Exploiting the

This home uses five natural systems to reduce its environmental impact, lower its operating cost, and improve its connection to the land

Elements of Passive Design

BY JAMES TUER

Every site has a story to tell, and the right house can help to tell that story. Located on the western coast of Bowen Island in British Columbia, this house is a good example. My clients, a professor of East Asian archaeology and a researcher from Kyoto, Japan, had worked the land for years, cultivating extensive gardens of ornamental plants from around the world. When they approached me to design a house for the property, they had only two requests: The home must fit the site, and it should have minimal impact on the landscape. The rest of the design was left in my hands. As a graduate of the University of Oregon, I have had a lot of training in passive design. It was only natural, then, to design around passive environmental systems that would use the natural elements of the site to improve the overall look, comfort, and performance of the house.

Passive environmental systems are a basic part of good home design

Passive systems harness natural elements—rain, wind, sunlight, soil—for the benefit of the house. They shouldn't be confused with active systems, such as photovoltaic cells or ground-source heat pumps. A properly designed house uses more than one passive system, and it relies on the relationships between each system to enhance the building's overall performance. The passive systems that I integrated into this house were based both on the general needs of the homeowners and on the specific demands of a challenging site.

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Modern and low-impact. *In its most basic form, this house illustrates environmentally responsible design and a contemporary style prominent in the Pacific Northwest. From the rainwater collection to the timber-frame joinery, each feature affects the way this home lives within its landscape. Photo taken at A on floor plan; inset photo taken at B.*

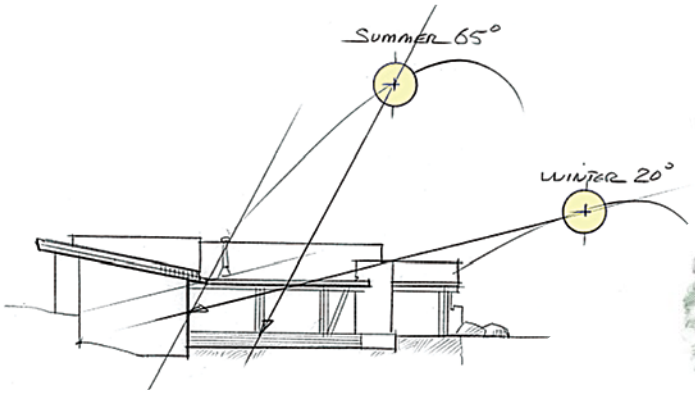
THE FIVE SYSTEMS THAT REDUCED THIS HOME'S IMPACT

