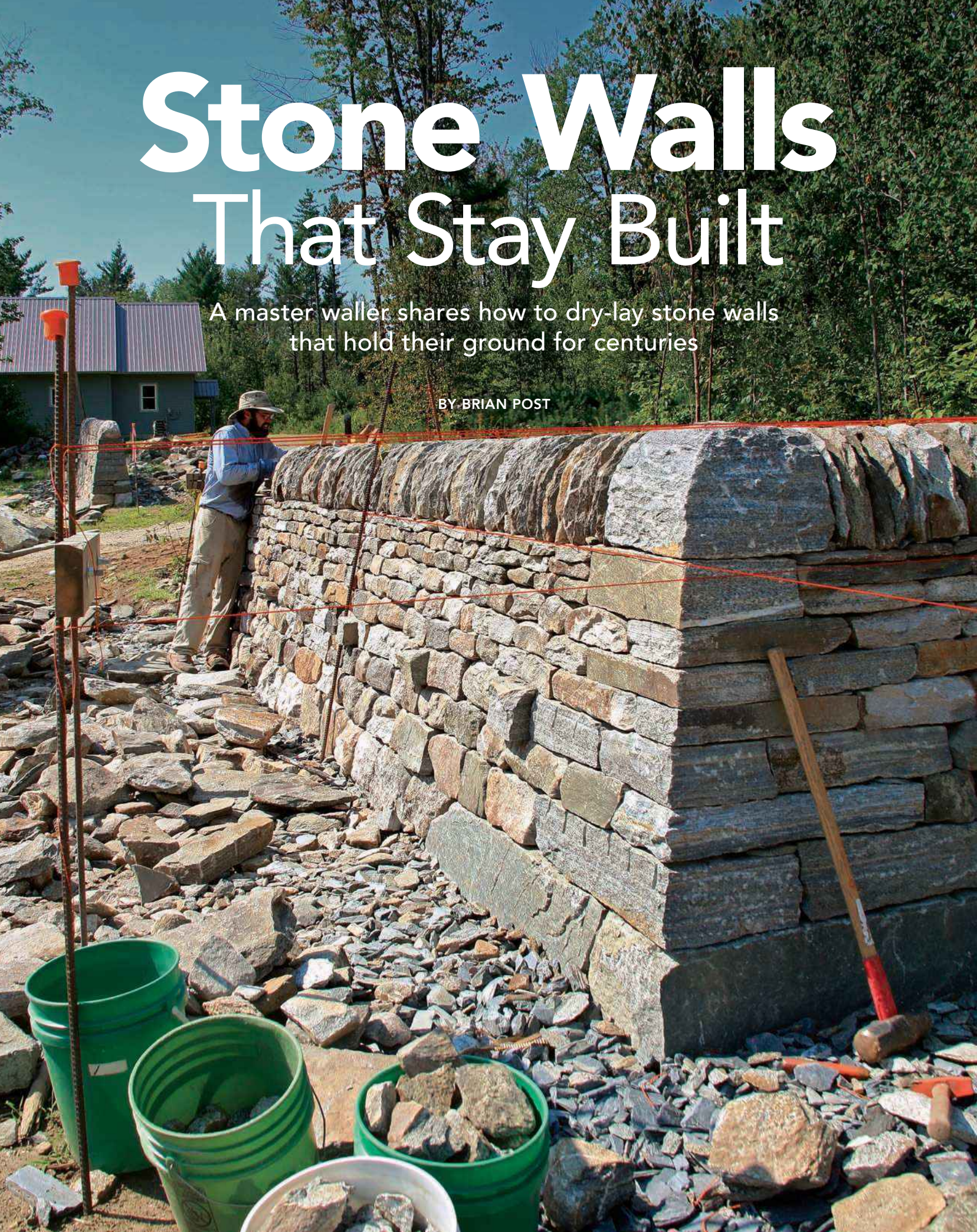
Stone Walls That Stay Built

A master waller shares how to dry-lay stone walls that hold their ground for centuries

BY BRIAN POST



I began my professional training as a waller working under certified craftsmen in Great Britain, a country whose landscape is laced with stone walls that date back millenia. In New England, where I live, two-century-old walls are common. While this may come as a surprise, that's far longer than most mortared walls last. If you learn to properly lay dry stone, you can build walls that outlast your great-grandchildren.

