Layout Under the Slab

If you're pouring concrete over plumbing, it had better be right the first time

by Greg Pringle

Until I moved to the Southwest, I thought all houses sat on foundation walls — if not on a full basement, at least on stemwalls. Shortly after moving to Albuquerque, N.M., I got my first carpentry job over the phone and was told to show up at a particular address the next morning. I drove up and down the street several times looking for a hole in the ground before I realized that this flat bare spot of concrete next to a lumber pile was where the house would be built.

Now after ten years of experience with slab-on-grade construction, I have come to appreciate its advantages as well as its pitfalls. Short of having the slab "get away" from the concrete crew, one of the worst things that can happen is to make a mistake on the plumbing or electrical layout under the slab. I'm going to focus on plumbing here, because it has less flexibility in its design, by far.

When framing the floor system, there's a little bit more latitude in both the timing and installation of the utilities. But if you are building on a slab and discover that the toilet somehow ended up right in the middle of the bathroom wall, you have a problem. And if you have one of the increasingly popular stained-concrete finished floors, forget about breaking it up. Once it's poured, you're married to it.

Read the Blueprints

Most of the work required to ensure a successful layout happens long before the first tape measure is pulled out. The process begins with a careful reading of the prints. I take the time to visualize

everything in the drawings in three dimensions. I read every word on every page of the drawings to make sure I'm aware of everything that goes under the slab, how it fits together, and in what order it needs to be placed (see illustrations on pages 3 through 6).

I build the project in my mind as I review the drawings and decide if what's on paper can actually exist in the real world. As any builder knows, the drawings tell you only *what* to build, not *how* to build it, and there may be logical contradictions that are not immediately apparent.

I make sure I have enough information. Are the drawings complete? Do they contain enough information to allow for accurate and correct decisions? I evaluate what the drawings look like compared to what the tradespeople will need to do. For example, if there are cabinets, countertops, and a wall-hung double sink specified in a kitchen (I have seen this), I'll want to find out why. Or maybe there's a 3-inch vent stack inside 2x4 framing with a cold water line coming up out of the slab on one side, but I need water on both sides. It's best to take care of that under the slab now, instead of over the ceiling later. The earlier I can catch these things, the less they cost to correct.

I look for ambiguity, omissions, and conflicts. Then I check for incomplete or mathematically incorrect dimension strings. If I see an "open" (or incomplete) dimension string, then I'll look for something wrong, especially on CAD drawings. If I see a note that says anything like "verify in field," this really gets my attention. I also read the general notes page and compare these instructions with applicable codes.

Dimensional consistency. Are all of the measurements from the face of the framing, or from somewhere else (like maybe a radius point that doesn't relate to anything)? Does the sheathing line up with the foundation, or does it overhang? Did the architect remember that drywall has thickness? I have received drawings stamped "for construction" that showed a whole bunch of 4-inch-thick walls. It doesn't take too many of these 1/2-inch errors adding up before the plumbing ends up outside the drywall at the far end of the building.

Overlays. Once I have sorted all of this out, I mentally overlay the framing plan on the foundation plan, with the plumbing and electrical plan on top of that (illustrations on pages 3 and 4). I check to make sure everything will actually fit in the space provided and that it overlays the way it should. I also make sure that everybody who will need to work in that space has enough room to do so without conflict. This includes the depth of each utility, and whether any one trade will install work that interferes with a later trade.

I also check to see if there is enough of an elevation difference to permit the drains to slope at 1/4 inch per foot from the farthest plumbing fixture to where the drain/waste lines tie into the sewer or septic system. Grinder pumps are pretty expensive ways to make up for this oversight if it is missed.

Next, I make sure there is someplace to run vent stacks. If the job involves a second floor, this is doubly important, and pay attention to the roof line. I don't want to move a wall in order to cover a vent stack, then discover that the vent stack pokes right through the middle of a valley. Watch out for island vents in the kitchen, too.

Then I check for any runs that exceed the length of the soft copper rolls my plumber uses. It comes in 40-, 60-, and 100-foot rolls, depending upon the diameter of the line. If I have a run longer than the roll of tubing, I need to find a wall where I can place a manifold. I do not allow joints in copper under the slab.

Any one of these considerations alone can hide the error that ruins my day if I don't double-check, find, and correct it ahead of time. If I need to get clarification, now is the time, but I keep these early communications to a well-organized minimum. I try to take care of all of my questions in the fewest number of phone calls. But I also don't want to be on the cell phone with the architect while the plumber or electrician is packing up to go to another job because I'm not available to answer a legitimate question.

