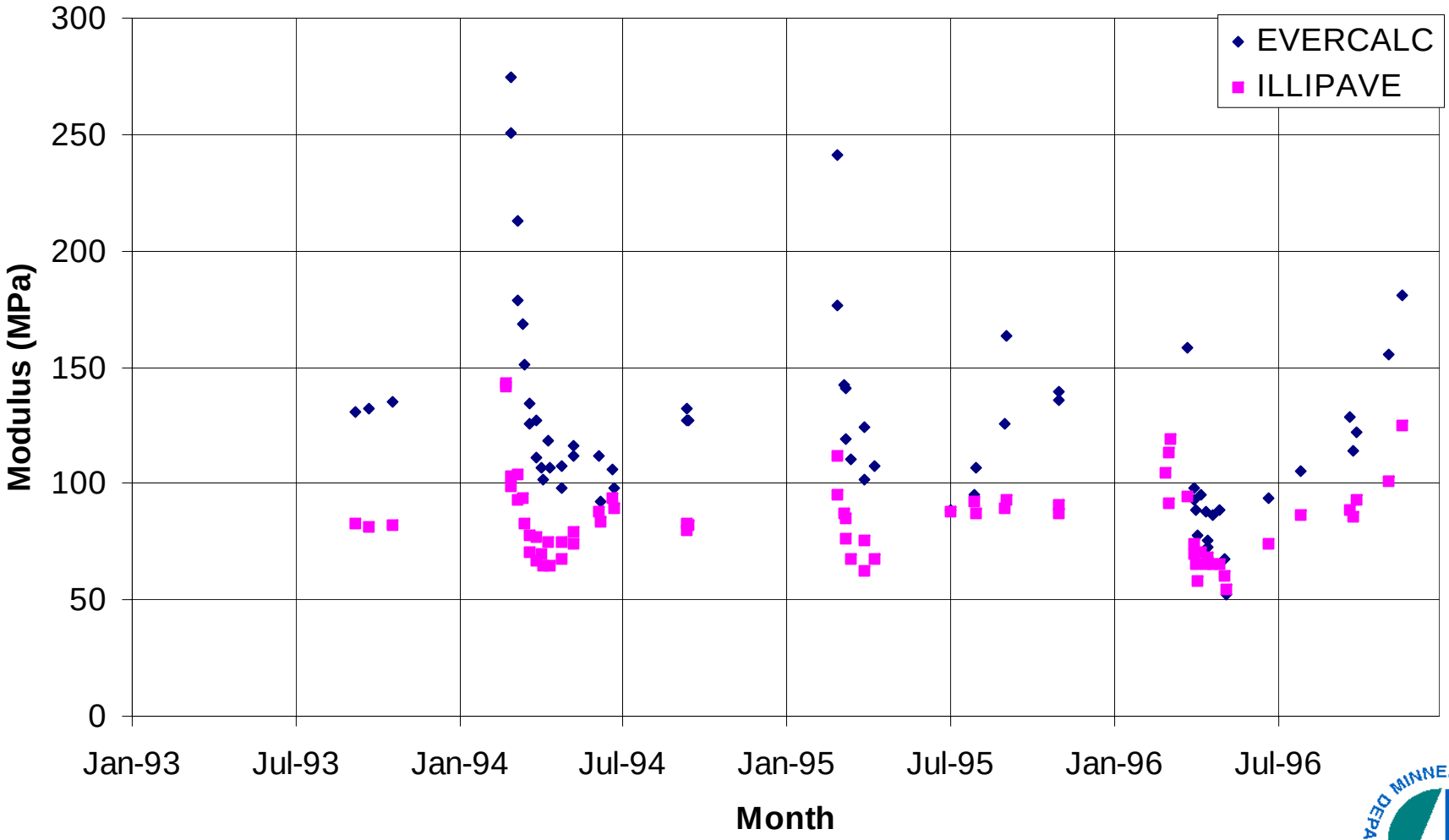

MnROAD Class 5 Moduli
Backcalculated E (MPa)
300
250
200
150
100
50
0
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Month
Cell 21
Cell 28
MINNESOTA DEPARTMENT OF TRANSPORTATION


MnROAD Class 6 Moduli
Backcalculated E (MPa)
300
250
200
150
100
50
0
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Month
Cell 22
Cell 24
Cell 27
MINNESOTA DEPARTMENT OF TRANSPORTATION

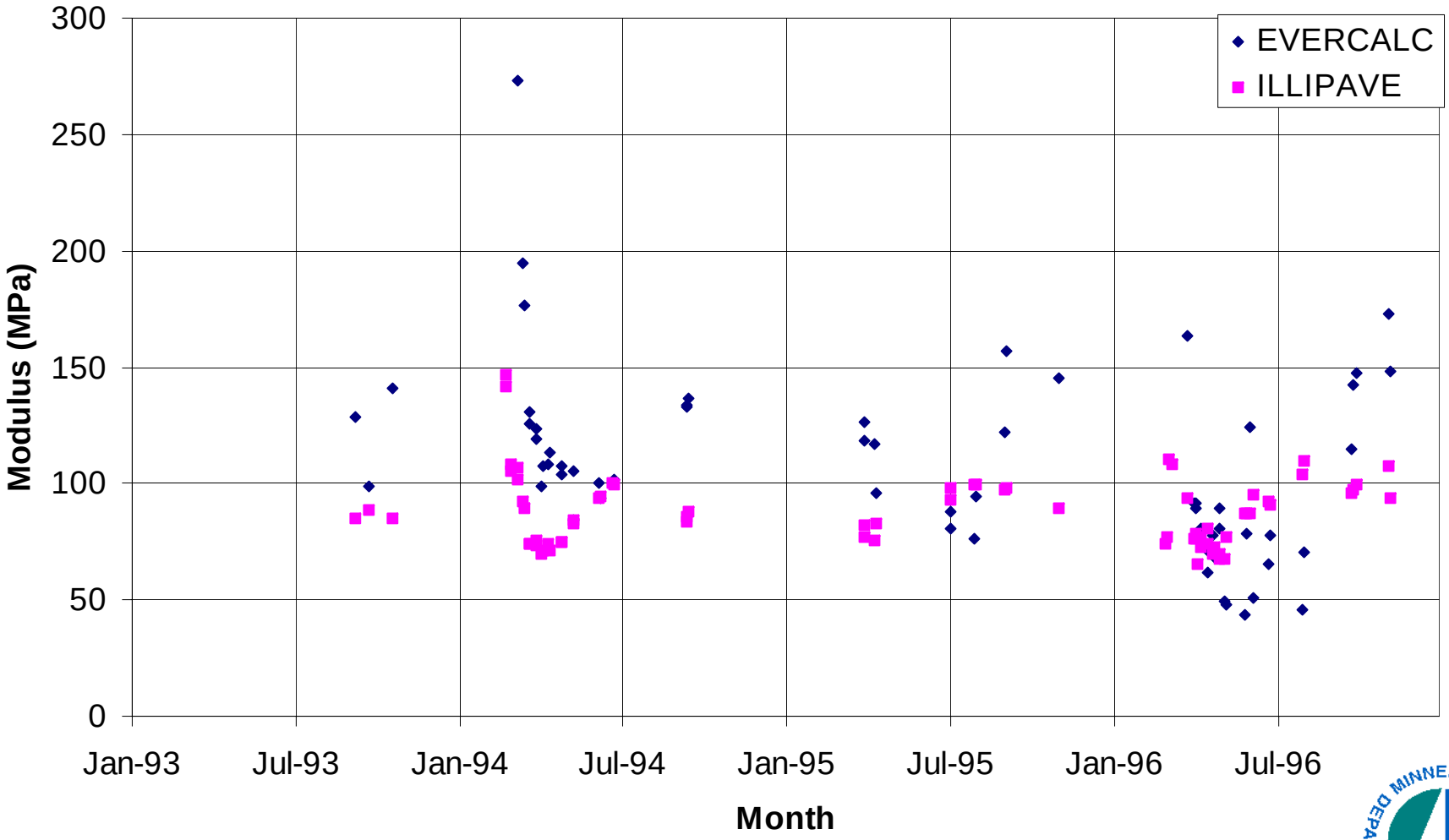
MnROAD Soil Moduls
Aggregate Base Sections: Cell 1



