Fine Homebuilding
February/March 1995 No. 93

Siting a House

Proper siting and design strategies enhance energy efficiency

by M. Joe Numbers

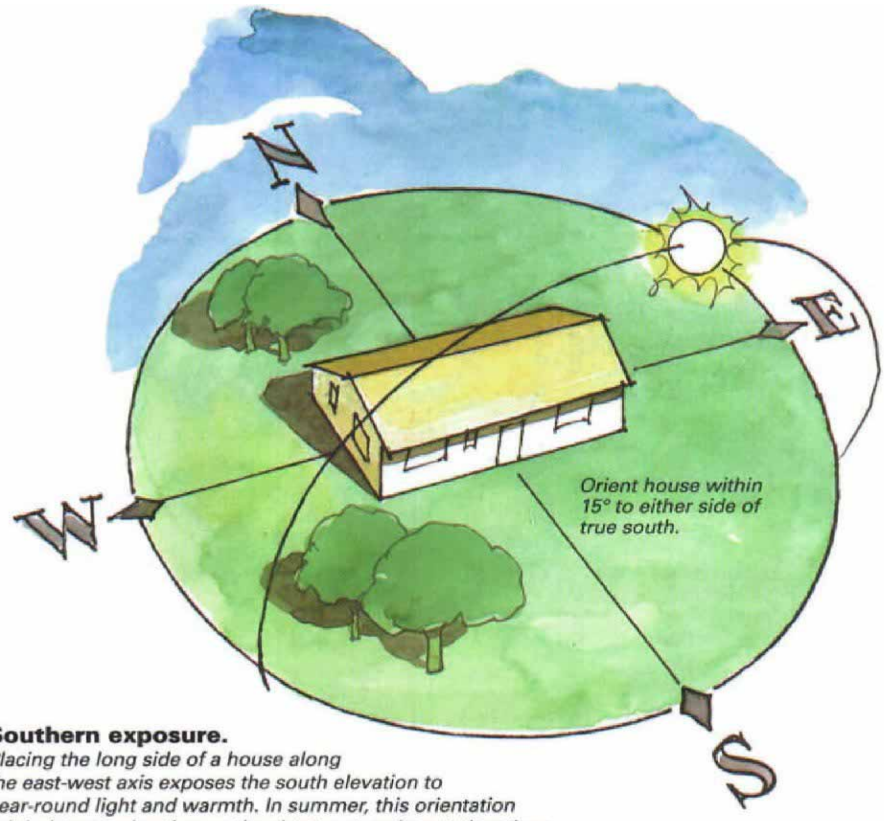
We architecture professors love a good riddle. Here's one: How do ancient Greek town grids, Anasazi Indian pueblos and New England saltbox houses differ from most residential construction today? Give up? The ancient Greeks oriented their town grids to receive winter sun and summer shade. The Anasazi Indians located their dwellings beneath cliff overhangs to take advantage of natural shading. Early American settlers oriented and configured their saltbox houses to minimize the cold northern facade and maximize the warm southern facade. In other words, each culture understood how to site a house.

Regrettably, the siting lore known to our ancestors has practically disappeared because of cheap energy and central-heating and central-cooling systems. That's too bad because a house's energy efficiency, comfort and marketability are all affected by its siting. A house that's sited to take advantage of the sun, the wind and the topography costs less to heat and cool and lets you enjoy indoors and outdoors longer, two strong selling points.

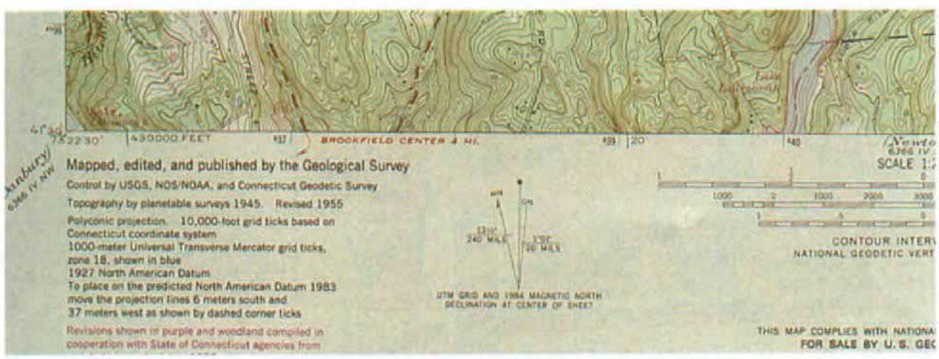
In my site-design classes, we break up solar-siting strategies into three categories: orientation, or which way the house faces; location, or where the house sits; and configuration, or how it's shaped. Figuring out the best orientation, location and configuration requires a little knowledge of local climatic conditions and an analysis of the site and its surroundings. Here, I'll discuss what to look for and where to find the information you need to reap the benefits of a properly sited house.

