

Email from Jacob Heck of NOAA

**From:** Jacob Heck - NOAA Federal [REDACTED]  
**Sent:** Thursday, July 29, 2021 2:10 PM  
**To:** Lina Dutky - NOAA Federal [REDACTED]  
**Cc:** Kelsey, Daniel (DLI) <dan.kelsey@state.mn.us>; Dave Zenk - NOAA Federal [REDACTED]  
**Subject:** Re: NOAA Manual NOS NGS 1

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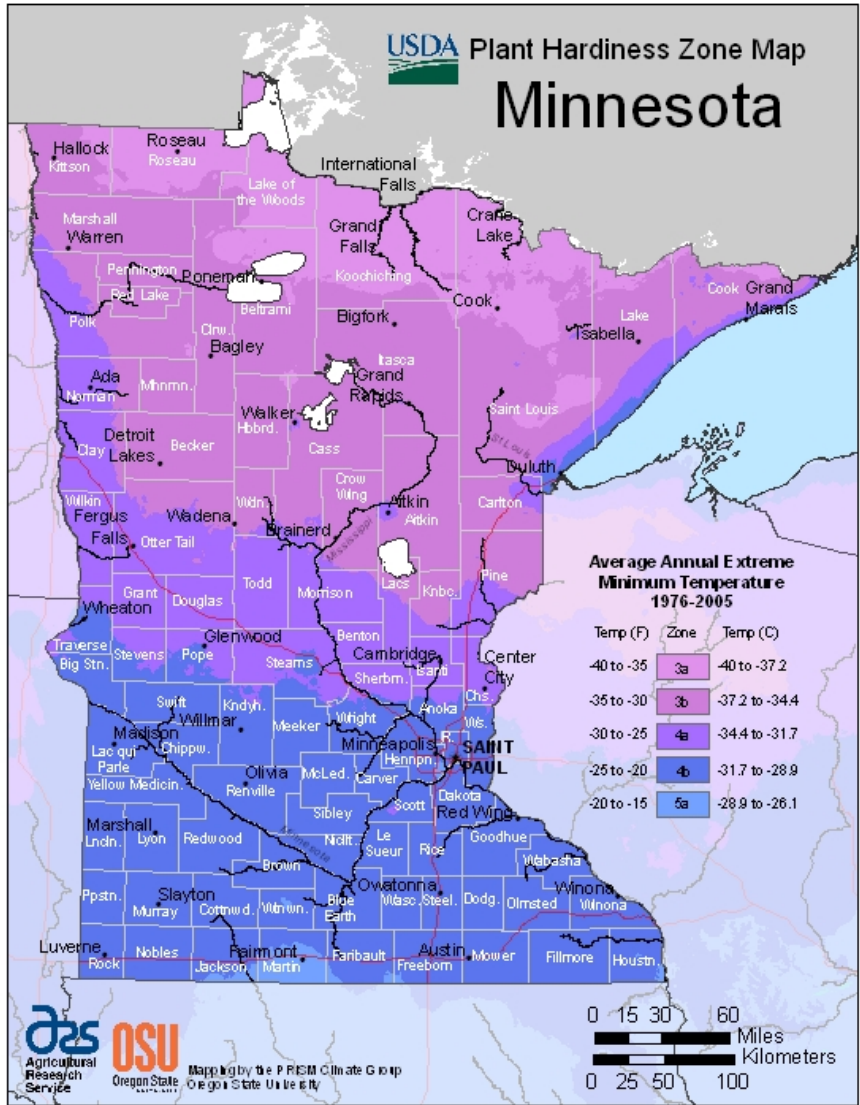
Hi Dan,

NOAA Manual NOS NGS 1 is the most recent version of the manual that NGS has. It contains generalized frost depth maps. NGS does not have any newer maps than those. I've also looped in Dave Zenk, the regional geodetic advisor for the Northern Plains (he's located in Minnesota) and he can chime in with more information as well. The NGS Bench Mark Reset Procedures (from 2011) may have additional information that might help you.

