



SOIL FREEZE DEPTH GUIDE FOR MANUFACTURED HOUSING IN PA

April 2014, 2ND ED. | Mark Fortney, Eric Burnett, and Brian Wolfgang

BACKGROUND

How deep does a foundation have to be?

The answer to this critical question has two parts. The first is that the foundation should be below the topsoil, which is usually much weaker and more susceptible to settlement than the subsurface soil. The depth of topsoil in Pennsylvania ranges from a few inches to more than two feet. The second, and more critical point, is the depth to which the ground may freeze. In Pennsylvania, this is usually considerably deeper than the depth of the topsoil.

Most people know that if a foundation is too shallow, freezing of moisture in the soil can cause movement that could result in damage. Poor performance (windows and doors will not operate, drywall will crack, etc.) could ultimately lead to structural failure. To protect a foundation from frost action, most foundations are designed and constructed so that the bottom of the foundation lies below the extreme freeze depth for a particular area. On the other hand, if the footer is located much deeper than really necessary, the foundation will cost more and this could affect affordability.

In order to provide an economical foundation that will last the life of the structure, the freeze depth of soil needs to be established. However, finding out the appropriate freeze depth for a particular location isn't a simple matter. Freeze depth estimates often vary widely between sources (building codes and standards, design manuals, etc.) for a given location probably because there are so many variables. These variables include soil types, porosity of soil, moisture content of soil, or the use of snow cover or sod in the determination of freeze depths. So what value should be used for manufactured housing and what other factors need to be considered?

PURPOSE

This document provides some guidance on minimum foundation depth to the manufactured housing industry in Pennsylvania to reduce the risk of damage from freezing soil. The intention is to avoid foundation movement due to freezing of the soil below the foundation.

Recommendations are provided in the form of maps (see Maps 1 and 2). The two maps are based on the Atlas of Soil Freezing Depth Extremes for the Northeastern United States prepared by the Northeast Regional Climate Center. Their work appears to be the most up-to-date and inclusive source of information. However, their maps do not incorporate the effects of a house. Erecting a house over or partially within the soil can significantly alter the freeze depth in the soil around a foundation. We have attempted to modify their maps to incorporate this effect.

SITE SPECIFIC CONSIDERATIONS

Users should be aware that conditions at the site will affect the freeze depth around the foundation. Table 1, on the next page, describes a few of the factors and how they may affect the freezing depth around the foundation of a house.

Another issue to consider is the interaction (or heat transfer) between the soil and the foundation. Heat transfer differs between various foundation types. A typical basement or crawl space is much more "connected" to the soil than a house set on pier foundations with skirting. Typically, the basement space in a house with an unheated basement is usually tempered by heat loss from the conditioned space above and will, therefore, stay much warmer than the winter temperature outside. The heat loss from the basement reduces the freeze depth. Houses with pier foundations with both skirting and insulated skirting have also been found to retard freeze depths around the foundation.

Table 1: Factors Affecting Soil Freeze Depth

Condition	Effect	Description
Snow Cover	Shallower	Snow cover insulates the ground and retards heat loss from the earth, reducing the freezing depth.
Wind Shielding	Shallower	Skirting around a pier foundation shields the wind from the foundation and the soil under the house. This will reduce the transfer of heat from the soil to the outside air, which will reduce the soil freezing depth.
Grass - Vegetation	Shallower	Grass and vegetation insulate the ground and retard heat loss from the earth. However, it is reasonable to assume that the area around a house, at some point in its life, will not be covered with grass or vegetation.
Non - Compacted Soil	Deeper	Typically soil that is removed during construction is not compacted when it is placed around the foundation. This backfill will allow the freeze to penetrate deeper into the earth.
Solar Shading	Deeper	Solar energy warms the soil and will help to reduce the freeze depth. If a house shades the soil under or around the foundation, the freeze depth will be increased.