Long side faces south—When siting a house, the most effective strategy you can use is to orient your building with the long side aligned on the east-west axis (drawing right). This orientation places the long side of the building where it can be reached and heated by the low-angle rays of the winter sun. Conversely, it places the short sides of the building to the east and the west to minimize solar gains during the overheated periods of summer.

Your building doesn't have to be exactly on the east-west axis; somewhere within 15° of this axis is fine. What's more important is that you orient toward true south, not magnetic south. Compass needles point to magnetic north, which deviates



Southern exposure. *Placing the long side of a house along the east-west axis exposes the south elevation to year-round light and warmth. In summer, this orientation minimizes overheating on the short east and west elevations.*



Topographical map shows declination. The U. S. Geological Survey prints maps that show the lay of the land. At the bottom margin there are three north bearings: magnetic north, true north and grid north. Magnetic north is compass-needle north, but it won't be helpful for solar siting, which calls for true north, indicated by the star. The difference between these bearings is the declination; in this case it's 13.5°.

Photo: Rich Ziegner

from true north by as much as 20°. The difference between magnetic north and true north is declination, and it varies across the United States (photo facing page). Information on declination can be found on U. S. Geological Survey topological maps (Mailstop 109,12201 Sunrise Valley Drive, Reston, Va. 22092; 800-872-6277). Most state energy offices also supply this information.

Once you know your area's declination angle, it's a matter of spinning the dial on a compass. For example, in Boise, Idaho, the declination angle is approximately 19° east, so you line up your compass on magnetic north and then rotate the dial until the needle is pointing to 19° east of the north mark on the dial. Now, the dial markings (not the needle) point to true north.

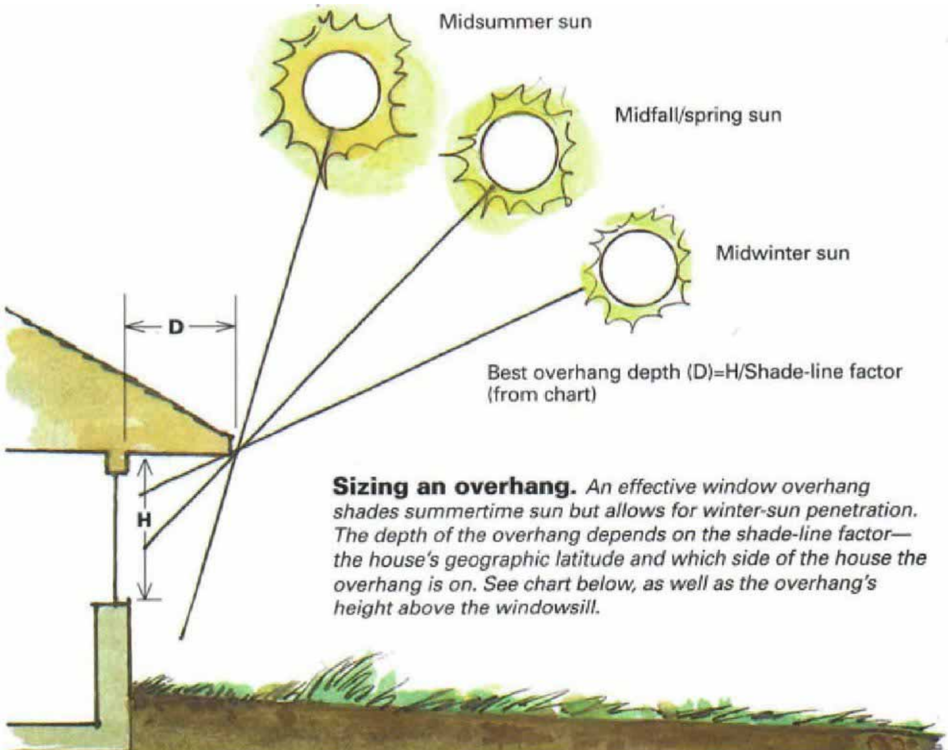
There are lots of related strategies that make the true-south orientation more effective. One is to reduce openings—windows and doors—especially on the north side of the house because doors and windows conduct more heat than a well-insulated wall. In cold climates, only about 5% to 10% of non-south-facing walls should be openings. In warmer climates you can get away with slightly more opening areas as long as the house is well-insulated.