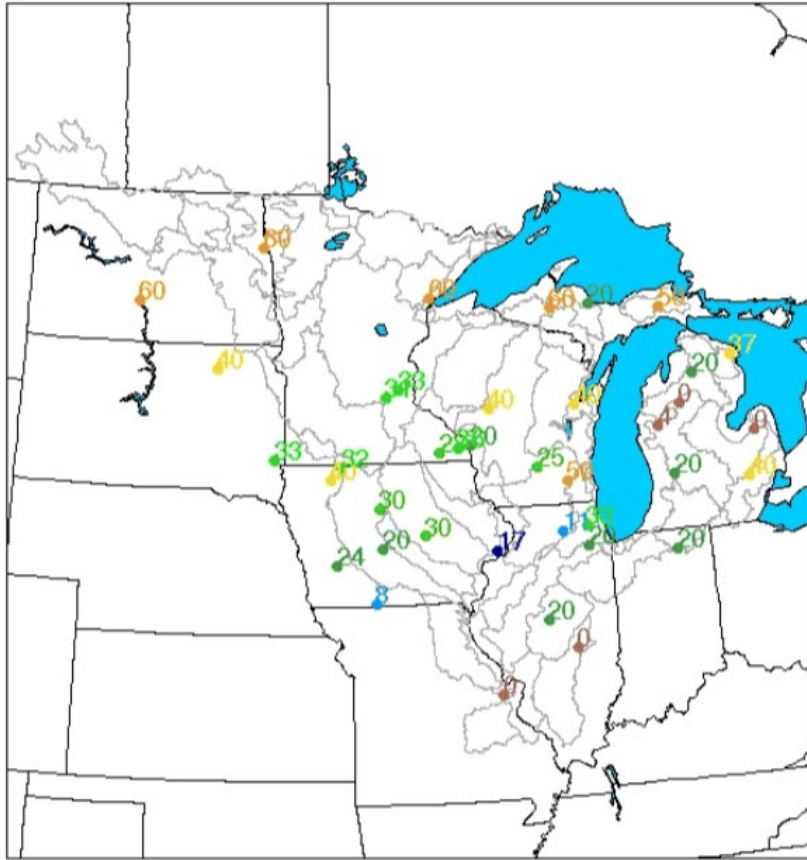
One of the leveling experts within NGS provided me with the following response and resources:

Frost depth is controlled by a number of environmental factors such as minimum temperatures, length of time freezing, latest month of freezing, elevation, solar radiation exposure (shading), soil type (saturation, porosity, granularity), snow cover and upward subterraneous heat flow.... The USGS might have such maps of frost depth. The Weather Service does have monitoring stations, see screen capture. I also found Minnesota Department of Labor and Industry current frost depth map, attached. I can see why more information is needed. I've attached a number of helpful links, none of which precisely answer the question of frost depth for Minnesota. Plant hardiness overlaid with soil types then correlated with the Weather Services frost depth gages might be a start to develop such a map.

[1984 Army Corps of Engineers](#)



<https://i1.wp.com/streets.mn/wp-content/uploads/2019/05/plant-hardiness.jpg?fit=612%2C792&ssl=1>



# Frost Depth

Date: March 10, 2003

Time: 5 pm

- 0 - 6 in
- 6 - 12 in
- 12 - 18 in
- 18 - 24 in
- 24 - 30 in
- 30 - 36 in
- 36 - 48 in
- 48 - 60 in

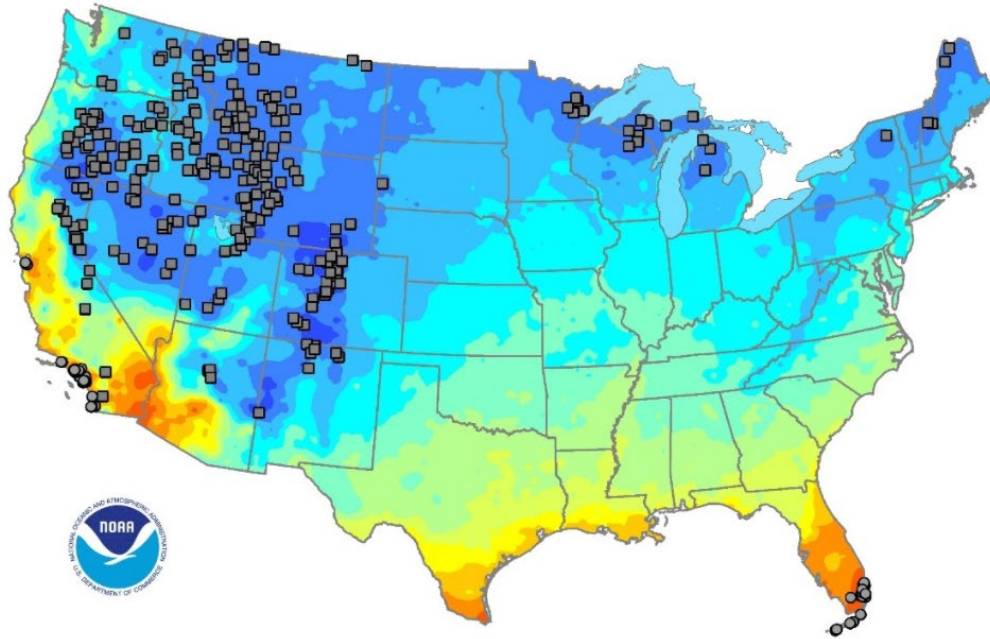
North Central River  
Forecast Center  
Chanhassen, Minnesota