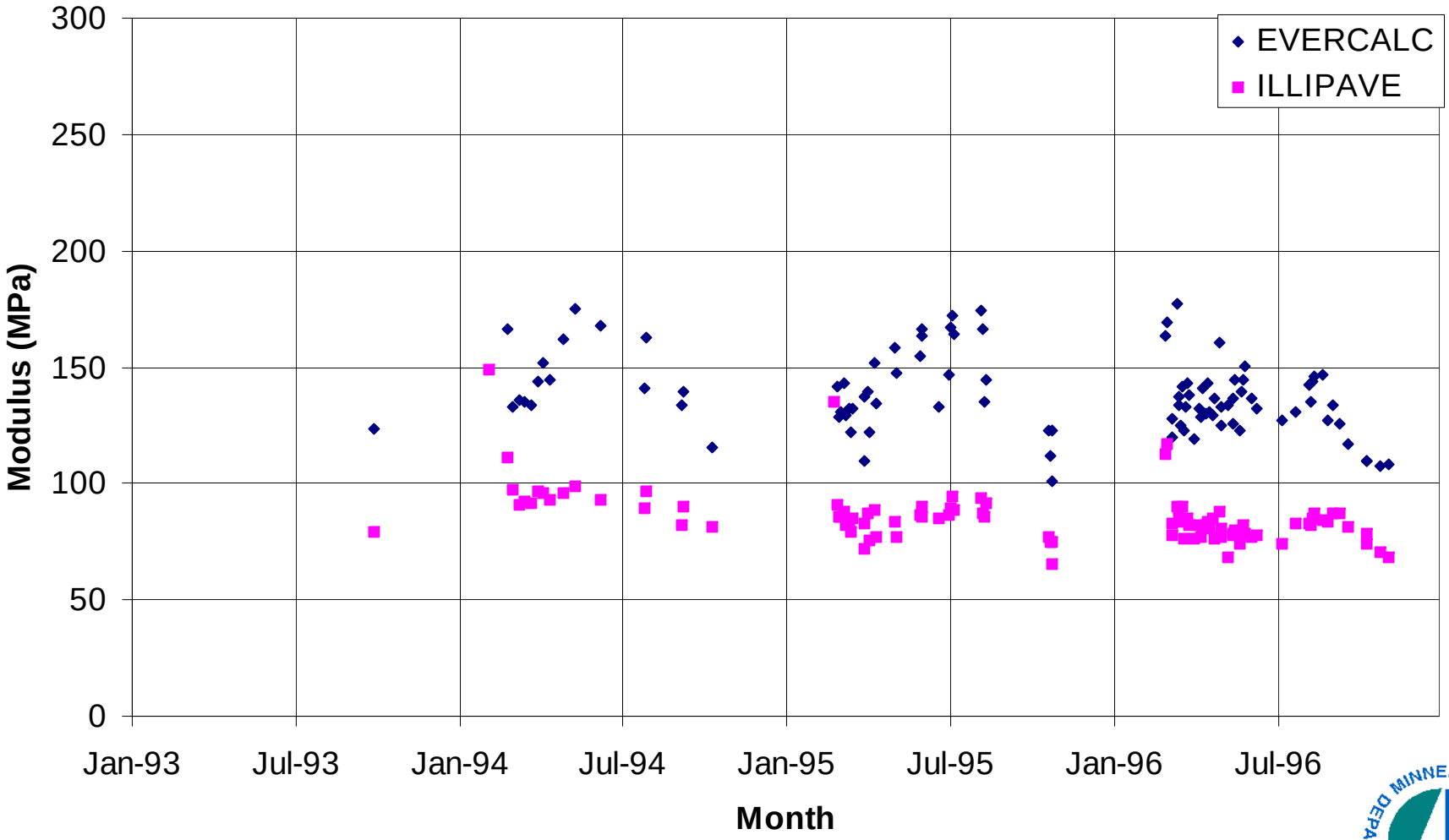
MnROAD Soil Moduls
Aggregate Base Sections: Cell 16



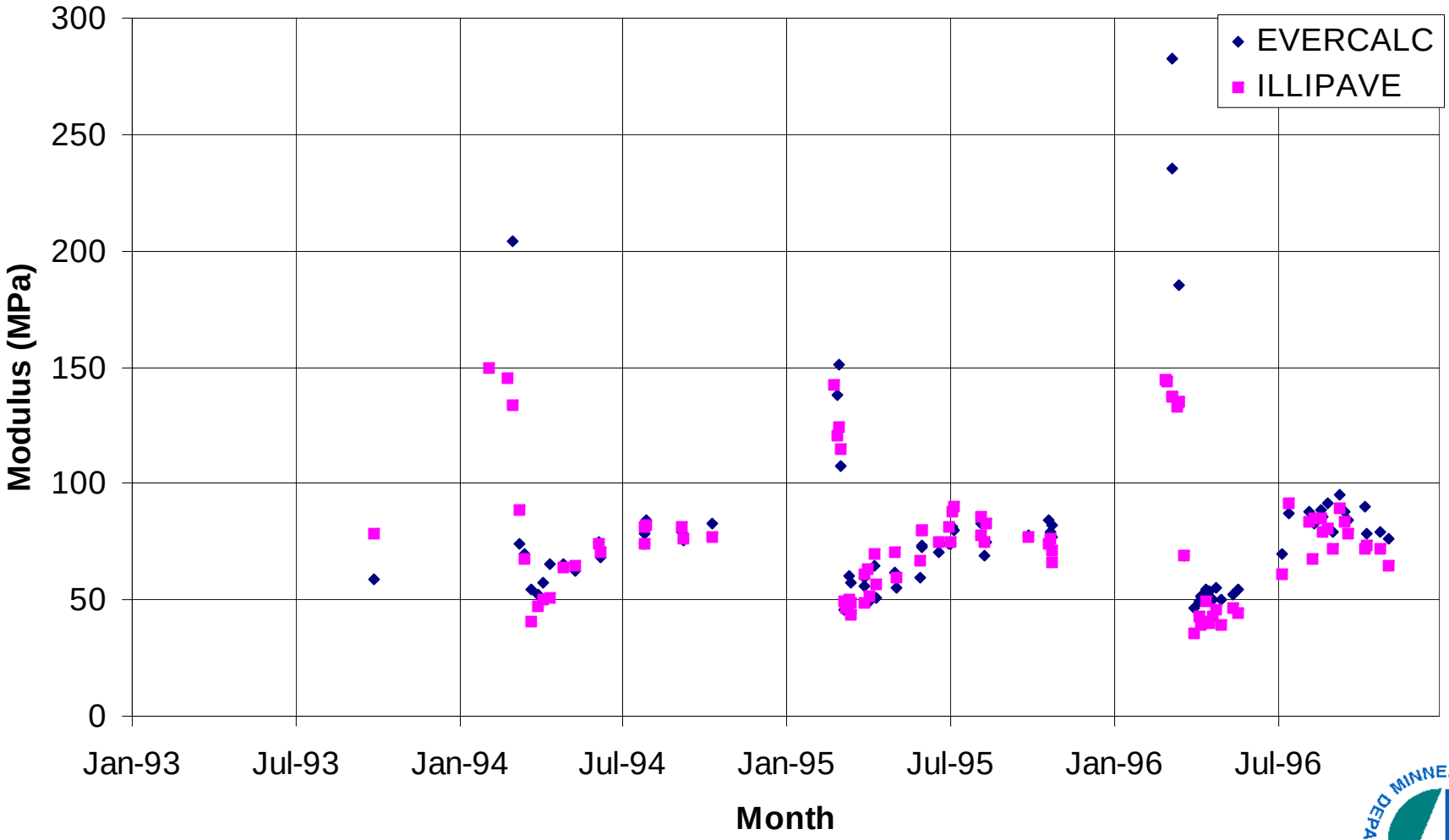
MnROAD Soil Moduls
Aggregate Base Sections: Cell 20