FREEZE DEPTHS BY FOUNDATION TYPES

Pier and Strip Foundations, General

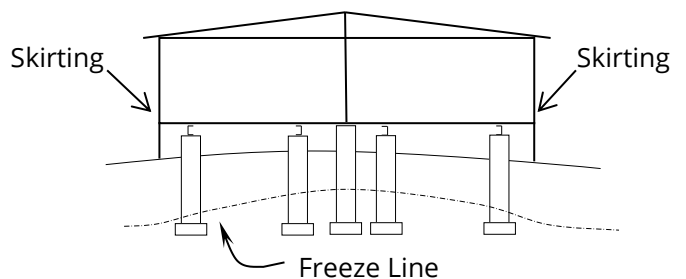
Economical and easy to construct, both pier and strip foundations are popular foundation systems for manufactured housing in Pennsylvania. They typically consist of a concrete footer or pad to spread the weight of the building over a larger area and a masonry or concrete pier or wall constructed on top of the footer or pad.

Pier and Strip Foundations with Skirting

When a stiff continuous skirting is provided, it provides protection for the foundation from the winter winds and creates a buffered space under the house. This buffered space retards heat loss from the earth under the house even if the house is not heated for a winter. Heat loss through the insulated floor of the house will also help temper this space. The net result is that the freeze depth of the soil line under the house is raised. However, manufacturer requirements for foundation ventilation may reduce the overall insulating effect of the skirting. Therefore, ventilated skirting cannot be relied upon to protect foundations from frost effects.

Additionally, the skirting will permit neither snow nor vegetation or other ground cover below the house. Vegetation around the house may be sparse in places and will have only a minimal effect on the freeze line. The snow directly around the skirting will melt fairly quickly, though it will have some insulating effect.

If insulation is installed behind the skirting, its presence will also contribute to reducing the freeze depth around the house. However, at this point, the effect of insulated skirting is ignored in determining extreme freeze depth, for a couple of reasons. First, most studies done to date have focused on heated structures, but in reality a house may not be heated during a winter at some point in its life. Second, the insulated skirting may be replaced with a different material by a future owner. In both cases, the foundation may be susceptible to frost damage. The foundation of any structure must be designed and constructed so it will perform for at least the life of the structure.



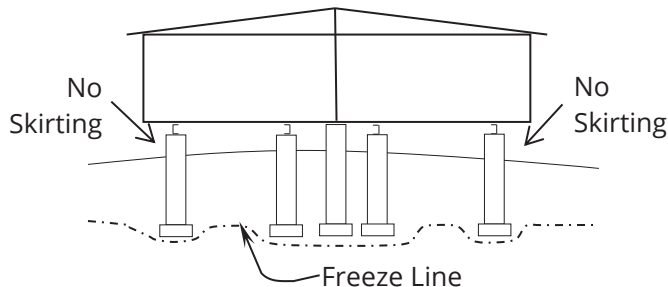
Pier and Strip Foundations With Skirting

For manufactured houses constructed with **pier or strip foundations with skirting**, the bottom of the foundation should be constructed at least as deep as the values shown in **Map 1**.

Note: The skirting has a tempering effect on freeze depth, which increases as the distance from the skirting increases. Accordingly, those portions of the foundation that are set 6 feet or more inward from the skirting may be 12 inches shallower than the depths shown in Map 1. However, **a depth of at least 18 inches should be maintained** to provide adequate bearing capacity of the soil.

Pier and Strip Foundations Without Skirting

The frost around the foundation is likely to go deeper when the unit is constructed without skirting. Why? Because the concrete or masonry portions of the foundation above the ground conduct heat very well, they draw heat from the earth directly around the foundation and release it to the outside air. Also, the earth under the house will be shaded and will not be warmed by the sun; it will be exposed to winter winds and will not be covered by snow or vegetation that would insulate the heat loss from the ground. If a foundation is to be constructed in this manner, the bottom of the pier or foundation will have to be considerably deeper than a foundation protected by skirting.