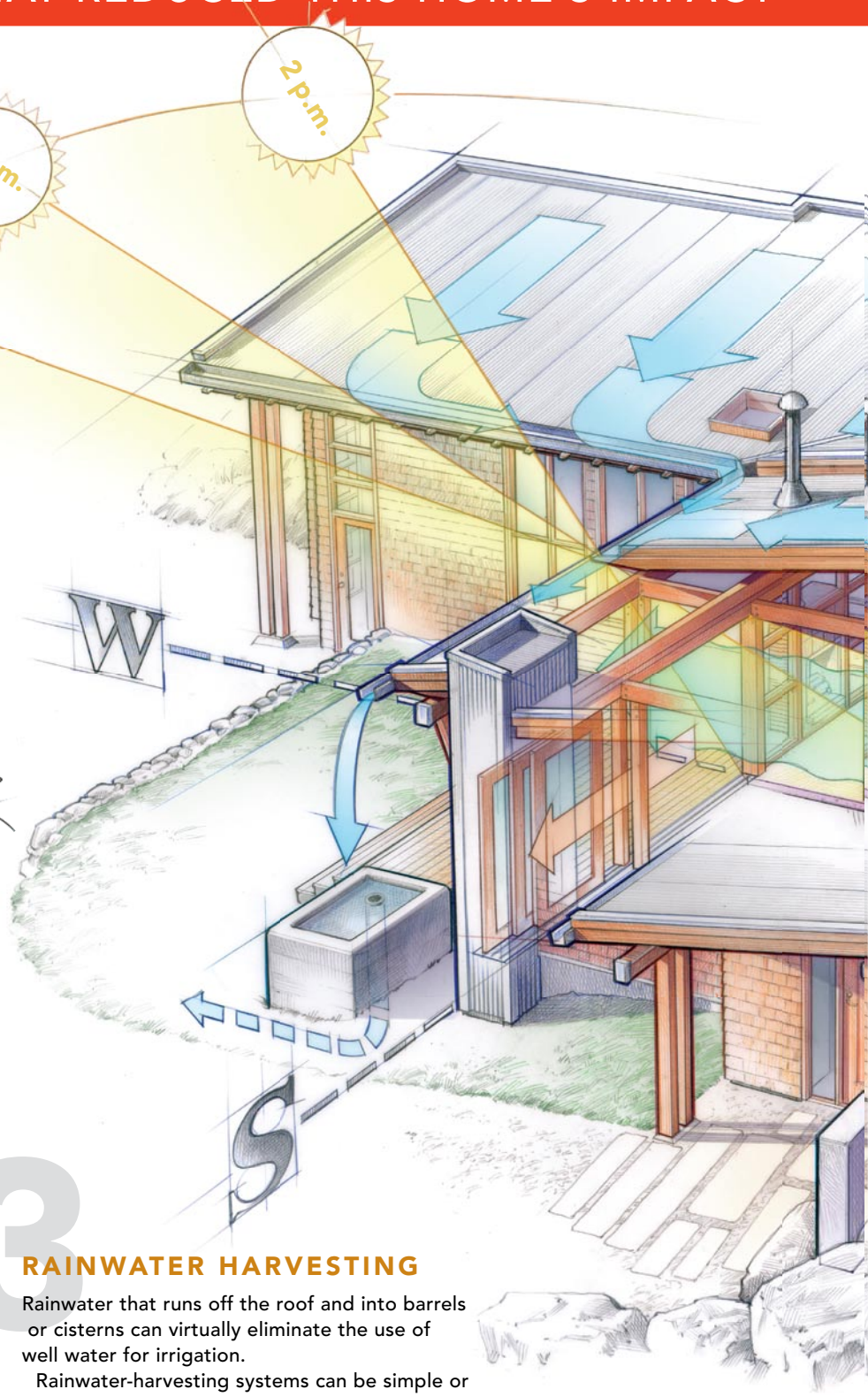
1 PASSIVE HEATING AND COOLING

Heating and cooling passively simply means using sunlight, shade, and ventilation to regulate the house's interior temperature.

On this home, a south-facing wall with floor-to-ceiling windows allows for heat gain throughout much of the day. In winter, the sun's trajectory is lower in the sky, so more light penetrates the west-facing windows of the house and warms the concrete floors and the east wall. This heat supplements the radiant-floor system that operates on an electric boiler.

To cool the house, I designed large sliding doors in the west wall that tuck into the Galvalume-clad "chimney" on the corner of the house. The entire wall can be opened, allowing cool evening air to infiltrate the home and chill the vast amount of concrete.





2 SOLAR-SHADING

Solar-shading keeps a house cool by blocking solar-heat gain and minimizes the damaging effects of solar rays. Once the sun's rays enter a house through glass, they have already been converted to heat, so it's critical that shading occur outside the building envelope.

Sunlight can be controlled through several structural details. Deep overhangs, small or well-positioned windows, and solar shades are all ways of controlling the influences of the sun.

While I incorporated several design elements to allow sunlight to enter the home, I also designed details to block sunlight. A deep, covered deck blocks the afternoon sun. Rafter tails extend beyond the roof's dripline and support a wide gutter that creates additional shade without blocking too much ambient daylight. The upper frames of glass in the master bedroom, which faces west, are clad with a screen made of 1x2 cedar to temper direct sunlight while letting in ambient daylight and offering views of the garden.

3 RAINWATER HARVESTING

Rainwater that runs off the roof and into barrels or cisterns can virtually eliminate the use of well water for irrigation.