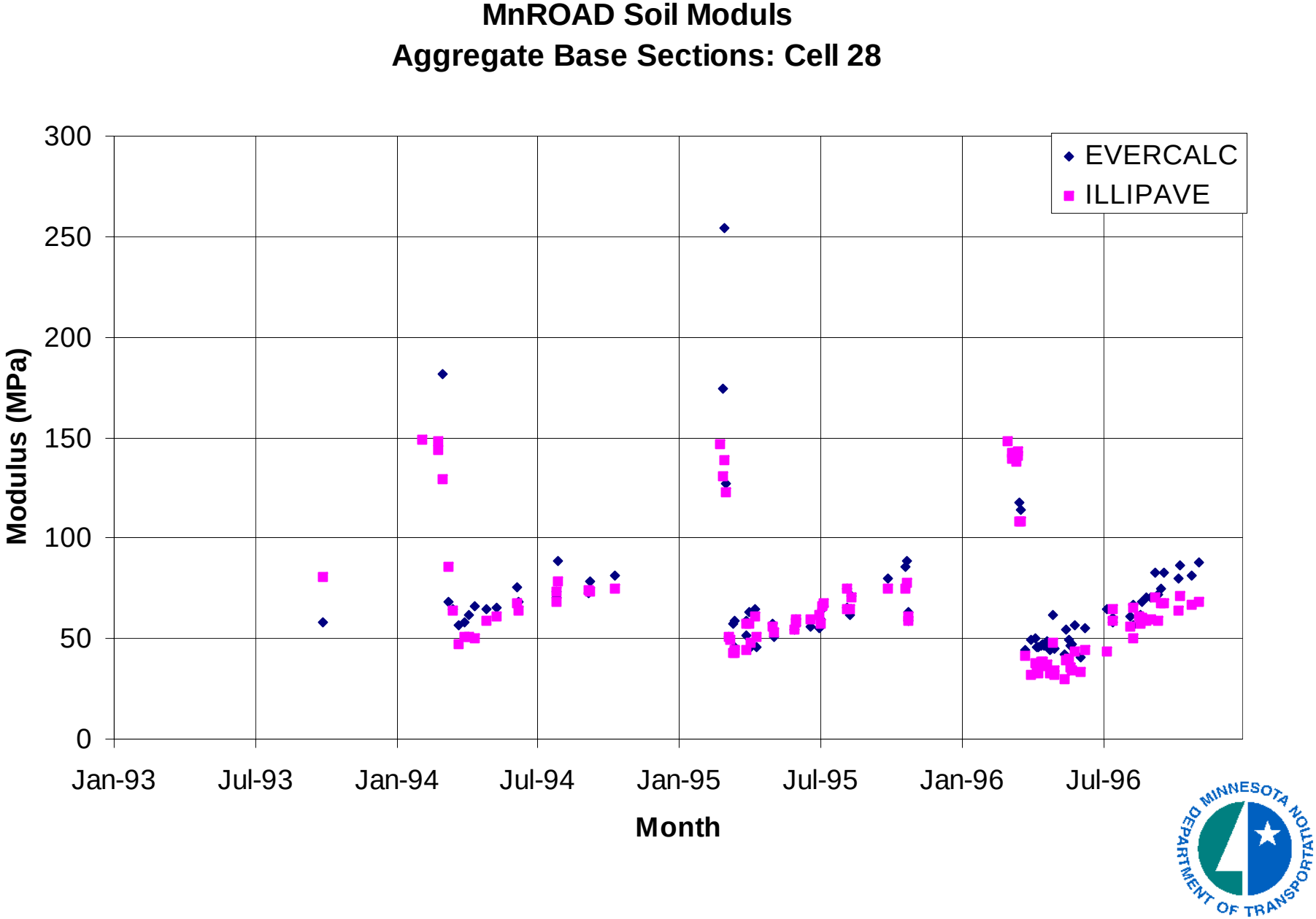


MnROAD Soil Moduls
Aggregate Base Sections: Cell 24

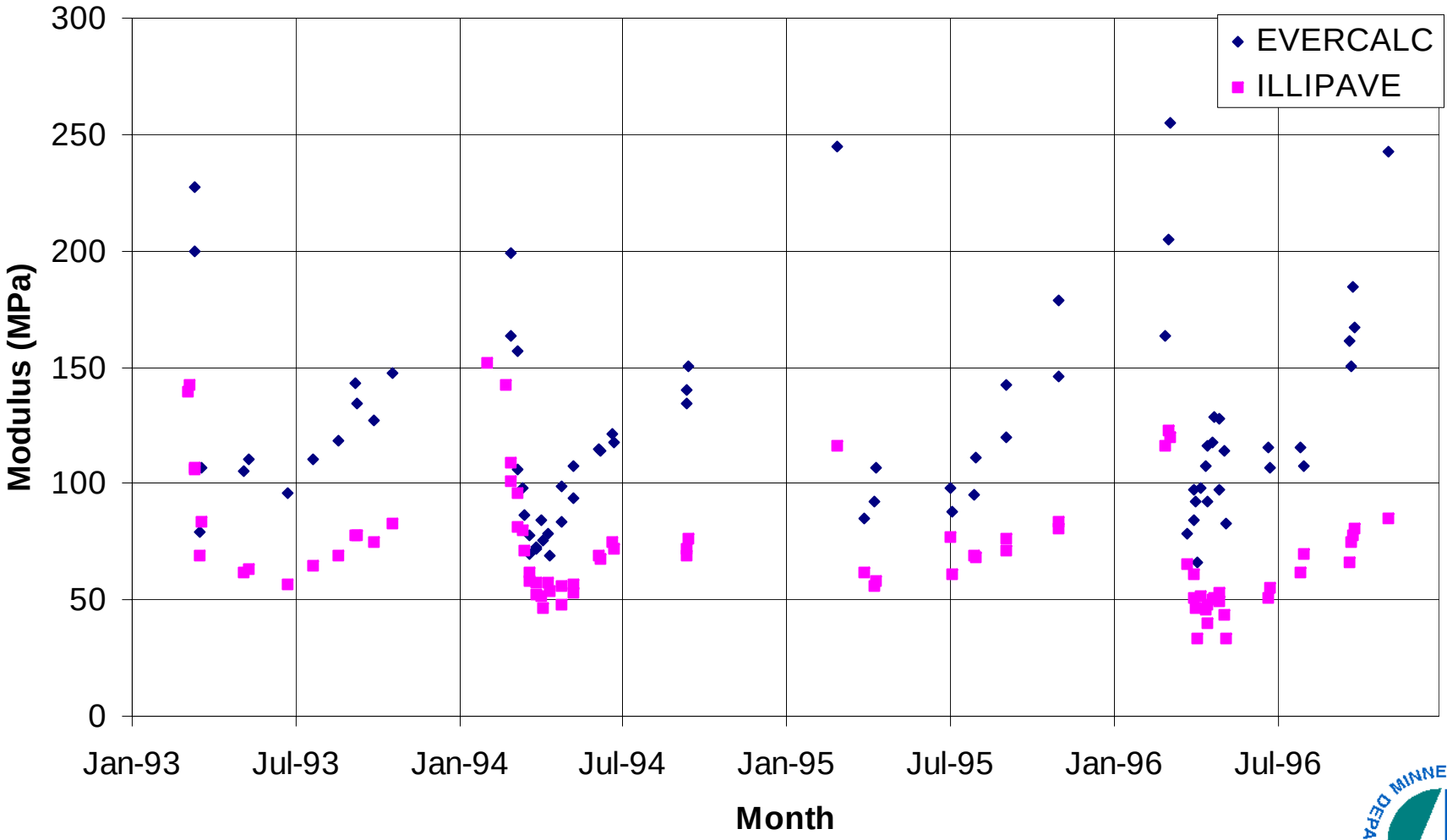


MnROAD Soil Moduls
Aggregate Base Sections: Cell 27

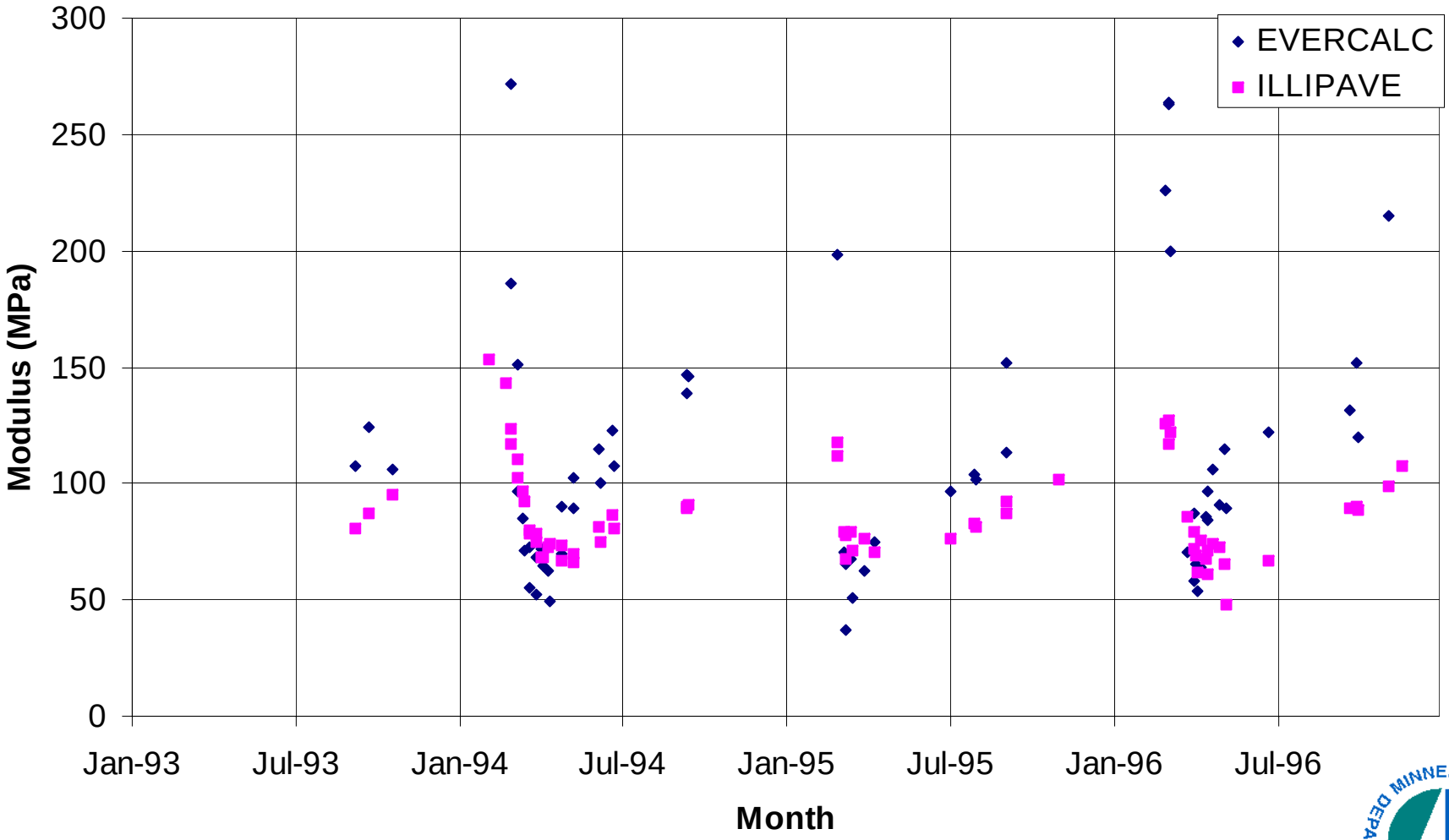



MnROAD Soil Moduls
Aggregate Base Sections: Cell 28
Modulus (MPa)
300
250
200
150
100
50
0
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Month
EVERCALC
ILLIPAVE
MINNESOTA DEPARTMENT OF TRANSPORTATION

