

# Buttoning up after the Flood

Oct, 3 2011

# Concerns

- Structural
- Snow
- Frost heave

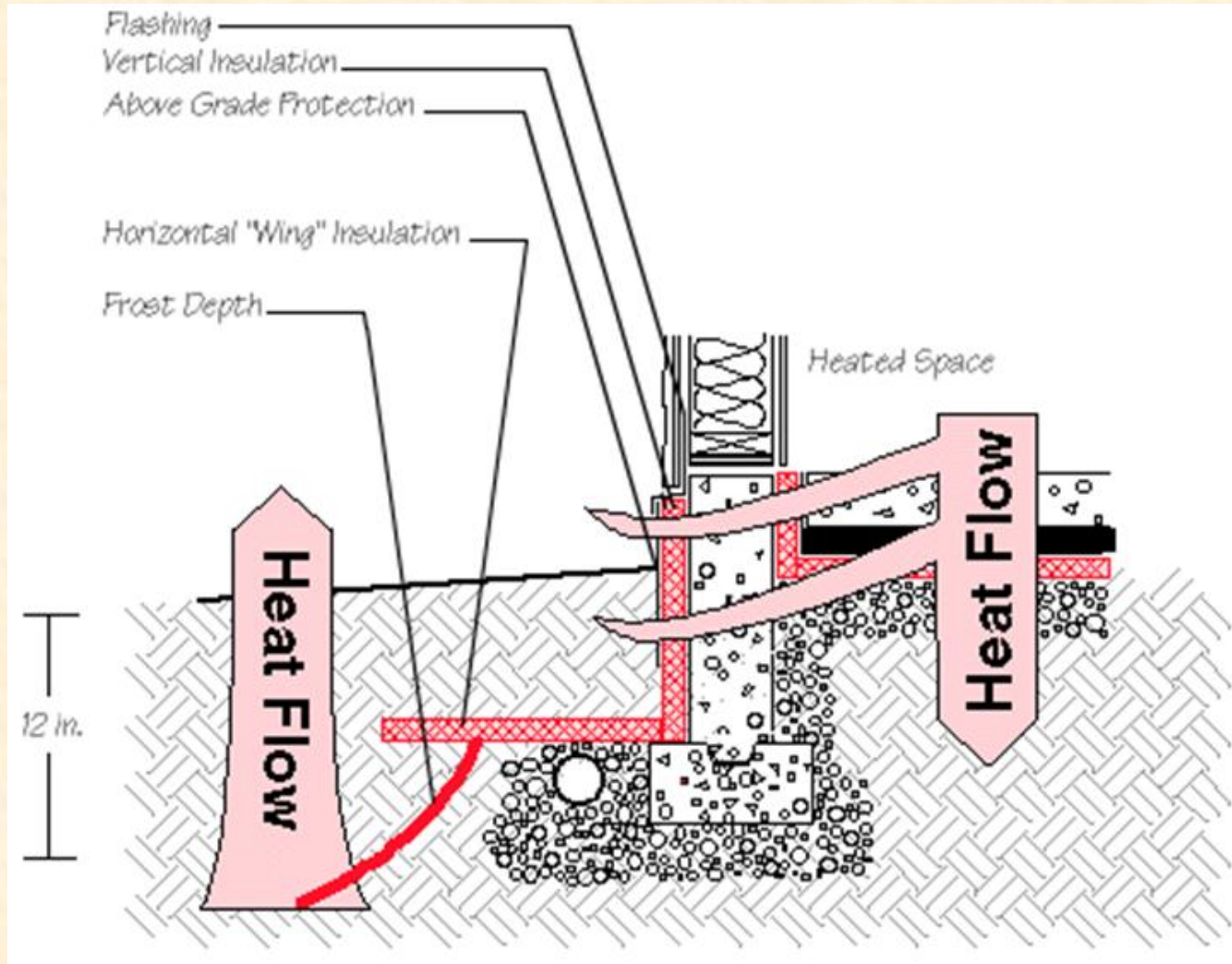


# Control Humidity

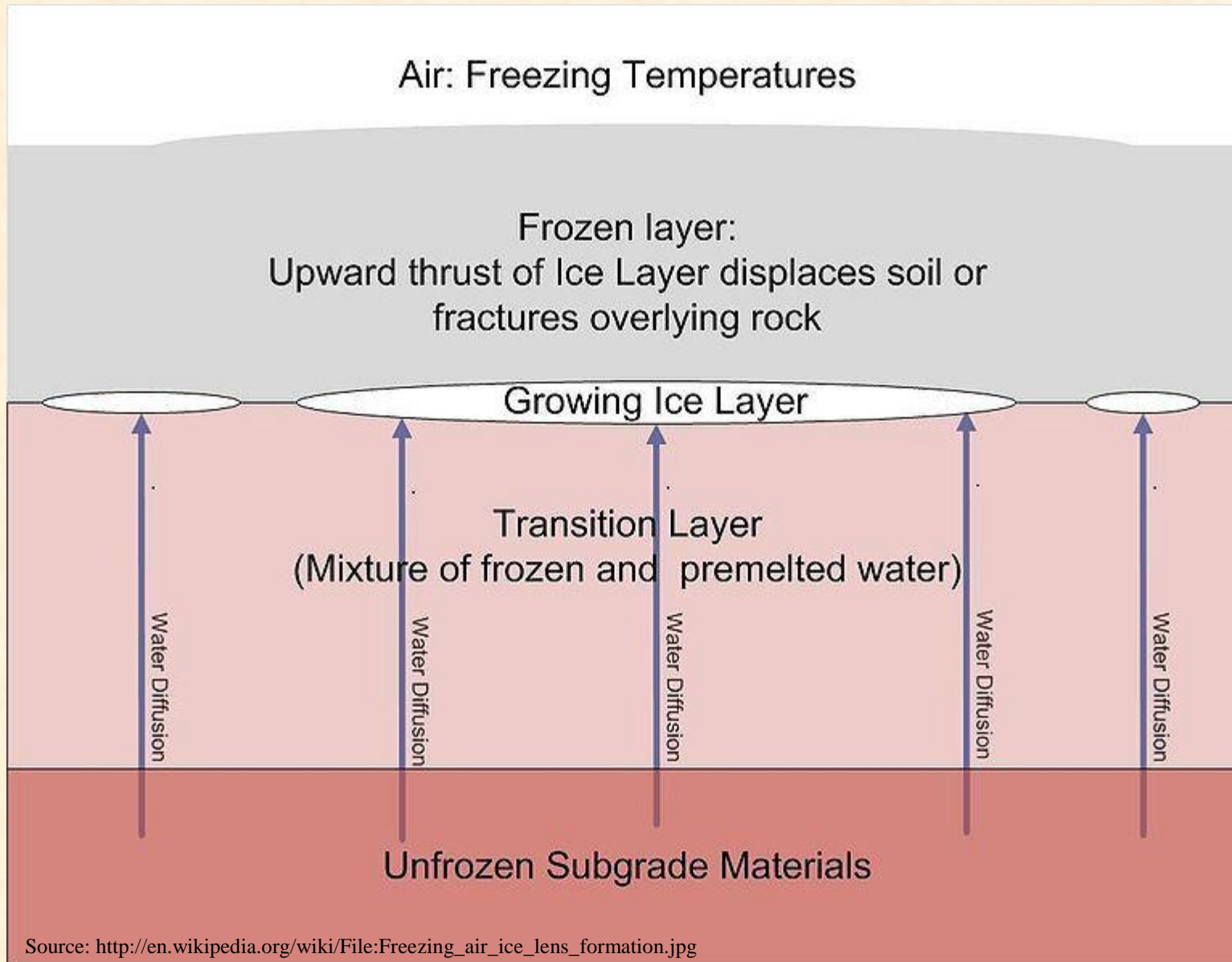
- Ventilate and Dry to prevent mold growth
- Condensation



# Footing



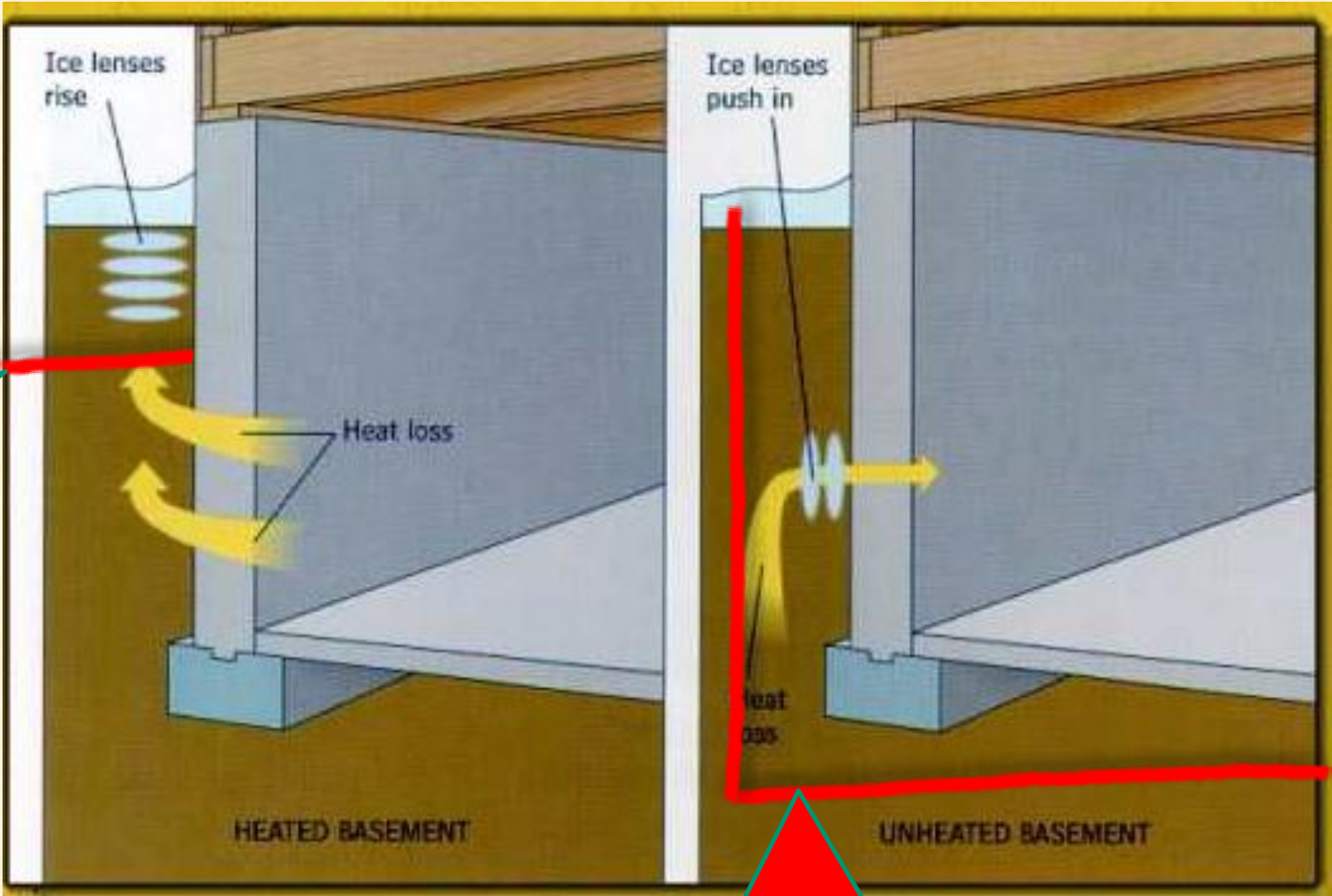
# Frost lenses



# Frost lenses

Needs

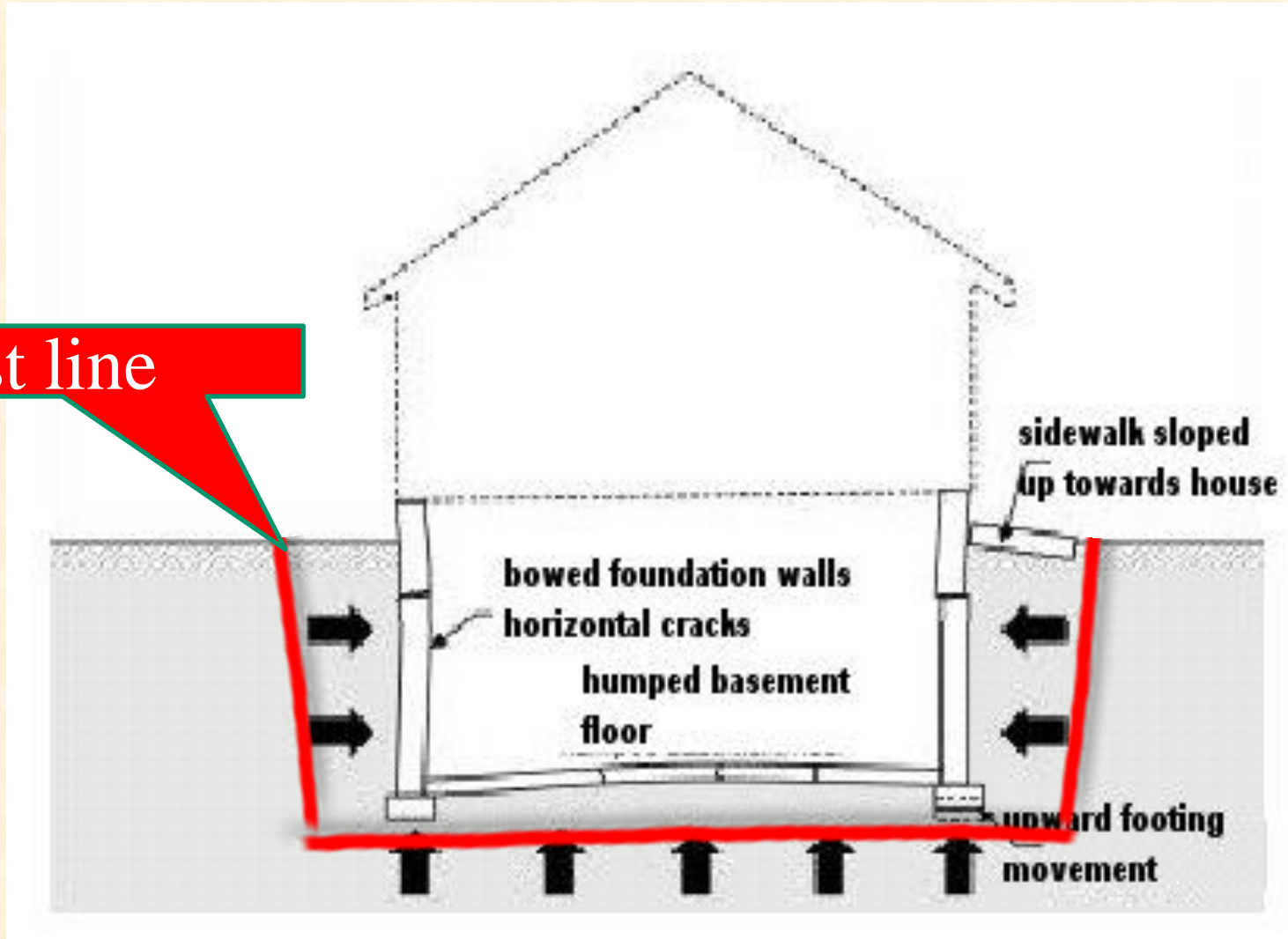
- Moisture
- Freezing
- Right soil



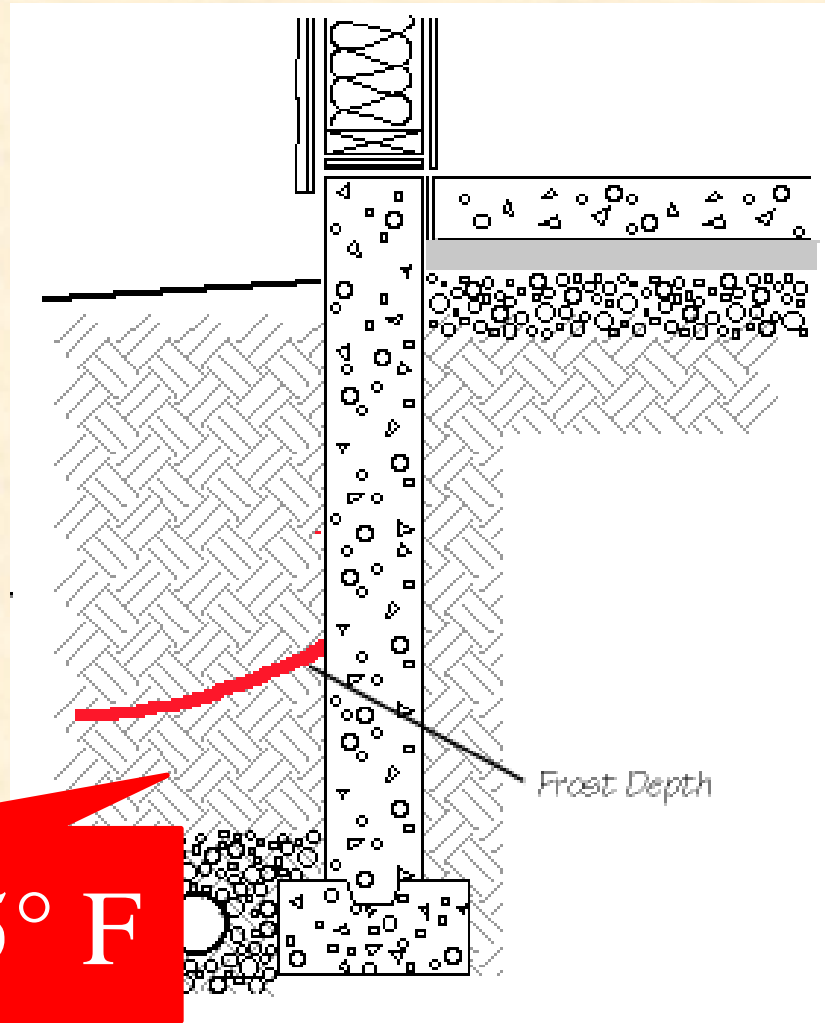
Normal Frost line

Frost line

# Frost Heave



# Typical Footing

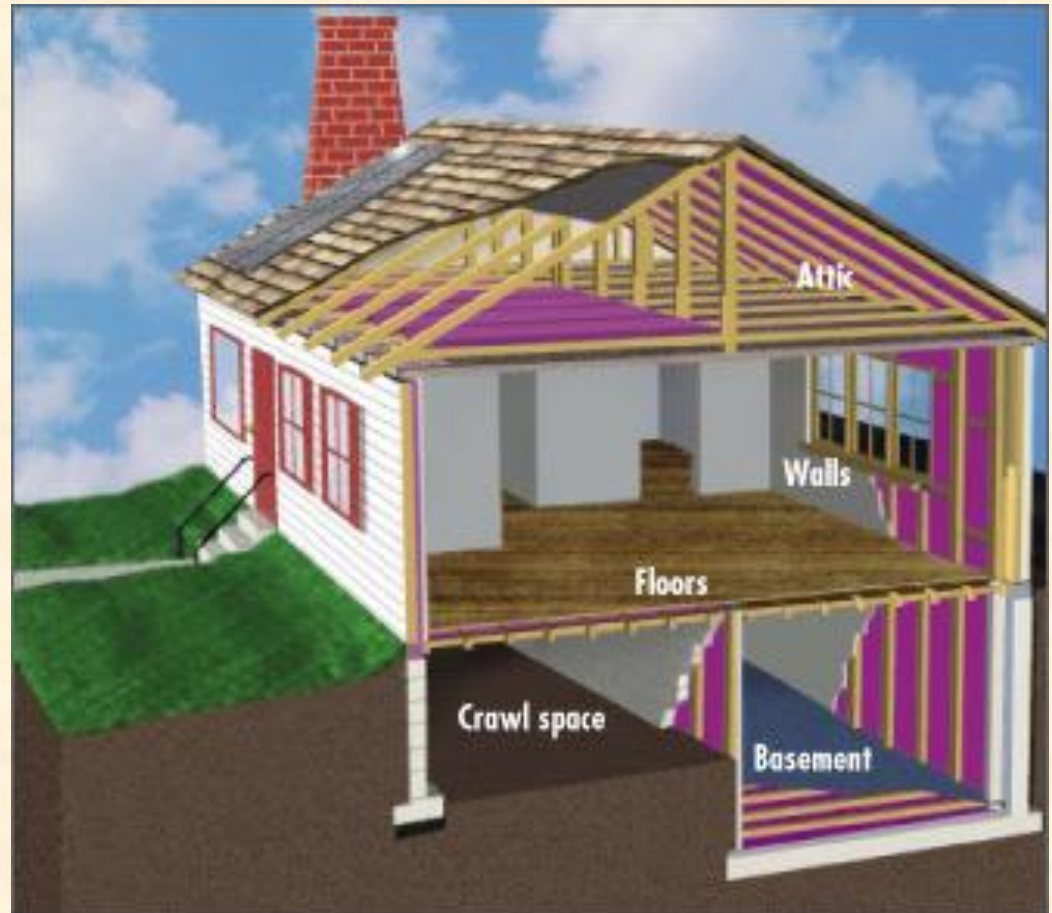


Ground ~ 45° F



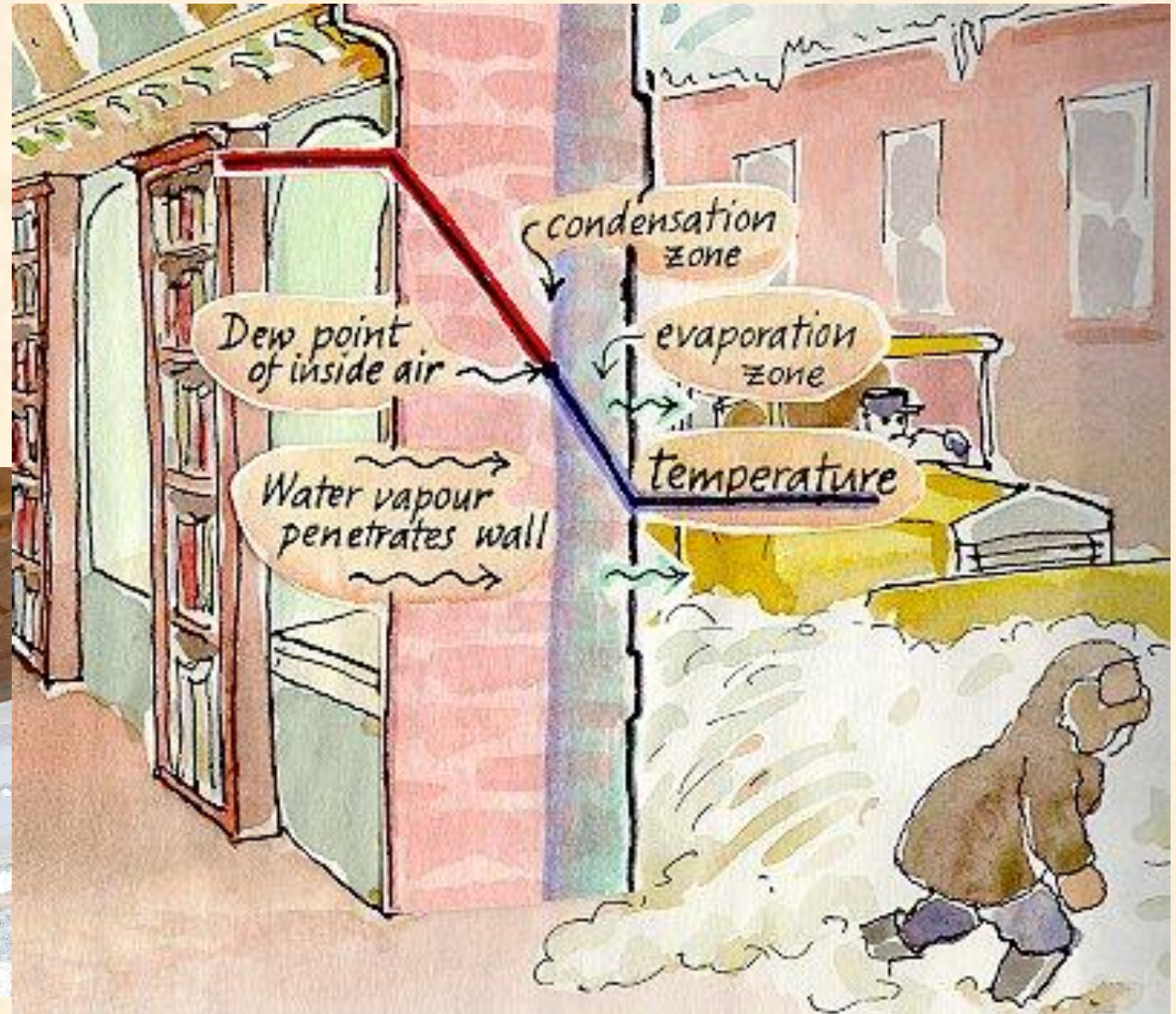
# Preventing Frost Heave

- Insulate and heat
- Outside or inside?