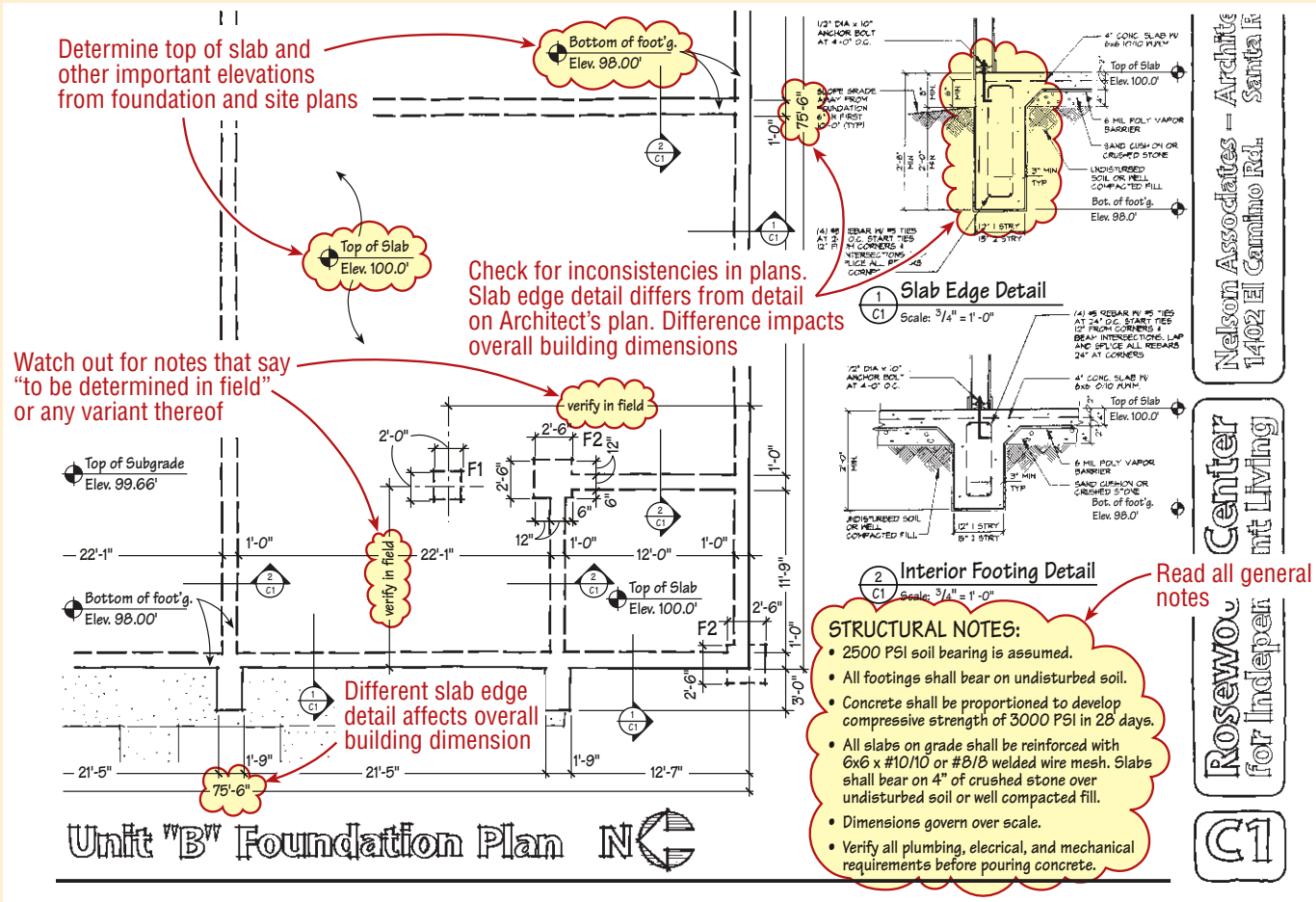
Check all finishes. If I'm given an interior dimension of 5 feet from framing to framing on the drawings, and a note somewhere says there is 5/8-inch drywall and 3/8-inch tile on three walls, I need to make sure I account for that. It can make all the difference — especially if I have to install cabinets or fixtures. I make sure I know what the actual dimensions of my framing materials are, especially if a mixture of materials are in the same room, like wood and steel studs with different finishes or partitions (illustrations on pages 44 and 45).