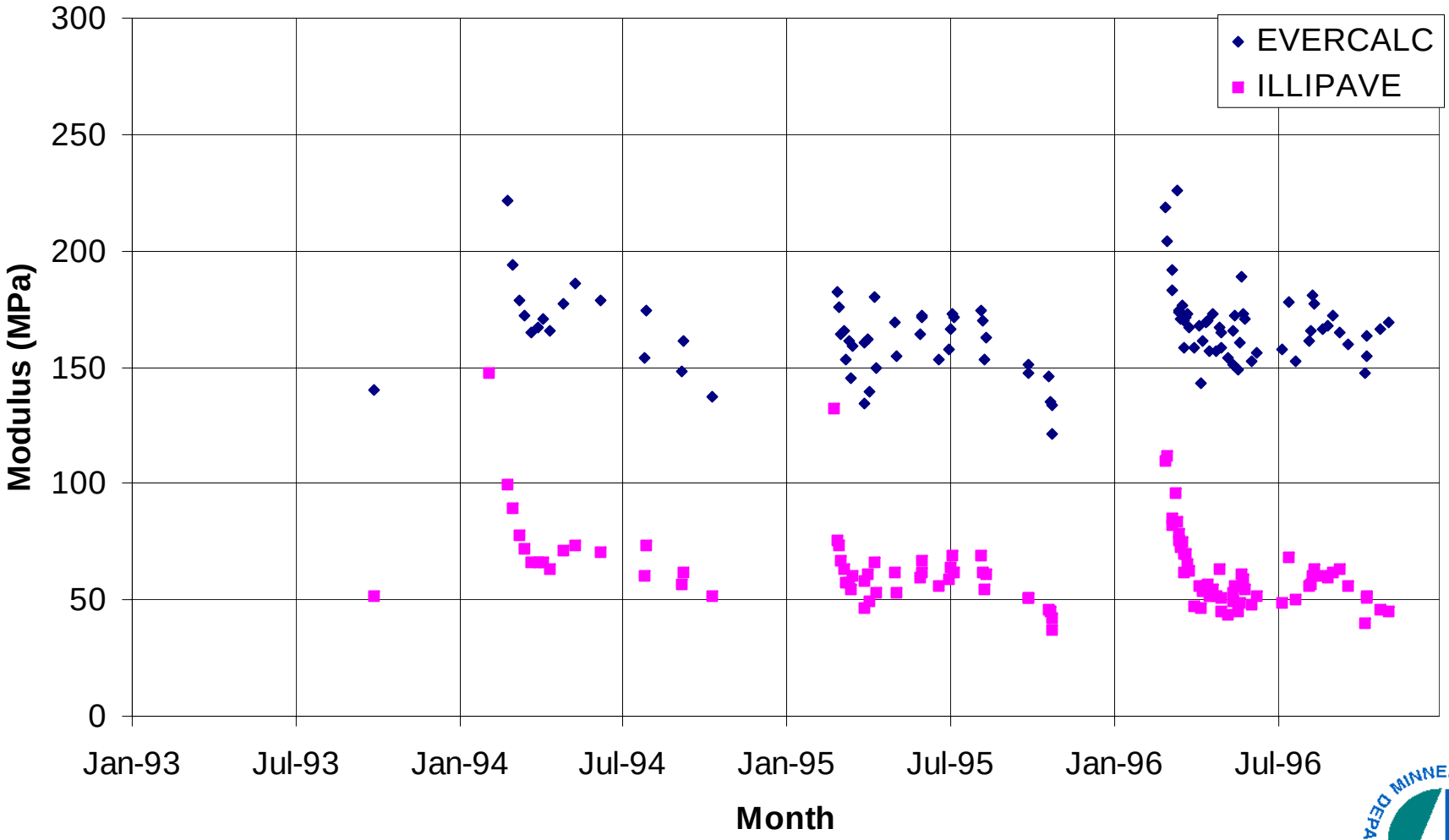
MnROAD Soil Moduls
Full-Depth Sections: Cell 4

