

BUILDING A HEALTHY BASEMENT

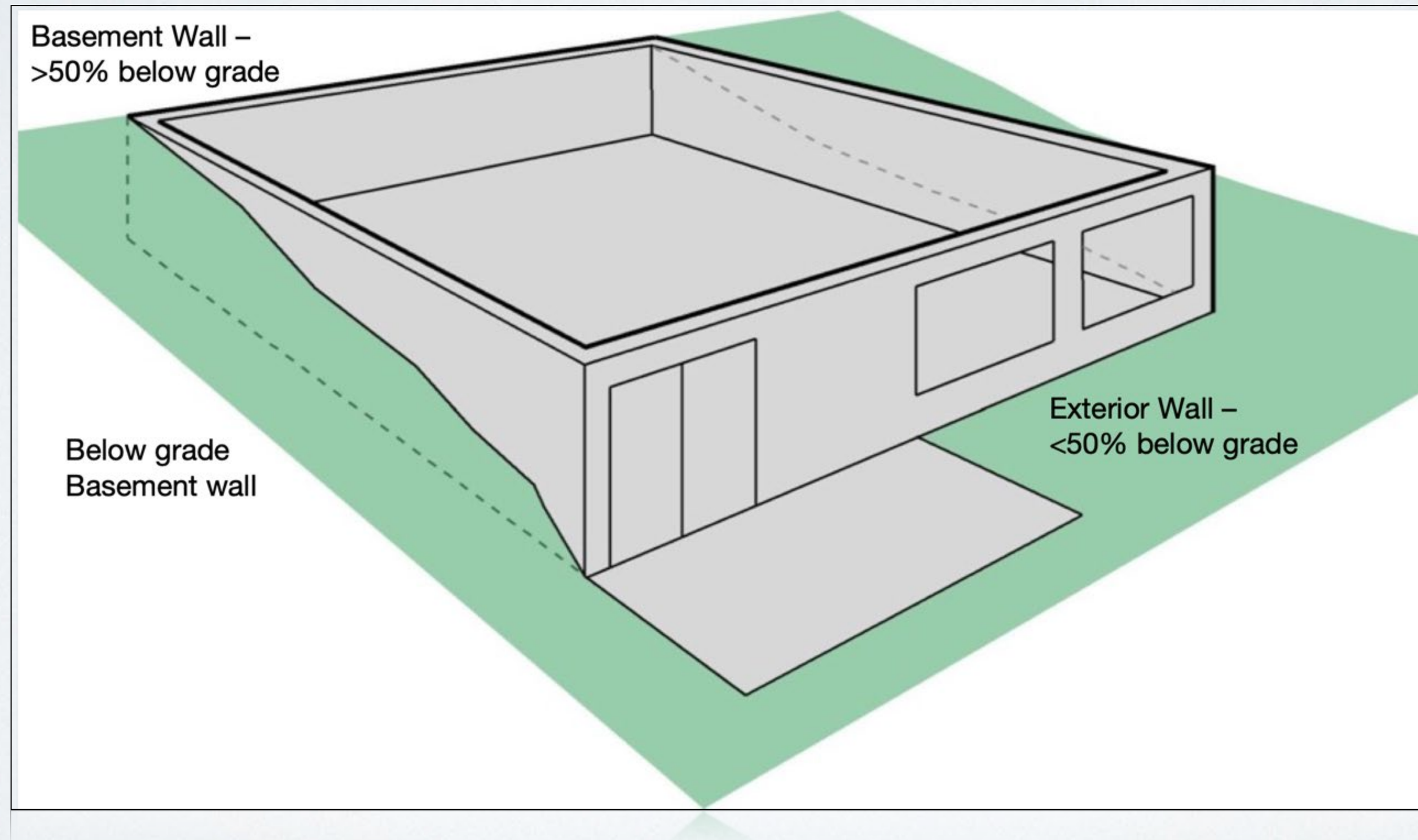
Maine Indoor Air Quality Council

December 8, 2022

Some terms...

Foundation... a structural element that transfers building loads to the ground

Basement... a floor of a building beneath the ground floor, at least partially below grade



WHY CHOOSE A BASEMENT FOUNDATION?

Basement pros...

We are already excavating below frost, so why not?

Provides space for mechanical systems

Provides space for a pool table!

Basement cons...

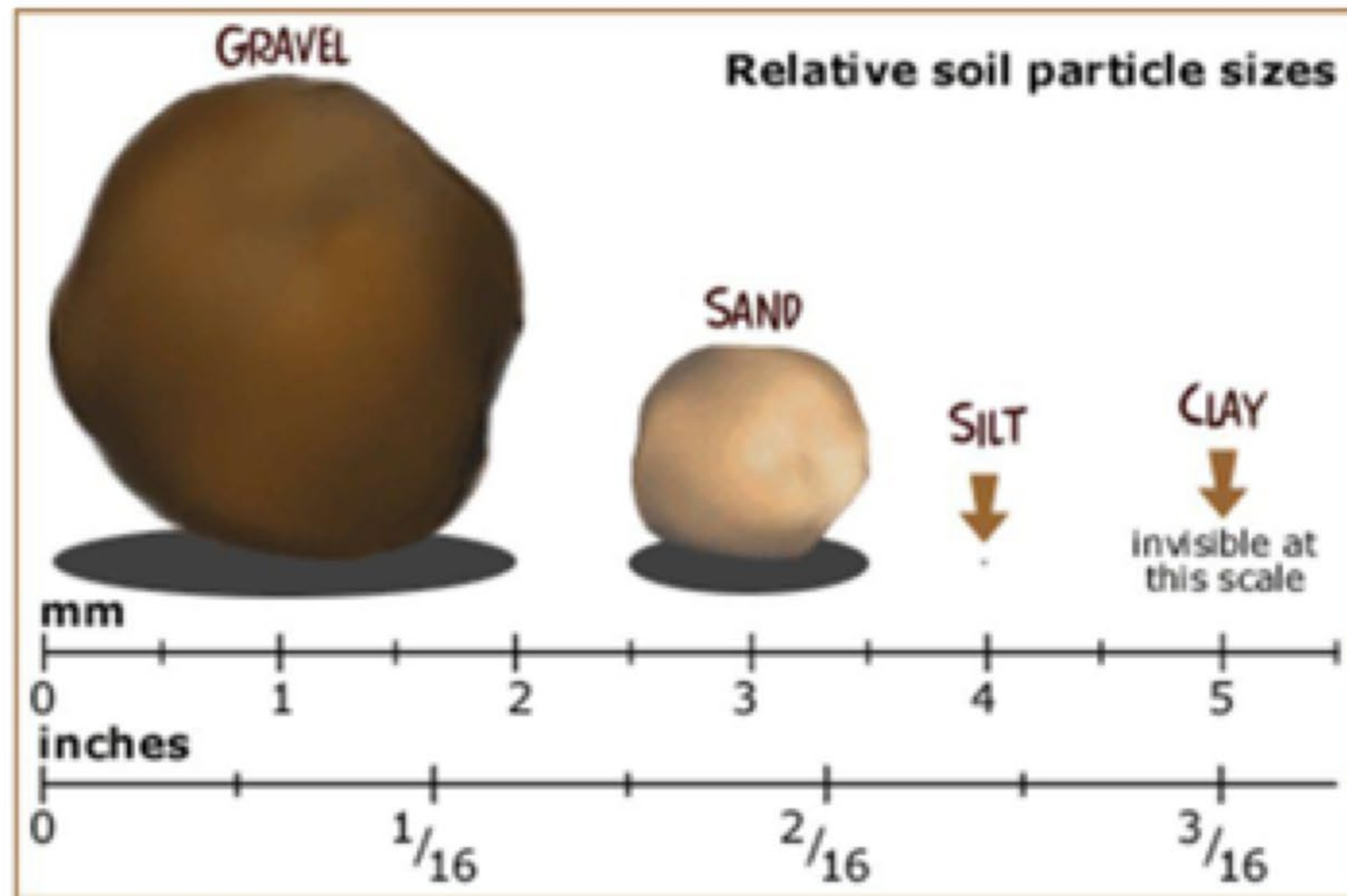
We are sinking a concrete bowl into the wet ground