Mortar hurts more than it helps

While it can take years of practice to efficiently build a near-perfect wall, building a good dry stone wall is quite easy. The process starts with forgetting what you think you know about the importance of mortar. One reason for their longevity is that properly laid dry stone walls flex as the ground moves, whereas a mortared wall will crack. This flexibility often allows dry stone walls to be built directly on the native soil, while mortared work requires a concrete foundation below the frost line. And while a dry stone wall allows water to pass through harmlessly, mortared walls can trap moisture that will destroy the wall when it freezes.

In a dry stone wall, the aim is to use gravity to maximize friction. Friction keeps the stones from sliding apart, and their weight increases the friction. But even the best built wall can fail if it is poorly designed.

Base the design on the site and stone

When siting, think about what can damage a wall. In northern areas, set walls back from roads and driveways so that plows won't push snow against them. Trees growing in girth can put pressure on walls, and roots can shift or lift when a tree blows in the wind, pushing a wall up from underneath. A good practice is to stay back at least 10 ft. from trees and roads.

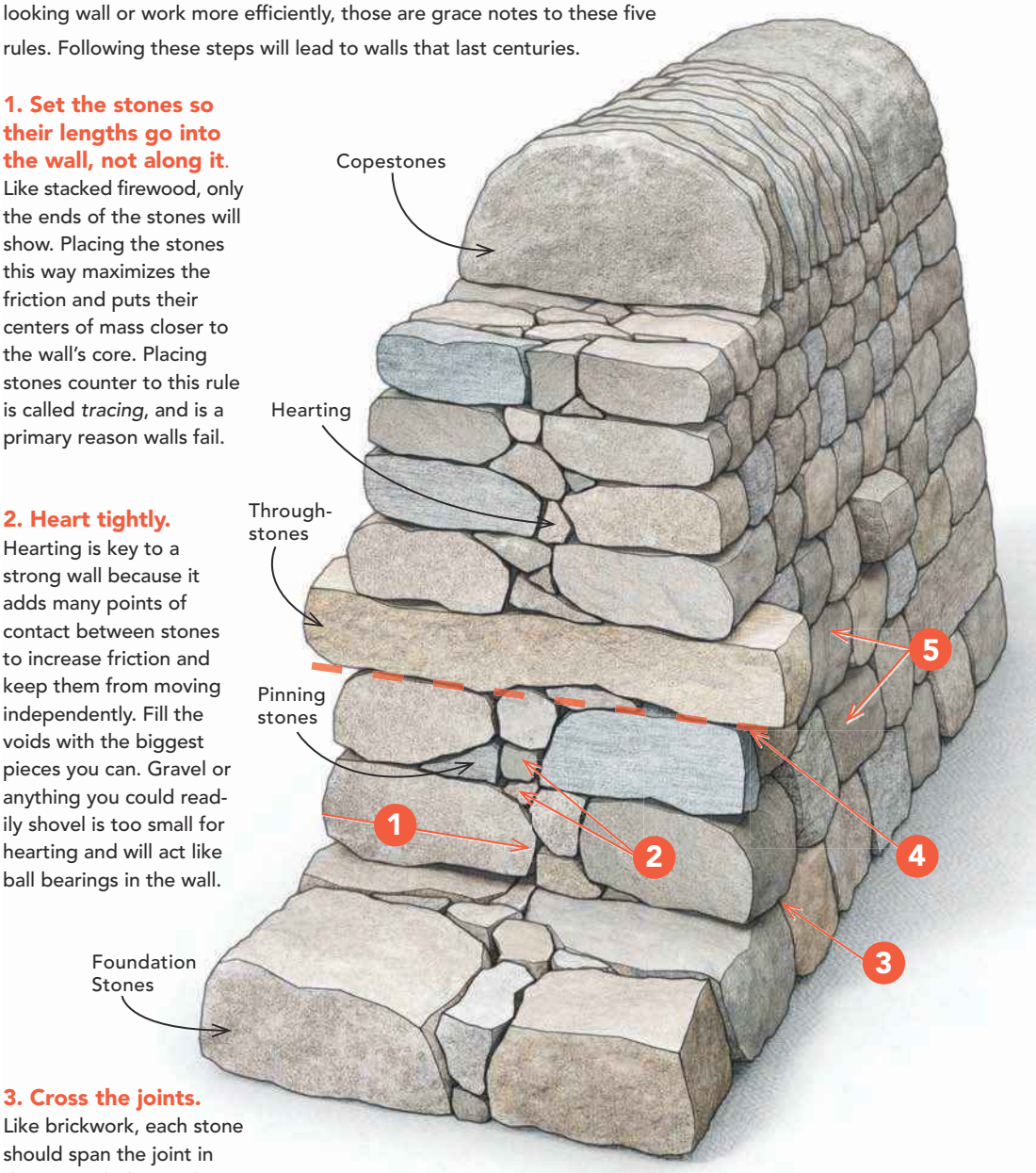
The foundation is the earth or gravel the stones rest on, and it should be dug so that it is level from side to side. If you are building on a slope with less than a 1-ft. elevation change in 20 ft., just run the wall parallel to the ground. On steeper slopes, dig the foundation in