# Concerns

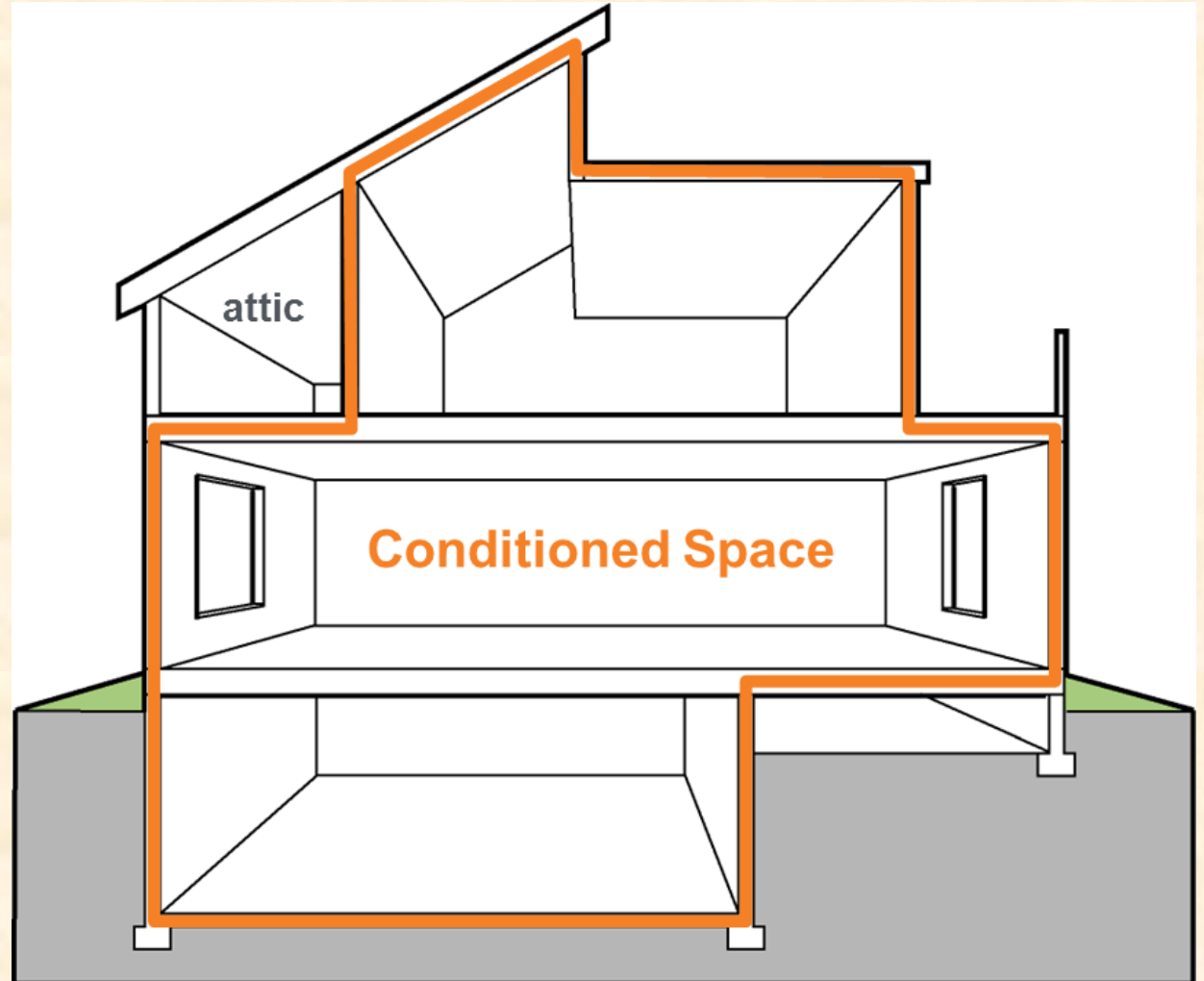
- Condensation  
– cold and wet





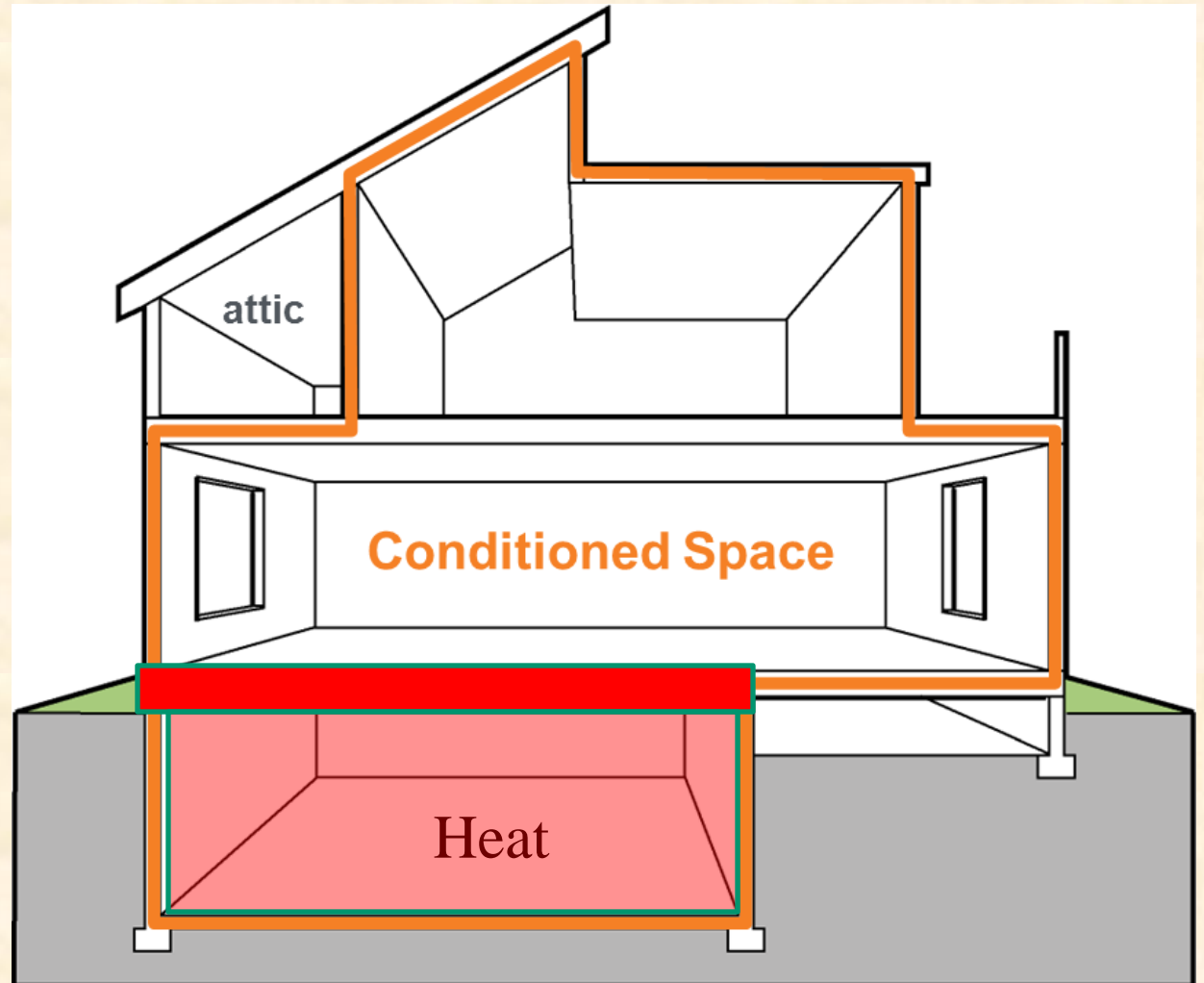
# Building Envelope Specific Requirements

- Building Envelope consists of:
  - Ceilings
  - Walls
    - Above grade
    - Below grade
    - Mass walls
  - Fenestration
  - Floors
  - Slab
  - Crawl space



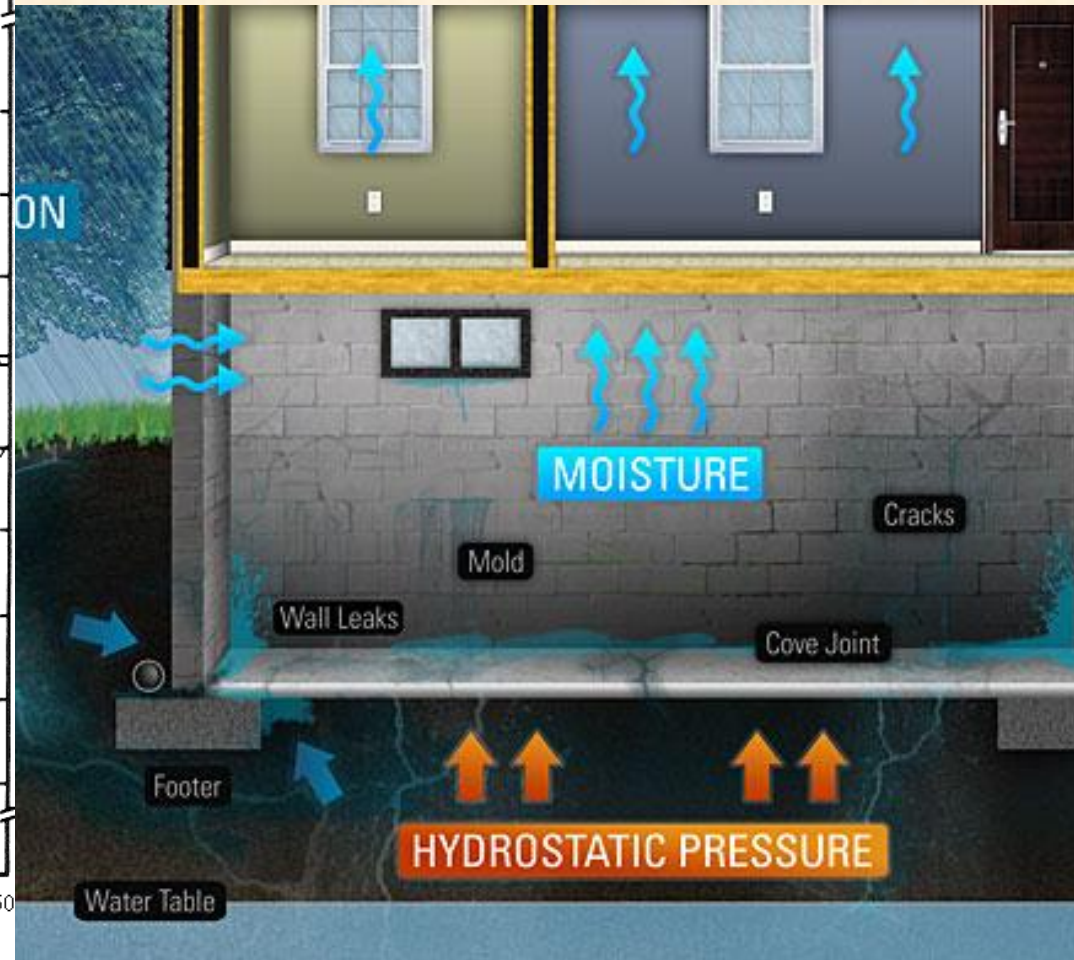
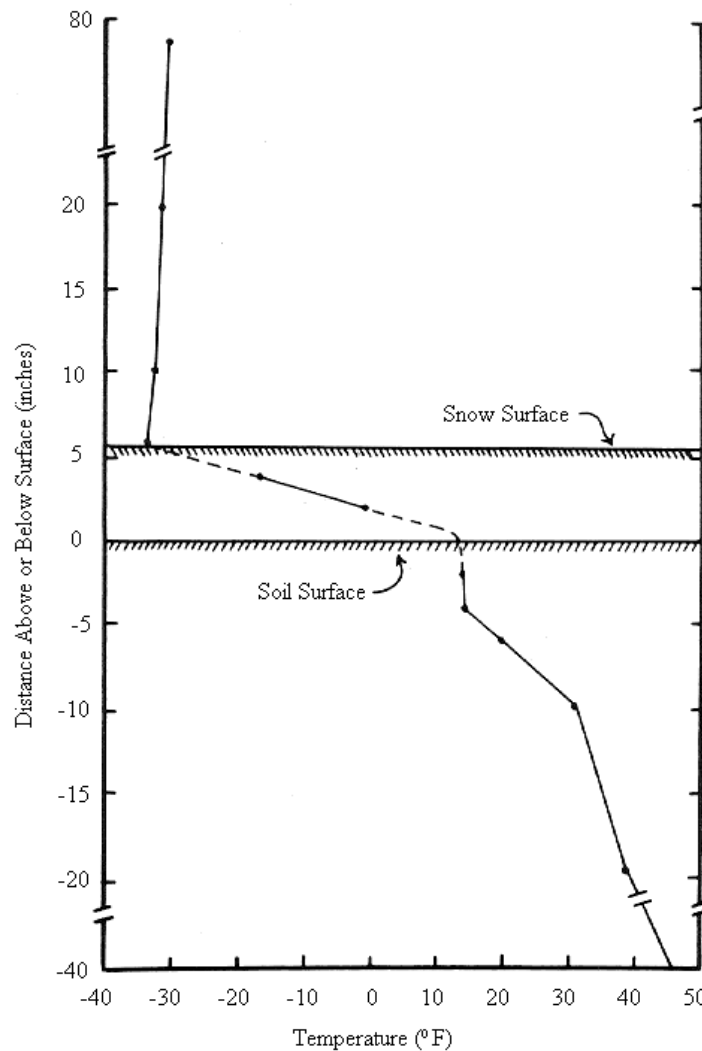
# Building Envelope Specific Requirements

- Building Envelope consists of:
  - Ceilings
  - Walls
    - Above grade
    - Below grade
    - Mass walls
  - Fenestration
  - Floors
  - Slab
  - Crawl space

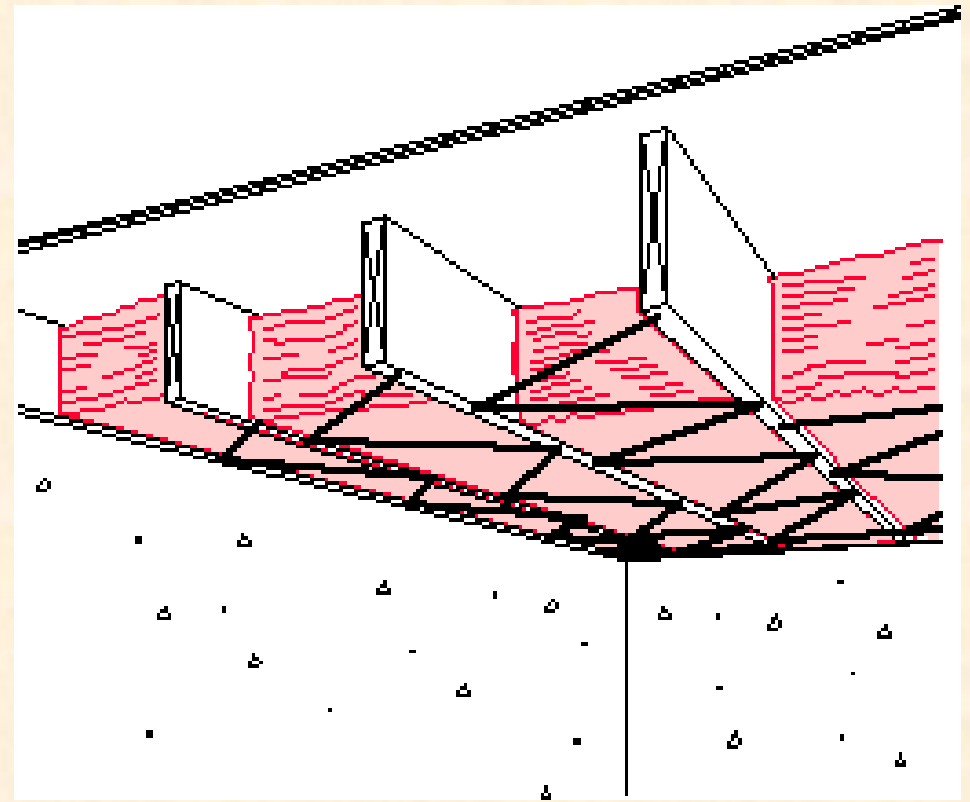


# Snow as insulation

Figure 24. Mean soil temperatures at Fargo, North Dakota in Fargo Silty Clay for the



# Insulation



# Vapor Retarder

- 6 mil poly
- Slows moisture
- Reduce mold growth
- Warm Side!!!!





### Expanded Polystyrene



#### **EPS is cheap and effective**

EPS is the least expensive and most vapor-permeable of the three types of rigid foam.

One inch of EPS has a permeance of 2.0 to 5.8 perms, making it a semi-permeable material.

R-value: 3.6 to 4.2 per in., depending on density

**EXPANDED POLYSTYRENE**

### Extruded Polystyrene



#### **XPS is versatile, tough, and waterproof**

Because of its high compressive strength and water resistance, XPS is often used below grade to insulate slabs and foundation walls.

One inch of XPS has a permeance of 1.1, while 2 inches have a permeance of 0.55, making XPS a semi-impermeable material.

R-value: R-5 per in.

**EXTRUDED POLYSTYRENE**

### Polyisocyanurate



#### **Polyiso is the most environmentally benign**

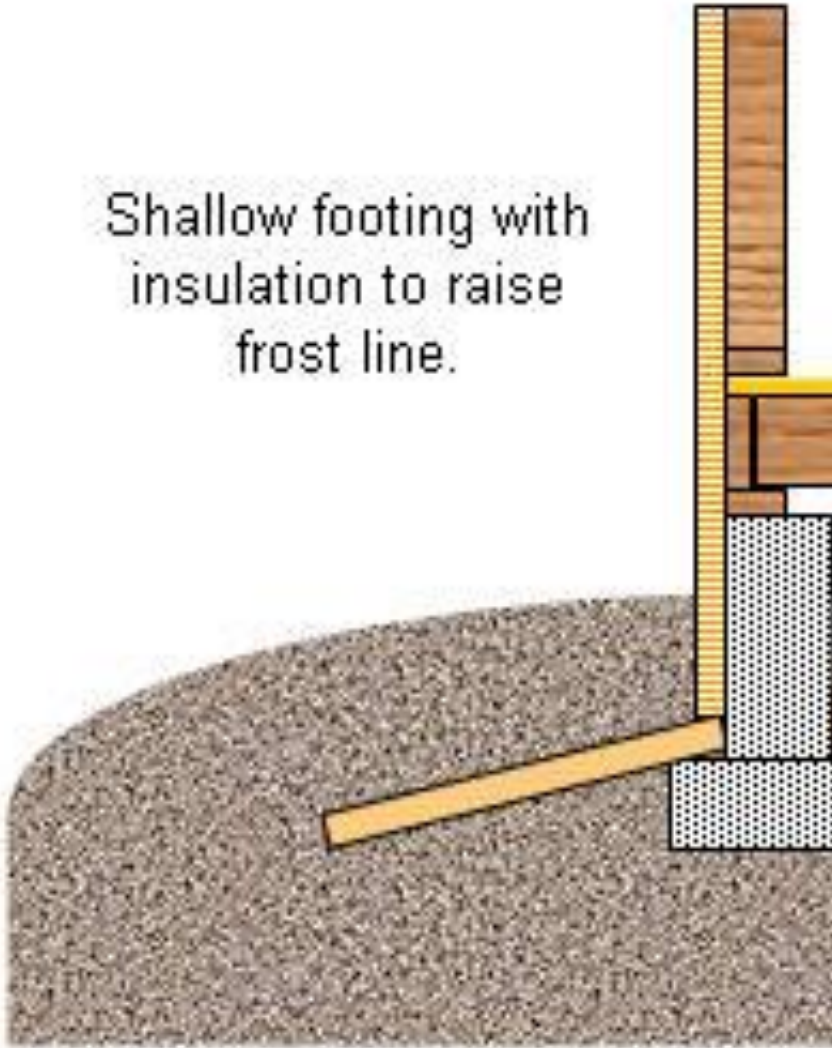
Polyiso doesn't use ozone-depleting blowing agents; it uses water.

Because it can absorb water, polyiso is not recommended for below-grade applications. The foil facing, however, makes it an excellent exterior drainage plane, as long as seams are taped.