Do mechanical systems really require that much space?

Provides space for a pool table..



Particle Sizes



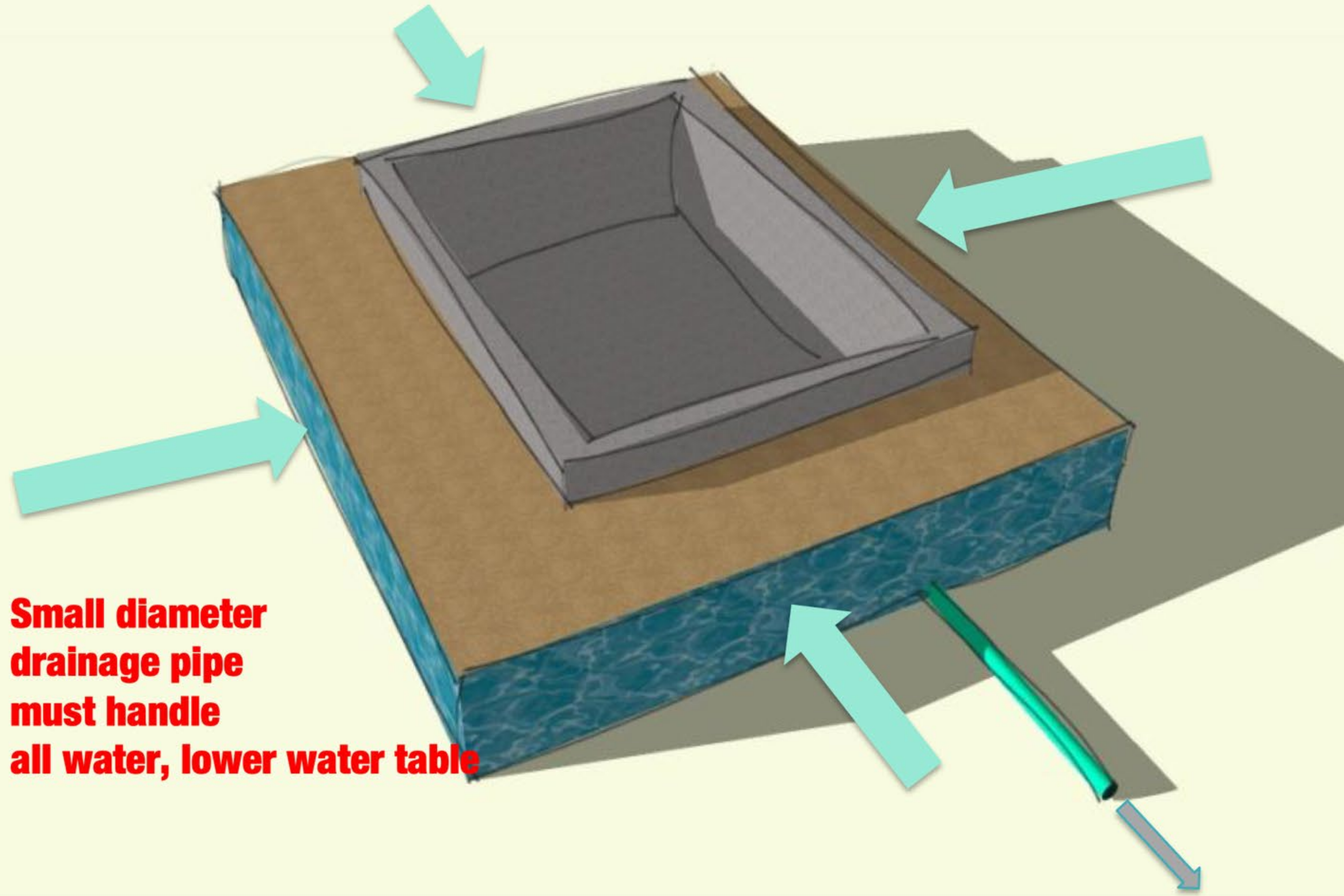
> 2mm... Gravel

0.06mm – 2mm... Sand

0.002mm – 0.06mm..Silt

< 0.002mm... Clay

Hydrostatic Pressure @ all four sides...and bottom



**Small diameter
drainage pipe
must handle
all water, lower water table**

A basement must be dry

It can be warm and dry, or cold and dry, but it must be dry

If there is any doubt, rethink the project



Concrete Masonry Unit (CMU)



Concrete

Insulated Concrete Forms (ICF)



Pitch away from foundation 5%
IRC 401.3

Provide porches and
deep overhangs

Minimize excavation depth

Gutters should be last resort



The 5% slope built into the project can easily become -5% over time

*Overfill to allow for subsidence,
or compact backfill during placement,
or regrade after a year or two?*

Site Evaluation

A clay hole presents problems

But a generous slope to
the south helps

A 6" diameter outfall pipe
will carry all the water

Waterproofing over
damp proofing



Why choose a 6" diameter outfall pipe?

$$\text{Cross sectional area} = \pi r^2$$


$$\text{Area} = 9\pi = 28.27 \text{ in}^2$$

6" pipe

4" pipe


$$\text{Area} = 4\pi^2 = 25.13 \text{ in}^2$$

Additional cost is double... \$300 versus \$150 for 50 LF



#4 bar to
increase
tensile strength
and
control cracking



Concrete was placed ...
not poured

I asked for and received
4" slump

It took some coaxing





This 5.25" slump
will yield inferior concrete

Dowels in place and capped

Warm, dry surface allowed
use of vapor barrier paint





Forms in place,
ready for concrete

$\frac{3}{4}$ " crushed stone
in place, inside and out

For drainage and
for workers' convenience



Cover the stone (and 4" \varnothing pipe) to prevent fines from clogging system



Between the forms...
but with sufficient cover

Insufficient cover



This was my
first choice
for waterproofing

Dimpled sheets
from Platon™

Breaks hydrostatic
pressure and
bridges cracks



Availability was a
problem, so...