On the south elevations, increase openings for winter solar gain, but shade them during summer months. Deciduous trees provide summer shading, as do awnings. You also can build overhangs for summer-sun shading. In the winter the overhangs shouldn't be so deep that they block the sun (top drawing, right). To figure out the optimal depth for overhangs in your area, use the shade-line-factor formula: The depth of an overhang equals the height from the bottom of a window to its overhang divided by the shade-line factor (chart right). This number varies with latitude, so you'll need to know your geographic latitude to choose the right shade-line factor. Most maps of the United States and most state maps show latitude.

Another way to make a southern exposure work harder for you is to coordinate the floor plan with the house's orientation. Locate public living spaces, such as the living room, the dining room, the kitchen and such, to the south side of the house where they will receive light and warmth throughout the year. Locate the private and unoccupied rooms—bedrooms, utility rooms, storage rooms, etc.—to the north where they will act as insulating buffers for living spaces (bottom drawing, right). These buffer spaces serve as a form of insulation (particularly if they can be closed off from the rest of the house) much like the closed airspace in your thermos keeps the cold air outside from cooling the warm liquid inside.

A house on a hill—Donald Trump once said that the three most important considerations when buying real estate are location, location and location. I doubt that he was referring to the potential for lower heating and cooling costs, but a house's location on a piece of land can make it less expensive to heat and to cool.

If you're considering building on a hillside, for example, locate your house according to its most appropriate zone (top drawing, p. 42). In cold or

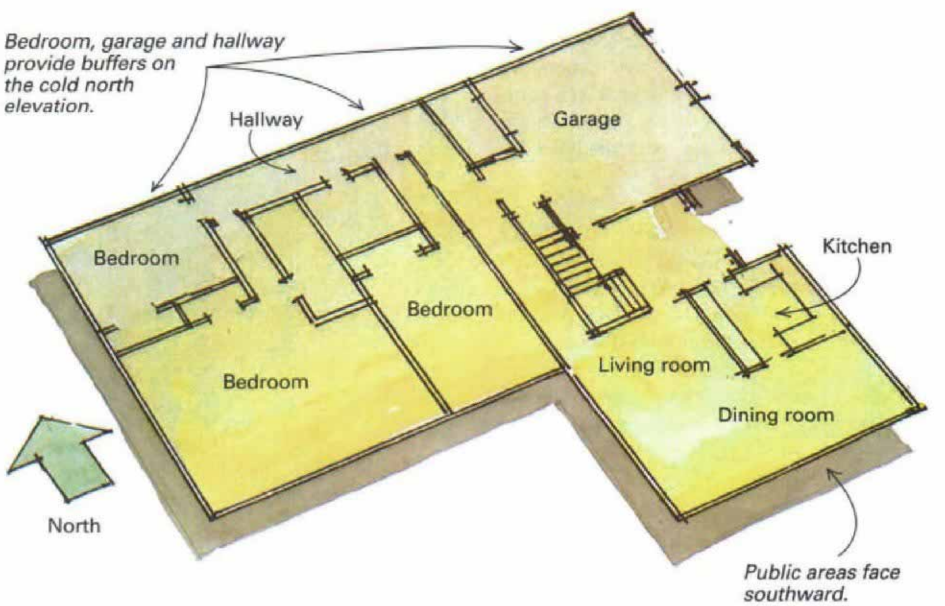


Sizing an overhang. *An effective window overhang shades summertime sun but allows for winter-sun penetration. The depth of the overhang depends on the shade-line factor—the house's geographic latitude and which side of the house the overhang is on. See chart below, as well as the overhang's height above the windowsill.*

Shade-Line Factors

Window faces	Latitude in degrees 25	30	35	40	45	50	55
East	.8	.8	.8	.8	.8	.8	.8
Southeast	1.9	1.6	1.4	1.3	1.1	1.0	0.9
South	10.1	5.4	3.6	2.6	2.0	1.7	1.4
Southwest	1.9	1.6	1.4	1.3	1.1	1.0	0.8
West	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Planning for greater comfort. *A floor plan can add to the benefits of southern orientation. Here, private and unoccupied spaces are at the north end of the house, where they act as insulators for the public areas on the southern end of the house.*



Drawings: Malcolm Wells

temperate climates, which encompass most of the United States, it's best to locate your house midway between the ridge and the valley. There, the house is not exposed to increased wind velocities at the ridge or subsiding cold air that settles at the valley bottom.