[https://www.weather.gov/ncrfc/LMI\\_SoilTemperatureDepthMaps](https://www.weather.gov/ncrfc/LMI_SoilTemperatureDepthMaps)

# Day of the Last Spring Freeze

from the 1981–2010 U.S. Climate Normals



- Too Cold to Compute
- Too Warm to Compute

On Thu, Jul 29, 2021 at 9:40 AM Lina Dutky - NOAA Federal [REDACTED] wrote:  
Hi Daniel, I'm not exactly sure which manual you are referring to, but I've contacted your NGS regional geodetic advisor Jacob Heck and I'm sure that Jacob will try to help you find the materials that you need. Good luck!

Best regards,  
Lina Dutky

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----- Forwarded message -----

From: **Kelsey, Daniel (DLI)** <[dan.kelsey@state.mn.us](mailto:dan.kelsey@state.mn.us)>

Date: Wed, Jul 28, 2021 at 10:56 AM

Subject: NOAA Manual NOS NGS 1

To: [REDACTED]

Cc: Kelsey, Daniel (DLI) <[dan.kelsey@state.mn.us](mailto:dan.kelsey@state.mn.us)>

To whom it may concern,

The NOAA Manual NOS NGS 1 is dated September 1978. Has this publication been updated, or is there a plan to update it?

If not do you have any newer data on frost depth, especially related to building foundation design and construction? Or do you know of any other groups that may have that data?

Thank you

**Daniel Kelsey, P.E.** (MN, IA, ND, WI)

Administrative Structural Engineer | Construction, Codes & Licensing- Building Plan Review

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Jacob M. Heck, Ph.D.

Great Lakes Regional Geodetic Advisor (MI,IN,IL,WI)

NOAA's National Geodetic Survey

NOAA Great Lakes Environmental Research Laboratory

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Ann Arbor, MI 48108

Mobile: (202) 306-6904

<https://geodesy.noaa.gov>

**From:** Akyuz, Adnan [REDACTED]  
**Sent:** Monday, August 23, 2021 1:14 PM  
**To:** Kelsey, Daniel (DLI) <dan.kelsey@state.mn.us>  
**Subject:** RE: Fw: MN Frost Depth: Data Clay County

Yes,

Here is the link and the reference information: <https://ndawn.ndsu.nodak.edu/deep-soil-temperatures.html>

Adnan

F. Adnan Akyüz, Ph.D.  
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Morrill Hall 304, NDSU  
Fargo, ND 58102

**From:** Kelsey, Daniel (DLI) <[dan.kelsey@state.mn.us](mailto:dan.kelsey@state.mn.us)>  
**Sent:** Monday, August 23, 2021 12:35 PM  
**To:** Akyuz, Adnan [REDACTED]  
**Subject:** RE: Fw: MN Frost Depth: Data Clay County

Dr. Akyüz,

May I share the information below with the Frost Depth Study Technical Advisory Group?

Thank you

**Daniel Kelsey, P.E.** (MN, IA, ND, WI)  
Administrative Structural Engineer | Construction, Codes & Licensing- Building Plan Review

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**Email from Dr. Akyuz with Deep Soil Temperature Locations in North Dakota**

**From:** Kelsey, Daniel (DLI)  
**Sent:** Monday, August 23, 2021 10:32 AM  
**To:** Akyuz, Adnan [REDACTED]; Greg Gust - NOAA Federal [REDACTED];  
Boulay, Peter J. (DNR) [REDACTED]; Ritchison, Daryl [REDACTED];  
**Cc:** Blumenfeld, Kenneth (DNR) [REDACTED]; Romolo, Luigi (DNR) [REDACTED]  
**Subject:** RE: Fw: MN Frost Depth: Data Clay County

Dr. Akyüz,

Thank you very much for the information below.