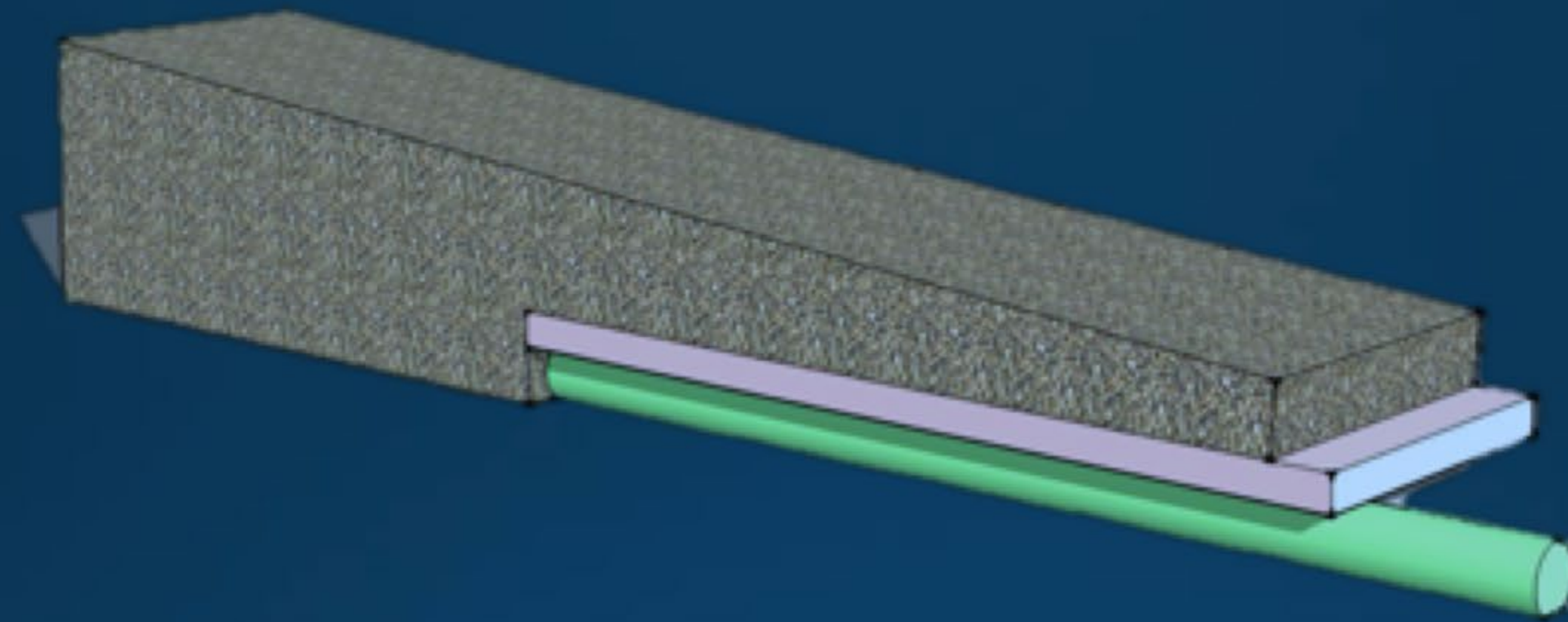


Plug holes with mastic

Apply damp proofing

Install reinforced polyethylene film

Backfill with coarse granular material



Insulation at outer end of outfall pipe, if needed

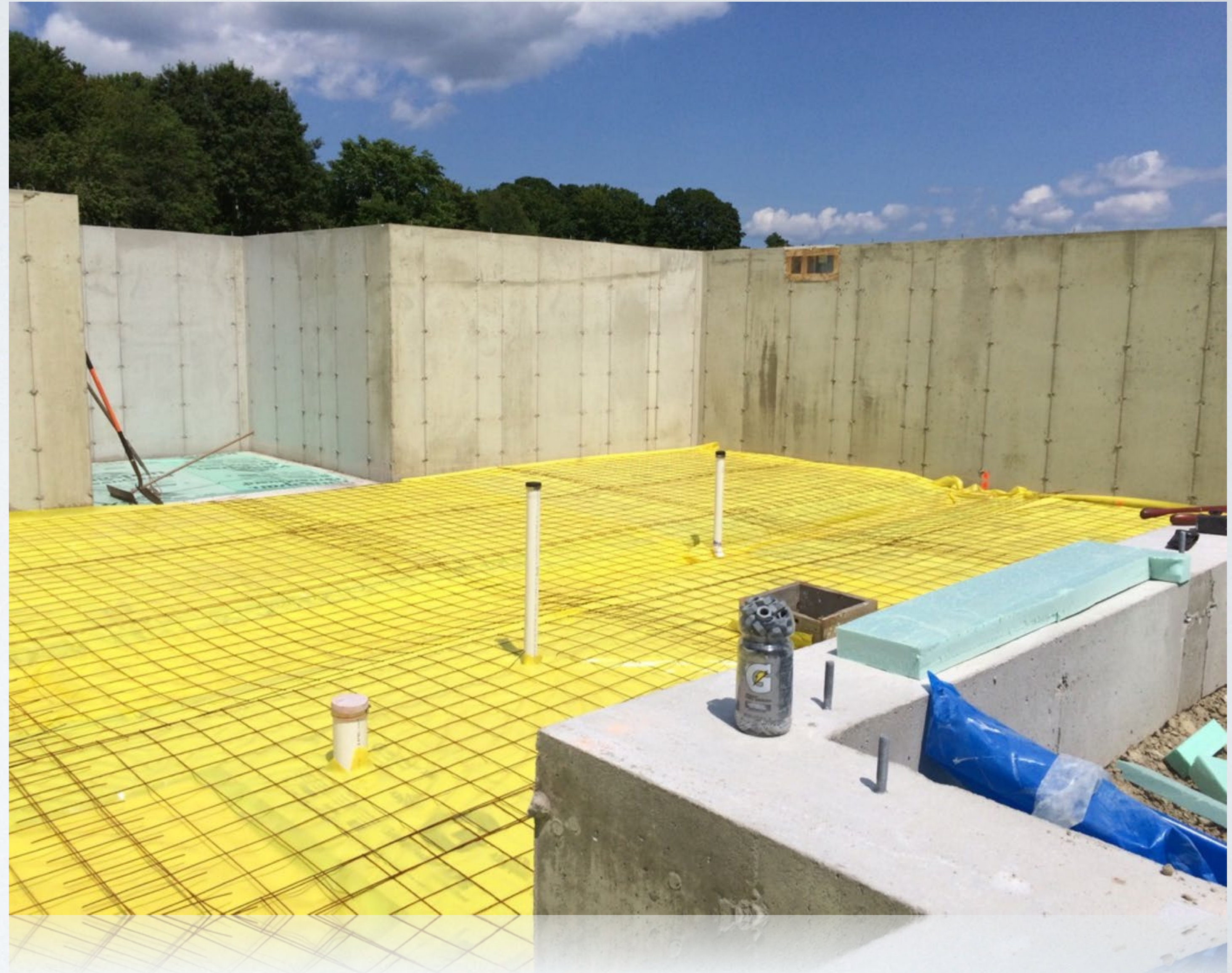
To prevent late winter, early spring freeze up