Essential rules

Although there are many more techniques that can help you build a better-looking wall or work more efficiently, those are grace notes to these five rules. Following these steps will lead to walls that last centuries.

1. Set the stones so their lengths go into the wall, not along it. Like stacked firewood, only the ends of the stones will show. Placing the stones this way maximizes the friction and puts their centers of mass closer to the wall's core. Placing stones counter to this rule is called *tracing*, and is a primary reason walls fail.

2. Heart tightly. Hearting is key to a strong wall because it adds many points of contact between stones to increase friction and keep them from moving independently. Fill the voids with the biggest pieces you can. Gravel or anything you could readily shovel is too small for hearting and will act like ball bearings in the wall.



3. Cross the joints. Like brickwork, each stone should span the joint in the course below and sit firmly on the two stones on either side of that joint. Vertical joints that break this rule and run through multiple courses are called *running joints*.

4. Set stones level. Each stone needs to be able to support the stones above. The simplest way to achieve this is to set each stone so its top is level.

5. Build with the wall's plane. Set stones so their faces line up on the outside face of the wall to create a smooth, even plane without hollows or overhangs, which can cause stones to tip.

Essential tools

- Braided mason's string
- Batter frames, made from wood or rebar
- Shovel
- Tape measure
- 2-ft. level
- 6-ft. pry bar
- 22-oz. brick or mason's hammer
- 3-lb. hammer
- 6-lb. to 10-lb. sledgehammer