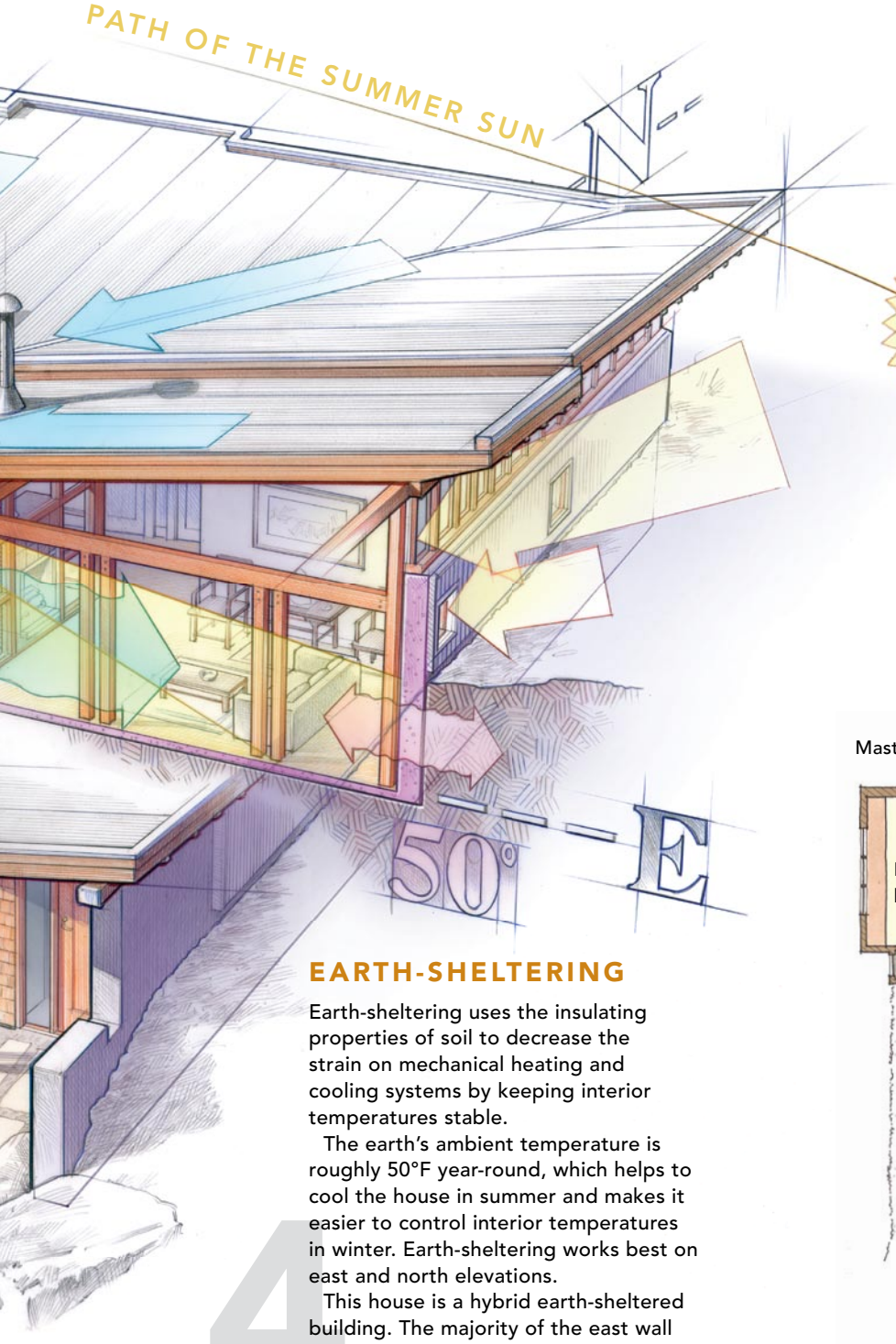
Rainwater-harvesting systems can be simple or complex. The easiest way to harvest rainwater is to place a barrel under a gutter's downspout. Cisterns should be covered in buggy areas, though, so that they don't turn into breeding areas for mosquitoes.