Plumbing in place

4" XPS installed

10 mil polyethylene laid

6" Welded Wire Reinforcing Mesh

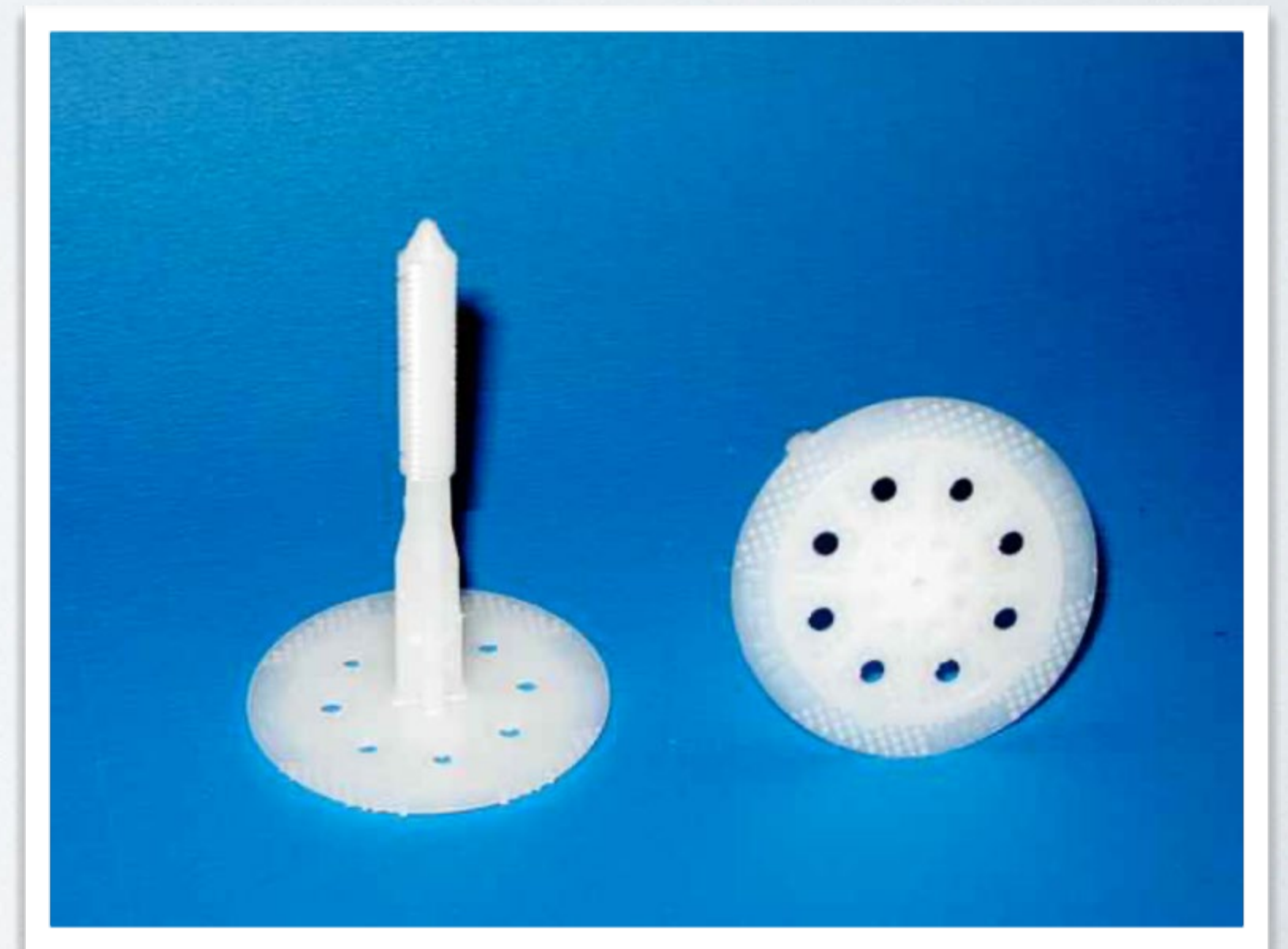




3" XPS attached to concrete

Rim joist sprayed

Hilti™ Insulation Anchors





**Table 402.1.1
Insulation and Fenestration Requirements by Component^a**

CLIMATE ZONE	FENESTRATION U-FACTOR ^b	SKYLIGHT ^b U-FACTOR	GLAZED FENESTRATION ^{b,e} SHGC	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE ⁱ	FLOOR R-VALUE	BASEMENT ^c WALL R-VALUE	SLAB ^d R-VALUE & DEPTH	CRAWL SPACE ^c WALL R-VALUE
1	1.20	0.75	0.30	30	13	3 / 4	13	0	0	0
2	0.65 ^j	0.75	0.30	30	13	4 / 6	13	0	0	0
3	0.50 ^j	0.65	0.30	30	13	5 / 8	19	5 / 13 ^f	0	5 / 13
4 except Marine	0.35	0.60	NR	38	13	5 / 10	19	10 / 13	10, 2ft	10 / 13
5 and Marine 4	0.35	0.60	NR	38	20 or 13+5 ^h	13 / 17	30 ^g	10 / 13	10, 2 ft	10 / 13
6	0.35	0.60	NR	49	20 or 13+5 ^h	15 / 19	30 ^g	15 / 19	10, 4 ft	10 / 13
7 and 8	0.35	0.60	NR	49	21	19 / 21	38 ^g	15 / 19	10, 4 ft	10 / 13