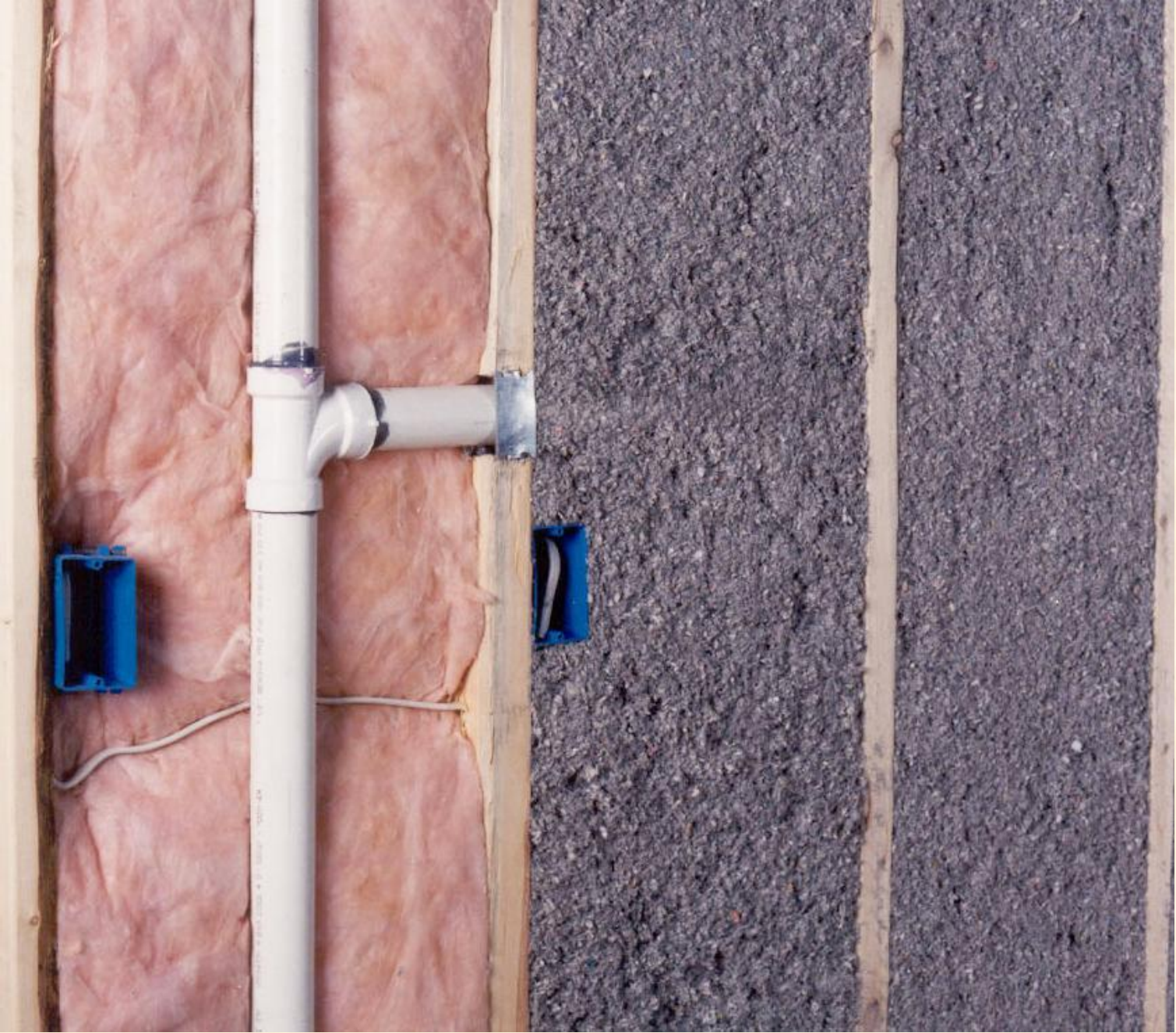
R-value: up to R-6.5 per in.

**POLYISOCYANURATE**

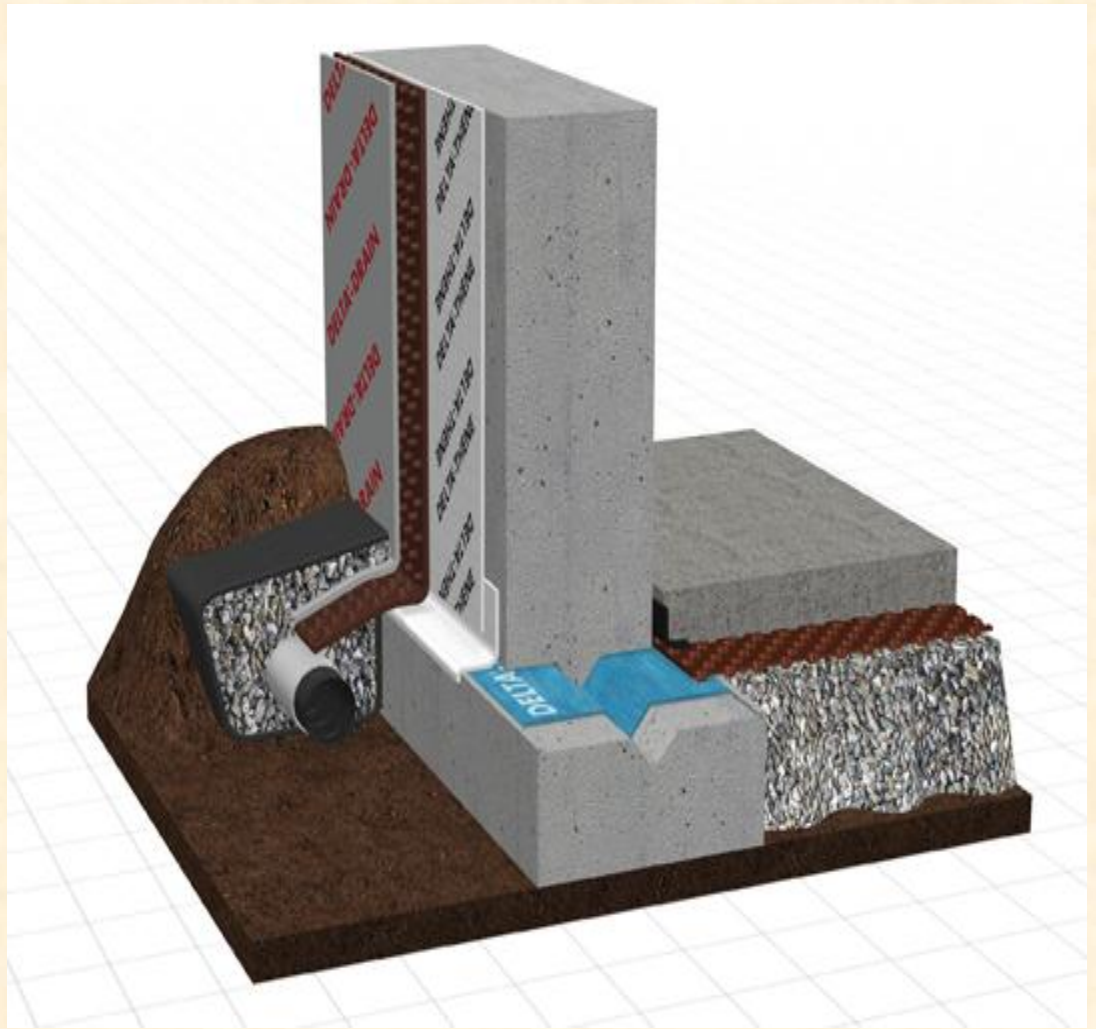
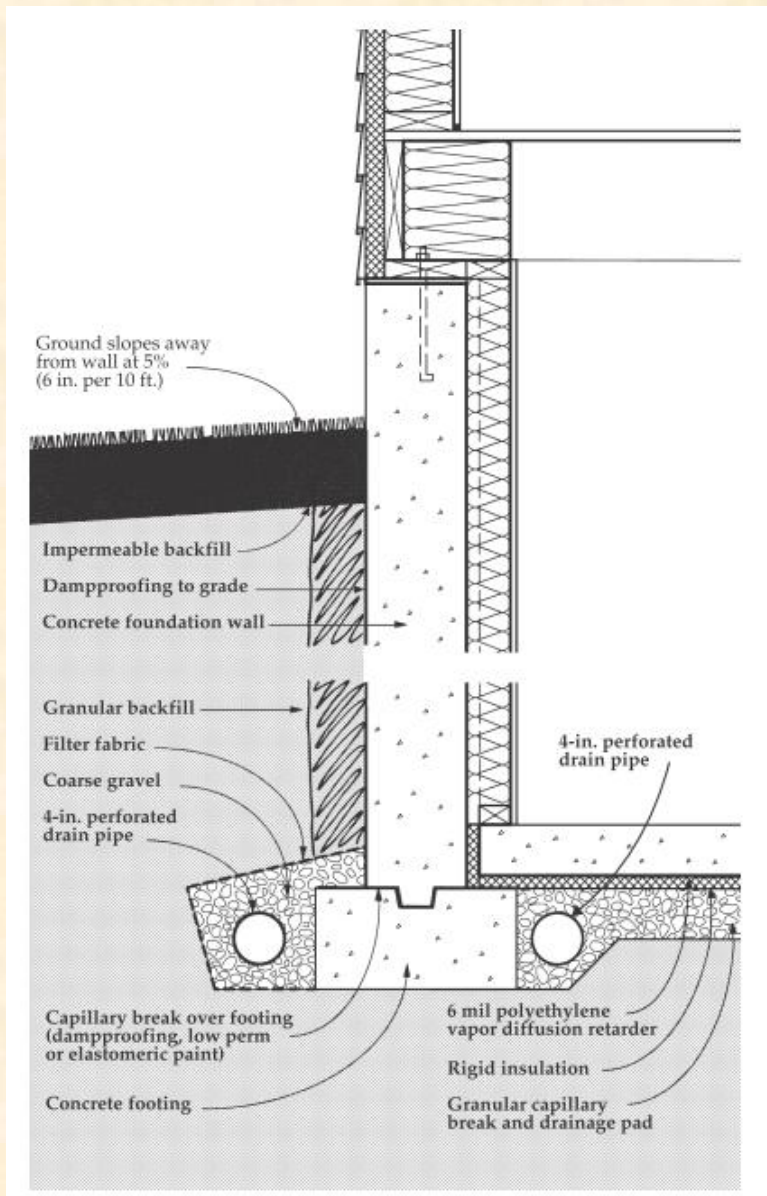
Shallow footing with  
insulation to raise  
frost line.



















SUMP PUMP

6-MIL POLY

BASEMENT WALL

FLOOR EDGING

CONCRETE PATCH

DRAINAGE TUBING

CONCRETE FOOTING

# Heating

- 35-40° F
- Moisture – burning a fuel
  - Ventilate
  - ½ gallon of water for each gallon of fuel
- Electric heat



# Safety!!!!!!!!!!

- Fire hazards
- Carbon monoxide
- Moisture

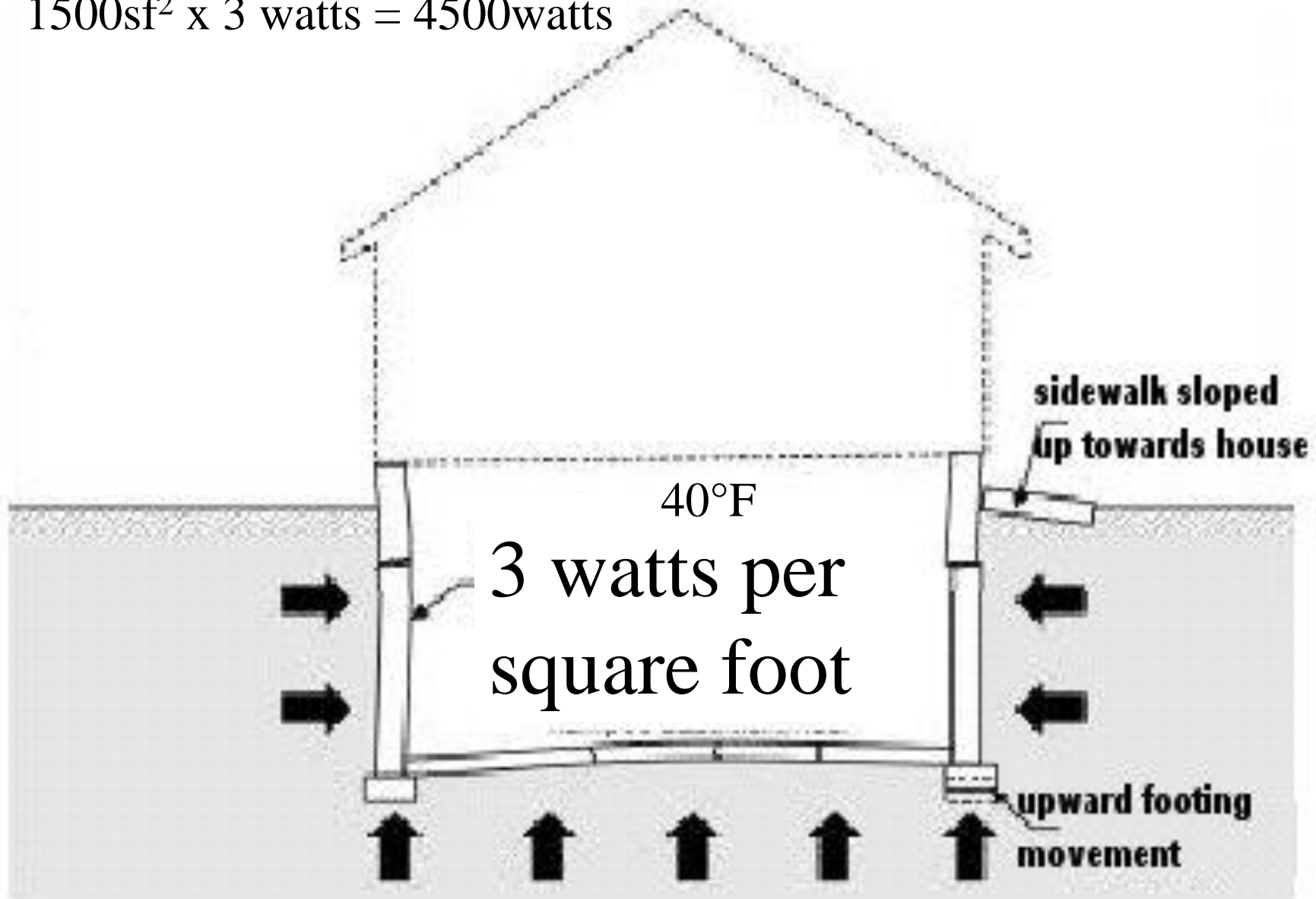


# Heat loss calculator - 70°F

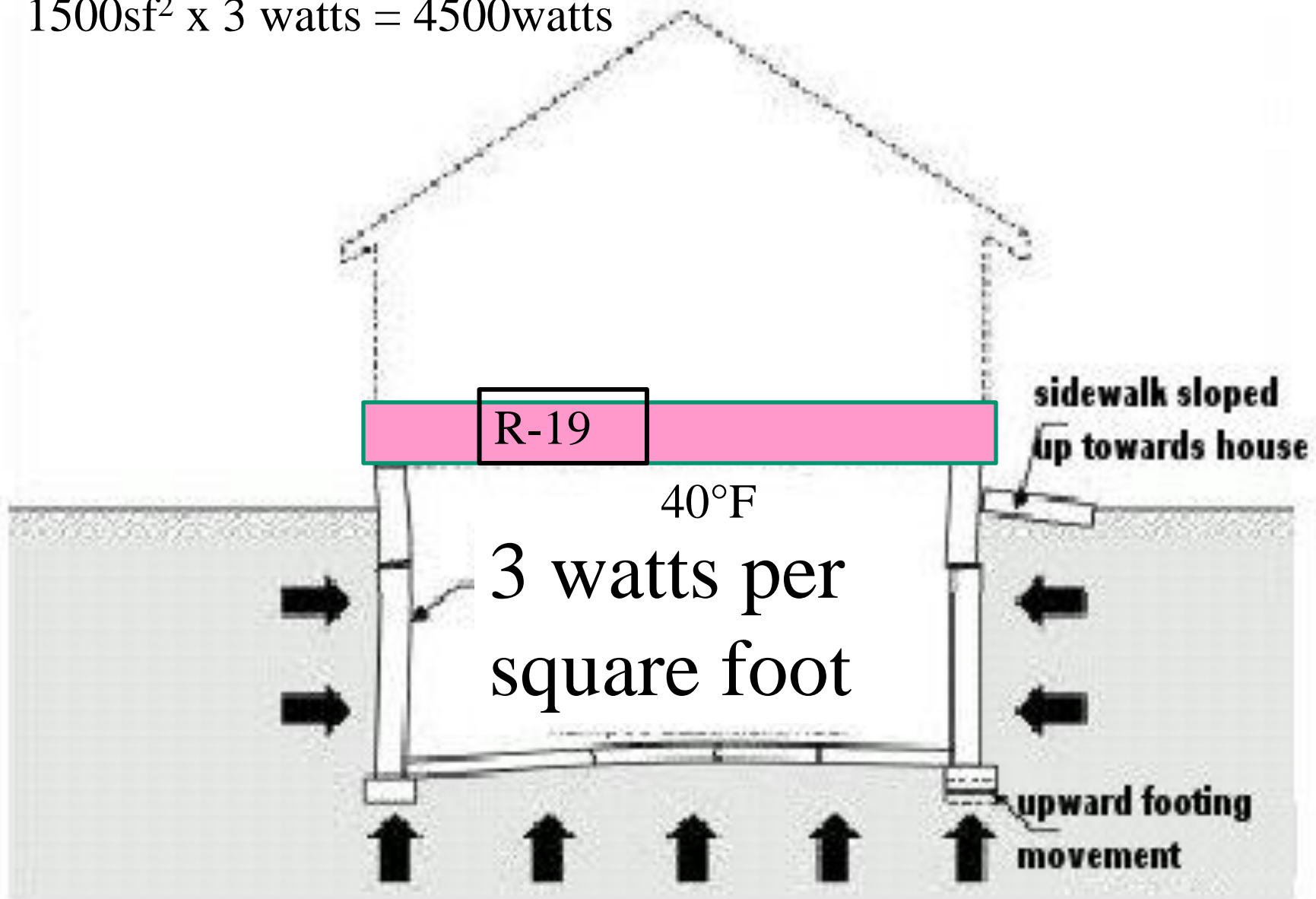
- Electric heat – very rough 10 watts / square foot
  - 1000sf<sup>2</sup> X 10 watts = 10,000 watts
  - 1500 watt heater = ~7 heaters
- Local contractors – utility company



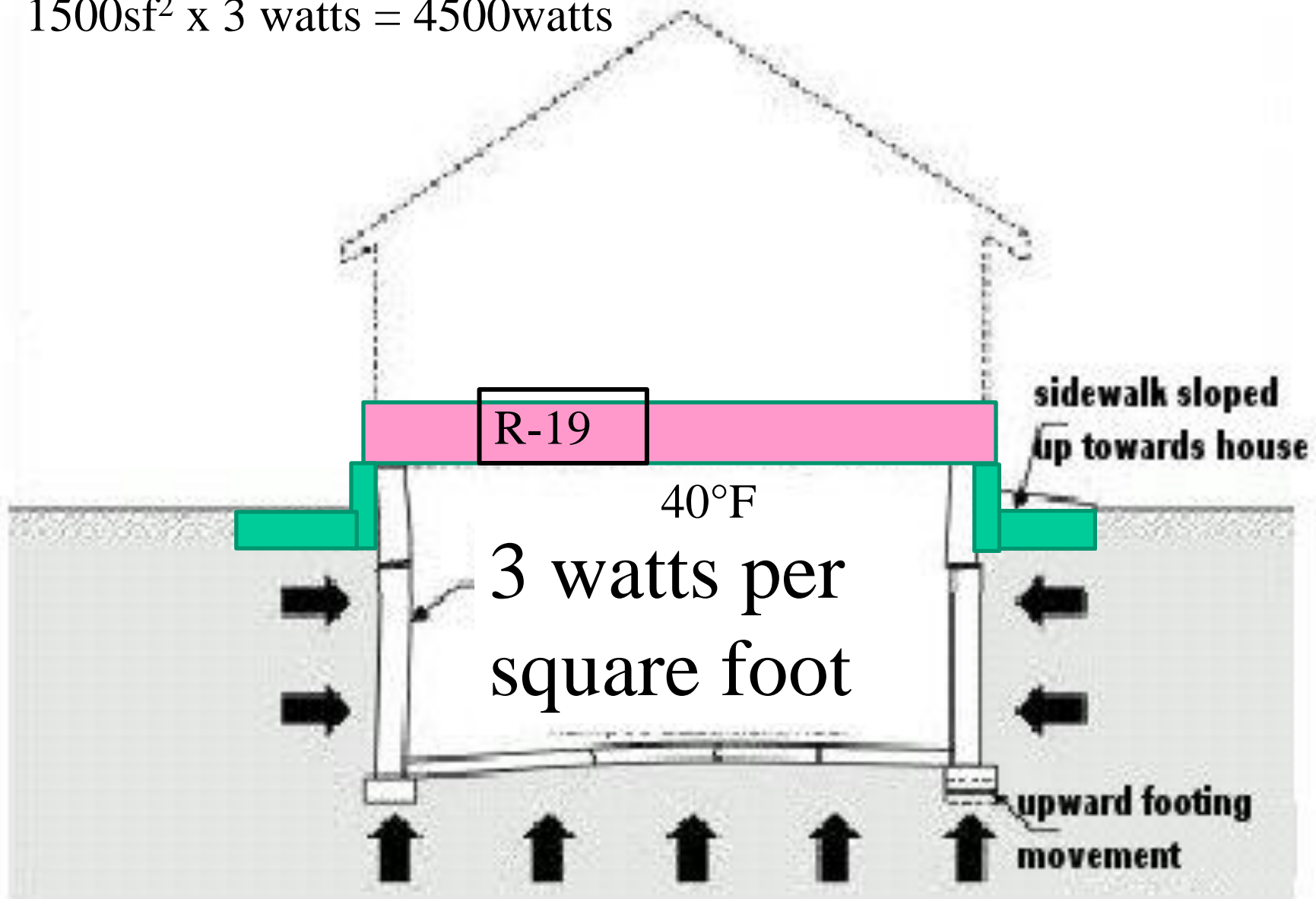
$1500\text{sf}^2 \times 3 \text{ watts} = 4500\text{watts}$