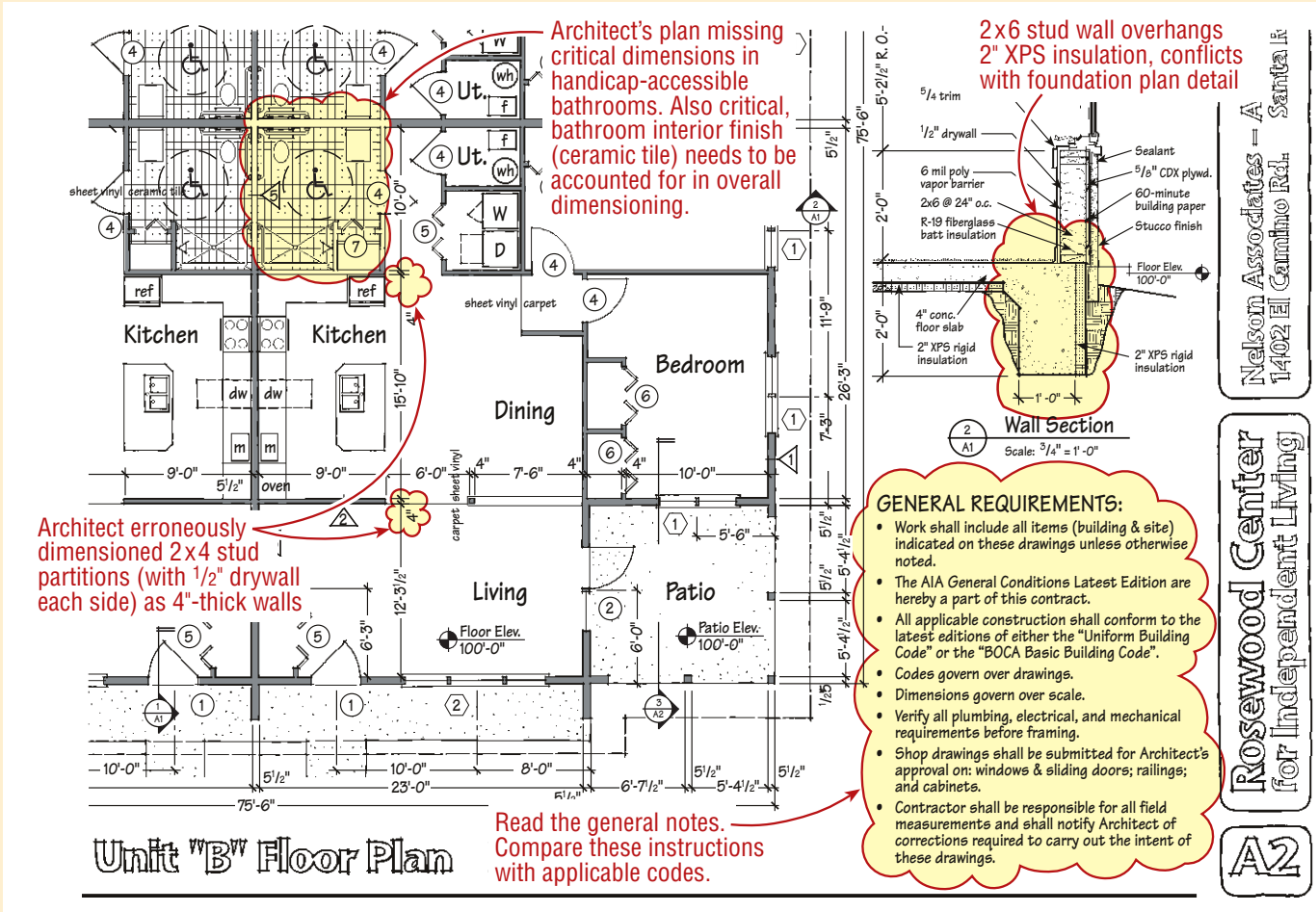
Have a plan. Before I start my layout, I ask myself, "What's critical on this job?" It could be that the bathroom framing is tight, and I need to work around that. It could be that the clients consider the view over the kitchen sink and out the window mandatory. Around here, it's a plumbing inspector saying, "That's 1/4 inch off. Move it." I try to figure out what part of my job is not negotiable in terms of placement and I work from there.

Laying Out

After working through this process, I am now ready to draw some lines. Builders who are new to layout inside concrete formwork can be confused by the idea that formwork is built in negative rather than positive space. Usually contractors build elements that are permanent. With formwork, you need to build solid blocking in all areas where you need a void, whereas voids in the

text continued on page 7


Determine top of slab and other important elevations from foundation and site plans
Bottom of foot'g. Elev. 98.00'
Top of Slab Elev. 100.0'
Check for inconsistencies in plans. Slab edge detail differs from detail on Architect's plan. Difference impacts overall building dimensions
Slab Edge Detail
Scale: 3/4" = 1'-0"
Watch out for notes that say "to be determined in field" or any variant thereof
verify in field
Top of Subgrade Elev. 99.66'
Interior Footing Detail
Scale: 3/4" = 1'-0"
Read all general notes
STRUCTURAL NOTES:
• 2500 PSI soil bearing is assumed.
• All footings shall bear on undisturbed soil.
• Concrete shall be proportioned to develop compressive strength of 3000 PSI in 28 days.
• All slabs on grade shall be reinforced with 6x6 x #10/10 or #8/8 welded wire mesh. Slabs shall bear on 4" of crushed stone over undisturbed soil or well compacted fill.
• Dimensions govern over scale.
• Verify all plumbing, elecrical, and mechanical requirements before pouring concrete.
Different slab edge detail affects overall building dimension
Unit "B" Foundation Plan
Nelson Associates — Architects
14402 El Camino Rd. Santa Fe
Rosewood Center for Independent Living
C1