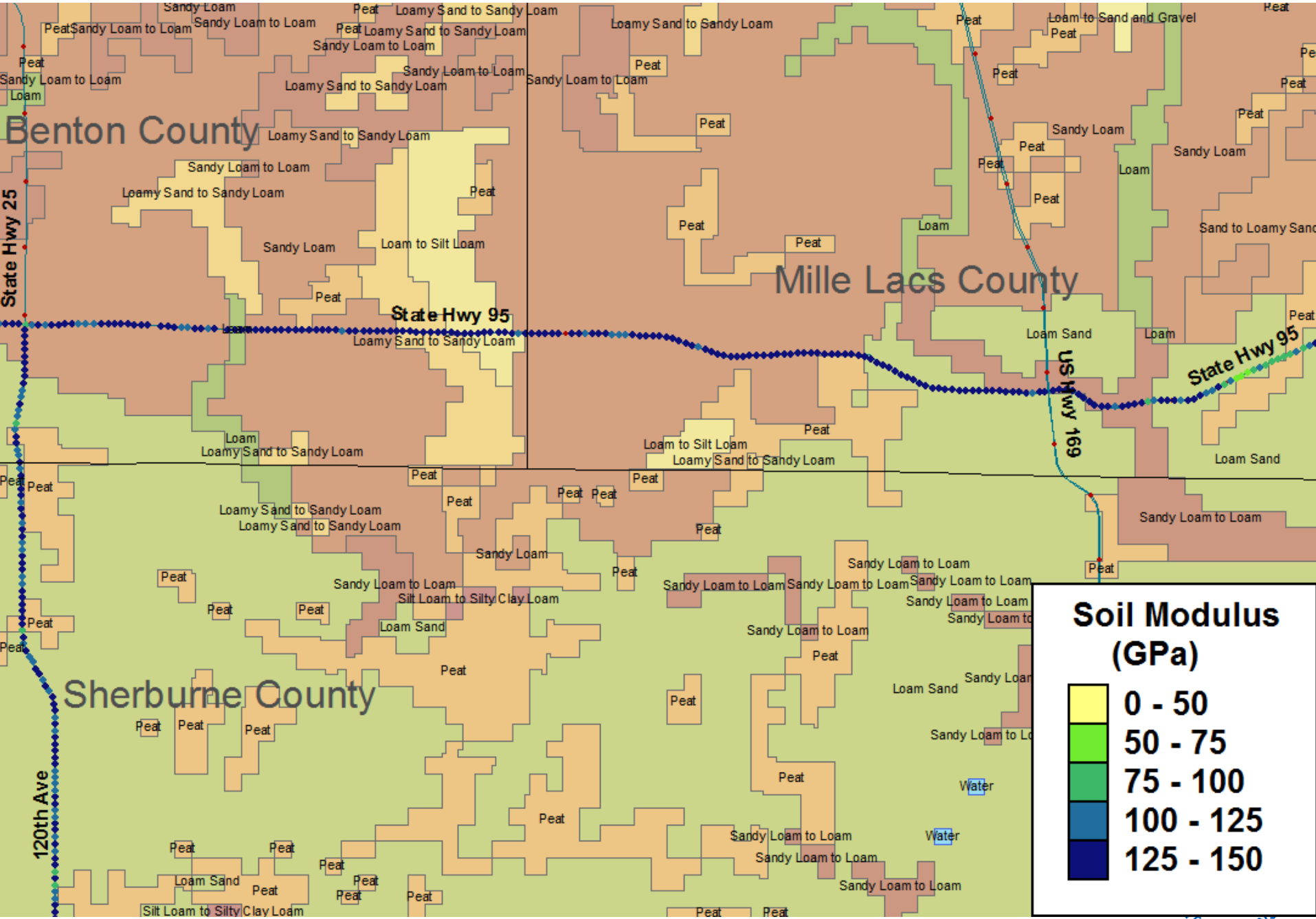


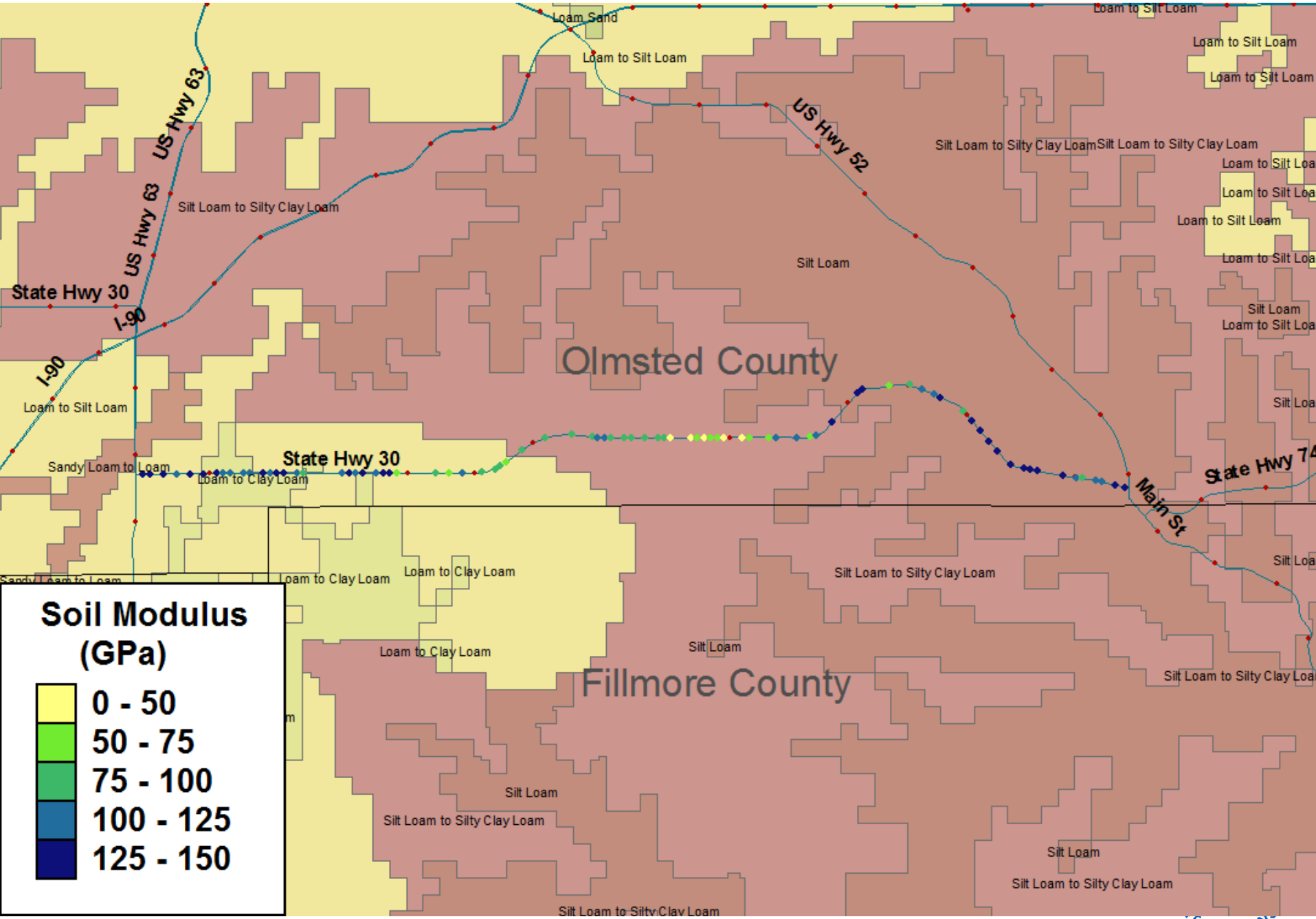
MnROAD Soil Moduls
Full-Depth Sections: Cell 14