In hot, humid climates—the Gulf Coast states and the Southeast—ridges generally provide the most exposure to year-round cooling breezes. In hot, arid climates—the Desert Southwest—valley floors tend to collect cold air overnight that helps to cool a house. You can trap this cold air by opening doors and windows at night and by closing them during the day.

Building on a south-facing slope, or aspect, of a land-form increases the exposure of a house and the surrounding grounds to the low-angle rays of the sun during the winter. For cold and temperate climates especially, avoid north-facing aspects whenever possible.

You also should take a good look at the adjacent area to the south of your building site. Avoid building on areas that will be shaded during winter by tall buildings, coniferous trees or landforms (ridges, etc.).

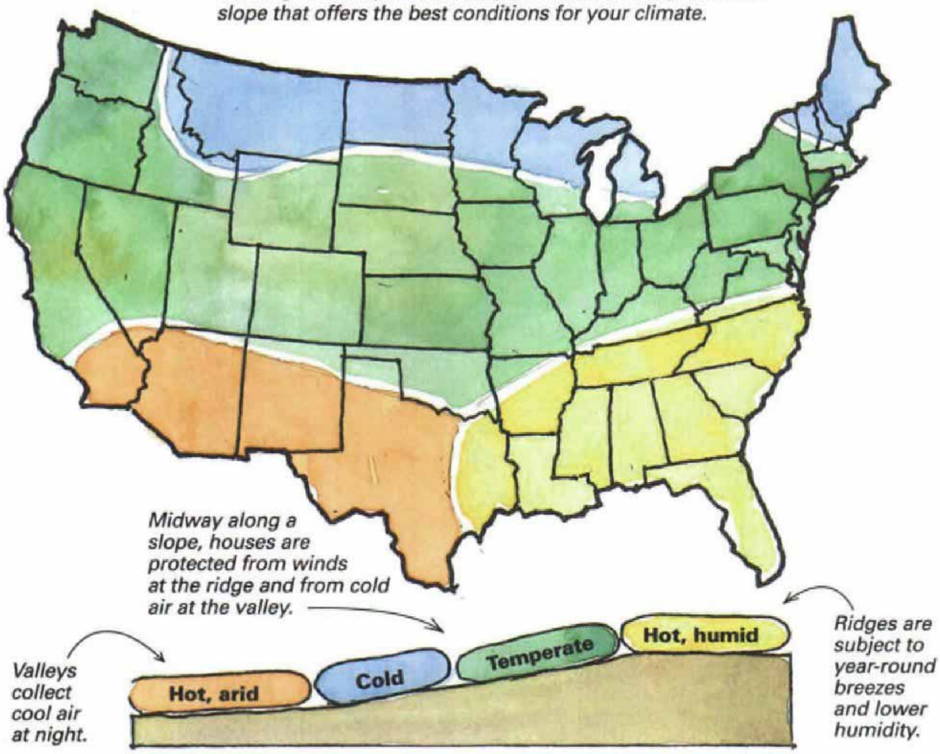
If you're in a cold or temperate climate, where it's best to build midway along the hillside rather than at the ridge or in the valley, you should study the contours of the hillside. Any natural drainages or depressions in the topography are poor choices for a building site (bottom drawing, right). A natural drainage or depression channels cold air down the hillside. This cold air will collect behind obstructions to its natural flow, so build away from these cold-air flows. If you simply cannot follow this strategy, use evergreen vegetation or solid fencing to divert cold air around and away from the house.

Whenever possible, recess the north, east and west sides of your house into the natural slope of your site, or pile soil against your house on these sides. These earth-berming strategies provide additional, permanent insulation against both winter winds and summer overheating.