IECC 2009

**TABLE R402.1.2
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT²**

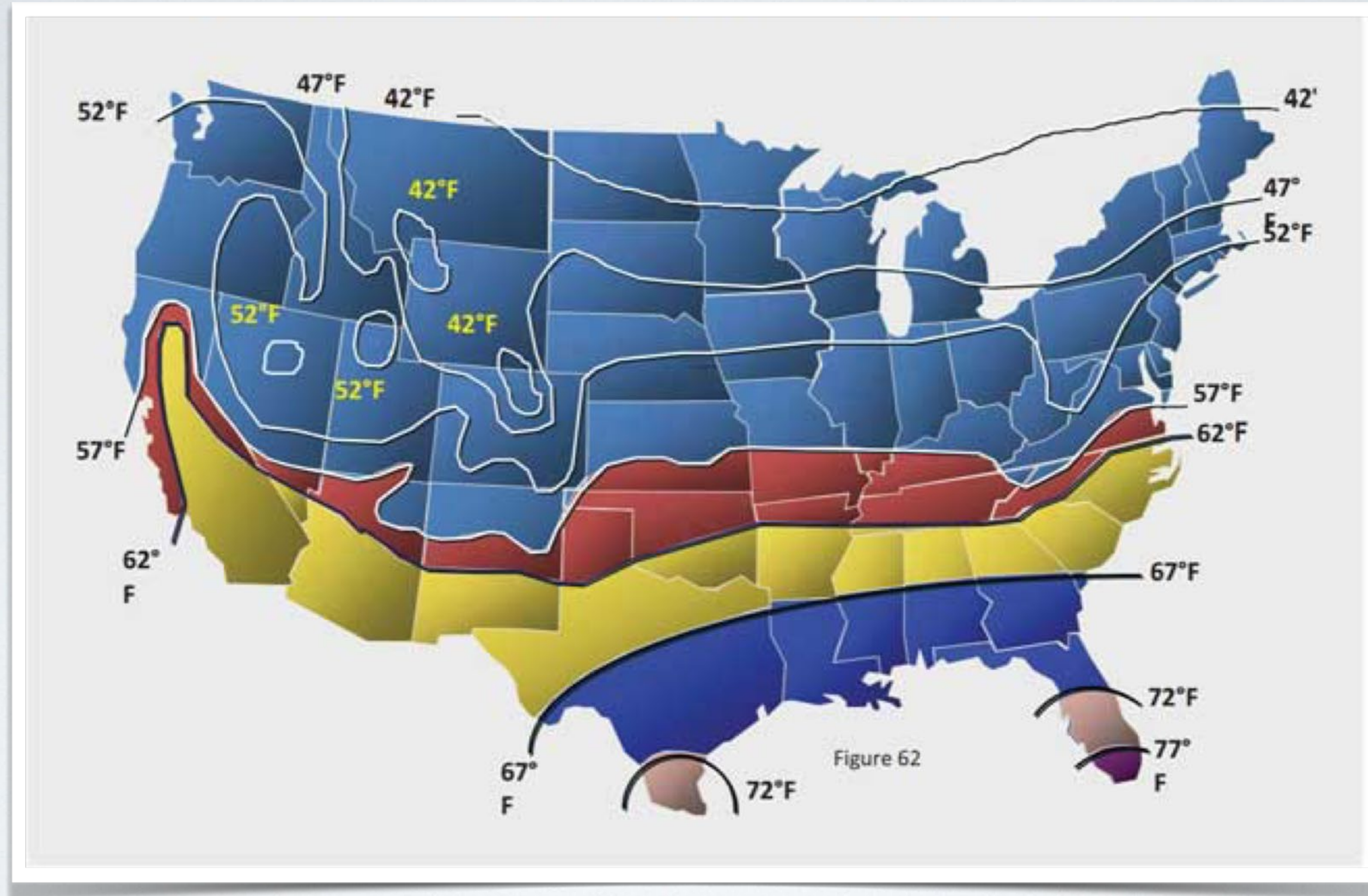
CLIMATE ZONE	FENESTRATION U-FACTOR ^b	SKYLIGHT ^b U-FACTOR	GLAZED FENESTRATION SHGC ^{b,e}	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE ^{h,i}	FLOOR R-VALUE	BASEMENT ^c WALL R-VALUE	SLAB ^d R-VALUE & DEPTH	CRAWL SPACE ^c WALL R-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13+5 ^h	8/13	19	5/13 ^f	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13+5 ^h	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13+5 ^h	13/17	30 ^e	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20+5 or 13+10 ^h	15/20	30 ^e	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	49	20+5 or 13+10 ^h	19/21	38 ^e	15/19	10, 4 ft	15/19