**Daniel Kelsey, P.E.** (MN, IA, ND, WI)  
Administrative Structural Engineer | Construction, Codes & Licensing- Building Plan Review

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**From:** Akyuz, Adnan <[adnan.akyuz@ndsu.edu](mailto:adnan.akyuz@ndsu.edu)>  
**Sent:** Friday, August 6, 2021 12:01 PM  
**To:** Greg Gust - NOAA Federal [REDACTED]; Boulay, Peter J. (DNR) [REDACTED];  
[REDACTED]; Ritchison, Daryl [REDACTED];  
**Cc:** Kelsey, Daniel (DLI) [REDACTED]; Blumenfeld, Kenneth (DNR) [REDACTED];  
[REDACTED]; Romolo, Luigi (DNR) [REDACTED]  
**Subject:** RE: Fw: MN Frost Depth: Data Clay County

Below is a pivot table of all deep soil temp locations in ND. I highlighted the Fargo location in the pivot table, showing the min temperatures in each level from 5 cm to 225 cm. Fargo's lowest soil temperature on -0.478 occurred at 125 cm (4.65'), based on the data from 2014 through 2021.  
Adnan

Row Labels	Min of 5 cm	Min of 10 cm	Min of 20 cm	Min of 30 cm	Min of 40 cm	Min of 50 cm	Min of 60 cm	Min of 80 cm	Min of 100 cm	Min of 125 cm	Min of 150 cm	Min of 175 cm	Min of 200 cm	Min of 225 cm
Adams	-13.77	-12.85	-11.85	-11.08	-9.86	-9.1	-8.41	-6.64	-4.916	-3.093	-1.704	-0.817	0.167	0.65
Amidon	-15.41	-13.35	-10.95	-8.34	-6.598	-5.133	-4.173	-2.561	-1.227	-0.012	0.098	0.137	0.337	1.343
Antelope Creek	-19.3	-16.42	-12.18	-9.24	-7.715	-6.382	-5.364	-2.623	-0.381	0.849	1.593	2.237	3.016	3.714
Ayr	0.351	0.377	0.289	0.172	0.032	-0.075	-0.132	-0.41	-0.488	-0.112	0.428	0.98	1.634	2.071
Bottineau	-8.1	-7.182	-5.894	-4.657	-3.789	-3.212	-2.56	-1.576	-0.447	0.199	0.475	0.527		
Bowman	-14.75	-13.34	-11.64	-9.6	-7.422	-5.475	-3.812	-1.339	0.233	1.023	1.571	2.026	3.278	3.767
Carrington	-16.47	-14.62	-12.26	-9.61	-7.641	-6.291	-5.277	-3.661	-2.3	-1.215	-0.702	-0.283		
Carson	20.09	20.59	21.15	20.97	20.03	18.91	18	16.49	15.3	13.92	12.71	11.61	10.41	9.67
Clyde	-0.924	-0.599	-0.542	-0.636	-0.692	-0.659	-0.528	-0.213	0.16	0.489	0.711	0.937	1.557	1.977
Courtenay	-11.89	-10.78	-9.08	-7.544	-5.695	-4.101	-44.65	-27.65	0.009	0.656	1.257	-25.12	2.58	2.971
Crane Creek	-17.52	-14.47	-9.93	-7.053	-5.099	-3.386	-2.006	-0.577	0.213	0.969	1.392	1.735	2.342	2.812
Croff	-19.23	-16.16	-12.53	-9.33	-6.419	-4.249	-2.789	-0.776	0.184	0.903	1.359	1.736	2.66	3.277
Denhoff	-7.151	-5.798	-4.51	-3.31	-2.484	-1.917	-1.295	-0.344	0.46	0.978	1.561	2.312	2.959	3.338
Dickinson	-16.25	-14.48	-12.37	-10.18	-8.36	-6.673	-5.49	-3.718	-1.406	-0.062	0.819	1.56		
Emerado	3.14	4.942	6.925	7.439	7.028	6.844	6.698	6.442	6.352	6.278	6.316	6.201	6.272	6.099
Epping	-15.41	-13.13	-9.87	-7.181	-4.991	-3.843	-2.839	-1.245	-0.558	0.063	0.417	0.732	1.353	1.88
<b>Fargo</b>	<b>-16.51</b>	<b>-14.41</b>	<b>-11.6</b>	<b>-8.99</b>	<b>-7.031</b>	<b>-5.723</b>	<b>-4.664</b>	<b>-2.707</b>	<b>-1.444</b>	<b>-0.478</b>	<b>0.125</b>	<b>0.877</b>	<b>1.736</b>	<b>2.252</b>
Fortuna	-15.26	-13.35	-10.7	-8.72	-6.564	-5.09	-3.695	-1.715	-0.738	-0.437	-0.12	0.142	-110.1	-50.99
Fox	-6.863	-5.582	-4.669	-3.865	-3.117	-2.36	-2.037	-1.196	-57.65	-0.063	-0.002	0.11	1.463	
Grand Forks	-17.65	-9.83	-6.935	-5.099	-3.472	-2.422	-1.865	-1.501	-1.067	-0.546	0.004	0.468	1.069	1.459
Grassy Butte	-16.77	-13.89	-9.01	-6.243	-4.974	-3.846	-2.541	-1.249	-0.361	0.566	1.318	2.032	2.633	3.322
Grenora	-19.81	-18.12	-13.93	-10.96	-9.07	-7.421	-6.023	-3.808	-2.245	-1.059	-0.032	0.871	1.989	2.57
Hettinger	-12.37	-10.6	-8.91	-7.133	-5.878	-123.8	-66.64	-17.27	-1.405	-119.3	0.787	1.757	11.09	10.22