$$1500\text{sf}^2 \times 3 \text{ watts} = 4500\text{watts}$$

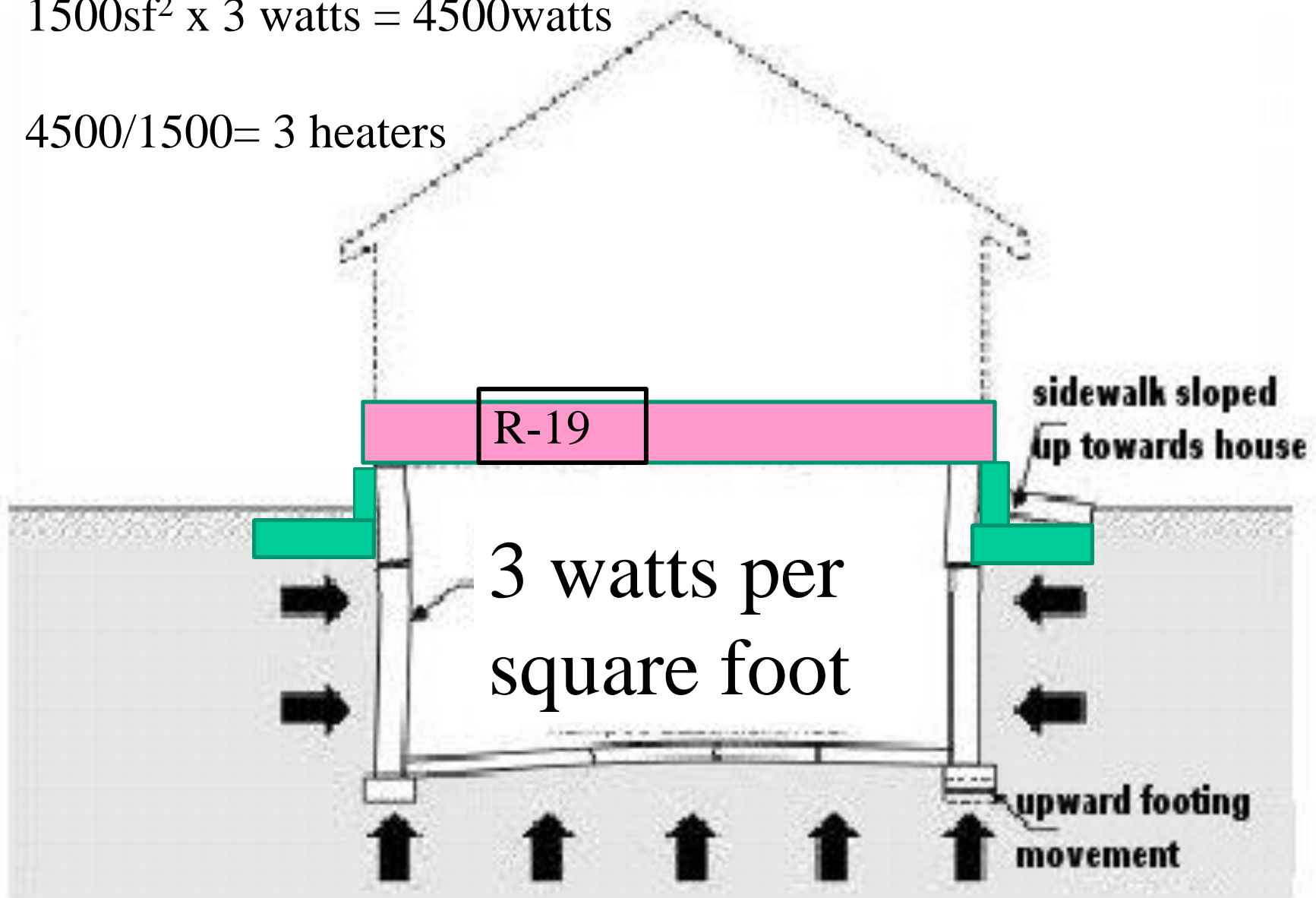


$$1500\text{sf}^2 \times 3 \text{ watts} = 4500\text{watts}$$



$$1500\text{sf}^2 \times 3 \text{ watts} = 4500\text{watts}$$

$$4500/1500 = 3 \text{ heaters}$$

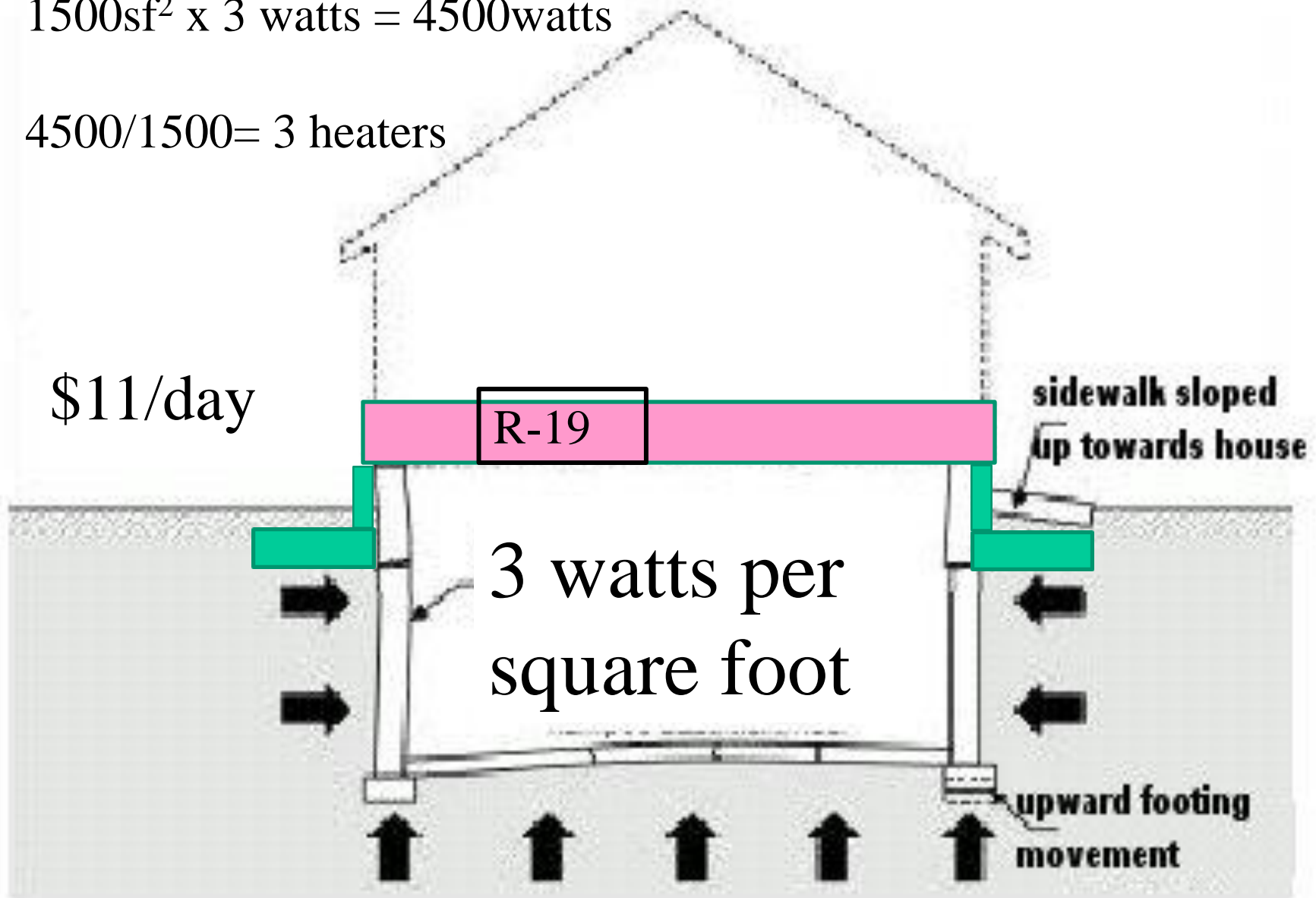




$$1500\text{sf}^2 \times 3 \text{ watts} = 4500\text{watts}$$

$$4500/1500 = 3 \text{ heaters}$$

\$11/day



# Fuel Cost Comparison

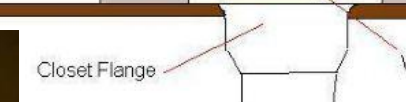
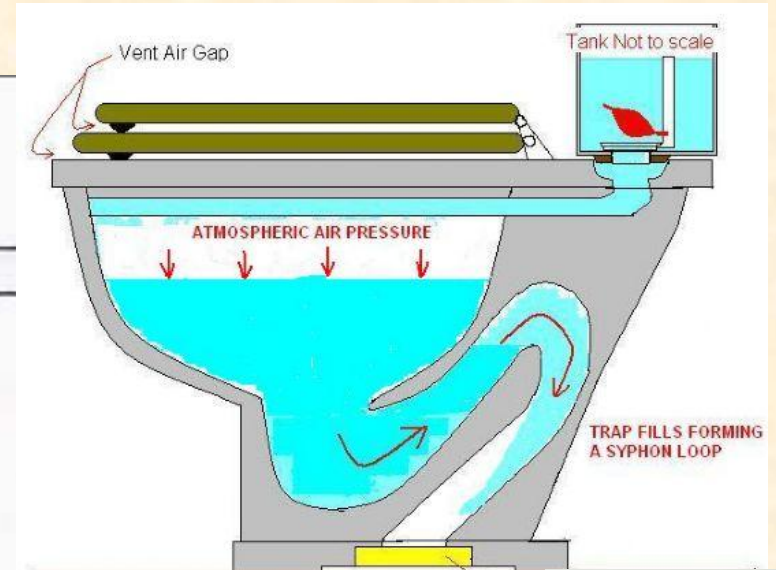
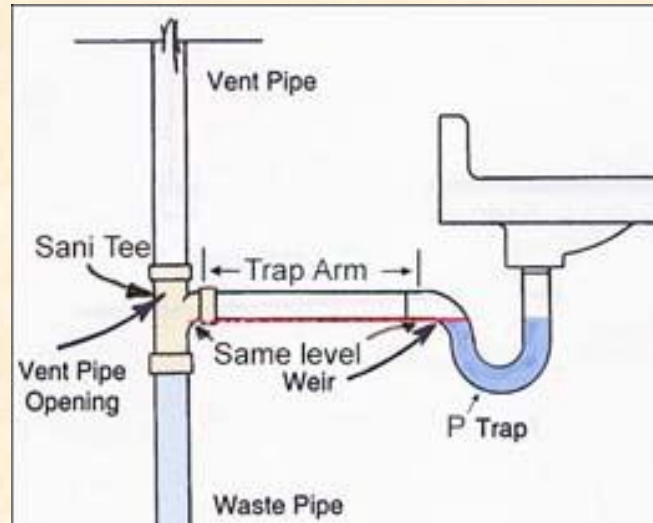
## Fuel Cost Comparison Chart

Equivalent Price of Each Fuel

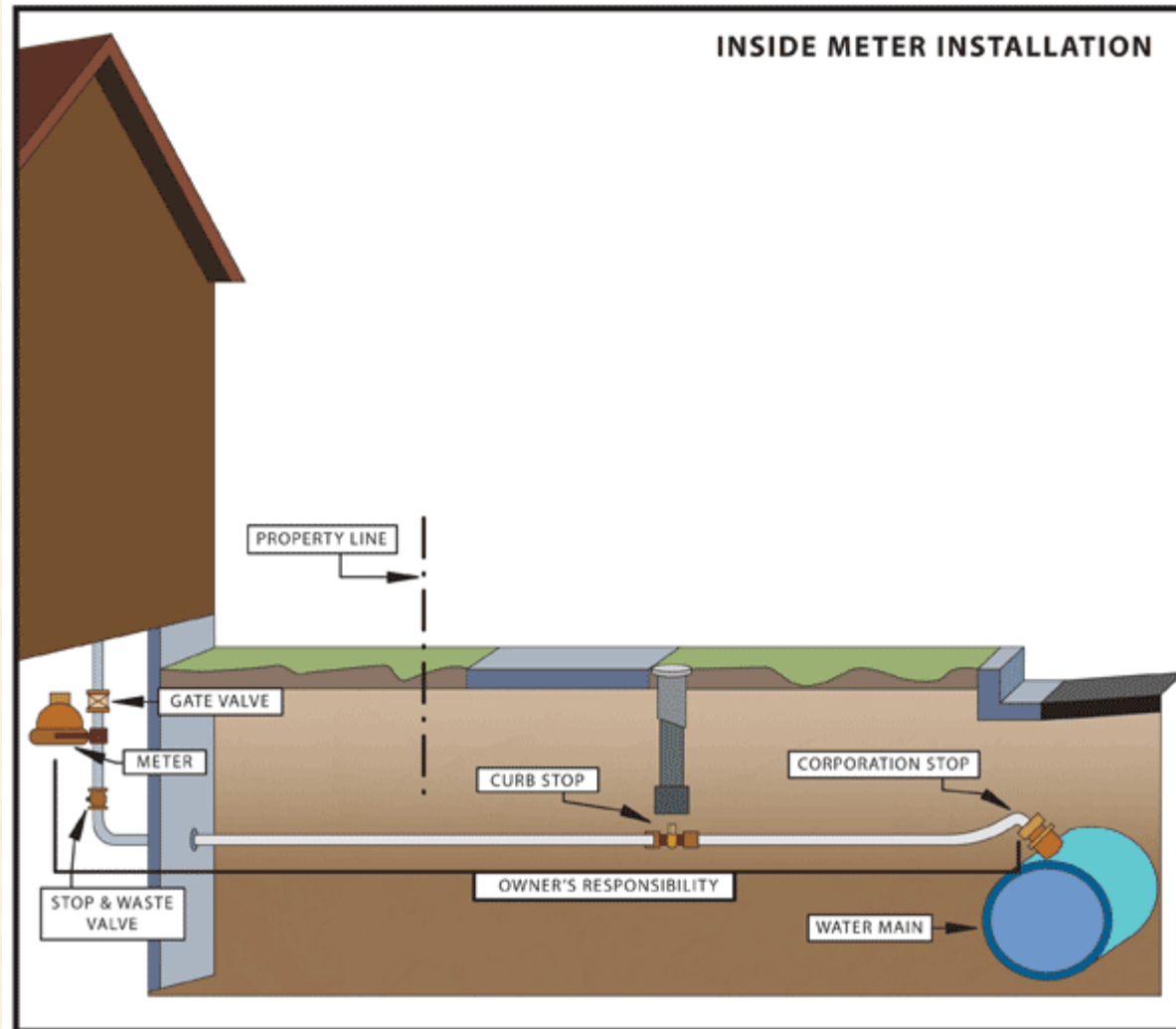
5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	Electric Resistance kWh (3
10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	Heat Pump (Air Source) kv
17.5	19.3	21.0	22.8	24.5	26.3	28.0	29.7	31.5	33.2	35.0	Heat Pump (Earth Source)
1.35	1.48	1.62	1.75	1.89	2.02	2.15	2.29	2.43	2.56	2.69	Natural Gas \$/Therm High
1.10	1.21	1.32	1.43	1.54	1.65	1.76	1.87	1.98	2.09	2.19	Natural Gas \$/Therm Low
1.38	1.52	1.66	1.80	1.94	2.08	2.21	2.35	2.49	2.63	2.76	#1 Fuel Oil (Diesel Fuel) \$/
1.43	1.58	1.72	1.87	2.01	2.15	2.30	2.44	2.58	2.73	2.87	#2 Fuel Oil and Diesel Fuel
1.01	1.11	1.21	1.31	1.41	1.51	1.62	1.72	1.82	1.92	2.02	Propane \$/Gal. (92,000 Btu
1.24	1.37	1.49	1.62	1.74	1.87	1.98	2.11	2.23	2.35	2.48	Propane \$/Gal. High Effici
0.71	0.78	0.85	0.92	0.99	1.06	1.14	1.21	1.28	1.35	1.42	Methanol \$/Gal. (64,700 B

# Winterize

- Water
  - Turn off
- Traps



# Winterize



# Questions

Carl Pedersen

[Carl.pedersen@ndsu.edu](mailto:Carl.pedersen@ndsu.edu)

(701) 231-5833



# Rebuild Right!!

- 73% of U.S electricity\*
- 40% total energy\*
- Last a long time
- Do it right now



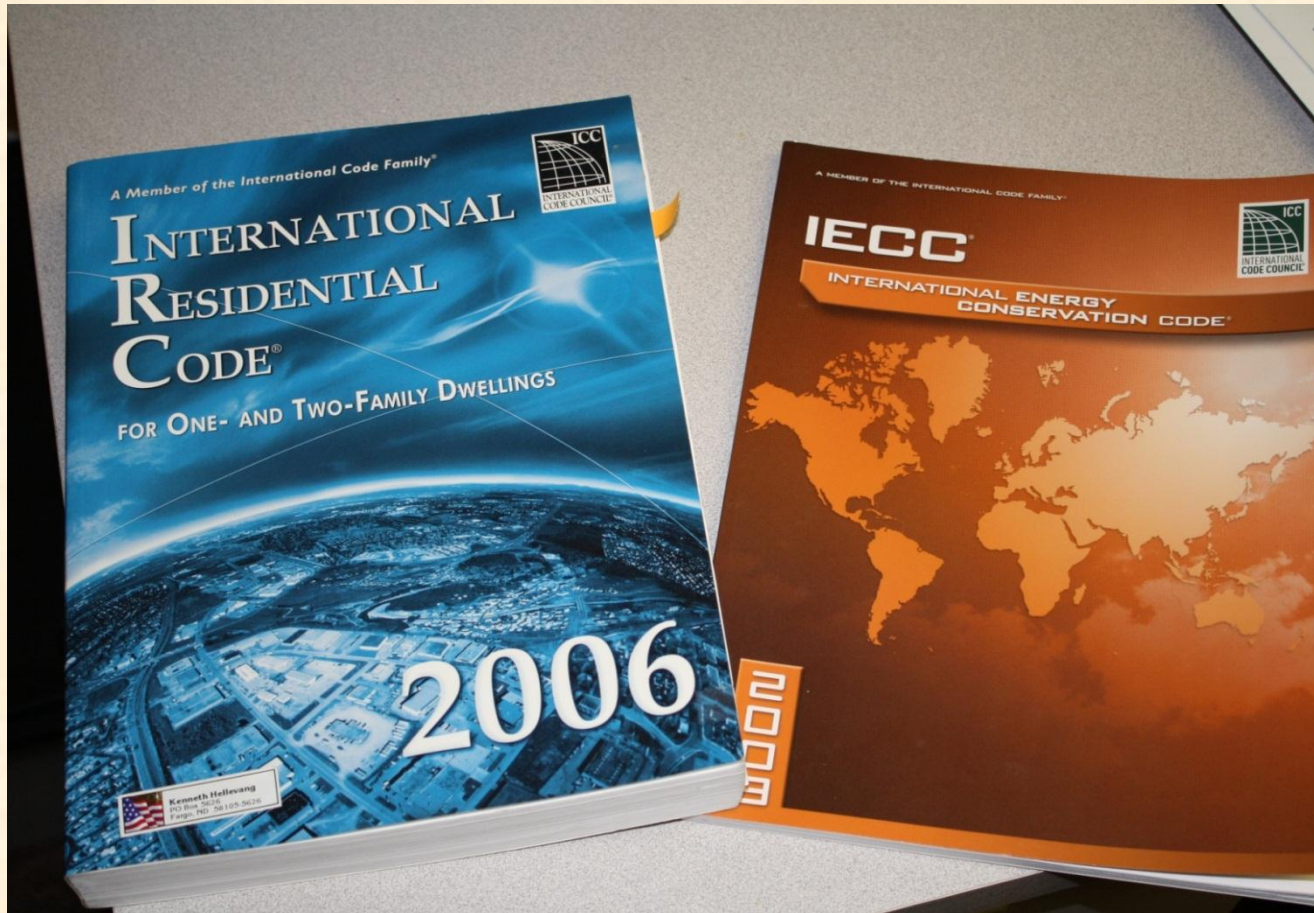
# Moisture Movement

- More to less
- Indoor – 40-60%
- Wet soil 100%
- Building materials
  - Concrete
  - Wood



# International Energy Codes

Varies by Jurisdiction



North Dakota  
DEPARTMENT OF COMMERCE

North Dakota  
State Building Code

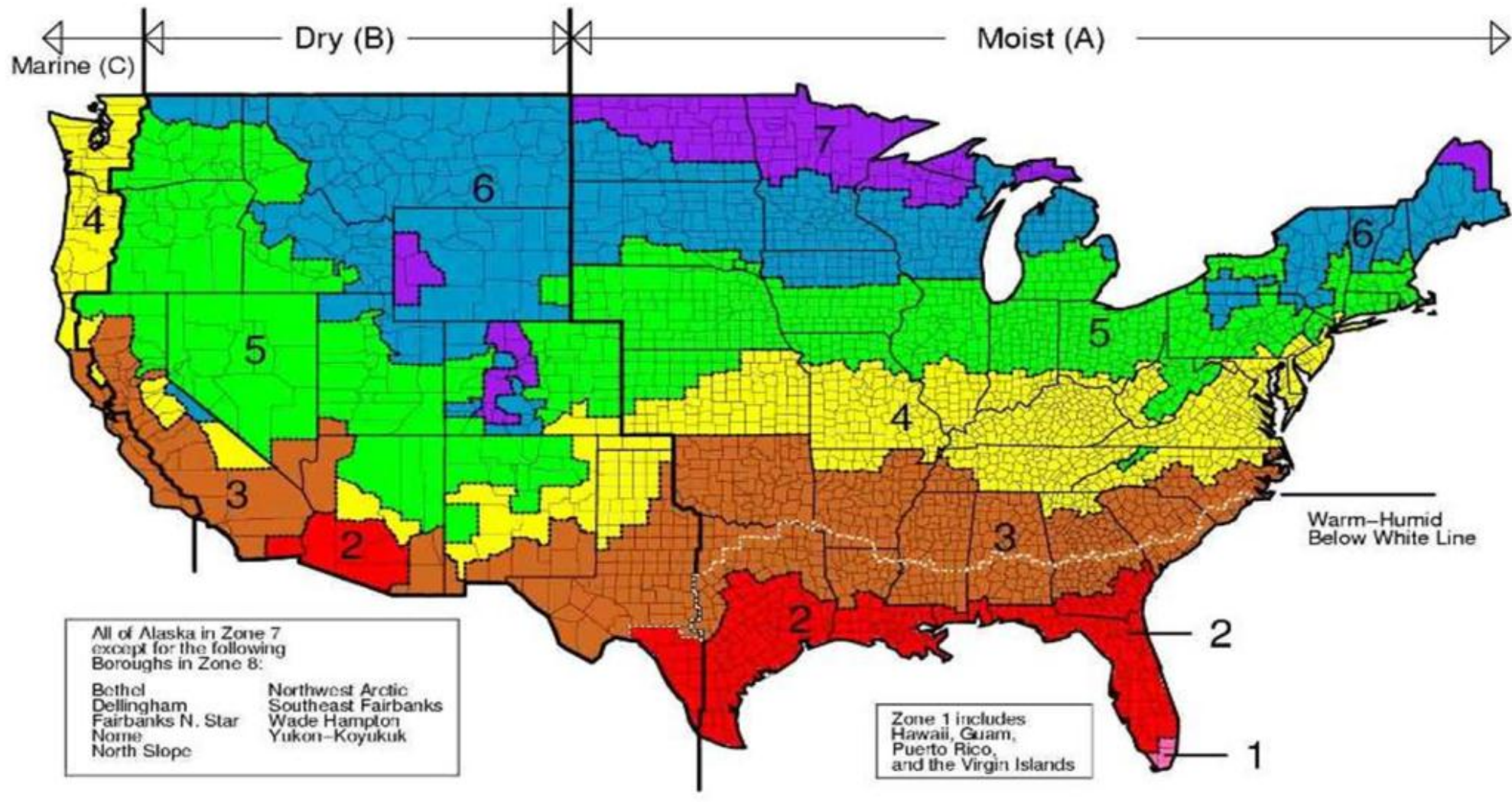
Effective  
January 1, 2011

Department of Commerce  
Division of Community Services  
1600 East Century Avenue, Suite 2  
PO Box 2057  
Bismarck, ND 58502-2057  
(701) 328-5300 Phone  
(701) 328-2308 Fax