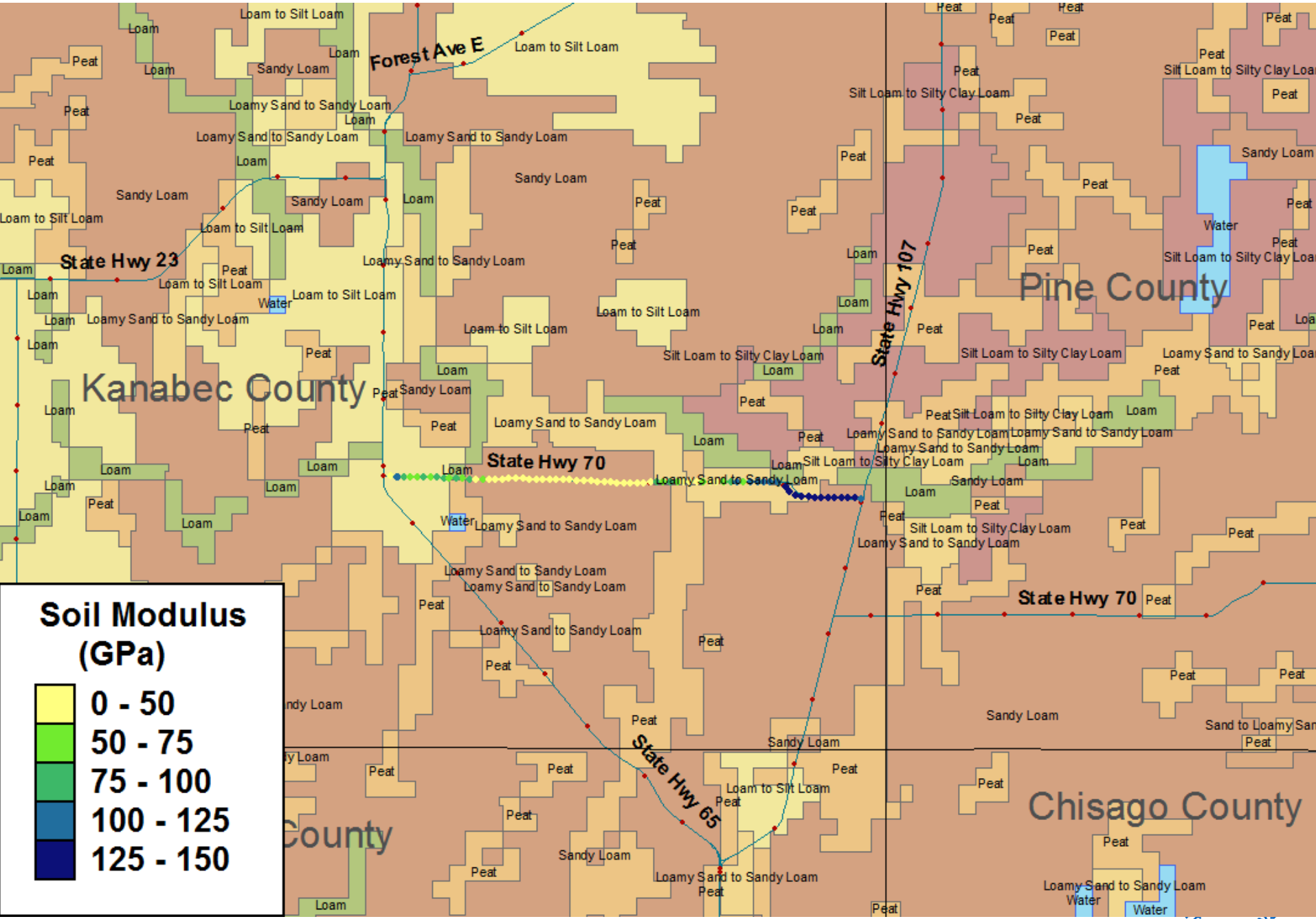


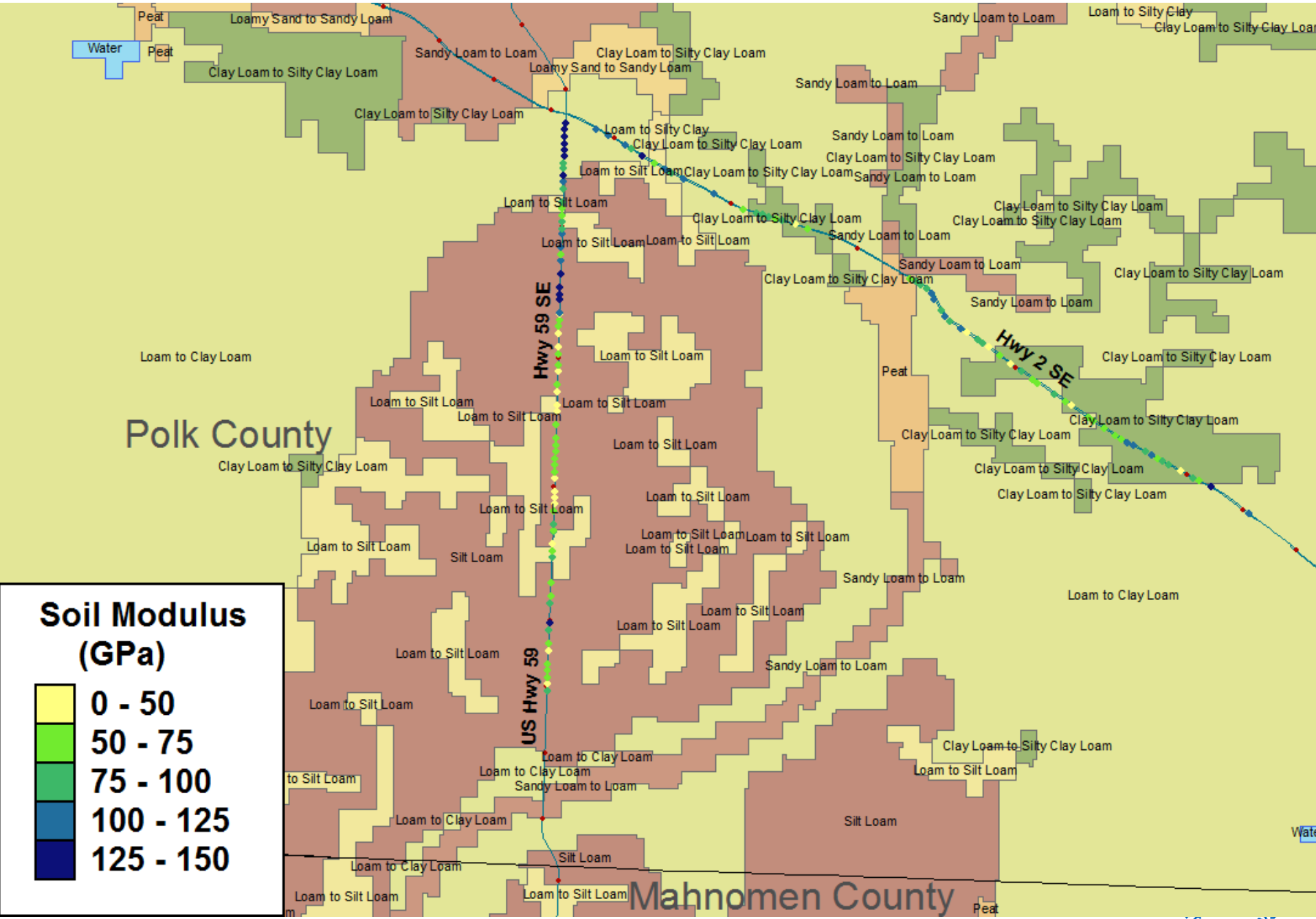
MnROAD Soil Moduls
Full-Depth Sections: Cell 25

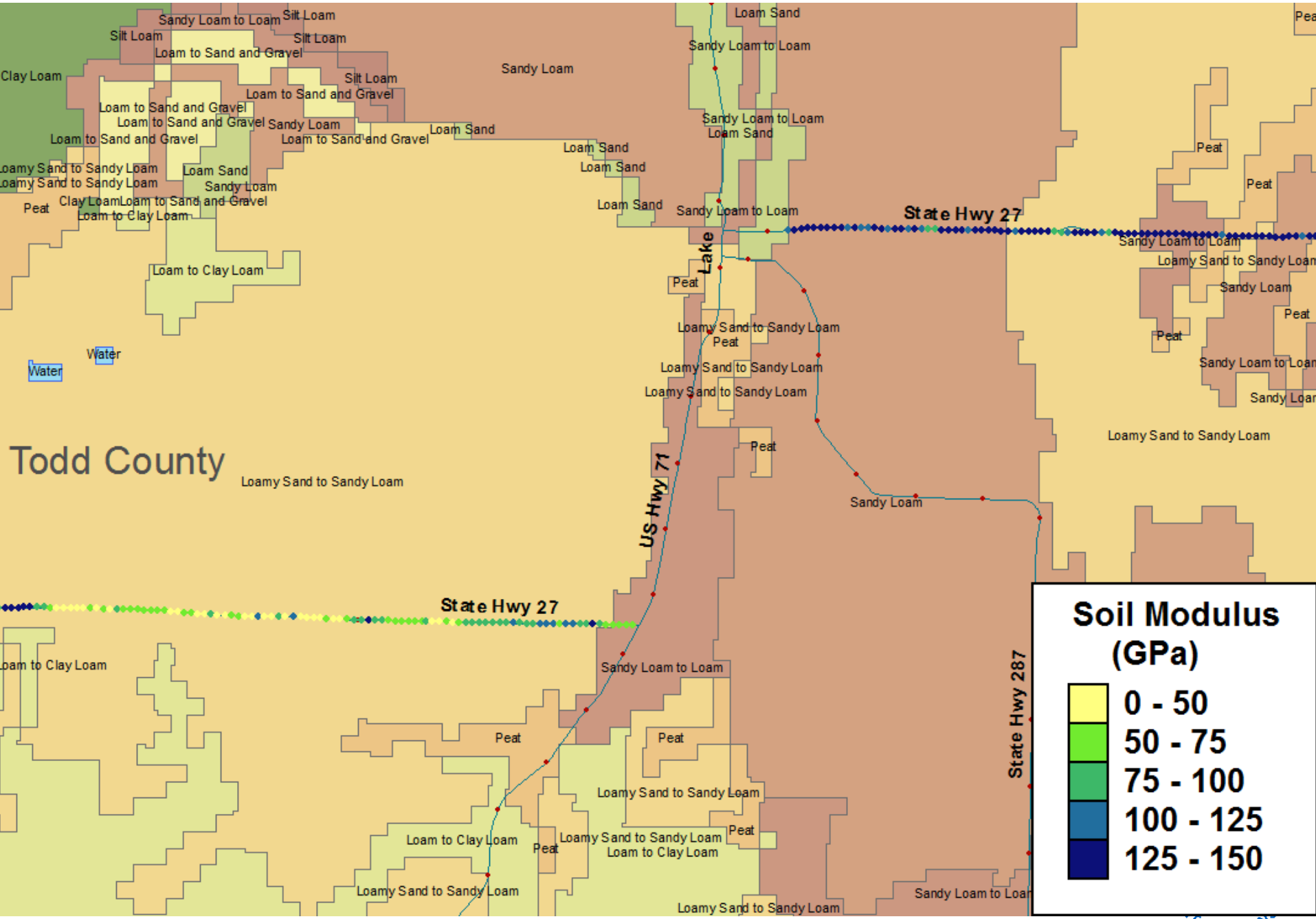



Benton County
Mille Lacs County
Sherburne County
State Hwy 25
State Hwy 95
US Hwy 169
120th Ave
Soil Modulus (GPa)
0 - 50
50 - 75
75 - 100
100 - 125
125 - 150
Water