Langdon	-16.13	-14.13	-11.56	-8.89	-7.444	-74.45	-5.527	-4.223	-2.723	-1.276	-0.411	0.121		
Logan Center	-6.514	-5.987	-4.767	-3.762	-2.656	-1.852	-1.064	-0.046	0.506	1.185	1.688	1.9	2.313	2.865
Maddock	-13.39	-11.78	-9.54	-7.463	-5.875	-4.984	-4.098	-2.676	-1.554	-0.316	0.296	0.662	1.515	2.357
Minot	-66.66	-74.43	-37.17	-71.39	-9.28	-7.647	-6.457	-39.91	-2.911	-1.962	-1.479	-2.406	1.143	-1.724
Mooreton	-18.79	-16.21	-13.01	-10.52	-8.39	-6.443	-4.676	-2.515	-1.728	-0.655	0.39	1.259	2.248	2.821
Mott	17.67	18.98	19.58	19.67	19.39	18.44	17.5	16.13	15.01	13.64	12.33	11.26	10.54	9.79
Niles	-6.416	-4.793	-3.344	-2.681	-1.976	-1.591	-1.211	-0.51	0.109	0.401	0.59	1.341	1.592	2.656
Noonan	-7.608	-6.687	-5.027	-3.653	-2.724	-1.908	-1.57	-0.98	-0.602	-0.489	-0.453	-0.243	0.63	1.048
Oakes	15.37	16.87	17.49	17.07	16.28	15.46	14.62	12.93	11.87	10.95	10.16	9.4	8.91	8.45
Palermo	6.873	7.873	8.59	8.61	8.25	7.639	6.912	5.893	5.23	4.687	4.33	4.096	3.933	3.86
Pekin	-14.34	-13.04	-10.58	-8.8	-7.061	-5.631	-4.411	-2.502	-1.127	-0.293	0.072	0.42	1.421	1.854
Perth	0.547	0.663	0.622	0.616	0.604	0.628	0.671	0.996	1.372	1.873	2.282	2.644	2.908	3.266
Portal	6.884	8.33	9.06	9.44	9.22	8.83	8.16	7.175	6.46	5.768	5.262	4.883	4.649	4.485
Prosper	-3.123	-2.527	-1.475	-0.599	0.097	0.465	0.582	0.814	1.029	1.126	2.58	3.983	4.588	5.13
Ray	12.55	13.62	14.58	14.97	14.97	14.12	13.31	11.75	10.57	9.34	8.36	7.576	7.029	6.597
Sawyer	-13.02	-11.76	-10.41	-8.55	-7.181	-6.025	-4.695	-2.871	-1.054	0.012	0.522	0.973	2.034	2.39
Steele	-12.8	-10.51	-6.836	-4.704	-3.088	-2.064	-1.473	-0.829	-0.287	0.4	1.005	1.356	1.959	2.706
Streeter	-12.38	-11.42	-8.95	-6.632	-5.145	-3.991	-3.503	-2.452	-0.994	-0.205	0.583	1.27	2.177	
Werner	13.12	13.67	14.63	15.07	14.97	14.21	13.64	12.81	11.85	10.95	10.14	9.32	8.68	8.13
(blank)														
Grand Total	-66.66	-74.43	-37.17	-71.39	-9.86	-123.8	-66.64	-39.91	-57.65	-119.3	-1.704	-25.12	-110.1	-50.99