ALTERNATIVE FORMATS FOR PERSONS WITH DISABILITIES  
ARE AVAILABLE UPON REQUEST

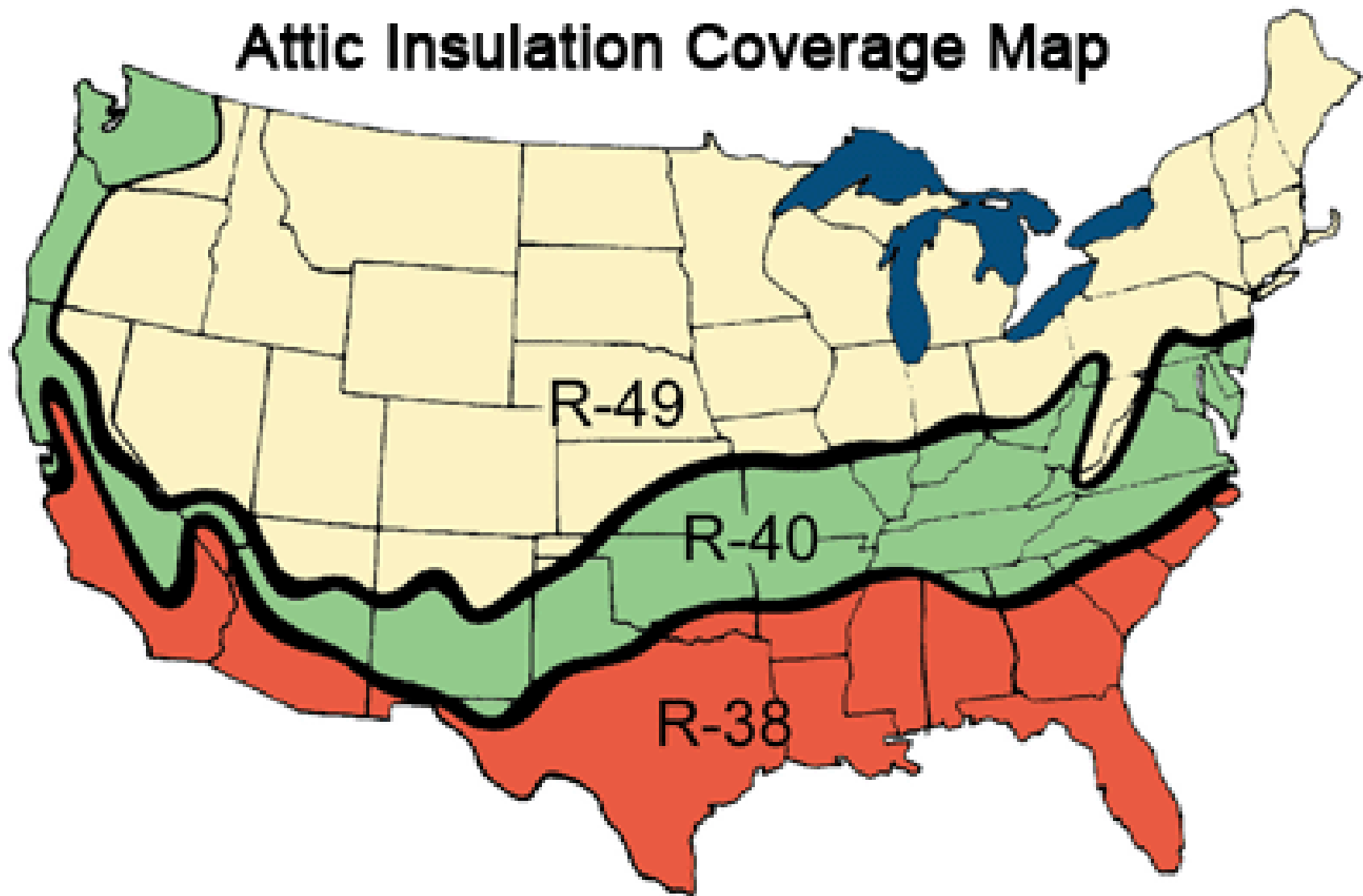
The image shows the cover of the North Dakota State Building Code. At the top is the North Dakota Department of Commerce logo. Below it is the title 'North Dakota State Building Code'. The Great Seal of the State of North Dakota is centered. Below the seal, it states 'Effective January 1, 2011' and provides contact information for the Department of Commerce, Division of Community Services. At the bottom, it notes that alternative formats are available upon request.





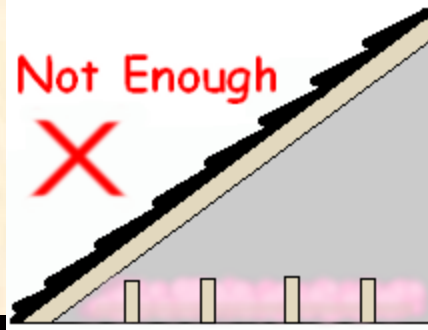


## Attic Insulation Coverage Map

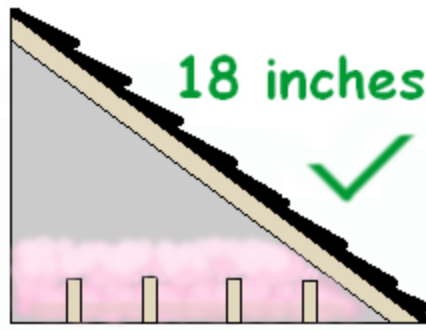




Not Enough

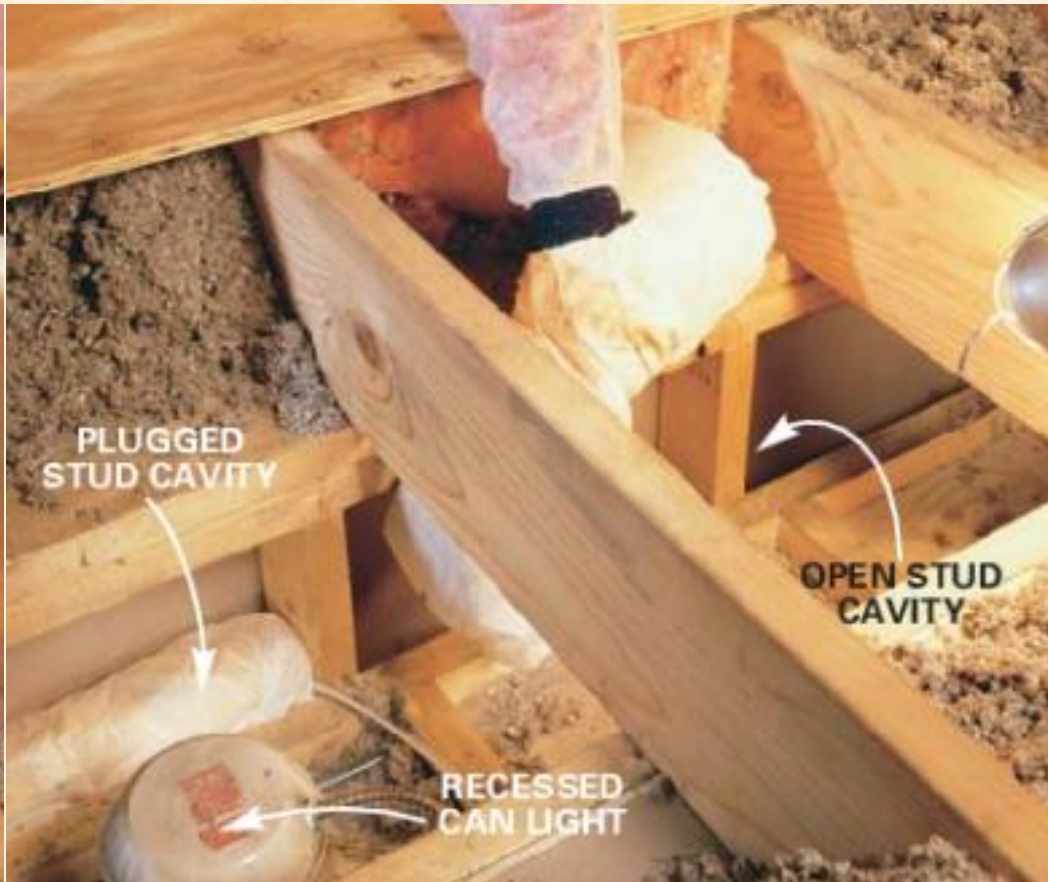


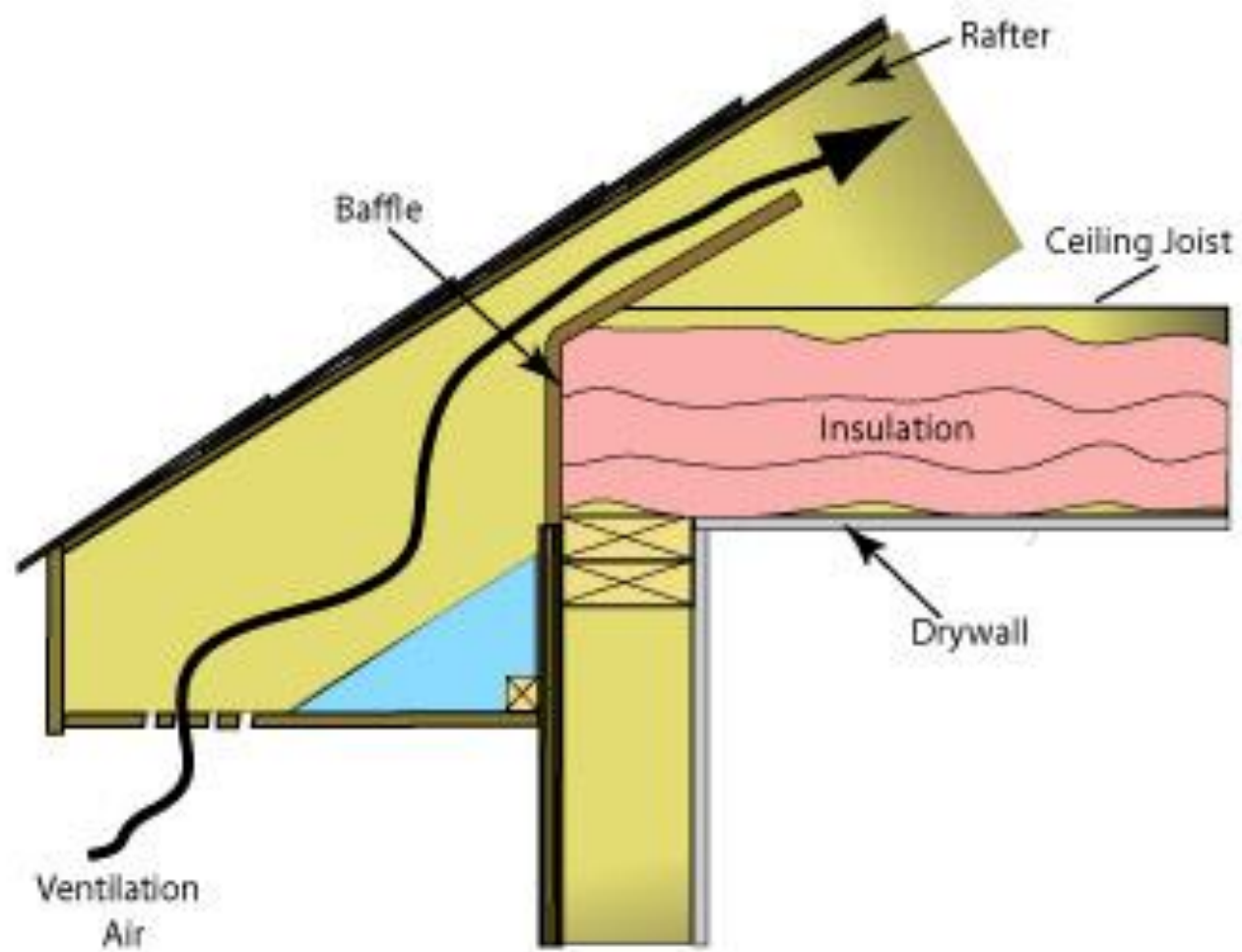
18 inches



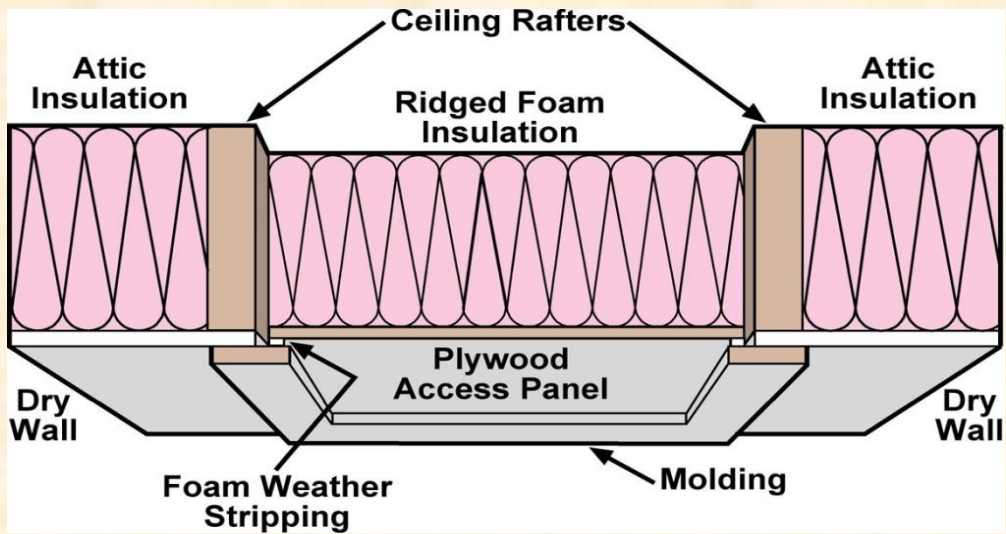
- Air infiltration
  - Attic moisture problems

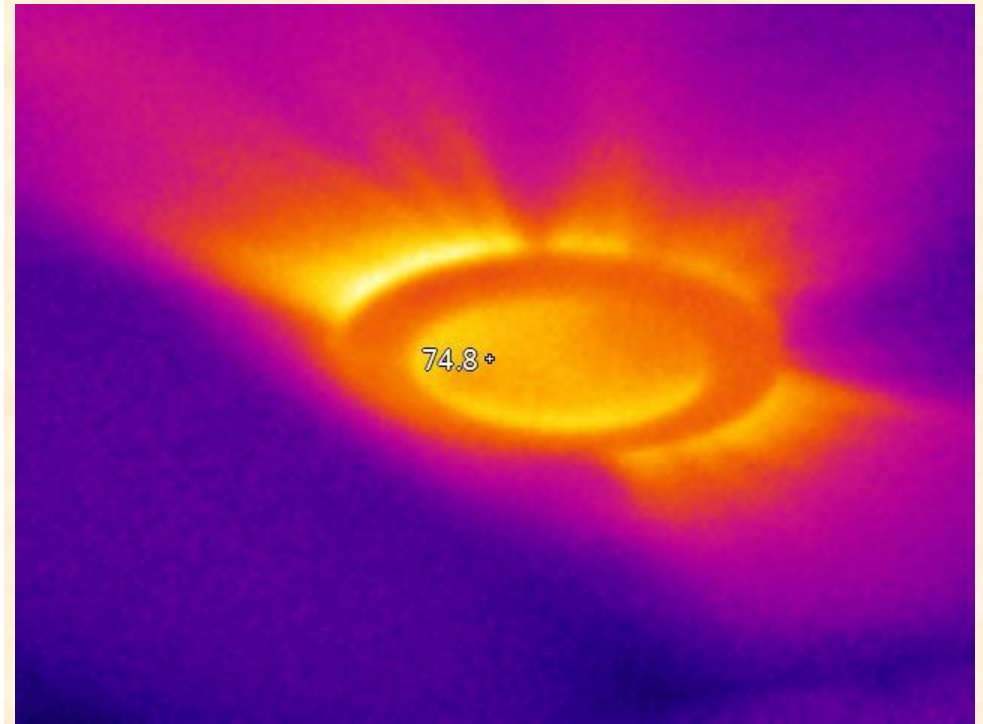
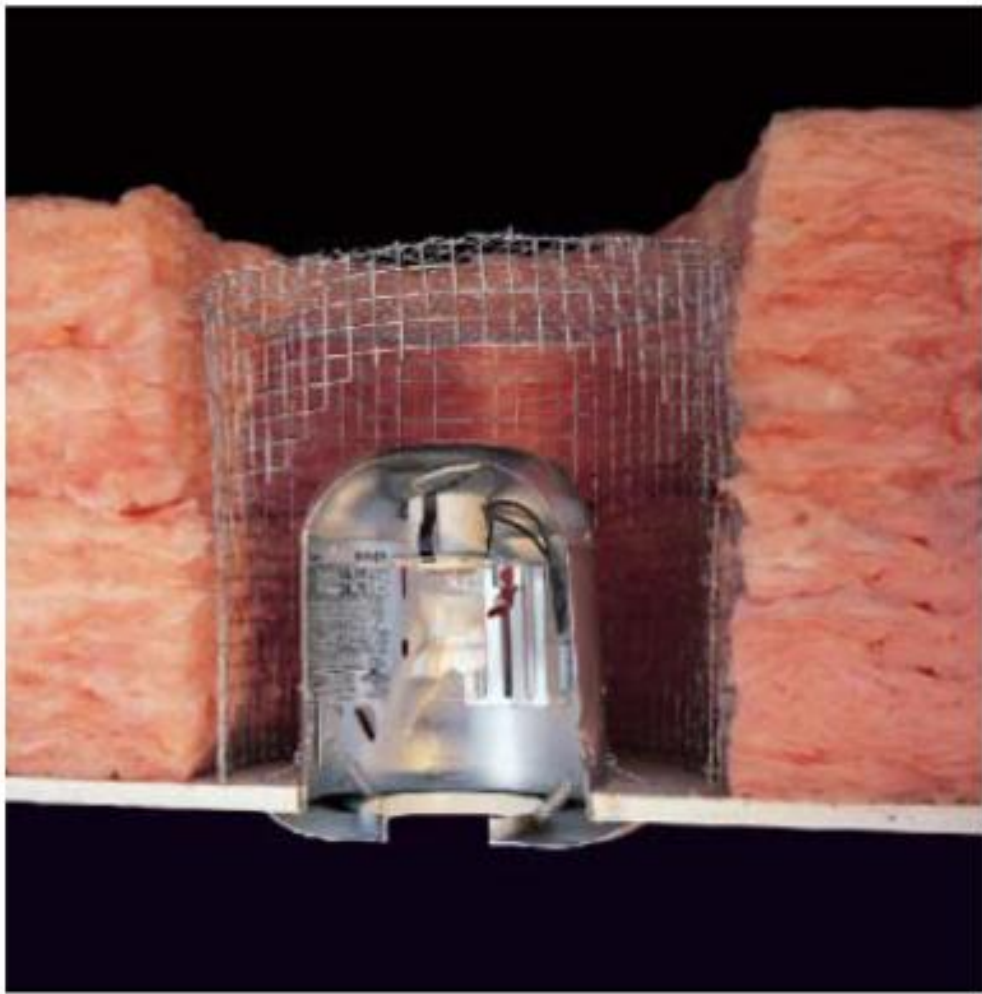