IECC 2015

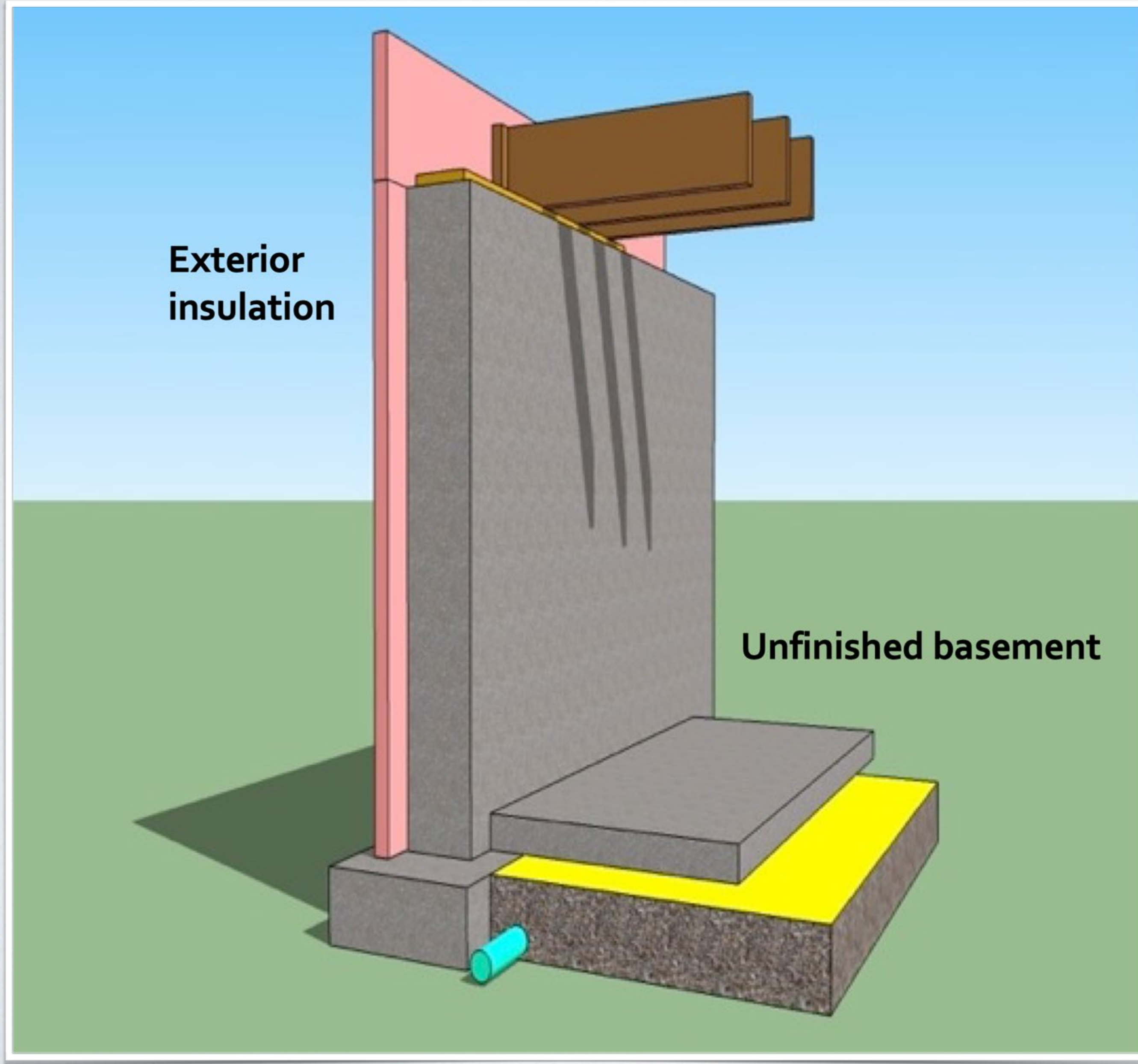
CLIMATE ZONE	FENESTRATION U-FACTOR ^{b, i}	SKYLIGHT ^b U-FACTOR	GLAZED FENESTRATION SHGC ^{b, e}	CEILING R-VALUE	WOOD FRAME WALL R-VALUE ^g	MASS WALL R-VALUE ^h	FLOOR R-VALUE	BASEMENT ^{c, g} WALL R-VALUE	SLAB ^d R-VALUE & DEPTH	CRAWL SPACE ^{c, g} WALL R-VALUE
0	NR	0.75	0.25	30	13 or 0& 10ci	3/4	13	0	0	0
1	NR	0.75	0.25	30	13 or 0& 10ci	3/4	13	0	0	0
2	0.40	0.65	0.25	49	13 or 0& 10ci	4/6	13	0	0	0
3	.30	0.55	0.25	49	20 or 13& 5ci ^h or 0& 15ci ^h	8/13	19	5ci or 13 ^f	10ci, 2 ft	5ci or 13 ^f
4 except Marine	.30	0.55	0.40	60	30 or 20&5ci ^h or 13& 10ci ^h or 0&20ci ^h	8/13	19	10ci or 13	10ci, 4 ft	10ci or 13
5 and Marine 4	0.30 ⁱ	0.55	0.40	60	30 or 20&5ci ^h or 13& 10ci ^h or 0&20ci ^h	13/17	30	15ci or 19 or 13& 5ci	10ci, 4 ft	15ci or 19 or 13& 5ci
6	0.30 ⁱ	0.55	NR	60	30 or 20&5ci ^h or 13& 10ci ^h or 0&20ci ^h	15/20	30	15ci or 19 or 13& 5ci	10ci, 4 ft	15ci or 19 or 13& 5ci
7 and 8	0.30 ⁱ	0.55	NR	60	30 or 20&5ci ^h or 13&10ci ^h or 0&20ci ^h	19/21	38	15ci or 19 or 13& 5ci	10ci, 4 ft	15ci or 19 or 13& 5ci

IECC 2021

Groundwater temperatures



Greater density equates to greater conductivity... 25 times that of air



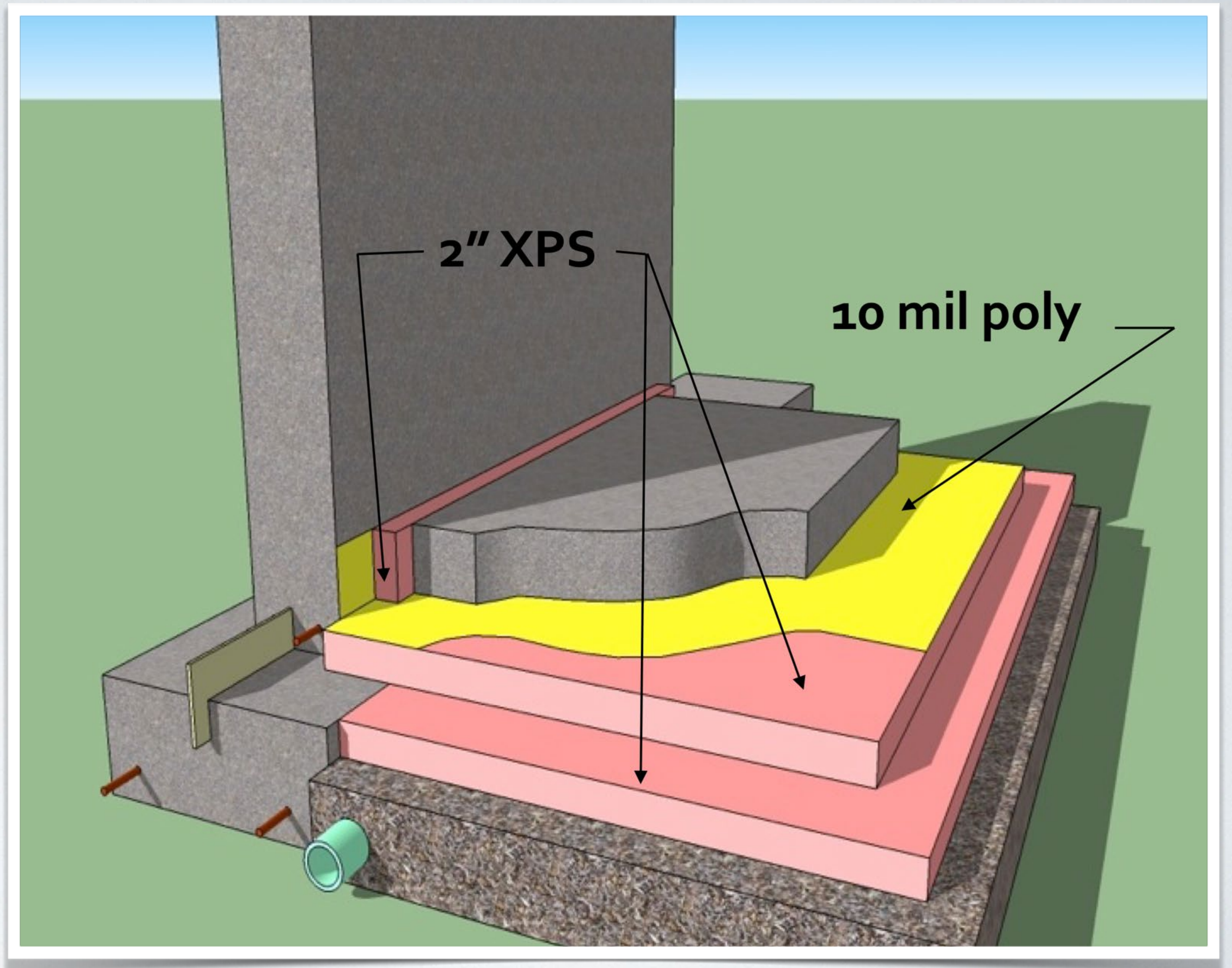
The idea is to de-couple the basement from the earth... which is wet, despite our best efforts