F. Adnan Akyüz, Ph.D.  
**NORTH DAKOTA STATE UNIVERSITY**  
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Fargo, ND 58102

**From:** Greg Gust - NOAA Federal [REDACTED]  
**Sent:** Friday, August 6, 2021 11:06 AM  
**To:** Boulay, Peter J. (DNR) [REDACTED]; Akyuz, Adnan [REDACTED];  
Ritchison, Daryl [REDACTED]  
**Cc:** Kelsey, Daniel (DLI) <[dan.kelsey@state.mn.us](mailto:dan.kelsey@state.mn.us)>; Blumenfeld, Kenneth (DNR)  
[REDACTED]; Romolo, Luigi (DNR) [REDACTED]  
**Subject:** Re: Fw: MN Frost Depth: Data Clay County

Hi Pete,

Adnan may be headed out on vacation... so I'll jump in. I've included Daryl Ritchison to this conversation as well. Here is the NDAWN location which has the Deep Soil Temp data from that network:

<https://ndawn.ndsu.nodak.edu/deep-soil-temperatures.html>

You can download the CSV file which the hourly data for each location, back to the stations beginning. For instance, the Fargo Deep Soil data goes back to 2014. I've attached, below, the current hours tabular display [10am CDT, 9am CST] data in degrees C, as an example. I've also downloaded the latest CSV file, which is an 8am CST file... so you can see there is some subtle differences between the two disparate times.