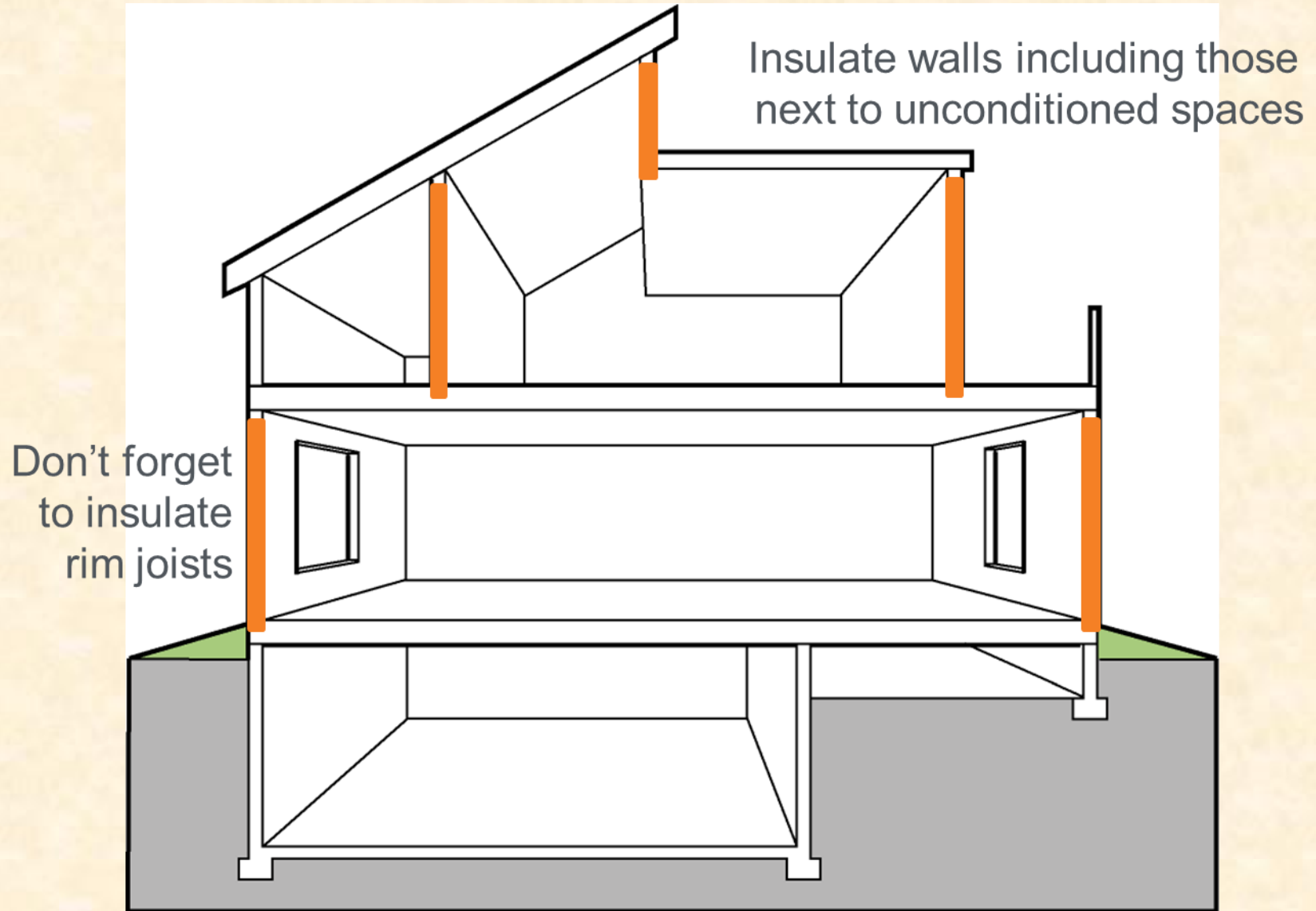








# Above Grade Walls



## Wood-Frame Walls

# R-19 – State Code



**This is a 2x6 wall with a metal strap brace, treated base plate, and blocking.**

## Wood-Frame Walls

# R-19 – State Code



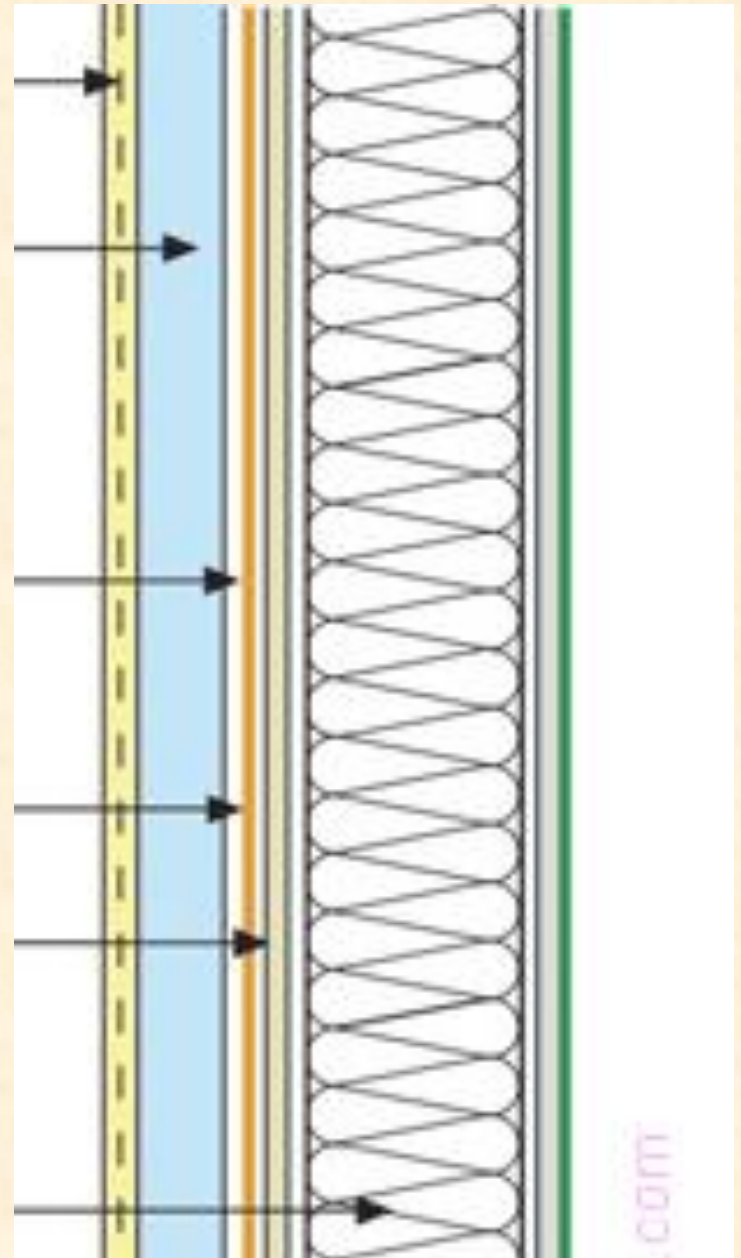
# Wood Walls

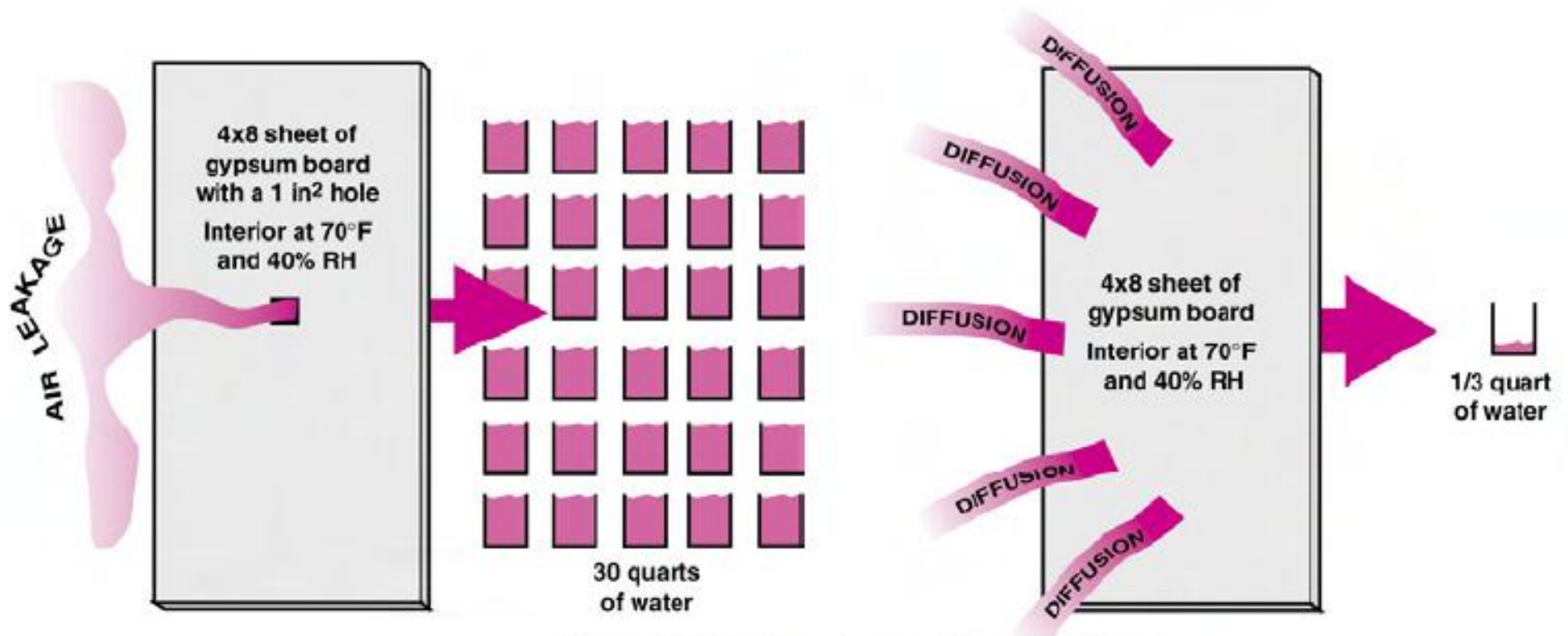
- R-19 2"x6" wall



# Above grade walls

- R-13 with 2"x4" wall





*Figure 6: Moisture transport comparison*

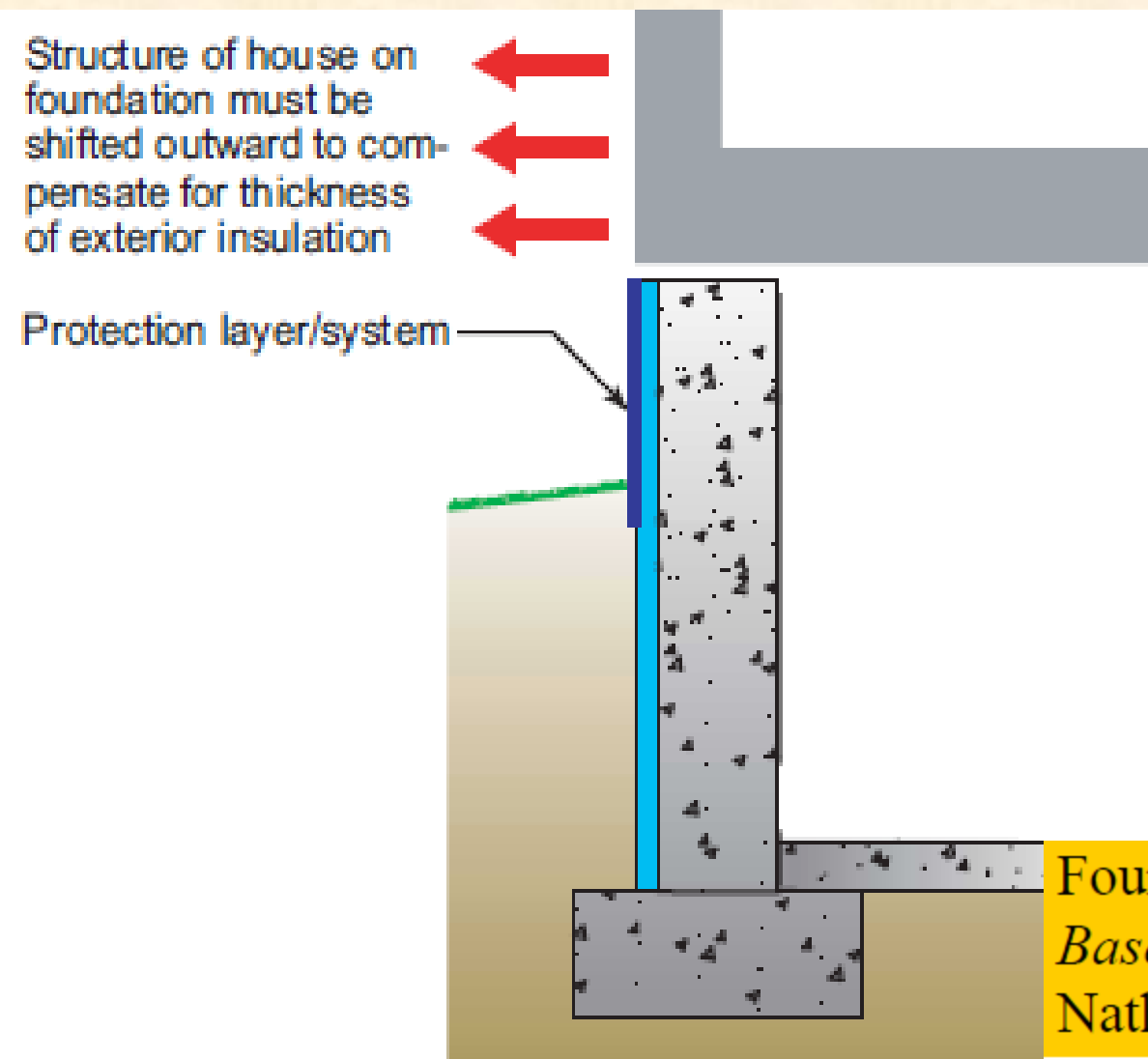


# Vapor Retarder

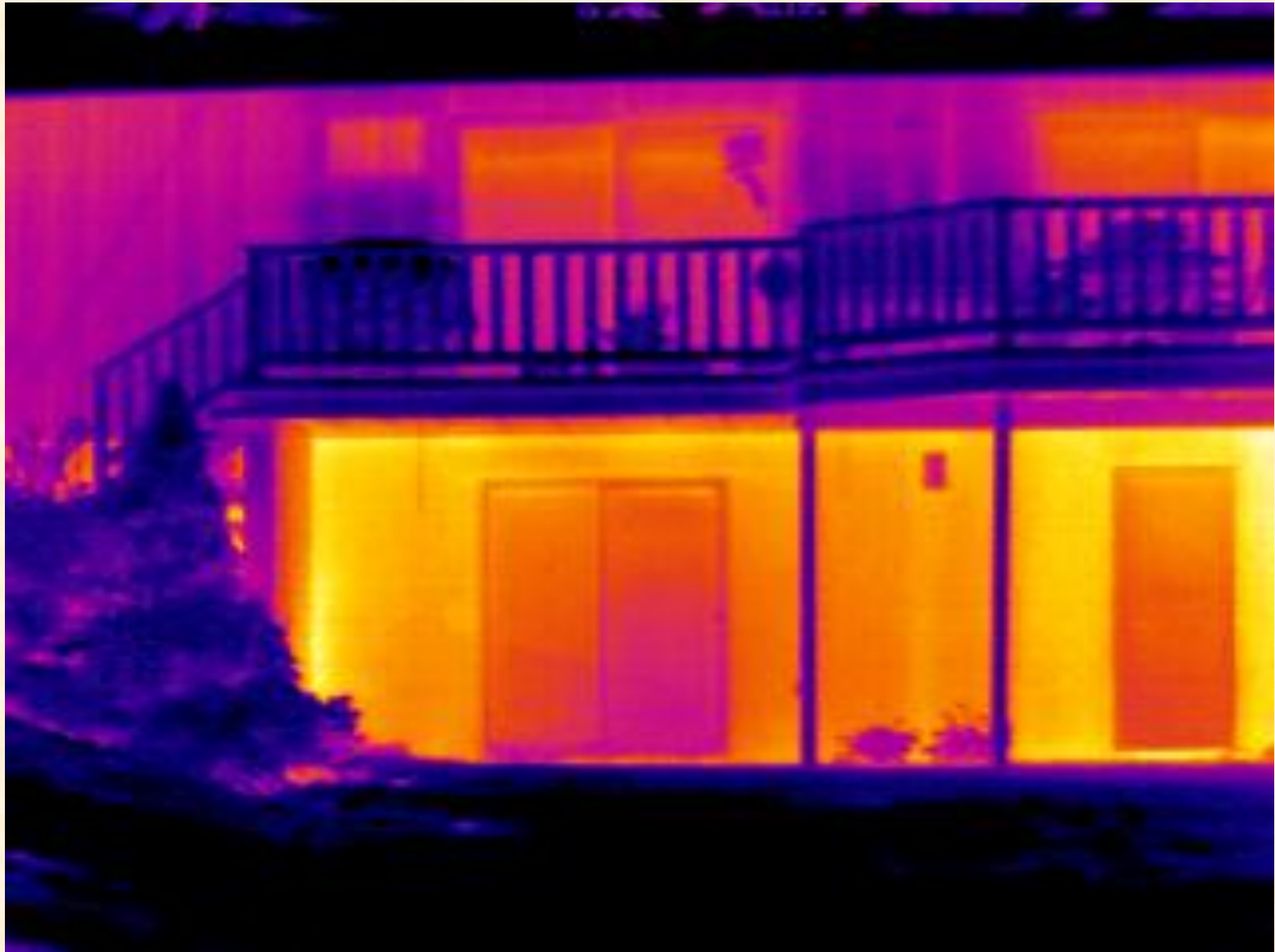
- 6 mil poly
- Slows moisture
- Reduce mold growth

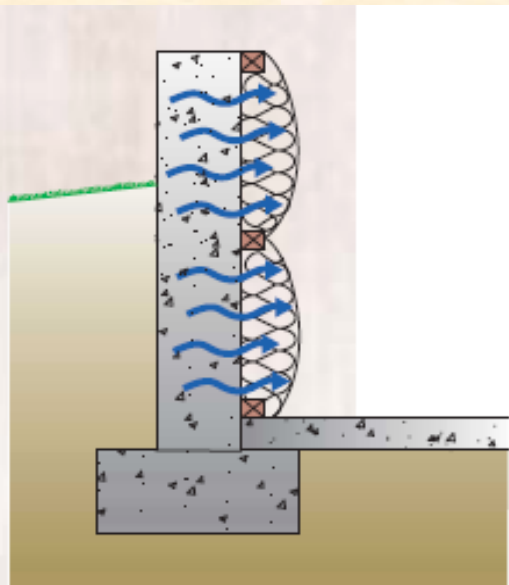


# Foundation Insulation



Foundation Insulation slides reprinted from *Basement Insulation Systems*. Authors: Nathan Yost and Joseph Lstiburek.

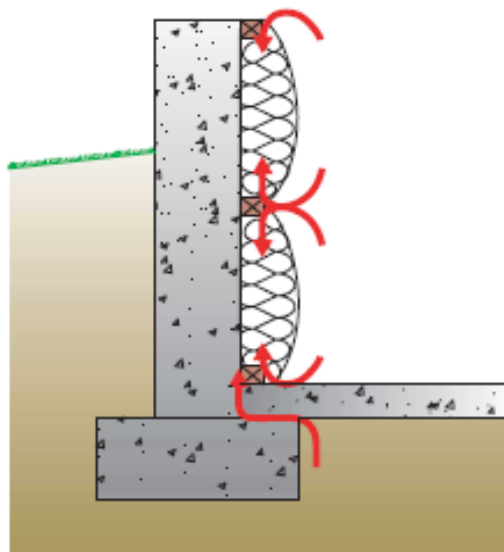




**Figure 4**

Moisture of construction

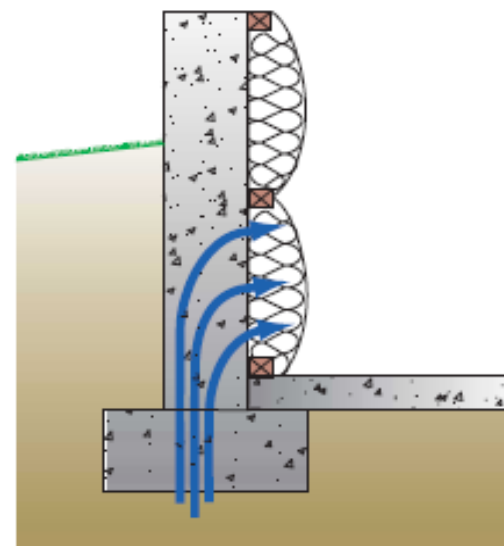
- Thousands of pounds of water are contained in freshly placed concrete in basement foundation walls; drying in uninsulated exposed walls takes many months, longer in walls with impermeable insulation systems



**Figure 5**

Air leakage from interior and from exterior under slab

- This is the "summer" problem where interior moisture laden air leaks into insulation systems and contacts cold concrete or masonry
- Can also be a winter problem, but is not usually common due to typically lower winter interior relative humidities - except in severe cold climates (greater than 8,000 heating degree days)



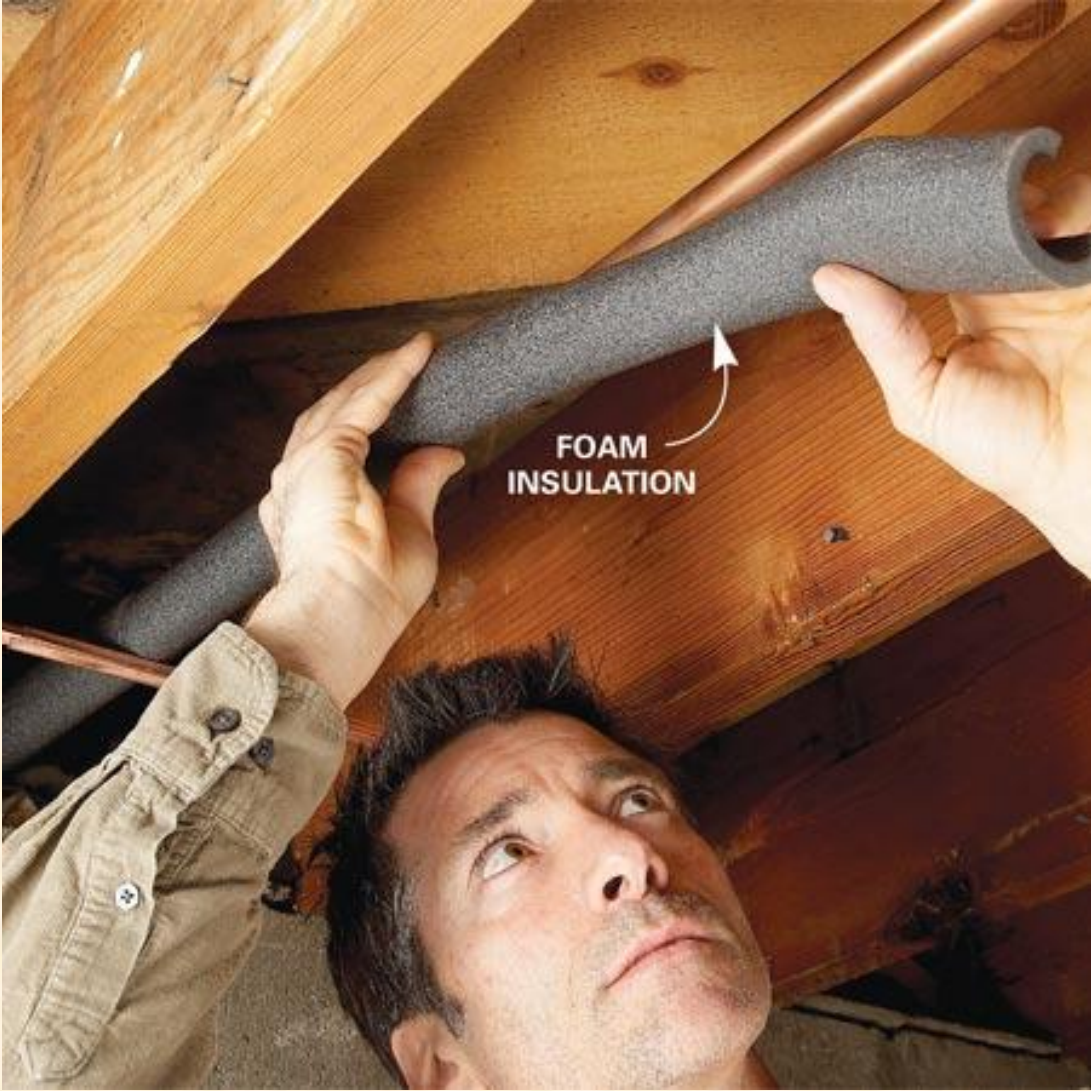
**Figure 6**

Capillary rise through footing

- This was rarely a problem until foundation walls became insulated on the interior with impermeable layers