Here, the entire roof is focused on catching rainwater. To drain the roof to one point, I stepped the east/west roof up the height of a 6x10 beam, allowing the higher east/west gutter to drain into the lower north/south gutter and into a concrete cistern. The cistern feeds underground irrigation pipes in the sloping lot.

Drawing this page: Bruce Morser. Floor plan, facing page: Martha Garstang Hill.

ON THE ENVIRONMENT

A well-designed house should work with nature, embracing its strengths and using its energy to make the structure efficient and comfortable. I used the following systems to reduce this house's impact on the land and its operating cost while enhancing its performance.



4 EARTH-SHELTERING

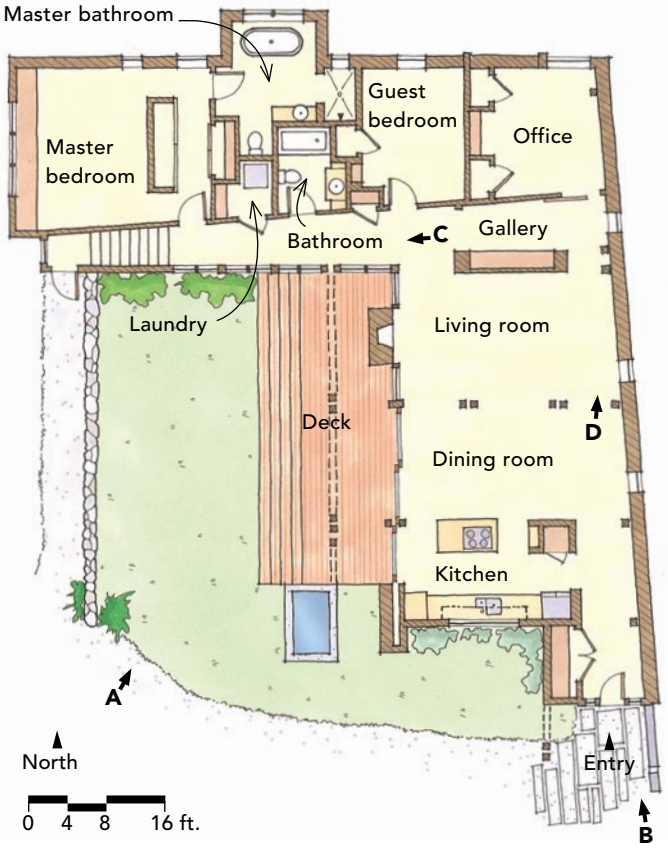
Earth-sheltering uses the insulating properties of soil to decrease the strain on mechanical heating and cooling systems by keeping interior temperatures stable.

The earth's ambient temperature is roughly 50°F year-round, which helps to cool the house in summer and makes it easier to control interior temperatures in winter. Earth-sheltering works best on east and north elevations.

This house is a hybrid earth-sheltered building. The majority of the east wall and part of the north wall are sheltered. Prior to being backfilled with sandy loam, the 10-in.-thick concrete wall was covered with a moisture-proof membrane, 4 in. of rigid-foam insulation, a drainboard below grade, and Galvalume siding above.

5 NATURAL DAYLIGHTING

A home that lets in ample daylight limits its reliance on electric lights, which lowers electricity bills. Daylight enters the space on an angle that has a rough proportion of 2.5-to-1 relative to the height of the window head. For example, an 8-ft.-tall window casts usable daylight 20 ft. into a room. Other than creating huge windows, there are ways of introducing natural light into a space. I brought natural daylight into this house from both the east and the west. The west wall is made of floor-to-ceiling windows and glass doors. However, on the same wall, I designed a 10-ft.-tall overhang to limit direct sunlight. Natural daylighting shouldn't be confused with direct sun rays, which I discovered were bothersome to the homeowners and can damage their Japanese artwork. So I used a long run of clerestory windows atop the east wall to bring indirect daylight into the living space in a balanced, less harsh way.



Photos taken at lettered positions.