Soil Modulus (GPa)
0 - 50
50 - 75
75 - 100
100 - 125
125 - 150
Olmsted County
Fillmore County
State Hwy 30
US Hwy 63
US Hwy 52
I-90
Main St
Loam Sand
Loam to Silt Loam
Silt Loam to Silty Clay Loam
Silt Loam
Sandy Loam to Loam
Loam to Clay Loam


Soil Modulus (GPa)
0 - 50
50 - 75
75 - 100
100 - 125
125 - 150
Kanabec County
Pine County
Chisago County
State Hwy 23
State Hwy 70
State Hwy 107
State Hwy 65
Forest Ave E
Loam to Silt Loam
Loamy Sand to Sandy Loam
Sandy Loam
Silt Loam to Silty Clay Loam
Peat
Water


Soil Modulus (GPa)
0 - 50
50 - 75
75 - 100
100 - 125
125 - 150
Polk County
Mahnomen County
Hwy 59 SE
US Hwy 59
Hwy 2 SE
Water
Peat
Loamy Sand to Sandy Loam
Sandy Loam to Loam
Loam to Silty Clay
Clay Loam to Silty Clay Loam
Loam to Silt Loam
Loam to Clay Loam
Silt Loam


Todd County
State Hwy 27
State Hwy 27
US Hwy 71
Lake
State Hwy 287
Water
Water
Soil Modulus (GPa)
0 - 50
50 - 75
75 - 100
100 - 125
125 - 150
Sandy Loam to Loam
Silt Loam
Loam to Sand and Gravel
Clay Loam
Sandy Loam
Loam Sand
Loamy Sand to Sandy Loam
Clay Loam
Loam to Clay Loam
Peat
Loam to Clay Loam
Loamy Sand to Sandy Loam
Peat
Loamy Sand to Sandy Loam
Loamy Sand to Sandy Loam
Peat
Sandy Loam
Loamy Sand to Sandy Loam
Sandy Loam to Loam
Peat
Loamy Sand to Sandy Loam
Peat
Peat
Loamy Sand to Sandy Loam
Loam to Clay Loam
Peat
Loamy Sand to Sandy Loam
Loam to Clay Loam
Loamy Sand to Sandy Loam
Loamy Sand to Sandy Loam

Van Genuchten Equation for Predicting Matric Suction from Field Moisture Content

$$\varphi = (\Theta^{-1/m} - 1)^{1/n}/\alpha$$

φ = matric suction (kPa)

Θ= degree of saturation

α,m,n = fitting parameters

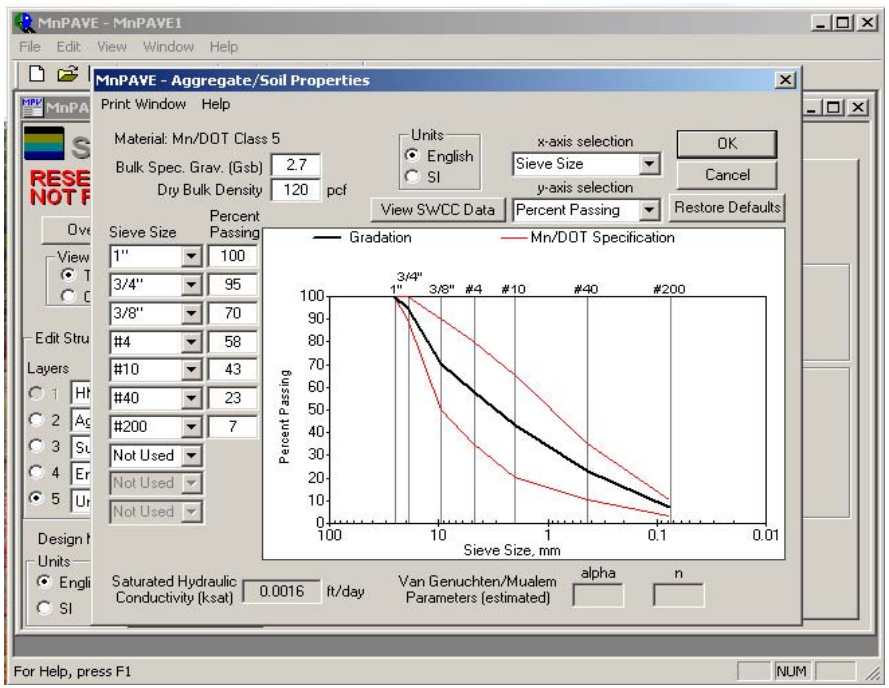
Van Genuchten alpha and n values for MnROAD Materials

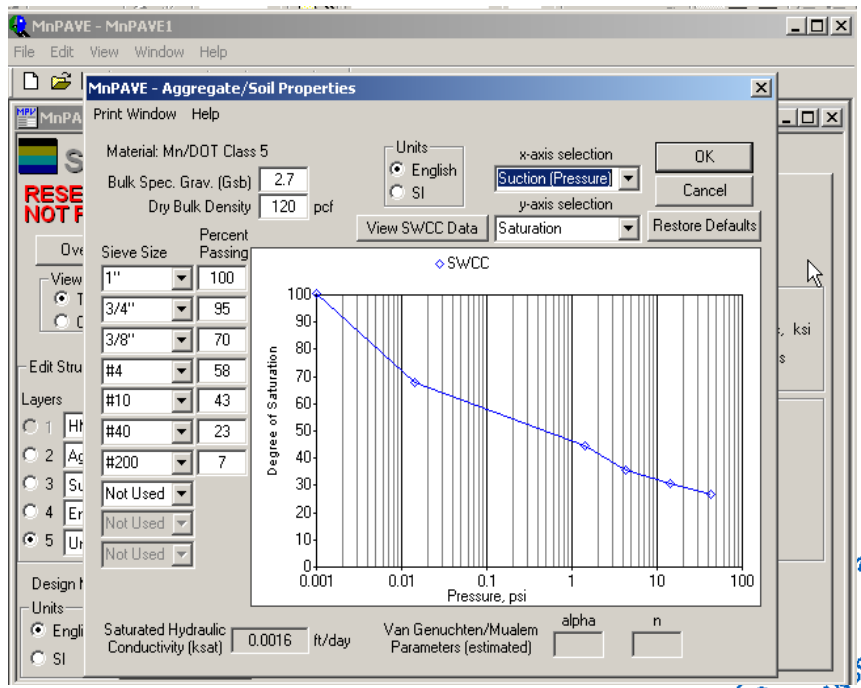
	Class 3 Sp.	Class 4 Sp.	Class 5 Sp.	Class 6 Sp.	Subgrade
alpha	49	34	4.77	97	1.00
n	1.35	1.28	1.44	1.28	1.23
Theta res	0.06	0.08	0.06	0.00	0.09
Theta sat	0.24	0.24	0.28	0.27	0.43

Roberson *et al* 2004

Material Moisture Characterization for M-E Design

- Estimating Soil Water Characteristic Curve
- Predict Stiffness (Resilient Modulus)
- Predict Strength (Failure Response)





Summary

- Task 1: Survey (75% complete)
- Task 2: Moisture Models – Soil and Aggregate Properties: 100% complete
- Next… Task 3: MnPAVE Programming

Questions