		Table													
		Graph													
Station	Last Updated	5 cm (2 in)	10 cm (4 in)	20 cm (8 in)	30 cm (12 in)	40 cm (16 in)	50 cm (20 in)	60 cm (24 in)	80 cm (31 in)	100 cm (39 in)	125 cm (49 in)	150 cm (59 in)	175 cm (69 in)	200 cm (79 in)	225 cm (89 in)
Adams	06 Aug 10:00 CDT	17.8 °C	18.0 °C	18.2 °C	18.3 °C	17.9 °C	17.4 °C	16.8 °C	15.6 °C	14.4 °C	13.2 °C	12.1 °C	11.2 °C	10.7 °C	9.8 °C
Amidon	06 Aug 10:00 CDT	19.7 °C	19.8 °C	19.9 °C	19.7 °C	19.2 °C	18.7 °C	18.3 °C	17.4 °C	16.6 °C	15.7 °C	14.8 °C	13.9 °C	13.0 °C	12.2 °C
Antelope Creek	06 Aug 10:00 CDT	21.7 °C	22.1 °C	22.4 °C	22.2 °C	21.8 °C	21.2 °C	20.7 °C	19.7 °C	18.8 °C	17.5 °C	16.2 °C	15.1 °C	14.0 °C	13.1 °C
Ayr	06 Aug 10:00 CDT	20.1 °C	20.6 °C	21.2 °C	21.3 °C	21.0 °C	20.6 °C	20.2 °C	19.0 °C	18.1 °C	16.9 °C	15.7 °C	14.5 °C	13.6 °C	12.7 °C
Bottineau	06 Aug 10:00 CDT	15.9 °C	16.3 °C	16.5 °C	16.3 °C	15.9 °C	15.5 °C	15.1 °C	14.4 °C	13.6 °C	12.8 °C	12.1 °C	11.3 °C		
Bowman	06 Aug 10:00 CDT	21.2 °C	21.3 °C	21.6 °C	21.3 °C	20.5 °C	19.6 °C	18.6 °C	17.1 °C	15.8 °C	14.7 °C	13.7 °C	12.8 °C	12.0 °C	11.3 °C
Carrington	06 Aug 10:00 CDT	20.3 °C	20.7 °C	21.1 °C	21.2 °C	20.7 °C	20.1 °C	19.5 °C	18.2 °C	17.2 °C	16.0 °C	15.1 °C	14.3 °C		
Carson	06 Aug 10:00 CDT	22.4 °C	23.1 °C	23.6 °C	23.2 °C	22.4 °C	21.6 °C	20.8 °C	19.5 °C	18.4 °C	17.0 °C	15.8 °C	14.6 °C	13.8 °C	12.9 °C
Clyde	06 Aug 10:00 CDT	17.3 °C	17.7 °C	18.3 °C	18.4 °C	17.8 °C	17.2 °C	16.7 °C	15.7 °C	14.8 °C	13.8 °C	12.9 °C	11.9 °C	11.6 °C	10.9 °C
Courtenay	06 Aug 10:00 CDT	23.5 °C	22.5 °C	23.1 °C	23.6 °C	23.6 °C	23.2 °C	22.6 °C	21.4 °C	20.3 °C	18.9 °C	17.7 °C	16.5 °C	15.7 °C	14.8 °C
Crane Creek	06 Aug 10:00 CDT	21.0 °C	21.2 °C	21.2 °C	20.8 °C	20.2 °C	19.5 °C	18.8 °C	17.6 °C	16.5 °C	15.4 °C	14.3 °C	13.4 °C	12.6 °C	11.9 °C
Croff	06 Aug 10:00 CDT	19.8 °C	20.3 °C	20.9 °C	20.8 °C	20.3 °C	19.7 °C	19.1 °C	17.8 °C	16.7 °C	15.5 °C	14.4 °C	13.3 °C	12.4 °C	11.7 °C
Denhoff	06 Aug 10:00 CDT	22.1 °C	21.0 °C	20.8 °C	20.8 °C	20.6 °C	20.2 °C	19.5 °C	18.4 °C	17.2 °C	15.8 °C	14.4 °C	13.0 °C	12.3 °C	11.6 °C
Dickinson	06 Aug 10:00 CDT	23.3 °C	23.7 °C	24.0 °C	23.7 °C	23.1 °C	22.3 °C	21.4 °C	19.6 °C	18.3 °C	16.9 °C	15.8 °C	14.8 °C		
Emerado	06 Aug 10:00 CDT	20.0 °C	19.3 °C	19.3 °C	19.5 °C	19.5 °C	19.1 °C	18.6 °C	17.4 °C	16.4 °C	15.2 °C	14.1 °C	13.0 °C	12.3 °C	11.4 °C
Epping	06 Aug 10:00 CDT	19.4 °C	19.4 °C	19.3 °C	18.7 °C	18.0 °C	17.5 °C	16.9 °C	16.0 °C	15.2 °C	14.3 °C	13.5 °C	12.7 °C	12.2 °C	11.6 °C
Fargo	06 Aug 10:00 CDT	18.4 °C	18.6 °C	19.1 °C	19.1 °C	18.5 °C	17.9 °C	17.3 °C	16.2 °C	15.1 °C	13.9 °C	12.9 °C	11.9 °C	11.0 °C	10.2 °C
Fortuna	06 Aug 10:00 CDT	21.4 °C	21.7 °C	21.7 °C	21.3 °C	20.5 °C	19.6 °C	18.8 °C	17.4 °C	16.4 °C	15.3 °C	14.3 °C	13.4 °C		
Fox	06 Aug 10:00 CDT	17.4 °C	17.6 °C	17.9 °C	18.1 °C	18.0 °C	17.8 °C	17.5 °C	16.9 °C		15.0 °C	14.1 °C	13.2 °C	12.5 °C	
Grand Forks	06 Aug 10:00 CDT	17.9 °C	17.7 °C	19.3 °C	20.0 °C	20.0 °C	19.7 °C	19.4 °C	18.5 °C	17.5 °C	16.0 °C	14.8 °C	13.5 °C	12.5 °C	11.5 °C
Granville	06 Aug 10:00 CDT	21.5 °C	22.2 °C	22.6 °C	22.3 °C	21.8 °C	21.2 °C	20.5 °C	19.5 °C	18.5 °C	17.5 °C	16.5 °C	15.5 °C	14.5 °C	13.7 °C

I know that the NCRFC has a few other [deep soil stations](#) that they access. But don't see any that are that are closer to Clay County than the Fargo NDAWN location.

-gg

On 8/6/2021 10:25 AM, Boulay, Peter J. (DNR) wrote:  
Hi Adnan and Greg,

This request came through folks working on new frost depth building requirements and are really looking for frost information for Clay County. The link below is a frost depth map I created for the Spring Flood Outlook in 2017 and it looks like there was frost depth data for the Fargo area at the time. Do either of you know where that record could be?