Details shine where materials meet

I've long been inspired by architects Peter Bohlin and Jim Cutler, two of the best-known practitioners of a Pacific Northwest style that highlights simple, exposed, and indigenous building materials. I try to infuse a similar style in my designs (photo above taken at C on floor plan). It's in the details that the Pacific Northwest style is felt most. To see more photos of this project and to hear more about the Pacific Northwest style of architecture, visit the **Magazine Extras section at FineHomebuilding.com.**

Custom brackets for timber-frame joinery. *Steel brackets can be painted, but galvanizing them ensures that the wood won't be stained by steel corrosion while the framing is exposed to weather.*

A lighting scheme that works. *The high windows in the east wall bring ambient light into this house's main living space. Carefully positioned spotlights illuminate the concrete wall, which serves as one of the homeowners' art galleries. Photo taken at D on floor plan.*

A unique lot provided natural design opportunities

On my first visit, I realized quickly that the property posed a unique set of design challenges. Not only did the building site face west, but it also was surrounded by forested hills and granite rock outcroppings to the south, east, and west that captured the warmth of the sun throughout the afternoon. Large stands of Douglas fir protected the site from the ocean breezes that typically cool island homes. The resulting microclimate is more like southern Oregon than southern British Columbia, which is known for its temperate summers. Developing a way to cool the house was as important as determining how to heat it.

The site's other major feature—a large, mature garden—demanded an intensive supply of water from an already-taxed well linked to several surrounding homes. Proper irrigation was a priority.

With these major challenges in mind, I integrated design details that would handle heating and cooling demands passively, the need for water conservation and rainwater harvesting, solar-shading, and natural daylighting.

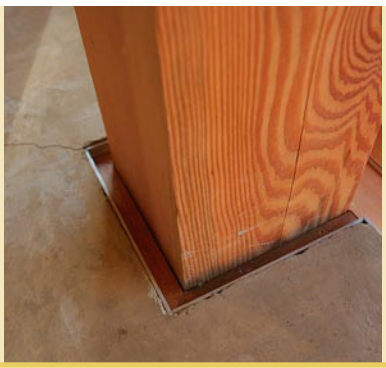
Simple, exposed materials are consistent with natural inspirations

In the houses I design, I like to keep the building materials simple. Steel, concrete, Douglas fir, birch, and cedar are all locally available and offer the crisp, natural style I'm after. In the Pacific Northwest, Douglas fir is the wood of choice for exposed framing. Known for its dense growth rings, small knots, and strength, Douglas fir takes on a mellow redwoodlike hue that brings a sense of warmth. I wanted the Doug-fir frame of this house to remain exposed to highlight the structure and to celebrate the craftsmanship of those who built it. Leaving the framing exposed also creates a stronger visual connection to the gardens and the surrounding fir forests.

Western red-cedar shingles are a locally produced material. From a design standpoint, the horizontal banding of the shingles on the south- and west-facing walls reinforces the horizontal lines of the house. From a practical standpoint, they'll weather gracefully. I chose galvanized steel for siding on the north- and east-facing walls and for the brackets that join the timbers. The steel brackets, which I designed with a bit of an Asian flair, were built by a local craftsman working out of a small shop in a nearby building-supply yard. I sent the brackets off-island to be galvanized (photo right, facing page).

I use concrete as a finished material on a lot of my projects. It's durable, strong, and readily available. It also has the highest rating for thermal mass of any common building material. Thermal mass is the amount of heat a material is capable of storing. In daytime, the concrete in this house stores up warmth that slowly radiates out in the evening. At night, the concrete cools and helps to moderate the indoor temperature during the day. The process keeps the house comfortable and reduces its dependence on mechanical systems, which ultimately helps to keep utility bills low. □

James Tuer, AIA, runs his firm, JWT Architecture & Planning, from his home on Bowen Island, B.C. Photos by Rob Yagid.



Disappearing posts and floating windows. *All interior posts (photo left) are framed by angled aluminum, creating a recess that is inlaid with stained fir. A similar treatment can be found around the windows (center photo), where stained fir fills the void between concrete and frame. Cedar slats limit direct sunlight and enhance architectural interest (photo right).*