Architect's plan missing critical dimensions in handicap-accessible bathrooms. Also critical, bathroom interior finish (ceramic tile) needs to be accounted for in overall dimensioning.
2x6 stud wall overhangs 2" XPS insulation, conflicts with foundation plan detail
Wall Section
Scale: 3/4" = 1'-0"
Architect erroneously dimensioned 2x4 stud partitions (with 1/2" drywall each side) as 4"-thick walls
GENERAL REQUIREMENTS:
• Work shall include all items (building & site) indicated on these drawings unless otherwise noted.
• The AIA General Conditions Latest Edition are hereby a part of this contract.
• All applicable construction shall conform to the latest editions of either the "Uniform Building Code" or the "BOCA Basic Building Code".
• Codes govern over drawings.
• Dimensions govern over scale.
• Verify all plumbing, electrical, and mechanical requirements before framing.
• Shop drawings shall be submitted for Architect's approval on: windows & sliding doors; railings; and cabinets.
• Contractor shall be responsible for all field measurements and shall notify Architect of corrections required to carry out the intent of these drawings.
Read the general notes. Compare these instructions with applicable codes.
Unit "B" Floor Plan
Nelson Associates — Architects
14402 El Camino Rd. Santa Fe
Rosewood Center for Independent Living
A2

Office Preparation Checklist

1. Read the Drawings — Every Word: Are the drawings complete? Make sure you have enough information to accomplish the job. Look for ambiguity, omissions, and conflicts.

2. Check Dimensioning: Are they consistent from page to page? Do they add up correctly? Are the measurements from the face of the framing, or from somewhere else? If you see an incomplete dimension string, find out why it's there. Watch out for notes that say "to be determined in field" or any variant thereof.

3. Cross Reference Drawings: Mentally overlay the framing plan on the foundation plan, with the plumbing and electrical plan on top of that. Make sure that everything that is supposed to fit inside the wall can actually fit there (vent lines, drain/waste lines, supply lines).

4. Determine Important Elevations: Determine top of slab, top of subgrade (below slab), existing grade, finished exterior grade, finished floor, sewer, and other important elevations from site and foundation plans.

5. Work Through the Plumbing Plan: Starting with the drain/waste lines, find the lowest point of the line. Make sure that at this elevation you can tap the sewer, manhole, or septic system outside the building. Then, work your way back to the highest (or farthest) point of the system at 1/4-inch per foot. Is the drain/waste line still under the slab?