-Pete

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**From:** Kelsey, Daniel (DLI) <[dan.kelsey@state.mn.us](mailto:dan.kelsey@state.mn.us)>  
**Sent:** Friday, August 6, 2021 10:13 AM  
**To:** Boulay, Peter J. (DNR) [REDACTED]; Mitch Okeson <the >; Romolo, Luigi (DNR) [REDACTED]  
**Cc:** Blumenfeld, Kenneth (DNR) [REDACTED]  
**Subject:** RE: MN Frost Depth Data

Yes

**From:** Boulay, Peter J. (DNR) [REDACTED]  
**Sent:** Friday, August 6, 2021 10:02 AM  
**To:** Mitch Okeson [REDACTED]; Romolo, Luigi (DNR) [REDACTED]  
**Cc:** Kelsey, Daniel (DLI) <[dan.kelsey@state.mn.us](mailto:dan.kelsey@state.mn.us)>; Blumenfeld, Kenneth (DNR) [REDACTED]  
**Subject:** RE: MN Frost Depth Data

Hi Mitch,  
Dan reached out to our office the other day and I provided him with some frost studies. Dan, could you forward the links I sent to you? It sounds like an interesting project. I am kind of ready for winter myself!

-pete

**Pete Boulay**  
Climatologist | MNDNR Ecological and Water Resources

**State Climatology Office**  
439 Borlaug Hall  
1991 Upper Buford Circle  
St. Paul, MN 55108  
Phone: 612-390-1301 (temporary)  
Email: [REDACTED]  
[mndnr.gov](http://mndnr.gov)

 **DEPARTMENT OF  
NATURAL RESOURCES**



**From:** Mitch Okeson [REDACTED]  
**Sent:** Thursday, August 05, 2021 5:13 PM  
**To:** Romolo, Luigi (DNR) [REDACTED]  
**Cc:** Boulay, Peter J. (DNR) [REDACTED]; Kelsey, Daniel (DLI) <[dan.kelsey@state.mn.us](mailto:dan.kelsey@state.mn.us)>  
**Subject:** MN Frost Depth Data

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Luigi,

I am a Panelist for a State of MN Technical Advisory Group looking into further into the Building Frost Depth requirements.

I came across the following links which provided relevant information of about the maximum frost depth per winter at the following URL's:

[https://www.dnr.state.mn.us/climate/journal/1701\\_frost.html](https://www.dnr.state.mn.us/climate/journal/1701_frost.html) [https://www.dnr.state.mn.us/climate/journal/1801\\_frost.html](https://www.dnr.state.mn.us/climate/journal/1801_frost.html)

We are interested in finding out all we can about the observed frost depth in Clay County over history. A phone call to understand what information your office has available as well as what our goals are would be very helpful; let me know if that is something we can arrange.

The end goal for the TAG is to provide a recommendation to the Governing Authority in regards to a Code change should we have reasonable justification that the current 60" required footing depth be excessive. FYI – Cass County North Dakota only requires 48" for footing depth.

Thanks in advance for your assistance!



**Mitch Okeson, PE, SE**

Principal Engineer

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## Email from Elizabeth Tomlinson

Hi Greg,

My close contact has limited their work with ASCE's Committee on Adaptation due to her service with Biden's Administration. I have reached out to Dr. Mari Tye (chair of the ASCE committee on adaptation) and Dr. Giovannettone (chair of future weather and climate extremes). I'll make an introduction to you when they provide the best contact. Hopefully they have an expert on frost depth analysis in changing climates. I know they've published [\*Climate-Resilient Infrastructure: Adaptive Design and Risk Management\*](#), [MOP 140](#).

Chatting with Dr. Crawley, chair of ASHRAE TC4.2 Climatic Information/Standard 169, we both want to highlight to the TAG that ASHRAE's shifting climate zones represent ambient temperature and humidity averages only. The calculation presented for consideration during the last TAG meeting does rely on ambient air temperatures as a proxy for frost depth, but an engineer needs to also consider heat flow at the air-ground interface. Influences to those calculations include cloud cover, wind speed, surface characteristics, and snow coverage. I do not advise the TAG to raise footing levels based on ASHRAE's Climatic Zones alone, but rather consider the 'low probability/high risk' events in our changing climate that can cause structural failure. Changes to average snow coverage and long duration extreme temperature events, like a polar vortex, are specific concerns. I am not a civil engineer and respectfully defer to your TAG experts for their input on this matter.

Another resource of interest: MnDOT is currently researching climate change impacts on freeze/thaw cycles. Preliminary submission indicates a low risk of increasing freeze/thaw cycles, but I'm waiting for the peer review and publication. If this research is of interest, you may want to contact MnDOT.

Sincerely,  
Beth Tomlinson