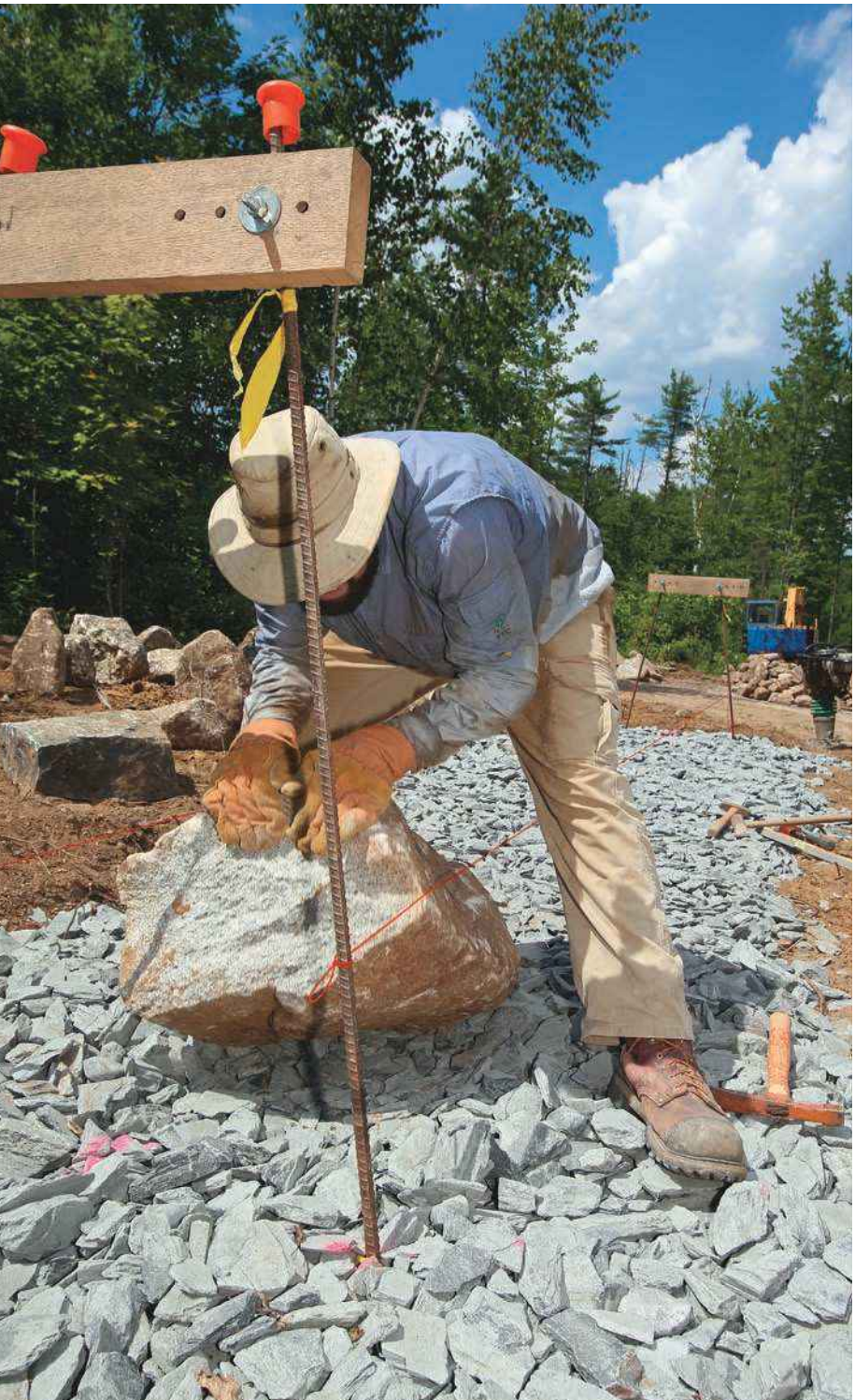
Drawing: Christopher Mills

Batter frames shape the wall. *This frame for a 1:6 batter is being set with a level and an angled wedge. A rotary hammer with an electrician's ground-rod driver pounds rebar several feet deep to ensure stability.*

level steps like stairs. Otherwise, the stones will gradually slide downhill and cause the wall to fail.

For stability, walls should be wider at the bottom than at the top. This taper is called batter. Expressed as a ratio of run to rise, batter typically ranges from 1:6 to 1:10. A 1:6 batter means that for every 6 in. of height, the wall narrows 1 in. on each side. So, a 3-ft.-tall wall with a batter of 1:6 would be 12 in. narrower (6 in. on each side) at its top. With flatter stones, a steeper batter like 1:10 may be appropriate, while a batter of 1:6 makes a wider base that's better for more irregular stone.

The width of a wall's base depends on its height, the width of the top, and the batter. Walls lower than 3 ft. lack enough area for the unevenness of individual stones to blend visually into a smooth face. Narrower walls use less stone, while wider walls make it easier to use larger stone and tend to be sturdier. With these factors in mind, the top is typically 14 in. to 18 in. wide. With smaller stone or flatter stone, you can make the wall closer to 14 in. at the top. With larger or rounder stones, make the wall closer to 18 in. at the top. The size of available capstones may also influence the top's width.



Choosing the right stone

A 4-ft.-high wall takes about 1,000 lb. of stone per linear foot, and the options vary by region. First, look for stones of a size you can move, and keep in mind that those with one longer dimension work better. Flat stone doesn't necessarily equal good stone, and round or irregular stone doesn't equal bad stone. Flat stone can make working with thickness variations between adjacent stones harder; plus, it's often thin, meaning lots of courses and slower building. Rounded stone makes it easier to work with thickness variations, and each course tends to be thicker, so building goes faster. With irregular stones, build a wall whose face stones fit more loosely. With flatter stones or ones that are easy to shape, build a tighter wall.