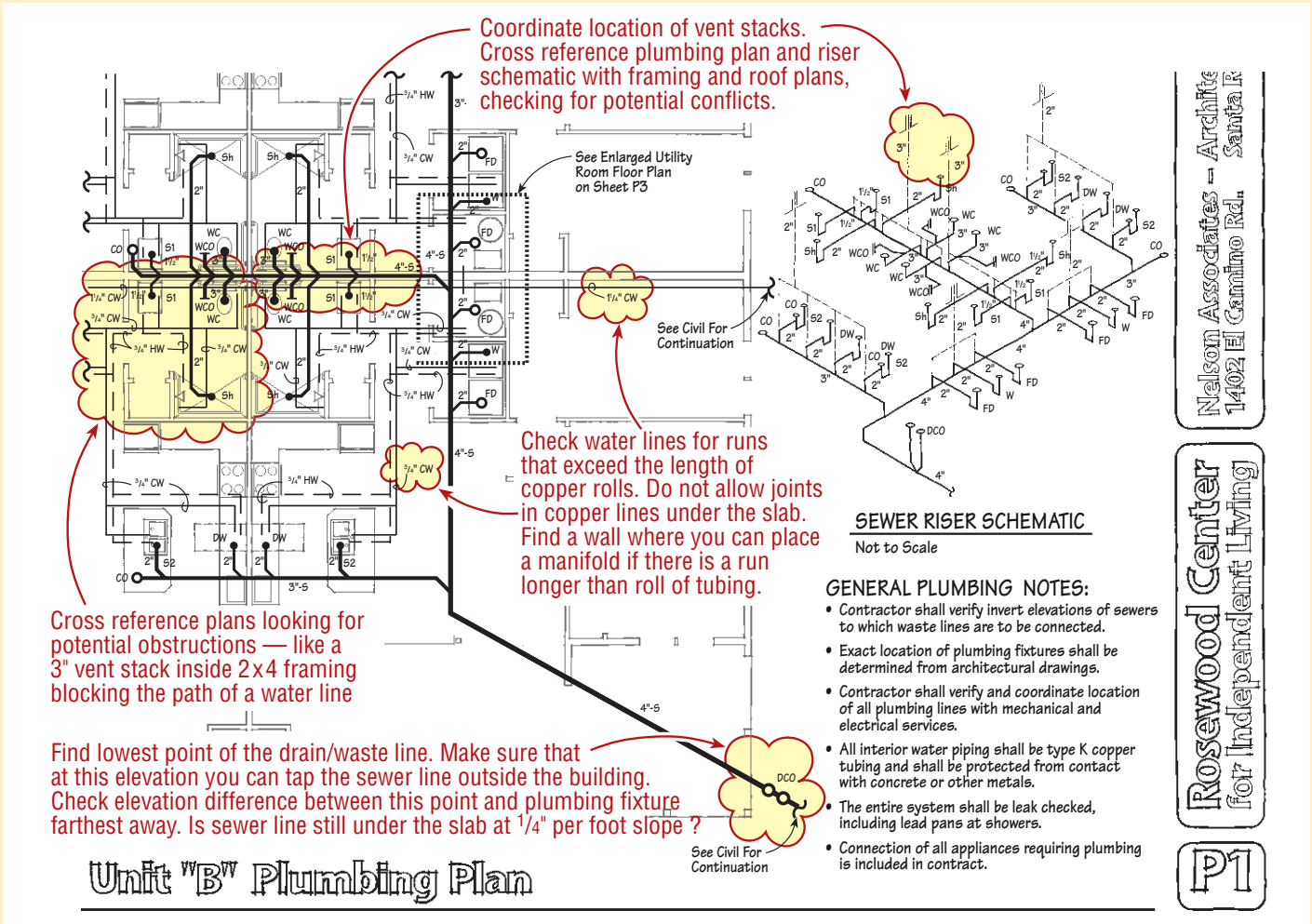
6. Check All Vent Stack Locations: Make sure their locations don't conflict with that of a window or the middle of a valley in the roof. Also notice if there are any island vents.

7. Check All Supply Lines: Can you get water everywhere it needs to go without encountering obstructions? Do any runs exceed the length of your tubing rolls? If so, find a wall where you can place a manifold.

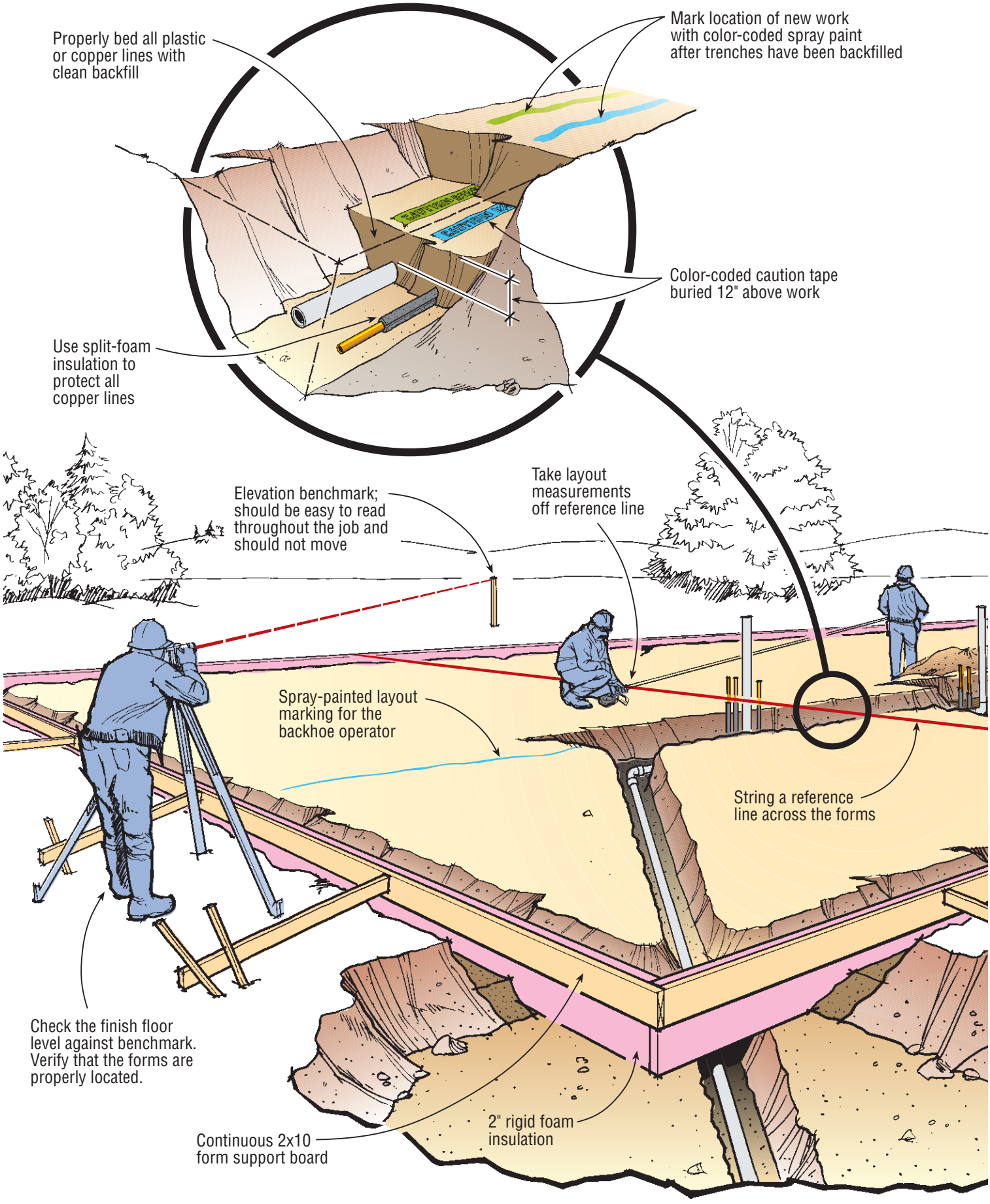
8. Check All Interior Finishes: Make sure you know what the actual dimensions of the framing materials are, especially if a mixture of materials are in the same room, like wood and steel studs with different finishes or partitions.