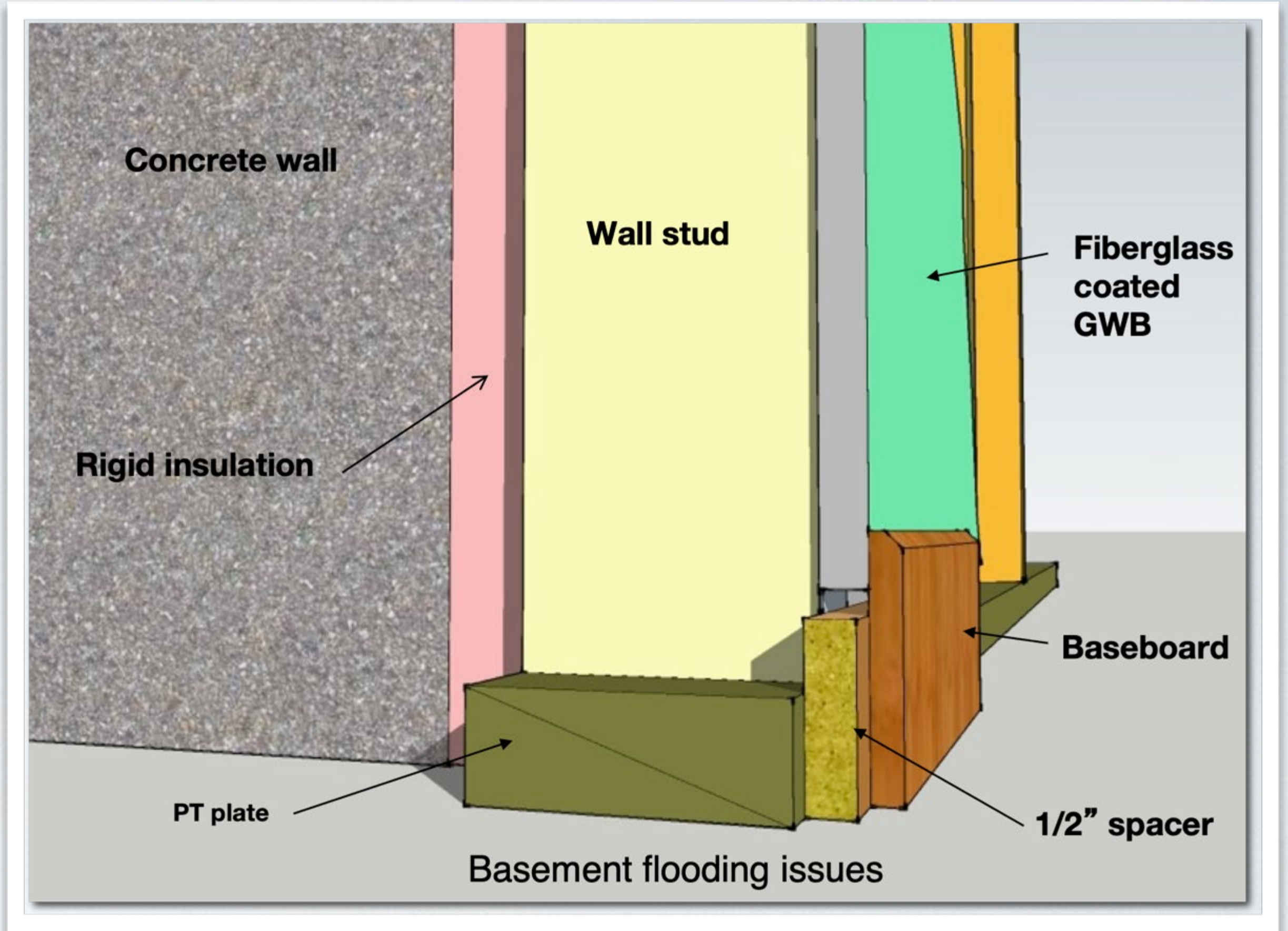


Insulate below the load...?



More likely method





Finishing the wall

Mold occurs within 24 to 48 hours

When the water heater fails...
When the sink overflows...
When the creek rises and the
sun don't shine...