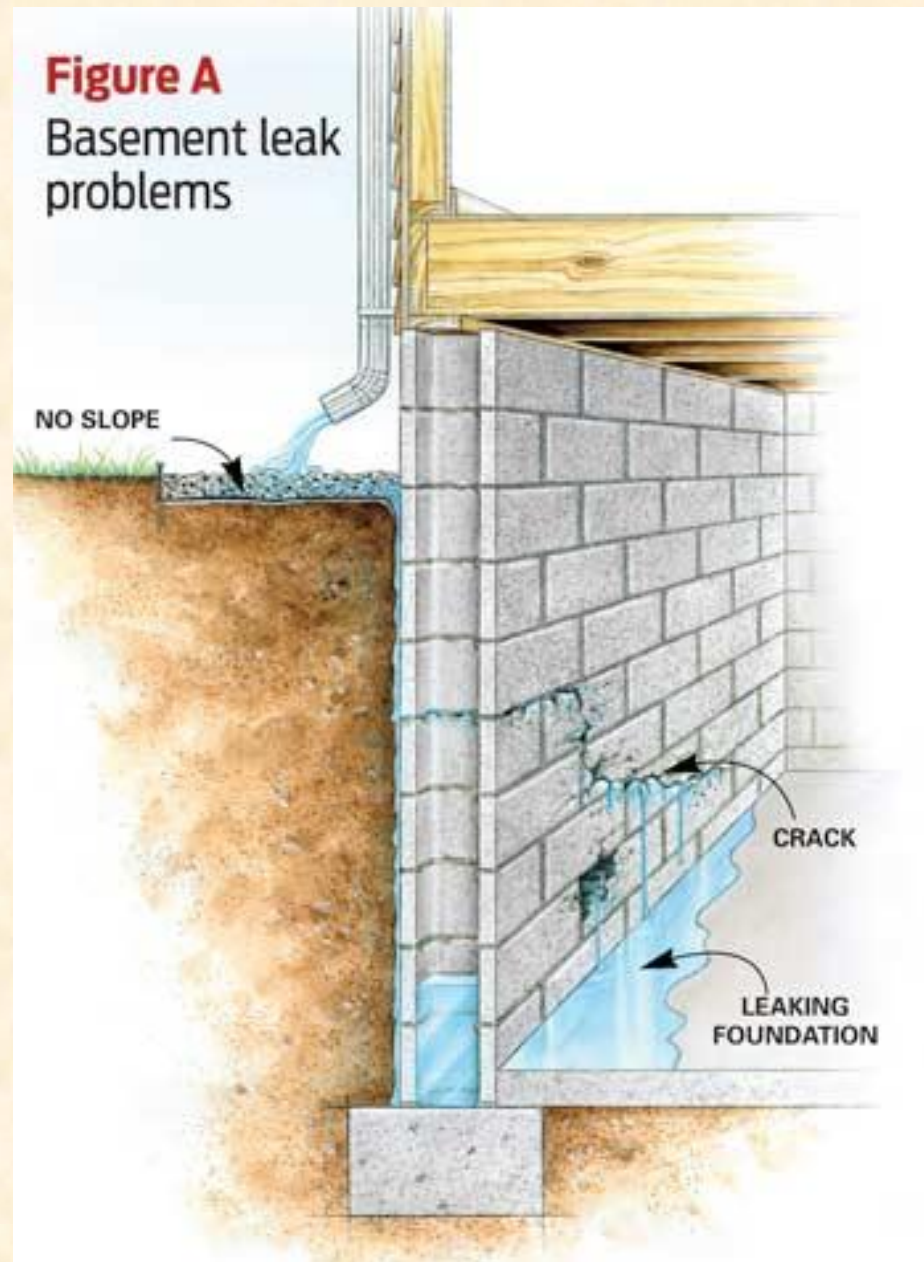
# Basement water test

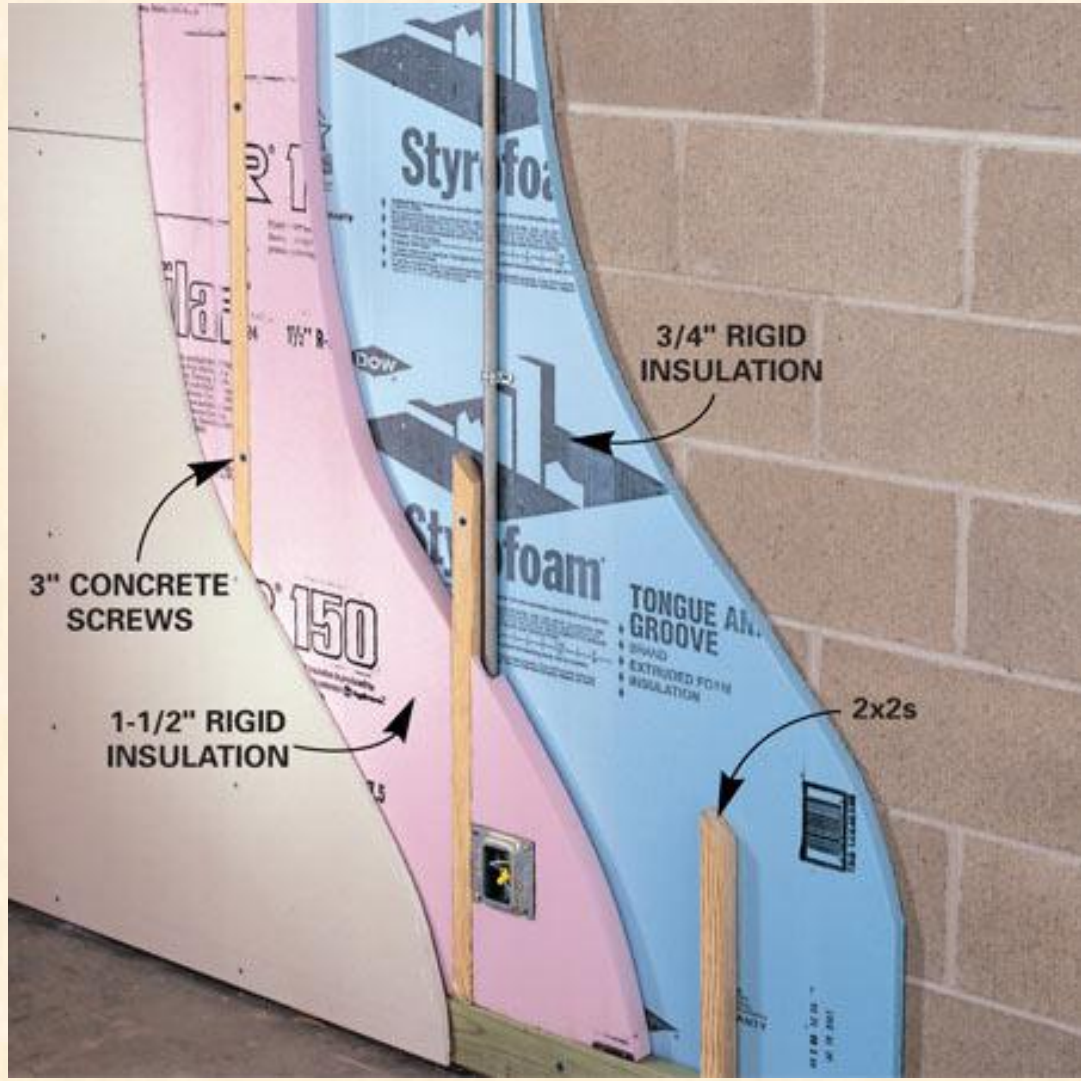




FOAM  
INSULATION

**Figure A**  
Basement leak problems





3" CONCRETE SCREWS

1-1/2" RIGID INSULATION

3/4" RIGID INSULATION

2x2s





# Foundation Insulation

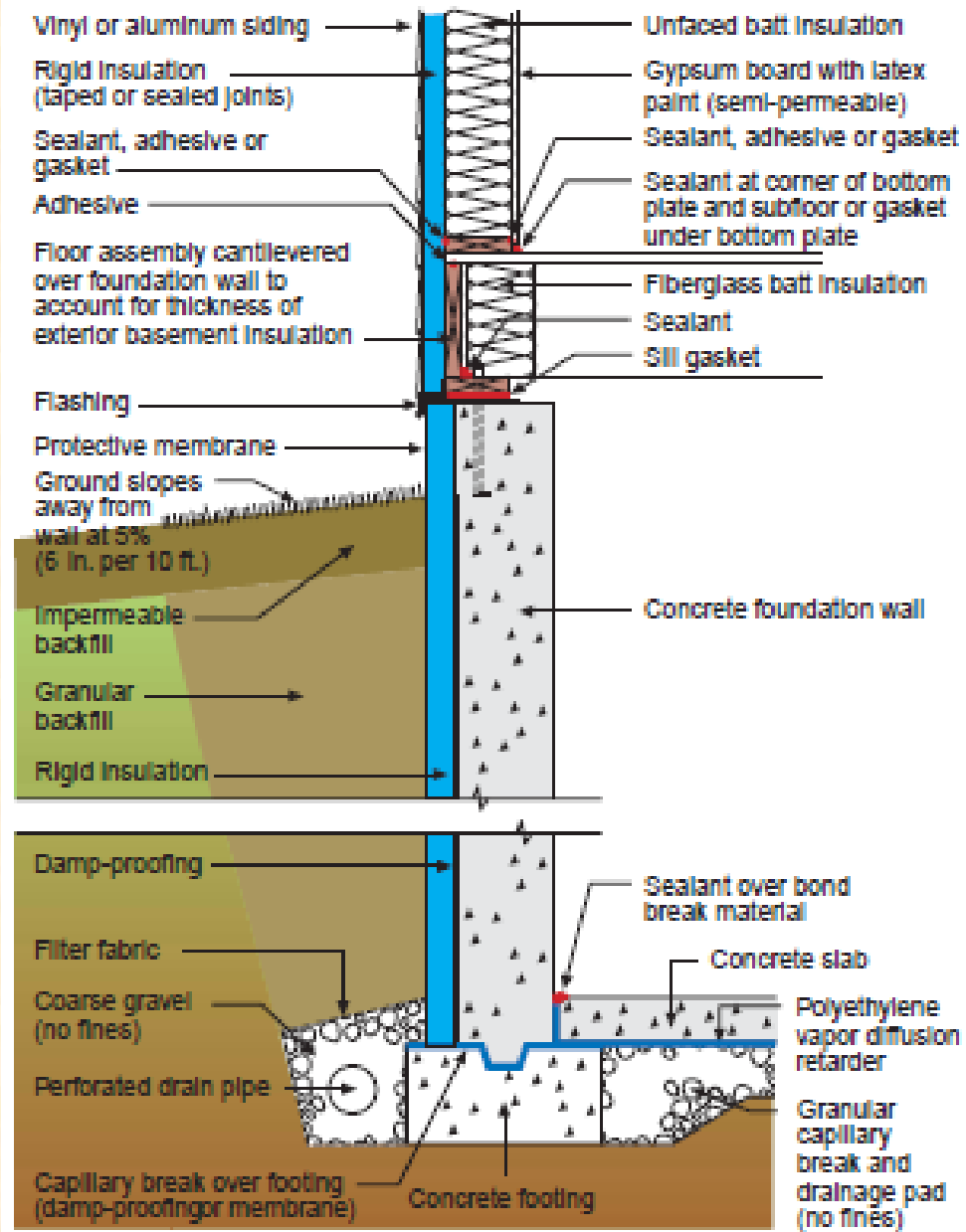
- Interior Insulation

## Recommendations

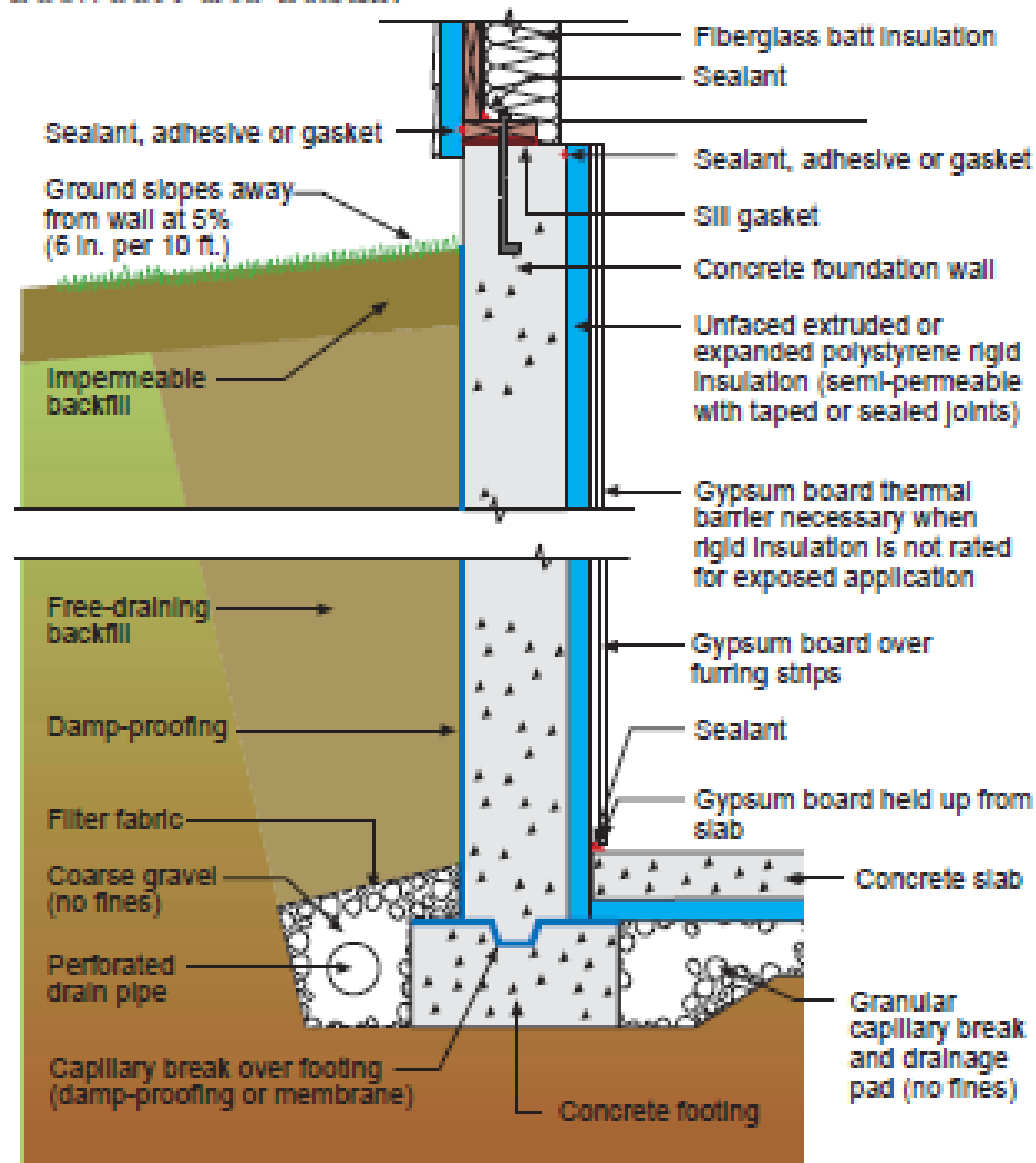
- Must be able to dry to interior if it gets wet
- Must prevent interior air from reaching foundation wall
- Material in contact with foundation wall must be moisture tolerant.



# Exterior Foundation Insulation



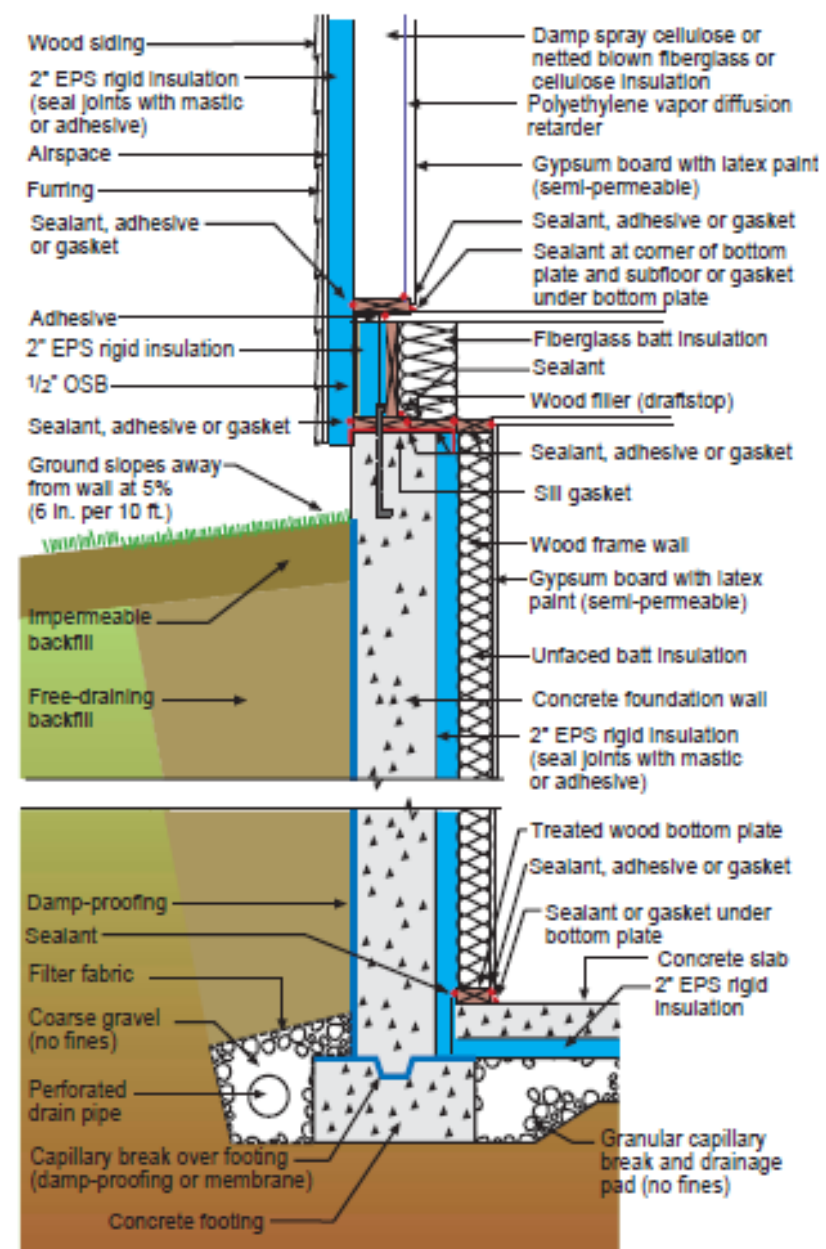
# Interior Foundation Insulation- Rigid Insulation



**Figure 13**  
Full height basement insulation

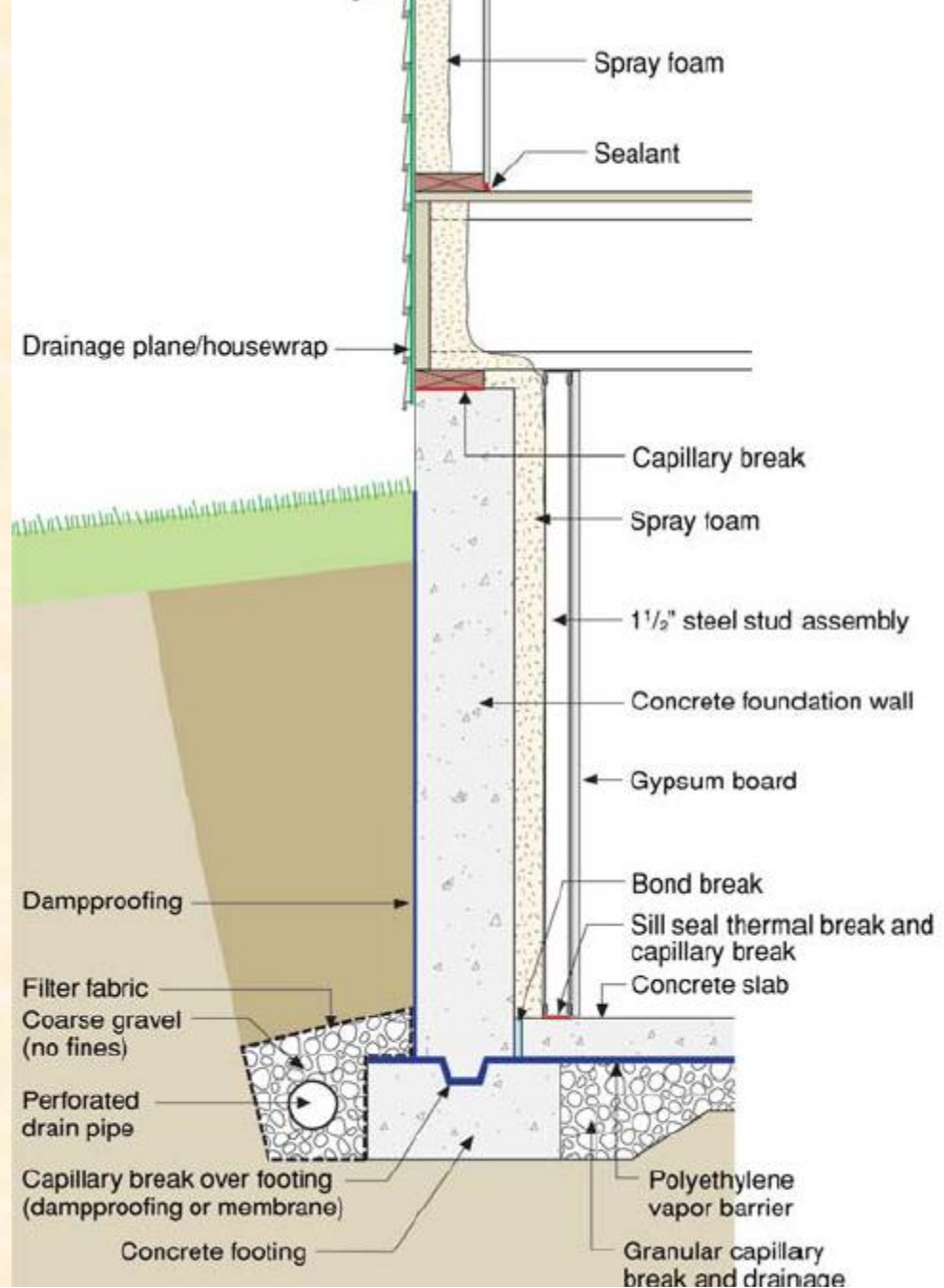
- Upper and lower portion of wall can dry to interior