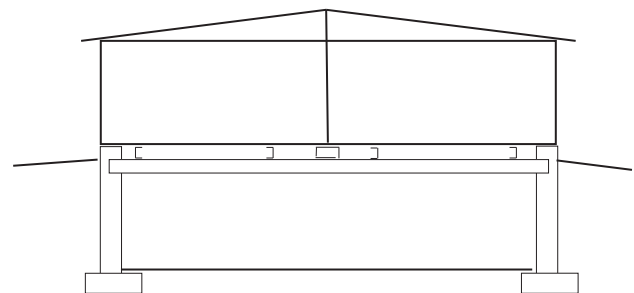


Pier and Strip Foundations Without Skirting
 For manufactured houses constructed with **pier or strip footings without skirting**, the foundations should be constructed at least as deep as the values shown in **Map 2**.
Note: Porches and other non-heated external structures will behave in a manner similar to that of foundations without skirting. So they should also be designed to **Map 2**. See below for notes on ancillary structures.

Perimeter Foundations, Basements & Crawlspaces

Perimeter foundations are usually constructed of masonry blocks, cast-in-place concrete, or precast concrete. These foundation systems are similar to those of site-built houses. The heat loss from the basement or crawlspace helps retard the freeze penetration around the foundation.

However, if a house is not heated for a winter, the freeze depth around the foundation may actually be slightly deeper than in the surrounding soil. Again, the basement wall conducts heat from the basement and the surrounding soil to the outside air. If it is possible or likely that the house will be unheated during the winter months, the foundation depth should be increased.



Perimeter Foundations
 For manufactured houses constructed with a continuous perimeter foundation, the bottom of the foundation at the perimeter should be located at least as deep as the values shown in **Map 1**.

OTHER CONSIDERATIONS

Frost Protected Shallow Foundations: Section R403.3 of the 2009 IRC, which addresses Frost Protected Shallow Foundations, does not apply to manufactured housing.

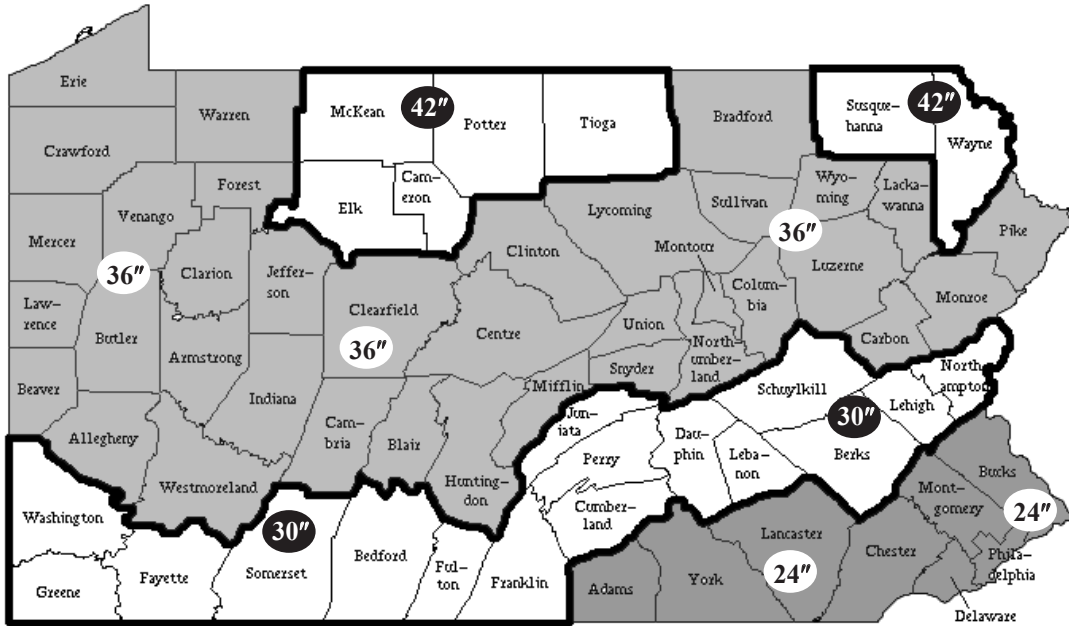
Local Code Requirements: Check with local municipalities where the house is to be located to see if they require other minimum foundation depths for manufactured housing. If so, local requirements should be followed.