As you start out, aim to build 5 sq. ft. to 15 sq. ft. per day. If you're slower than that, you are likely being too fussy.

Stone from the ground right by the wall is the traditional material to use. Old piles that were collected but never built into walls and debris from construction sites can also be good sources. For reasons of historical preservation, even with permission, harvesting stone from old walls or structures is frowned upon and may be illegal. But taking stones from walls in poor condition that aren't visible from a road and don't mark property boundaries is more of an ethically gray area.

Crushed stone quarries often produce an 18-in. and smaller size (referred to as "18 minus") that can be used quite effec-

Tie strings to the frames. *Set strings level with each other, just above course height. Sight between the string and batter frame to locate the edges.*

tively. Gravel-pit leftovers or tailings can also work well. Stone from these sources may include a lot of unusable shapes, but it is often available for as little as $20 per ton. Another option is palletized stone from landscape yards, but it often costs over $200 per ton. Usually meant for use as veneer, it tends to have either long side faces or large flat surfaces rather than the end faces best for dry-laid walls.

People worry too much about the foundation

With well-drained soil, foundation preparation can be as simple as removing the topsoil and compacting the grade below. If the soil is prone to settling or holding water—for example, clay or silt—put in a foundation of ¾ in. to 2½ in. of clean, crushed stone. The smaller stone shovels more easily, but larger stone tends to be more stable. Crushed stone has sharp, angular shapes that knit together and work much better than rounded gravel. A 6-in. to 18-in. foundation about a foot wider than the wall is typical, with dense clay and other poorly drained soils at the upper end of that range. Water that collects in the crushed stone needs a 4-in. perforated pipe pitched to daylight for drainage. Otherwise, you've just made a pond under your wall.

Compact the foundation using a jumping-jack compactor or by driving back and forth a few times with a loaded pickup truck or tractor. A walk-behind vibratory plate compactor does virtually nothing and is not worth using.