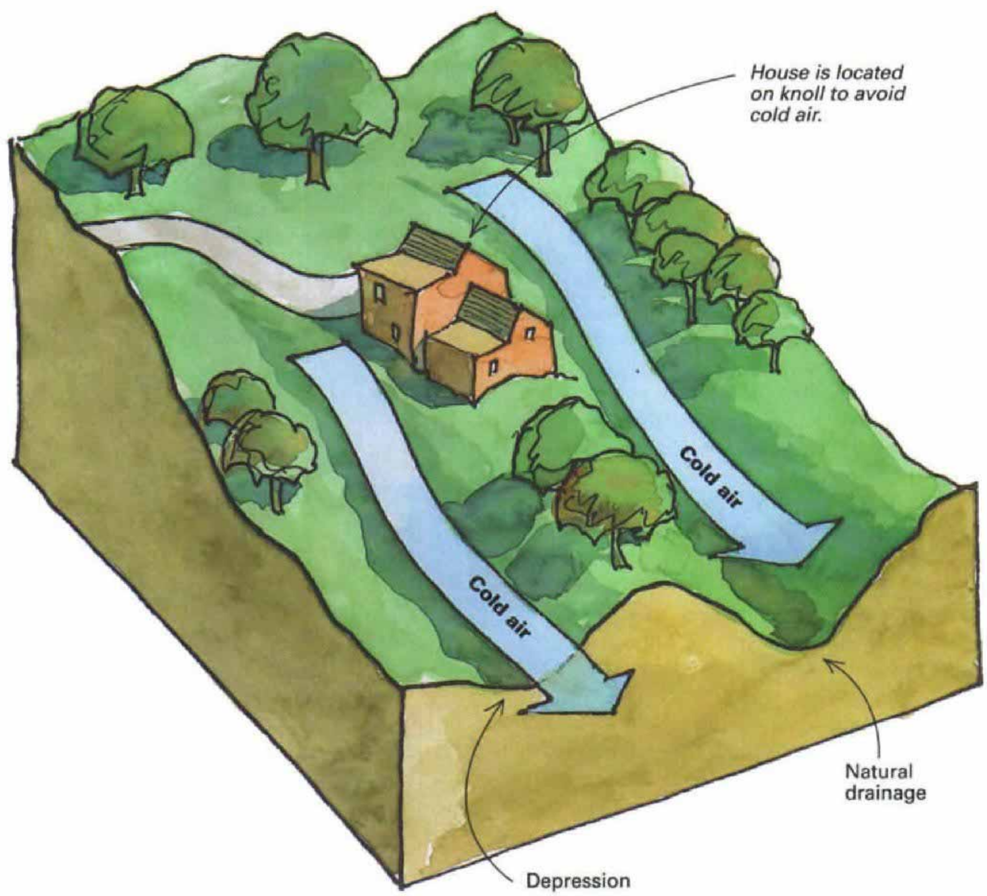
Earth-berming strategies require careful detailing to prevent water damage to the structure and are generally more expensive than typical above-ground construction. When properly done, however, they provide long-term, low-maintenance energy savings. If you are not familiar with earth-berming strategies but have a site that is suitable, consult an architect or a designer experienced in this type of construction.

Make the wind work for you—Generally, summer and winter winds come from different directions. It's usually possible to divert winter winds and channel summer breezes by carefully locating the house in relation to the surroundings. Check with your local airport, meteorological station or state energy office to determine the prevailing summer- and winter-wind directions for your area. Also, this data can be obtained from the U. S. Department of Commerce, National Climatic Center in Asheville, N. C. (National Climatic Center Environmental Data Service, Federal Building, Asheville, N. C. 28801; 704-2714800). Ask for a copy of the *Airport Climatological Summary or Local Climatological*

Build at the appropriate elevation. *If you're building on a hilly site, locate your house on the part of the slope that offers the best conditions for your climate.*



Cold air flows downhill. *Cold air is heavier than warm air, so at night cold air travels downhill along natural drainages and depressions.*



Data for your area. Study the adjacent topography, trees and buildings during your initial site inspection. Look for those existing conditions that will block or divert cold winter winds around your building site. Locate your house in these lee-side areas (drawing right).

In warm or humid climates, place your house in the area of your site that maximizes summer ventilation. For example, the process of evaporation cools summer breezes as they pass over water bodies. These water bodies don't have to be big to have an effect. Locate your house to catch prevailing summertime breezes coming off lakes, ponds, rivers and even streams.

Conversely, in cool and temperate climates, avoid locations near bodies of water on the lee-side of prevailing winter winds. In other words, if winter winds generally blow from the north, avoid sites at the south end of a water body.

Water isn't the only medium that induces cold winter winds. Land-forms, vegetation and buildings can increase wind velocities because of a phenomenon called the Venturi effect.