Encountering Rock: When excavating or boring for the foundation, builders may encounter rock or an outcropping of rock. In such cases, the foundation may be built on the cleaned rock surface without being placed to the full depth required by either Map 1 or Map 2. However, if the rock outcropping appears to be restricted to only a limited portion of the site, more excavation should be done to find out whether the rock is large enough to support the load imposed by the house.

Ancillary Structures: The foundations of ancillary structures, such as porches or other non-heated external structures, will behave like pier and strip foundations constructed without skirting. They should be designed to Map 2.

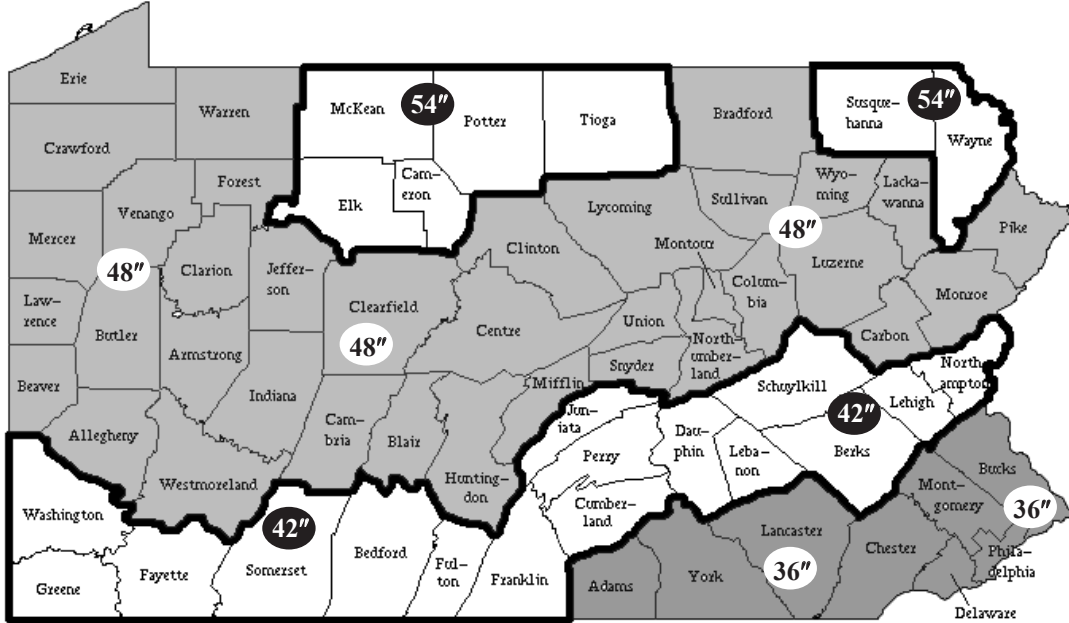
Water Hazards: Wet areas and areas with a high water table should be avoided. These areas may be identified through vegetation (such as cattails, marsh grass or willow trees) or if water is found when excavating or boarding for the foundation. If the site must be built on, a design professional should be consulted.

Map 1: Soil Freeze Depths for Pier and Strip Foundations With Skirting and Perimeter Foundations



Note: Based on a 25-year return period.

Map 2: Soil Freeze Depths for Pier and Strip Foundations Without Skirting



Note: Based on a 25-year return period.

Disclaimer:

The Pennsylvania Housing Research Center (PHRC) exists to be of service to the housing community, especially in Pennsylvania. The PHRC conducts technical projects—research, development, demonstration, and technology transfer—under the sponsorship and with the support of numerous agencies, associations, companies and individuals. Neither the PHRC, nor any of its sponsors, makes any warranty, expressed or implied, as to the accuracy or validity of the information contained in this report. Similarly, neither the PHRC, nor its sponsors, assumes any liability for the use of the information and procedures provided in this report. Opinions, when expressed, are those of the authors and do not necessarily reflect the views of either the PHRC or anyone of its sponsors. It would be appreciated, however, if any errors, of fact or interpretation or otherwise, could be promptly brought to our attention.