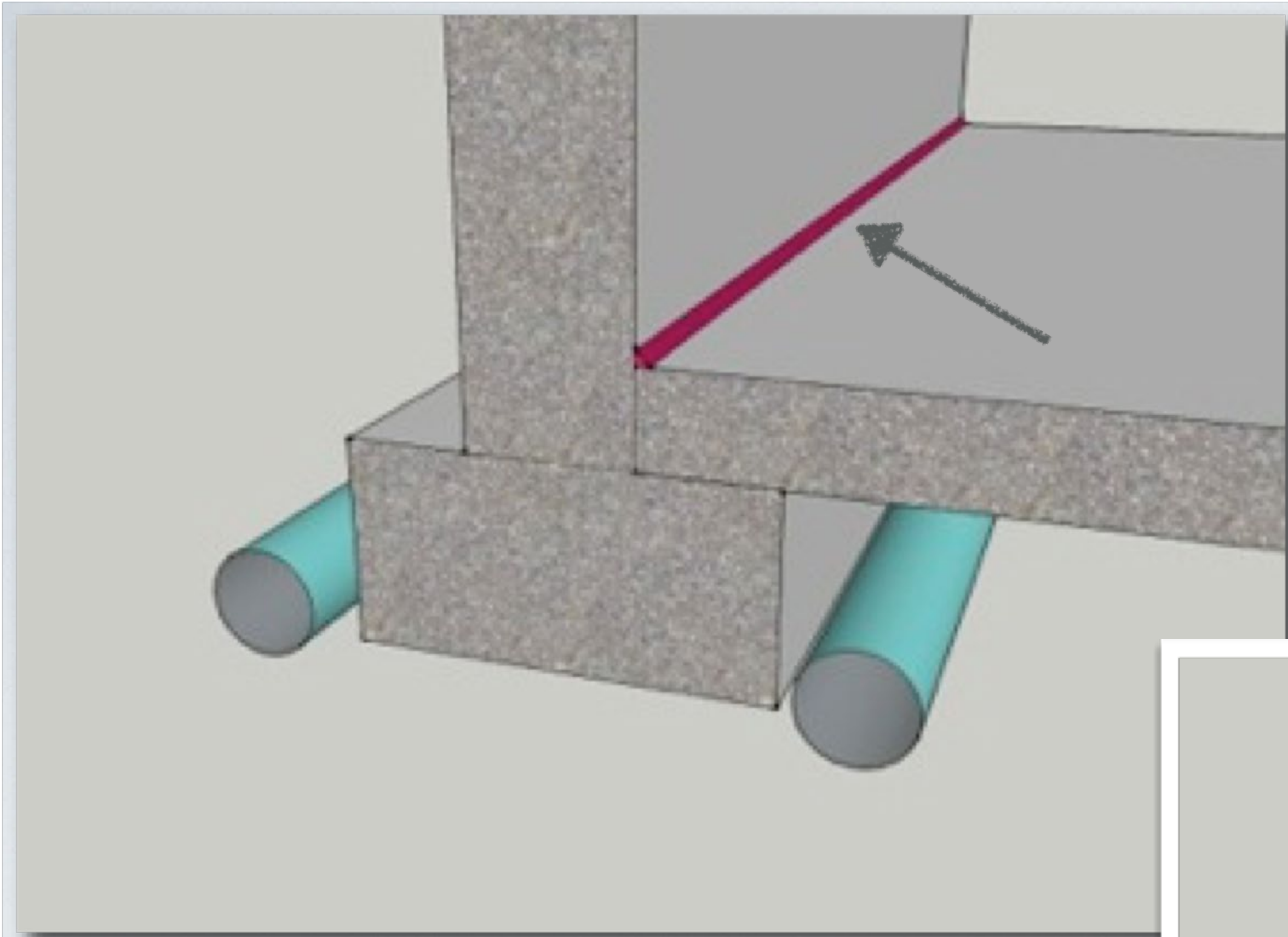
Drying this out is a problem



ASTM E-1465-08

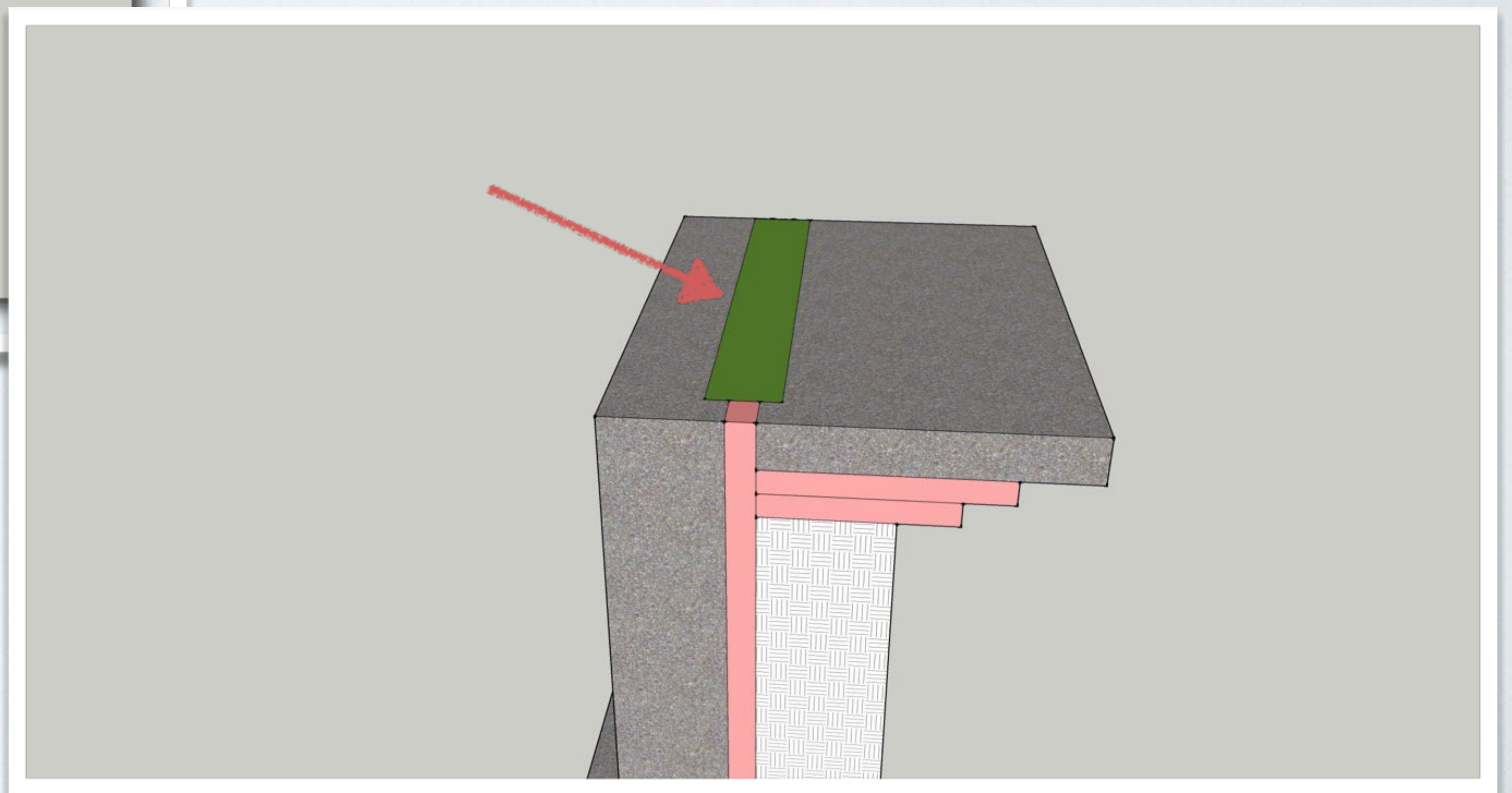
RADON STANDARDS

- Accommodations for active or passive system in all new homes *1465 1.1*
- All new homes tested prior to occupancy by registered tester *1465 6.10.5*
- All failed homes mitigated by registered mitigator
- RRNC (Radon Resistant New Construction)



Caulk the floor/wall joint
prior to insulation...

...or tape the joint with high grade tape...
Rissan™ from Siga™





Summertime humidity can make a mess

Air temp 68°
RH 65%
Lower wall temp 49°

Using dpcalc, $T_{dp} = 56^\circ$

Dew point reached



Open windows, uninsulated floor, ineffective dehumidifier



Dewpoint temperature reached



Expensive acquisition

Inexpensive operation



Some basements need bulkheads

Bulkheads are easily broken off

This method allows some heat loss,
thereby preventing frost heaving

A nicely finished
basement

Note the hard surface
flooring





I agreed to finish it knowing bulk water was well managed

The chimney material was taken from the excavation... blasted rock

Radon was kept under control with sub-slab depressurization



Plenty of room for an idle pool table



Baseboard is screwed into place

Another finished basement

Painted concrete floor



David Johnston

Maine Indoor Air Quality Council

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