The Venturi effect occurs when any moving medium—in this case air—squeezes through a constricted opening. To maintain a constant volume of air passing through the opening, the wind velocity increases accordingly. That's why it's so windy at the base of tall buildings.

Keep away from topography, adjacent buildings and vegetation that funnel cold winter winds at increased velocities. If you do have a problem because of the Venturi effect, you can locate adjacent outbuildings and evergreen trees and shrubs where they will block winter winds.

Conversely, locate your house (and any new vegetation, fences or outbuildings) to take advantage of increased wind velocities created by the Venturi effect during summer months (bottom drawing, right). Use buildings and vegetation to channel summer winds into the house. As a rule of thumb, try to orient your house within 30° of perpendicular to prevailing summer winds to maximize cooling effects of breezes.

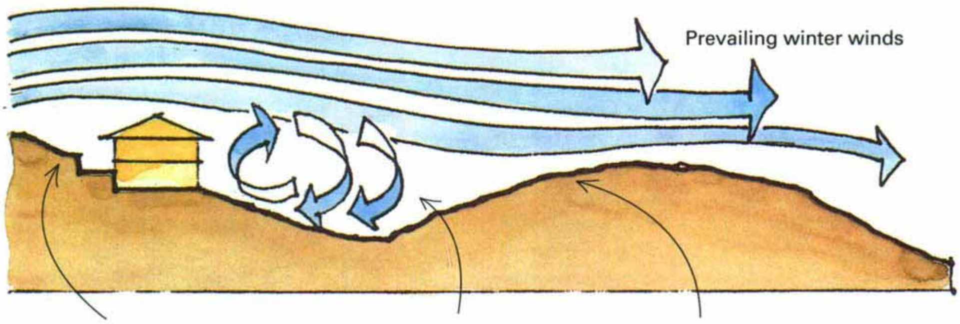
If solar orientation and siting for wind are at cross-purposes (that is, if optimum solar orientation is perpendicular to optimum siting for wind), then solar orientation should take precedence because it has a greater cumulative effect on the heating and cooling of the house.

Shape according to climate—Have you ever seen aluminum heat-radiating fins that you slip over hot-water pipes in your basement? They're supposed to turn hot-water pipes into heating elements to heat the basement. The principle behind the fins is that they increase the heated surface area so that more heat escapes from the pipe with the fins than from the bare pipe.

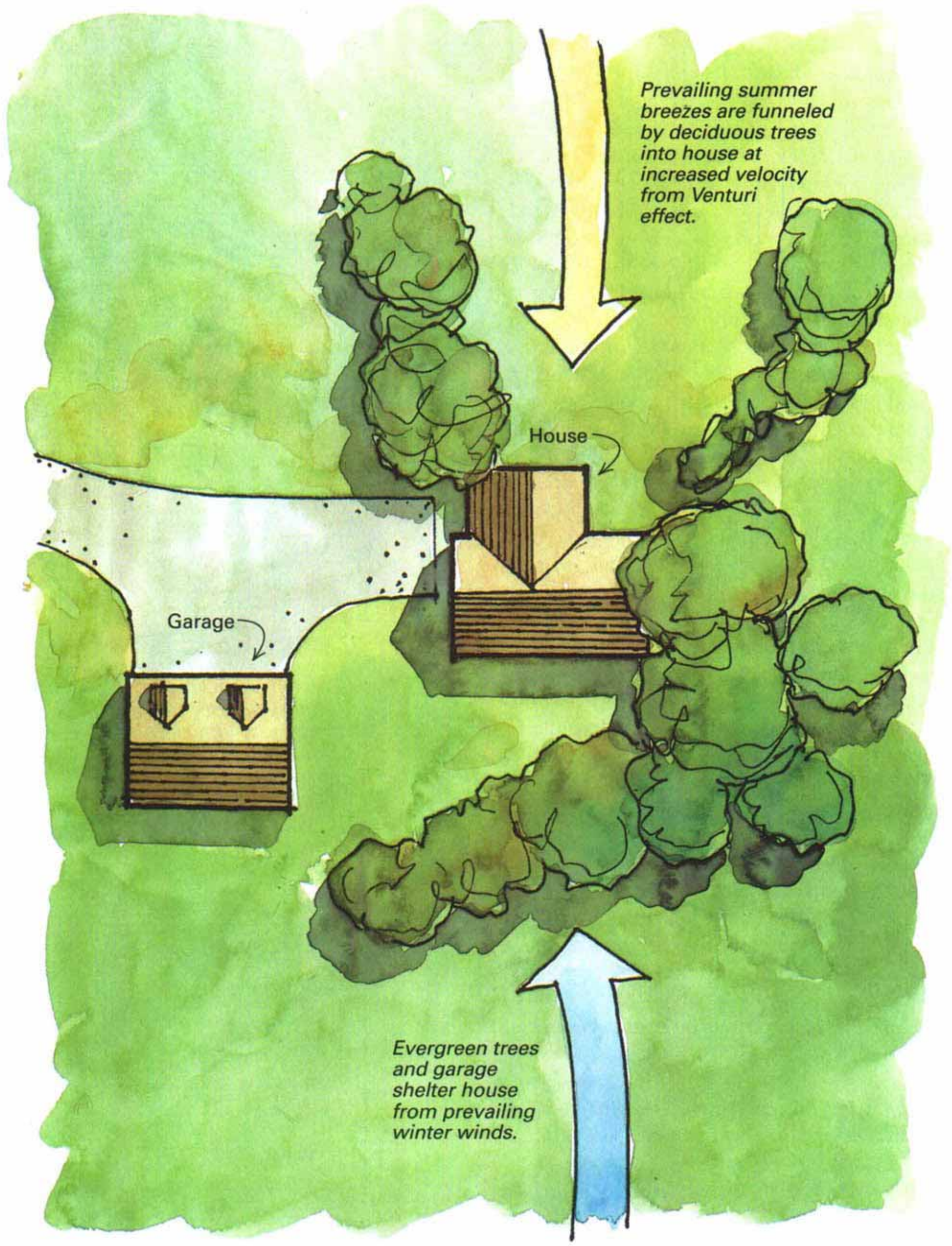
This same principle applies to a house's shape, or configuration. As a house's surface area increases, so does the amount of heat it loses. To hold onto the heat, configure your house so that it is relatively compact. Compact shapes, such as cubes, lose less heat through the building skin than narrow or elongated shapes.