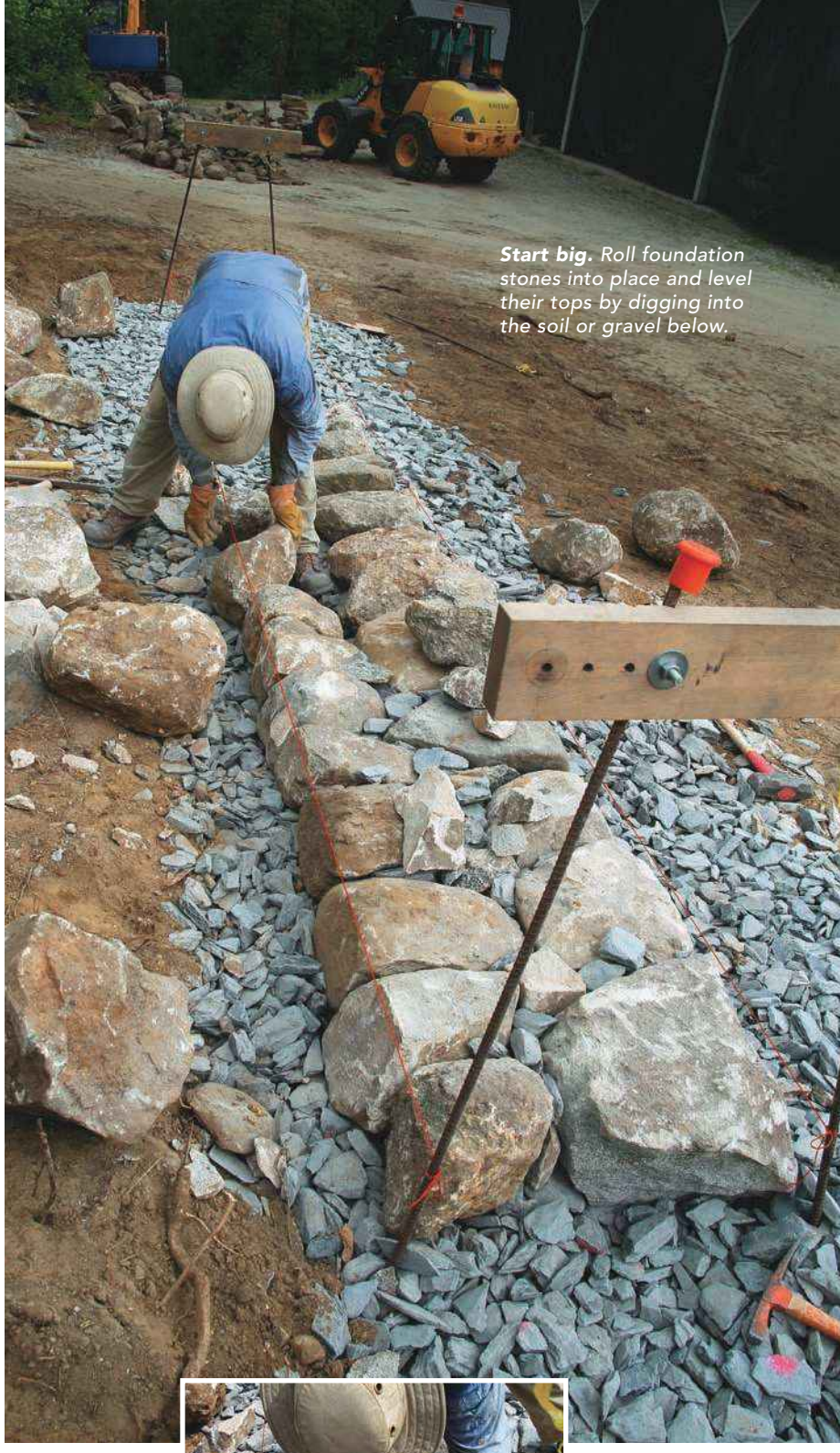
Before starting to lay stone, get organized. Walls should be built with larger stones at the base, graduating to courses of smaller stones near the top. Sorting the stone by thickness beforehand will increase your speed and help to ensure that each stone is used to its maximum benefit. Sort the stones into big, medium, and small sizes. Place an equal amount of stone on each side of the wall, leaving 18 in. of clear walking space, with the thickest stones near the foundation and smaller stones farther out.

If you're faster than that, you're likely not being careful enough.

Set pieces of the size and shape needed for through-stones and cap- or copestones aside, as well as any stones that have even a possibility of being useful in a wall end. Ends are tricky, and a large selection of stone is important. Pile hearting near the wall every 6 ft. or so, moving it around in 5-gal. buckets.

Although professional wallers can usually build 20 sq. ft. or more per day, as you start out, aim to build 5 sq. ft. to 15 sq. ft. per day. If you're slower than that, you are likely being too fussy. If you're faster than that, you're likely not being careful enough.

Completing shorter sections of wall at a time is more efficient. Step back the ends of each section so the next section of wall ties into the area you've just finished. Define these sections by setting up sturdy batter frames 5 ft. to 20 ft. apart. String is used as a guide to keep walls straight and level or parallel to the ground. Tie strings to the inside edge of the batter frames on



Start big. *Roll foundation stones into place and level their tops by digging into the soil or gravel below.*

There will be voids. *Face stones don't have to meet tightly inside the wall. Just pack the spaces full of hearting stones.*

Pin from within. *Pinning stones shim the face stones level and solidify their placement. Never pin from the face of the wall because it will just fall out over time.*

Tie the sides together. *It's typical to let through-stones extend 1½ in. past the wall face to allow for flexibility in their length and for the wall to settle without slipping off them.*

each side of the wall, level with each other and just higher than the course you're laying.

Set foundation stones so that the top edges of their faces align with the string (bumps may protrude past the string on this course). When sighting stones, line the string up to the inside edge of the batter frame, or use two string lines on each side of the wall, one about 8 in. higher than the other, and sight down between the two. It's usually easier to place the foundation stones along one side at a time, and quicker to set stones from one end to the other rather than working in from two ends and filling the middle with stone of an exact width. It's best to place stones so any sloped faces match the batter. A stone face that angles down will cast shadows that make the wall look rougher.