9. Figure Out What's Critical: Try to determine what part of the job is not negotiable in terms of placement, and work from there.

10. Help Your Subs: Provide your subcontractors with a full set of prints. This way they receive the courtesy of understanding how their work fits into the bigger picture, including what work is already there and what trades have to follow.



Trench Infill Detail



On-Site Layout Checklist

1. Set an Elevation Benchmark: Set an elevation benchmark prior to excavation. Place benchmark somewhere convenient and make sure everybody on the site knows where it is.

2. Check Concrete Formwork: Double-check forms, verifying that they are located properly, both in relation to the corner points the surveyor set prior to excavation and in relation to the elevation benchmark.

3. Set Reference Line: Mark on edge of forms one reference point from which each subtrade can take dimensions and work. A string line across the forms is ideal. To locate this reference line, I use some feature of the building that I know cannot change, usually the longest bearing wall. I make sure that everyone clearly understands how this line corresponds to their work.

4. Study Edge of Slab/Wall Detailing: Take time to understand the relationship between the edge of the form and the edge of the wall. Explain it to the plumber and other subs.

5. Plumbers First: When starting layout, make sure the plumber is the first trade in. Let other subs work around him — it's a lot easier for an electrician to snake around obstructions than for the plumber.

6. Locate Utilities Before Excavating: Have the site spotted for existing utilities before anybody digs for anything. The location service is free, and it's legally required in most locales.

7. Excavation: Mark excavation layout for the backhoe operator with spray paint. Use a spotter in the ditch. The spotter can help with a laser or transit to get the excavation to the right depth, avoiding shovel work later, and can help watch for unexpected problems. Coordinate where the spoils pile is going to go.