As a rule of thumb for siting in cold regions, the long dimension of the house should be approximately 1.1 to 1.3 times the length of the short

Lee-side siting. *Once you know the direction of prevailing winter winds, choose a site where topography, vegetation and other buildings offer protection from these winds.*



Controlling wind exposure. *Use plants and outbuildings to direct prevailing summer winds into the house and to divert prevailing winter winds away from the house.*



side (drawing right). This proportion yields a high ratio of heated interior space to exterior skin. Remember that the longer side is oriented along the east-west axis.

For temperate climates, the configuration is not as important; there is less environmental stress on the building skin, and the designer has more freedom in terms of building configuration. For this region a ratio between 1.6:1 and 2.4:1 provides good energy performance.

In hot, arid climates the environmental stresses are greater, so buildings should be shaped similarly to cold-climate configurations. A ratio some where between 1.3:1 and 1.6:1 is the most energy-conserving for hot, arid climates.

In warm or humid climates, elongated shapes with openings on the long sides allow for cross-ventilation. As a rule of thumb, ratios in the range of 1.7:1 and 3.0:1 are preferred. When these elongated plans are oriented with the long side on the east-west axis, summer overheating at the short east and west elevations is avoided.

Try to keep corners on the house to a minimum. Unnecessary corners mean more exterior-wall surface is exposed to wind, which increases heating loads on the house.

Regardless of wind direction and particularly in areas where wind direction changes frequently, a good overall strategy is to use a compact, low-profile design for the house itself. Avoid tall facades and roof designs that block or trap wind. For example, a tall, broad gable is less aerodynamic than a hip roof, which allows for smoother air flow around and over the house. Orient the narrowest dimension of the house into prevailing winter winds to minimize wind exposure.