Try to find stones whose faces mate with their neighbors, but don't be too fussy. Large stones tend to meet with larger gaps, and when looking at a finished wall your eye will focus on its top half, which will be built with smaller stones that tend to fit more tightly.

Thicker foundation stones can be dug into the foundation so that they sit securely. Eyeball the stones so their tops are as level as possible, and keep the tops of adjacent stones even. If the top of a stone must slope, slope it toward a neighboring stone. Sloping it toward the face will cause stones placed atop it to slide out, and sloping it toward the core will push the wall apart over time. Stabilize stones as needed with wedge-shaped pinning stones placed from within the wall, leaving no large voids.

A mouse might be able to work its way through a well-hearted wall, but a squirrel will definitely not.

Don't worry too much about how the stones fit inside the wall, just pack voids tightly with hearting. Stones that wobble are not properly hearted. A mouse might be able to work its way through a well-hearted wall, but a squirrel will definitely not.

Building upward, course by course

After finishing one course, move the strings up by the thickness of the next. Ensure each stone meets the five rules of walling, keeping the points of contact near the stone's face. If a stone tips when you push down near its face, the contact points are too far back. Focus more on following the five rules than fitting the stones' faces like puzzle pieces. A strong wall will look good, but an incorrectly built wall, no matter how tight-looking it starts out, will fall down. Experience will develop your ability to fit the stones tightly while still following the rules.

Once you've placed a few feet of stones on both sides of a course, fill any voids between them up to the top of the stones. Set hearting so it won't move when the next course's weight is added.

Unlike the foundation course, only the farthest point of each stone from the second course to the top of the

wall should align with the string. Keep the strings just above the course you are working on so stones won't push on the string. When working with smaller stones, set a few on the wall and move them until you find a place for each rather than looking for stones to fit specific spots.

There is an exception to the rule about every stone sitting on the two below: A smaller stone may sit entirely on a larger one. You may have situations where two stones are needed to equal the thickness of a neighbor. This is also acceptable, and creates a way of changing thicknesses within a course.

The faces need a strong connection

It's vital to a wall's structure to tie its sides together with through-stones placed at mid-height. Arrange through-stones no more than 3 ft. apart along the length of the wall and in good contact with the stones below, being careful not to create running joints. Heart under each through-stone so no daylight comes through or they may break from weight placed above. Walls over 5 ft. tall require additional rows of through-stones spaced no more than 2 ft. apart vertically.

Ends must tie the two sides together and tie back into the wall (corners are built much the same way). Ends are traditionally plumb to meet a gatepost, but a slight batter such as 1:48 on the end face will increase the strength.

The best stones for ends are long and large with flat and parallel top and bottom surfaces. Cube-shaped stones won't tie back and will force the creation of a running joint in at least one direction on the next course. The contact points below each stone should be close to the outside corners. You will likely need to shape stones used in wall ends and corners, so plan to spend time on these features.

Build ends and corners like log cabins. *Shaping is often needed to fit end stones. Alternate stones that span the wall width with long stones that tie back into each course.*

The top stones help hold the wall together

Walls are topped with either capstones or coping to give it a finished look, to knit the sides together, and to protect the stones below. Thick and flat, capstones are laid across the width of the wall. Coping consists of flat stones set on edge like books on a shelf and is structurally the best way to top a wall. Coping provides the equivalent weight of very thick capstones without the hassle of lifting massive stones to the wall top. They provide many points of contact with the last course, anchoring it with lots of weight and friction. And because of their height, copestones can substitute for one or more upper courses.

Keep copestones as vertical as you can, make the end pieces as big as possible so they won't be pushed off, and make sure they don't rock. For a refined finish, shape them uniformly before setting them on the wall. To get the tops even, tie a string at the top height of the copes on either side of the wall. Tighten the coping by hammering small wedges of stone between the copestones at the top, and hammer pinning stones into any large gaps at the bottom corners. This will build up a tremendous amount of friction between the copestones. When finished, they shouldn't wiggle at all. □

Copestones protect the wall top. *Placed on end like books on a shelf, copestones add height and weight to the wall and tie the top together.*

Landscape architect Brian Post is a DSWA-GB certified Master Craftsman and executive director of The Stone Trust in Dummerston, Vt. Photos by Andy Engel.