# Interior Foundation Insulation – Rigid Insulation with fiberglass



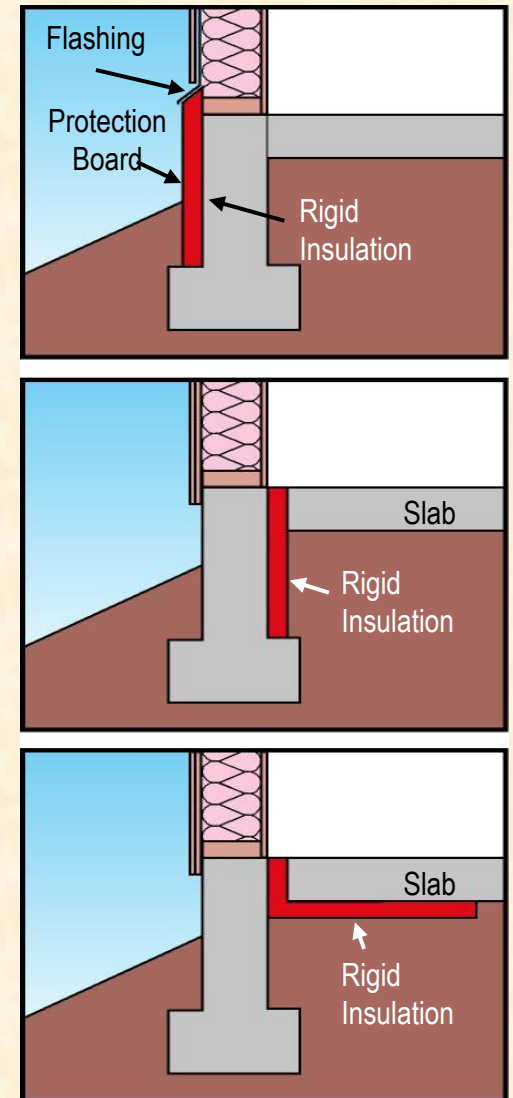
**Figure 14**  
Additional interior basement insulation

# Interior Foundation Insulation – Spray Foam



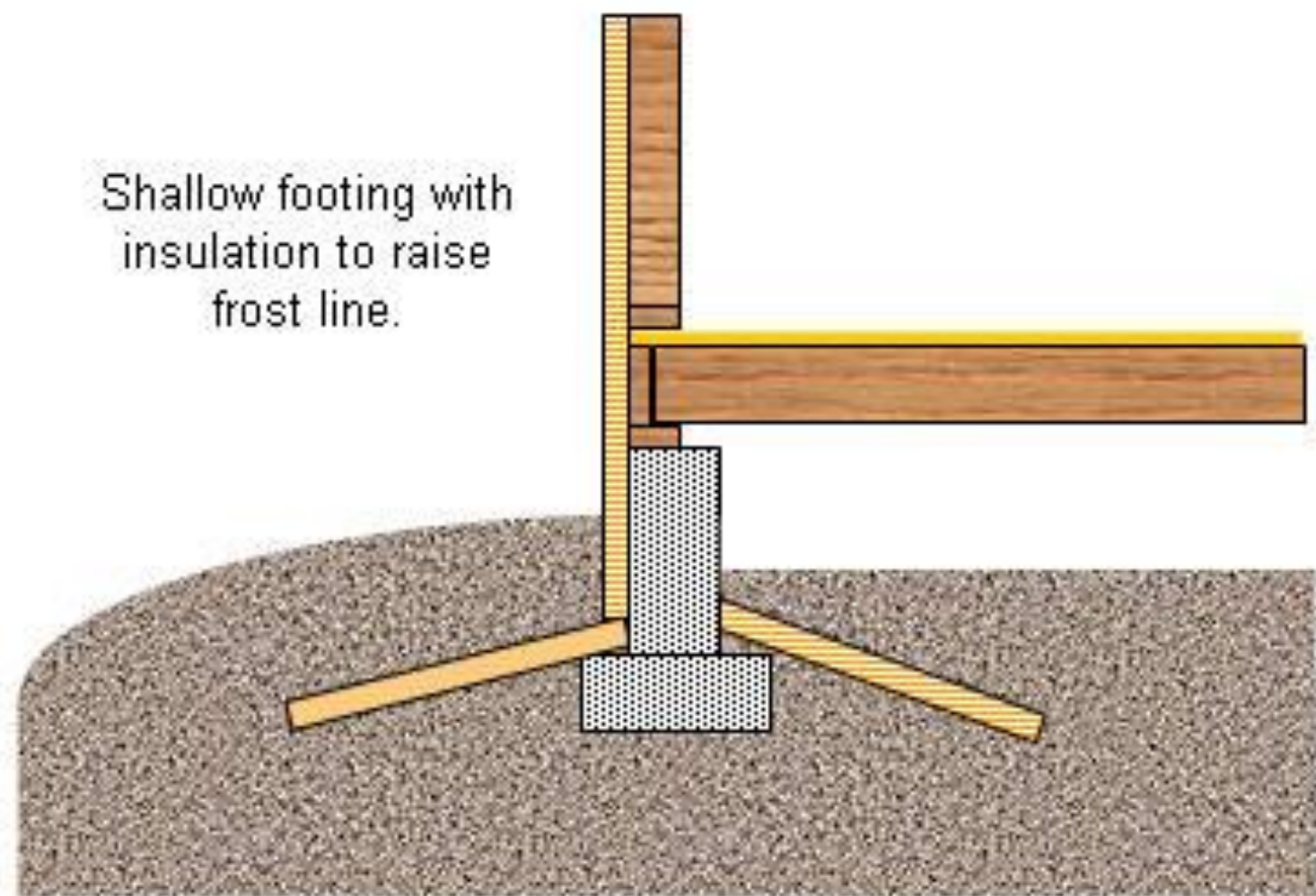
# Slab Edge Insulation

- R-10 (typically 2 inches)
- extend downward from top of slab a minimum 4 feet
- Insulation can be vertical or extend horizontally under the slab or out from the building
- Insulation extending outward must be under 10 inches of soil or pavement
- An additional R-5 is required for heated slabs



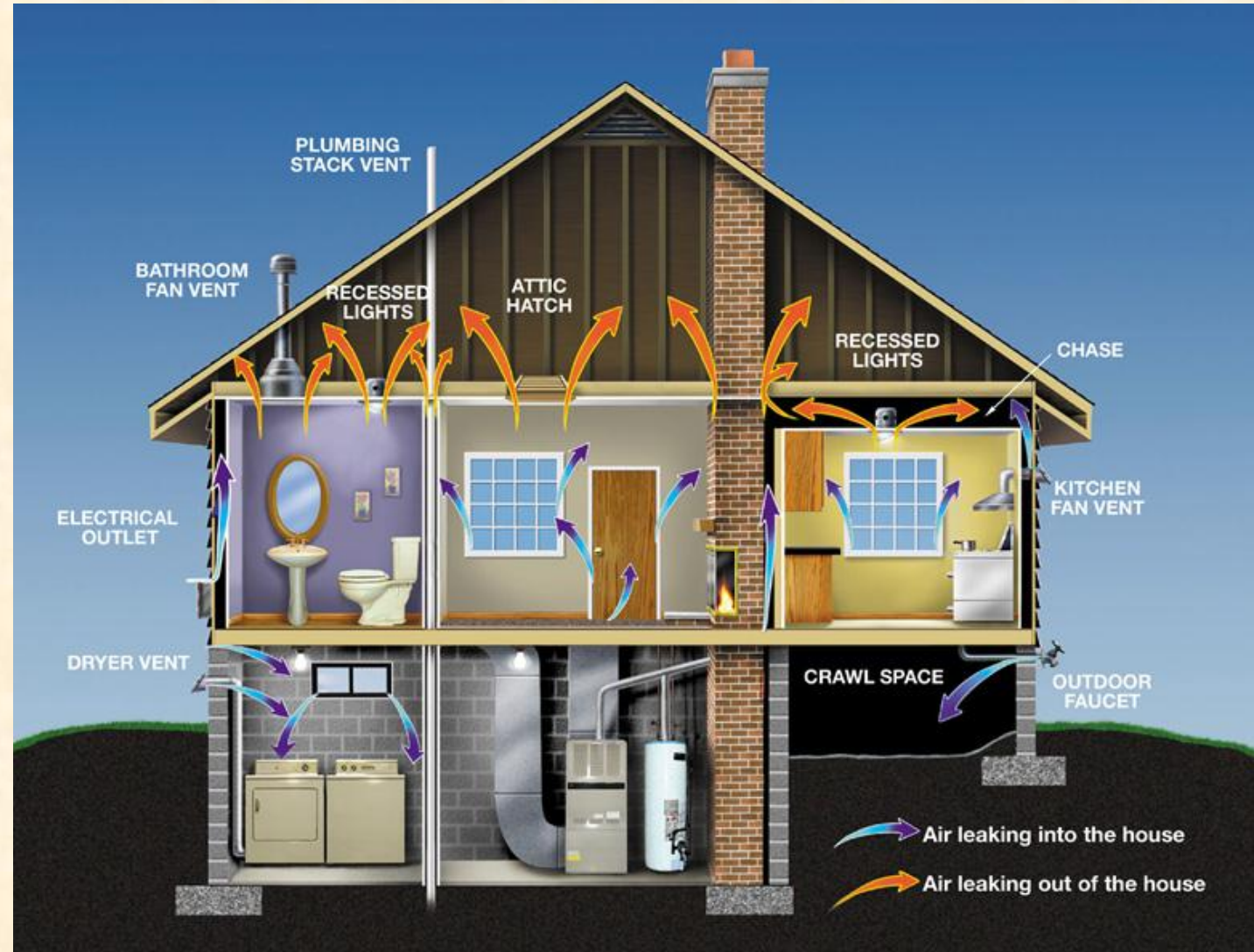


Shallow footing with  
insulation to raise  
frost line.



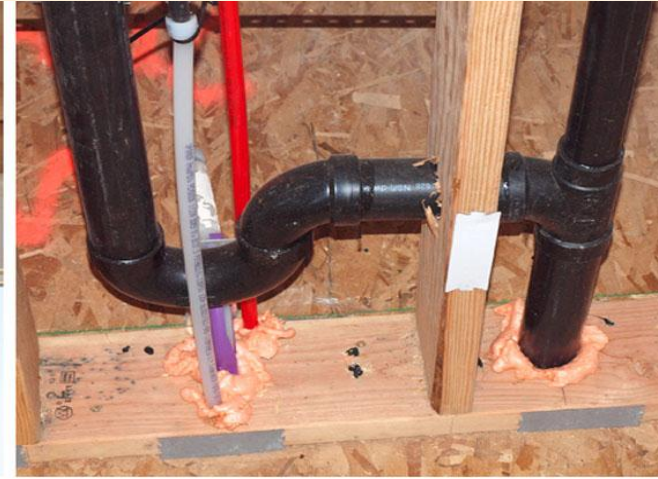
# Areas for Air Leakage (Infiltration)

- Windows and doors
- Sill plates
- Floors and exterior wall panels
- Plumbing
- Electrical
- Service access doors or hatches
- Recessed light fixtures
- Rim joist junction



# Air Leakage Control

- Building thermal envelope
  - Durably sealed
    - Caulked
    - Gasketed
    - Weather-stripped
    - Air barrier material
    - Suitable film or solid material



# Heating Systems



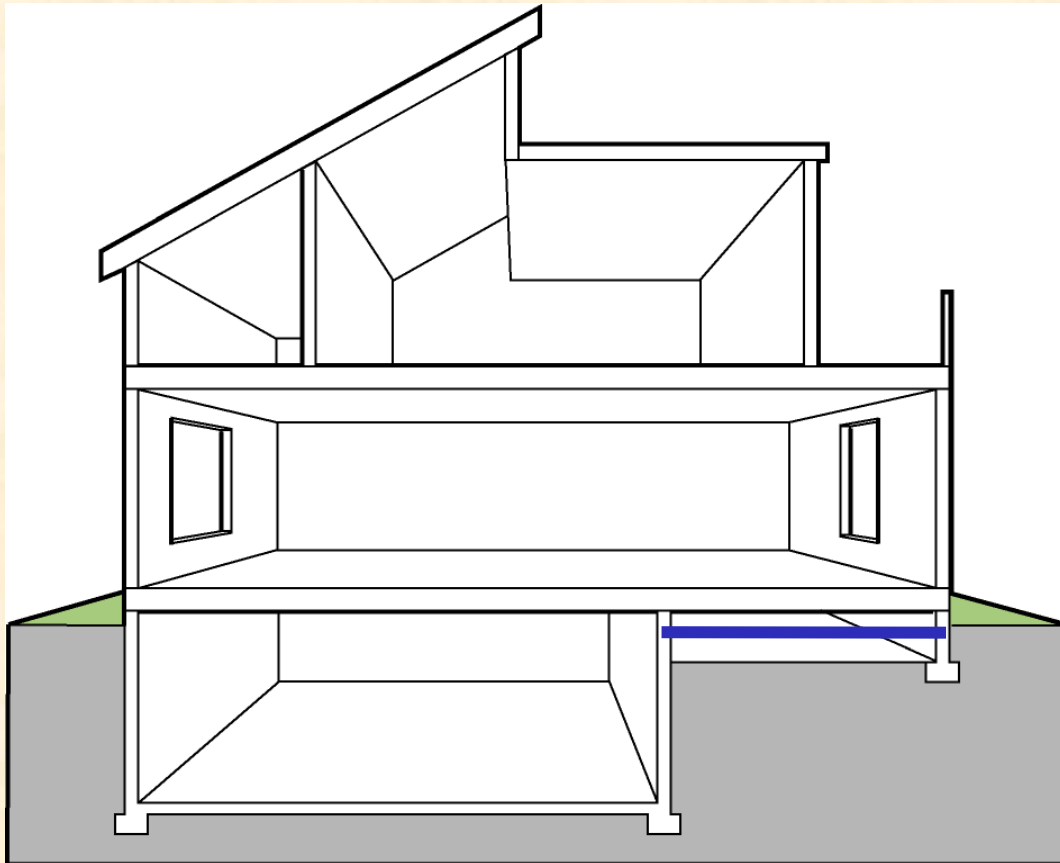
Draft inverter furnace.



High-efficiency furnaces

# Floors over Unconditioned Space N1102.2.6

- Unconditioned space includes unheated basement, vented crawlspace, or outdoor air



- Insulation must maintain permanent contact with underside of subfloor

\* Exception:

Climate Zones 4c-8

R-19 permitted if cavity completely filled





# www.NDSU.edu/energy

The screenshot shows a Windows Internet Explorer browser window displaying the NDSU Energy website. The address bar shows the URL <http://www.ag.ndsu.edu/energy/>. The browser's menu bar includes File, Edit, View, Favorites, Tools, and Help. The Favorites bar shows several links, including 'NDSU Energy - NDSU'. The website header features the NDSU logo on the left and 'NORTH DAKOTA STATE UNIVERSITY FARGO, N.D.' on the right. A green banner with the word 'Energy' is prominent. Below this, a yellow bar indicates 'You are here: Home'. The main content area is titled 'NDSU Energy' and includes a navigation menu on the left with items like 'About Us', 'Biofuels', 'Farm and Ranch', 'Home Energy', 'News', 'Solar', 'Wind', 'Energy Code Training', 'Extension Home Page', 'Department Home Page', and 'Oil'. The main text area contains the heading 'NDSU Energy' followed by the text 'To access the Home Energy 101 - online informational course click the link below'. A large green button with the text 'Home Energy 101' is displayed. Below this, there is a link to a 'North Dakota Residential Construction Energy Efficiency-related Practices Study' with two sub-links: '\* Executive Summary (pdf)' and '\* Full Report (pdf)'. A photograph of a modern building interior is shown at the bottom. A small advertisement for 'Tips for Saving Energy and Money for Renters' is visible in the bottom right corner. The Windows taskbar at the bottom shows the system tray with the date and time '6:24 PM 8/16/2011' and various application icons.

NDSU Energy — NDSU - Windows Internet Explorer

http://www.ag.ndsu.edu/energy/

foundation frost heaves

File Edit View Favorites Tools Help

NDSU Energy — NDSU Main Page eXtension Co... Rose State College Online ... Faculty and Staff Directory TWC Interactive Local Weather ...

NDSU Energy — NDSU

NDSU NORTH DAKOTA STATE UNIVERSITY FARGO, N.D.

Energy

Accessibility

Google™ Custom Search

Energy

- About Us
- Biofuels
- Farm and Ranch
- Home Energy
- News
- Solar
- Wind
- Energy Code Training
- Extension Home Page
- Department Home Page
- Oil

You are here: Home

## NDSU Energy

To access the **Home Energy 101** - online informational course click the link below

### Home Energy 101

North Dakota Residential Construction Energy Efficiency-related Practices Study

- \* **Executive Summary** (pdf)
- \* **Full Report** (pdf)

Tips for Saving Energy and Money for Renters

6:24 PM 8/16/2011



Energy Code Training — NDSU - Windows Internet Explorer

http://www.ag.ndsu.edu/energy/Energy%20Code%20Training

foundation frost heaves

File Edit View Favorites Tools Help

★ Favorites | ★ NDSU Energy — NDSU | ✖ Main Page eXtension Co... | 🌸 Rose State College Online ... | 📄 Faculty and Staff Directory | 📺 TWC Interactive Local Weather ...

Energy Code Training — NDSU

Home RSS Email Print Page Safety Tools

## Energy

- About Us
- Biofuels
- Farm and Ranch
- Home Energy
- News
- Solar
- Wind
- Energy Code Training**
- Extension Home Page
- Department Home Page
- Oil

# Energy Code Training


[f](#) [t](#) [g+](#) [+](#) Share

**The material and links provided here are supplements to North Dakota residential energy code training workshops. The NDSU Extension Service does not endorse commercial products or companies even though reference may be made to trade names, trademarks, service names or web pages.**

## Resources

The following links are provided for those that are looking for more detail and description of specific techniques.

- ♦ [Link to FREE – IECC download from ICC](#)
- ♦ [DOE Link to ResCheck and ComCheck compliance programs](#)
- ♦ [Link to Energy Code Training presentation \(.pdf\)](#)
- ♦ [Cold and Very Cold Climates Best Practices \(.pdf\)](#) click on the "Trades" tab in the menu for information on slab insulation, foundation insulation, house wrap and air sealing.
- ♦ [Basement Insulation Systems \(.pdf\)](#) – Fact sheet on insulating basements including descriptions of the best systems and relative costs.
- ♦ [Understanding Basements \(.pdf\)](#) – Fact sheet describing the best practices for insulating and moisture control in basements.
- ♦ [New Light in Crawl Spaces \(.pdf\)](#) – Fact sheet describing best practices for crawl spaces.
- ♦ [Crawl Space Insulation \(.pdf\)](#) – basic fact sheet including diagrams
- ♦ [Builder's Foundation Handbook \(.pdf\)](#) – detailed information on building and insulation all types of foundations.
- ♦ [Moisture Control for New Residential Buildings](#)



Internet | Protected Mode: On

100%

6:36 PM  
8/16/2011

# www.ag.ndsu.edu/flood

Flood Information — NDSU - Windows Internet Explorer

http://www.ag.ndsu.edu/flood

File Edit View Favorites Tools Help

Favorites NDSU Energy — NDSU Main Page eXtension Co... Rose State College Online ... Faculty and Staff Directory TWC Interactive Local Weather ...

Flood Information — NDSU

NDSU NORTH DAKOTA STATE UNIVERSITY FARGO, N.D.

## Flood Information

Accessibility

Google™ Custom Search

### Flood Information


- House & Home
- Family & Children
- Farm & Ranch
- Resources in Other Languages
- Additional Resources
- Media Resources

You are here: Home

## Flood Information

### Dry Out Before Rebuilding

Don't be in a hurry to get your home back to "normal" after flooding. Wood must **dry out** to 13 percent moisture before replacing Sheetrock and other wall coverings. This video shows **how to use a moisture meter** to measure.




[Facebook](#) [Twitter](#) [LinkedIn](#) [Share](#)

### Flooded House Clean-up

NDSU Extension Engineer Ken Hellevang shares information on how to clean a flooded home. Here he narrates the PowerPoints in five sections and provides the PowerPoint slides as handouts.

Protection from Hazards	<a href="#">Narrated PowerPoint</a> <a href="#">PPT Slides</a>
Structure, Utilities and Mold	<a href="#">Narrated PowerPoint</a> <a href="#">PPT Slides</a>
Clean-up Process 1	<a href="#">Narrated PowerPoint</a> <a href="#">PPT Slides</a>
Clean-up Process 2	<a href="#">Narrated PowerPoint</a> <a href="#">PPT Slides</a>

#### Ask an Expert



**Question**

**Location and County**

Ohio

**Image (optional)**

You can upload .jpg .png or .gif. Max size of 2MB each.

**Email** (please type it twice to confirm)

Done

Internet | Protected Mode: On

100%

12:03 PM 8/30/2011

## NDSU Extension Service - Ward County

Accessibility

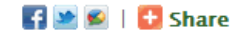
Google™ Custom Search

### Ward County Extension

- Who We Are ▾
- Horticulture ▾
- Crops ▾
- Livestock ▾
- 4H and Youth ▾
- Parent Resource Center ▾
- Food, Nutrition and Health ▾
- RAFT Client Application ▾

You are here: Home

## Ward County Extension Service



### FLOOD Recovery

Whether your home has flooded or your basement is wet or if it's just a flooded landscape and property, recovering can be an overwhelming task.

NDSU Extension has a web site full of resources to help in the clean up! Information, instructions, videos, moisture meters, and specialists available to you at <http://www.ag.ndsu.edu/flood>

North Dakotans whose homes have been affected in any way by water this spring (even major basement seepage, not just true flooding) need to report it for the state to have any chance of full federal disaster declarations and reimbursements. Please report any and all flood/water damage at the **ND Flood Damage Hotline, 1-877-212-0316**.

Hotline hours are 7:00 am to 7:00 pm (CT). Callers will be directed through a series of simple questions. The call should only take a few minutes. Those impacted will also be referred to volunteer agencies that are providing assistance if necessary.

### RAFT Case Manager Applications Available

Case Managers are now available in **Ward County** to assist survivors of Flood 2011 through RAFT. The Resource Agencies Flood Team (RAFT) is a cooperative effort of faith-based and community-based agencies to assist disaster victims as they recover. You may **download and print the application here (PDF)** or pick one up at our **Ward County Extension** office in the **Ward County**



[www.extension.org/ask](http://www.extension.org/ask)

#### NDSU Extension News Feed

Youth Development Webinar Series Set  
Aug 30, 2011

Learn About Livestock, Agriculture  
Aug 25, 2011

Prairie Fare: Onions Offer More Than Flavor  
Aug 25, 2011

More...

# References

- The majority of slides were obtained and modified to fit local conditions from the U.S. Department of Energy Building Energy Codes Program presentations available at <http://www.energycodes.gov/training/presentations.stm>
- Yost, Y. and J. Lstiburek. 2002. *Basement Insulation Systems*. Building Sciences Corporation

# Questions?

Carl Pedersen

[www.ndsu.edu/energy](http://www.ndsu.edu/energy)

[www.ag.ndsu.edu/flood](http://www.ag.ndsu.edu/flood)

[Carl.pedersen@ndsu.edu](mailto:Carl.pedersen@ndsu.edu)

(701) 231-5833