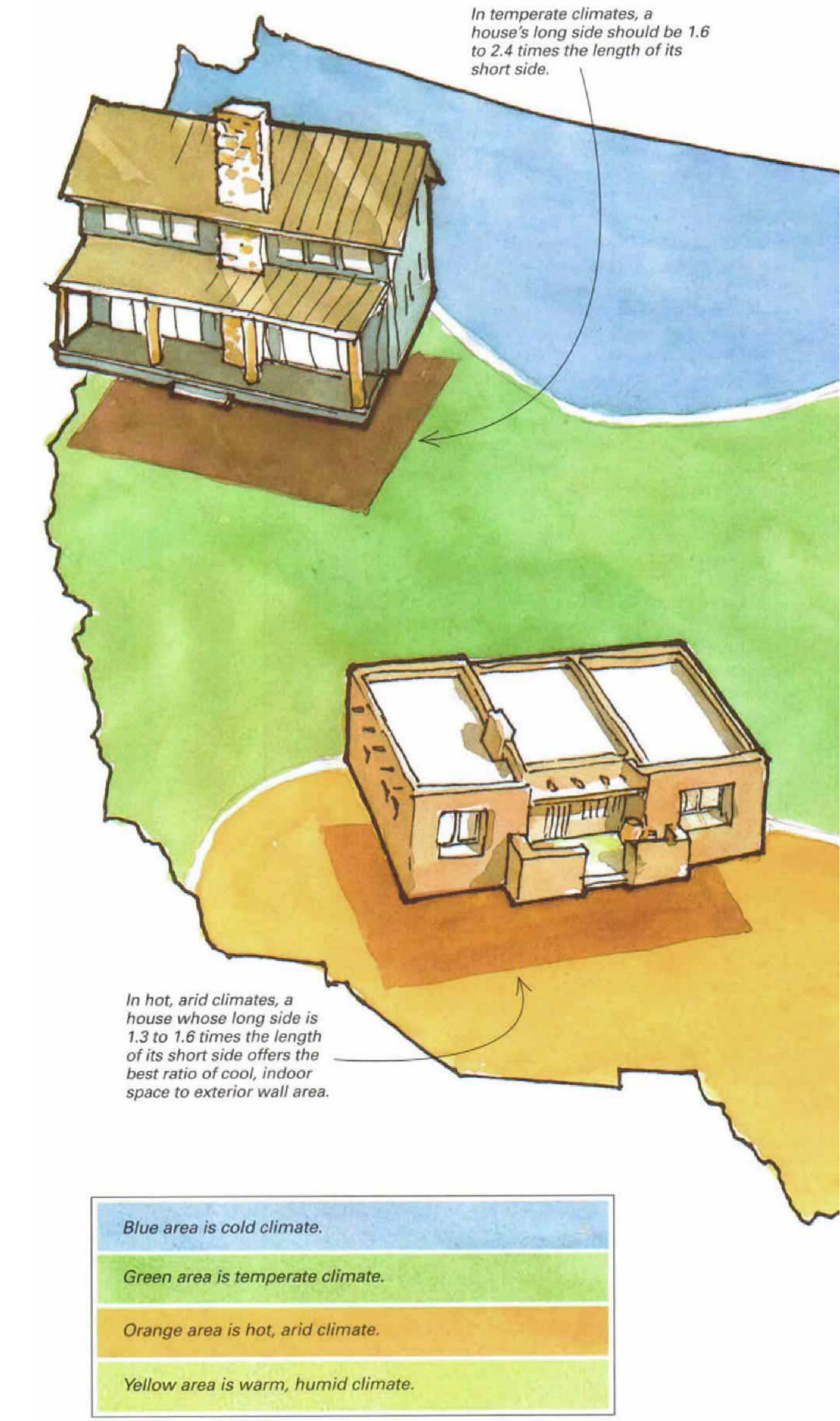
Configure your house and its surroundings to funnel or channel cooling summer breezes into windows and screened-door openings. For example, orient breezeways and window openings to accept these summer winds. Use roof overhangs to trap incoming breezes and channel them into window openings. On the other hand, locate and configure your house to avoid channeling the cold winter winds into the doors and the windows.

Further reading on siting principles—For more information on siting principles, additional detailing and solar-design strategies for the house itself as well as the mathematical formulas required to analyze these strategies for their potential energy savings, check the following two books. These books form an excellent foundation for further understanding of solar siting and building design. They are well-written and fully illustrated with examples of each particular strategy. Each of these books contains a wealth of helpful charts, meteorological data and reference for further information to help in the siting of houses.

Climatic Building Design by Donald Watson and Kenneth Labs (New York: McGraw-Hill, Inc., 1983).

Sun, Wind, and Light by G.Z. Brown (New York: John Wiley & Sons.Inc., 1985). □

M. Joe Numbers is assistant professor of architecture at The University of Idaho in Moscow, Idaho.



Guidelines for shaping an energy-efficient house

A house with a high ratio of interior space to exterior envelope costs less to heat and to cool. So in very cold and very hot areas, houses should be more square than rectangular. In temperate areas shape is not too critical, but in humid areas a long, narrow house allows for cross-ventilation.