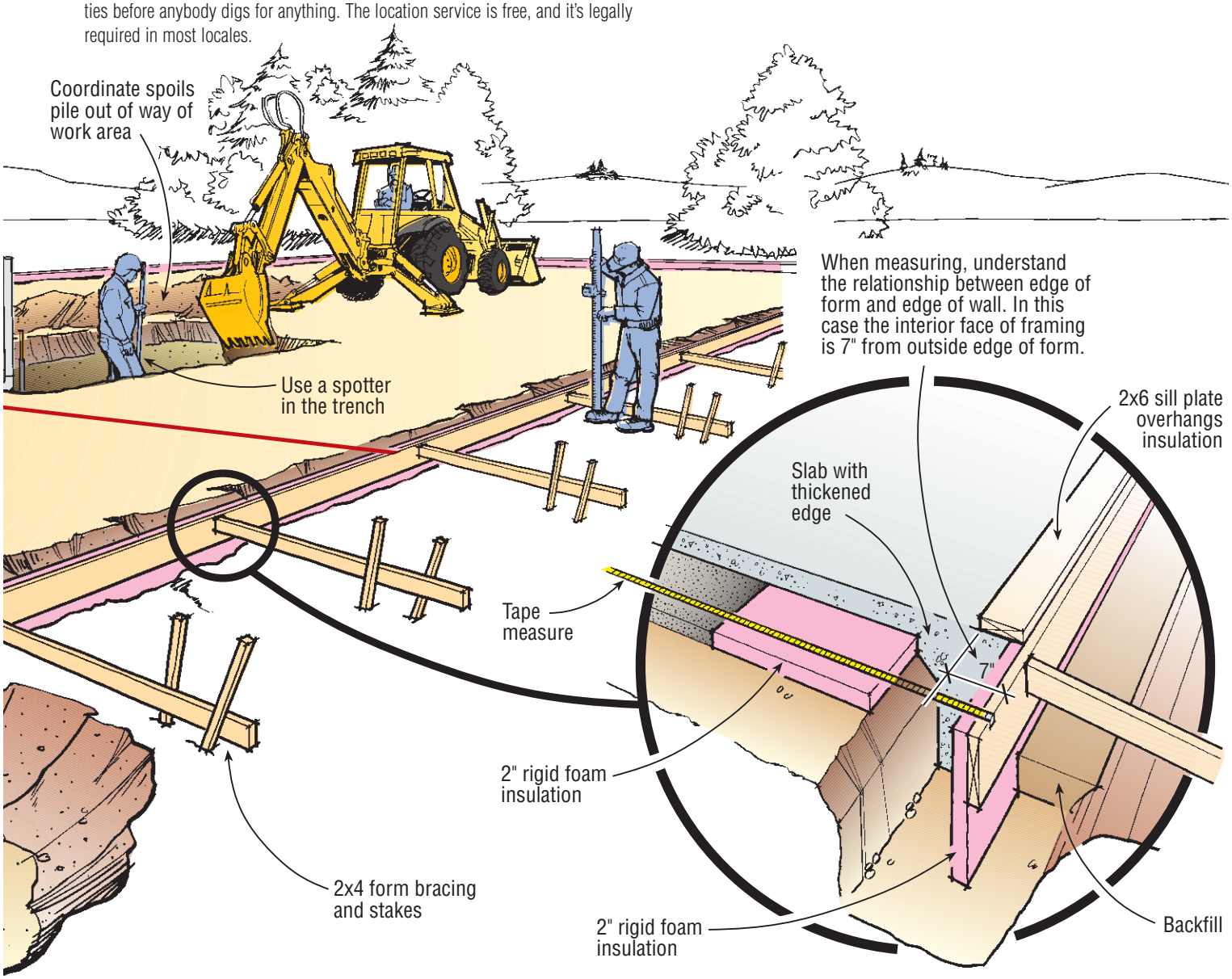
8. Line Protection and Backfilling: After the service lines have been installed, all plastic or copper lines should be properly bedded (clean fill, no rocks) and tested for leaks prior to backfilling. All copper should be checked for dents or abrasions and wrapped in split-foam insulation or something similar to protect it.

9. Install Caution Tape: Make sure every trade buries color-coded caution tape 12 inches above their work. These plastic caution tapes are color coded: red for electric, blue for water, green for sewer, yellow for gas, and orange for phone.

10. Compaction: Make sure that water is available on site. It's difficult to get the recommended 95% backfill compaction without water.

11. Mark Location of New Work: Use spray paint to color-code the location of new work after backfilling trenches. It's easy to forget where lines run a few days after a trench has been backfilled.

12. Take Notes: Don't leave anything to memory. Before the concrete trucks show up, make notes either on the drawings or in a site log.



Measuring off the Form

continued from page 2

formwork become solid concrete. It sounds easy, but beyond simple foundation walls it can be challenging, especially concrete stairs. It's amazing how often foundations (or framing) end up exactly 1 1/2, 3, or 4 1/2 inches off.

If contractors are accustomed to doing their plumbing and electrical rough-in on buildings that already have their floors and walls in place, they can get a little disoriented trying to fit everything in a bathroom or kitchen that doesn't exist yet. Where normally there is a wall to work from, now there is only a reference line.

Otherwise, there is nothing different or difficult about getting the plumbing and electric properly located under a slab. It involves the same logical process required for any other job, except it happens earlier and corrections or changes can't be made easily.

Figure 1. A stringline for reference helps everyone. On this job some walls were in place prior to pouring the slab, but the principles are the same.

Use reference points. Before anything else happens, I double-check my forms to make sure they are located properly, both in relation to the corner points the surveyor set prior to excavation and in relation to an elevation benchmark I have already set on the site. Because one of the least negotiable items on a monopour is the finish floor elevation, I always set an elevation benchmark somewhere convenient. I make sure everybody on the site knows what and where it is, and I encourage them to use it. This can be a nail set into a curb or a dot of paint on the base of a lamp post. It doesn't matter exactly what the benchmark is as long as it will be easy to read throughout the job and it isn't going to move. If I need to make adjustments, now is the time to do so. Assuming that the forms are in the right place, I can use the edge of the form to locate the exterior walls.

Having located my exterior walls, I can identify and mark on the edge of the forms one reference point from which each subtrade can take dimensions and work. A string line across the forms is ideal (Figure 1).

To locate this reference line, I use some feature of the building that I know cannot change. I generally use the longest bearing wall and any essential construction feature, for example, a "wet" wall. I make sure that everyone clearly understands how this line corresponds to their work.

It's an option to lay out the walls that run perpendicular to the exterior walls on the edge of the forms, but this is not necessary for most subcontractors. Whatever I do, I make sure my plumber and I understand the relationship between the edge of the form and the edge of the wall — and I make sure to account for foam insulation or sheathing. Around here, we routinely use 2-inch foam insulation on the outside of foundation walls (in other words, inside the forms). This extra 2 inches can make a big difference for the plumber.

The key to success is communication. I always point out the reference line and explain, "This is written in gold. I put this here for you, and it's the only point you work from. From here on out, if you do your job right and anything goes wrong, it's my problem." This helps everybody because now each trade can just do their job.

Help your subs. From this point, the layout is just like any other layout. The only difference is the builder can't afford a mistake, so I stay involved. Some GCs provide only the framing page to the framers, the plumbing page to the plumbers, and so on. This is a good way to invite trouble. I provide every one of my subcontractors with a full set of prints. Sure, it costs a few bucks more for printing, but this way they receive the courtesy of understanding how their work fits into the bigger picture, including what work is already there and what trades have to follow. In return, I don't ever want to hear from any of them, "I didn't know the electric would be in the way."

Plumbers First

I make sure the plumber is the first trade in and I let everyone else work around him. (The only exception is the rare job with hvac in the floor being run by someone else; in that case, I get that sub in ahead of the plumber.) We all know the First Rule of Plumbing: It's a lot easier for an electrician to snake around obstructions, and electricity has no problem with gravity (Figure 2).

I am not a plumber. I do not know all of the subtleties and nuances, but my plumber does. Regardless of how good the plans are, questions will arise. I encourage the tradespeople to figure out an answer for themselves. The

most direct answer is almost always the best. But I am there to make sure that the answer they come up with fits the big picture.

I do the layout with my plumber and with each respective trade. If I do the layout by myself, I will not be giving each tradesperson the full opportunity to do their best. If they do it themselves, I may not get exactly what I need.

Excavation

No matter what, I have the site spotted for existing utilities before anybody digs for anything. I don't take chances with other people's lives. The location service is free, it's legally required in most locales, and I am going to feel really stupid (or dead) if I hit a gas or electric line I didn't know was there.

Sometimes I use spray paint to mark the layout for the backhoe operator. If he or she uses a 12-inch bucket, my horizontal location will be close enough. I also use a spotter in the ditch. This person can help with a laser or transit to get the excavation to the right depth, avoiding shovel work later, and can help watch for unexpected problems. I coordinate where the spoils pile is going to go. It can make a big difference in everyone's ability to move around the site, and avoids interference with the work of other subtrades.

Backfilling. All plastic or copper lines should be properly bedded (clean fill, no rocks) and tested for leaks prior to backfilling. All copper (including cold water lines) which will be below grade should be checked for dents or abrasions and wrapped in split-foam insulation or something similar to protect it.

I make sure every trade, no matter what, buries a marker tape 12 inches above their work (Figure 3). This is extremely important, because you can trace the location but not the depth. These plastic caution tapes are color coded: red for electric, blue for water, green for sewer, yellow for gas, and orange for phone. In a perfect world, anybody trenching after previous subs have buried their work will notice this tape before they find a pipe or cable the hard way, which is why it's important to locate the tape 12 inches above the line.

Figure 2. It's easy for the electrician to work around the plumber, but it's also easy to accidentally get in the plumber's way.

Figure 3. Locating color-coded marker tape 12 inches above the buried line is essential for safety.

Backfill compaction is usually expressed as a percentage at optimal moisture content, so I make sure that water is available. Without it, it's difficult to get the 95% compaction that's recommended.

For the convenience of everyone on the site, especially subsequent trades, I also use spray paint to color-code the location of new work after the trenches have been filled. While you are digging, it's easy to think you'll never forget where you ran a line, but a few days after you have backfilled the trench, it all starts looking like dirt.

Blocking Out

After the subgrade has been established, I double-check all penetrations before the slab is poured. This includes toilet flanges, drain boxes, turn-ups for water, electric, gas, phone, or floor drains. Each trade will have some method for securing their work and will often use temporary supports made from conduit or rebar. If I need additional penetrations for any reason — such as possible electrical runs in a stemwall — now is the time to block them out. I like to use rigid foam to block out a pour because it's always on site, it's easy to remove, and, if the penetration proves to be unnecessary, I often can leave the foam in place.

Take Notes

I don't leave anything to memory. Before the concrete trucks show up, I make notes either on the drawings or in my site log. That way, when questions arise, I don't need to recalculate anything.

Greg Pringle is a carpenter and construction superintendent in Santa Fe, N.M.