

WINTER 2008

# bgbj

BOULDER GREEN BUILDING JOURNAL



INDOOR AIR QUALITY  
BUILD TIGHT, VENTILATE RIGHT  
HOME SAFE HOME





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## INDOOR AIR QUALITY

WINTER 2008

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Cover photo: ©2008 Daniel O'Connor/danieloconnorphoto.com

The focal point of Merten Homes' new Tuscan-inspired straw bale house in Old Town North, Fort Collins, is the kitchen island with its polished concrete countertop and seating for six.

### BUILDING CASE STUDY **OLD WORLD CHARM MEETS HIGH PERFORMANCE**

Old world craftsmanship and innovative materials produce superior indoor environmental quality and exemplary energy efficiency in this Fort Collins home.

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by Tom Wilson and Larry Kinney

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### IN OUR NEXT ISSUE

In their enthusiasm to embrace green building, builders and consumers sometimes lose sight of the basics. In our next issue, we will focus on maximizing energy efficiency, choosing resource-conserving materials and strategies, and putting it all together into a comfortable, beautiful building. We'll include a case study of an exemplary green building project.

# Breathing Easy at Home

About 25 years ago, my sister became seriously ill. Her symptoms were mostly respiratory, but included some bizarre neurological and cognitive deficits. This went on for months, and she declined rapidly as summer became fall and then winter. Her doctors were stymied.

Alarmed, my parents traveled to Colorado for Christmas, and took her to stay with them in their hotel suite. Within 24 hours she started to feel better, and in a week's time she experienced a miraculous recovery.

It turned out that her landlord, in a well-meaning attempt to create affordable housing in Boulder, had finished her new apartment entirely with interior grade particleboard. The urea formaldehyde offgassing from the particleboard was poisoning her.

Although she is still sensitive to formaldehyde, my sister is healthy today. Her story had a happy ending.

Not everyone is so lucky.

Jill Sverdlove Iwaskow, author of "Home Safe Home," has extreme chemical sensitivities that she will live with for the rest of her life. My view is that people like Jill are the human equivalents of the canaries in the coal mine. We're all affected by exposure to toxic chemicals, some of us more than others.

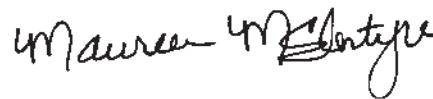
The good news is that we now know how to build and remodel homes that offer refuge from the ubiquitous toxins in modern products and furnishings. In our cover story, Brad

Duckham describes one such home. Straw bale walls, natural plasters, and carefully considered details and finishes ensure that the occupants of this house will breathe easy.

Our Green Geek, Larry Kinney, and his colleague Tom Wilson, offer tips to reduce air leakage while protecting indoor air quality, and Collin Tomb discusses the importance of both a tight, well-insulated building envelope and carefully-designed mechanical ventilation. Finally, Kurt Buss gives us a primer on deconstructing houses to salvage usable materials rather than hauling them to the landfill.

We recently circulated a *Boulder Green Building Journal* (BGBJ) reader survey, and the results were very encouraging (go to [www.bgbg.org/Images/BGBJSurvey\\_Jan08.pdf](http://www.bgbg.org/Images/BGBJSurvey_Jan08.pdf)). We welcome your feedback on both the survey, which we hope to refine in the near future, and on anything you see or would like to see in BGBJ.

To be the best it can be, BGBJ needs your help, both editorially and financially. To make a tax-deductible contribution, send your check to BGBF, 2020 20th Street, Boulder, Colorado 80302. Thanks!



Maureen McIntyre, Editor and Publisher  
[maureen@mccomm.com](mailto:maureen@mccomm.com)



The Boulder Green Building Journal is printed on recycled paper with vegetable ink.

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*The Boulder Green Building Guild is a 501(C)(6) nonprofit trade organization.*

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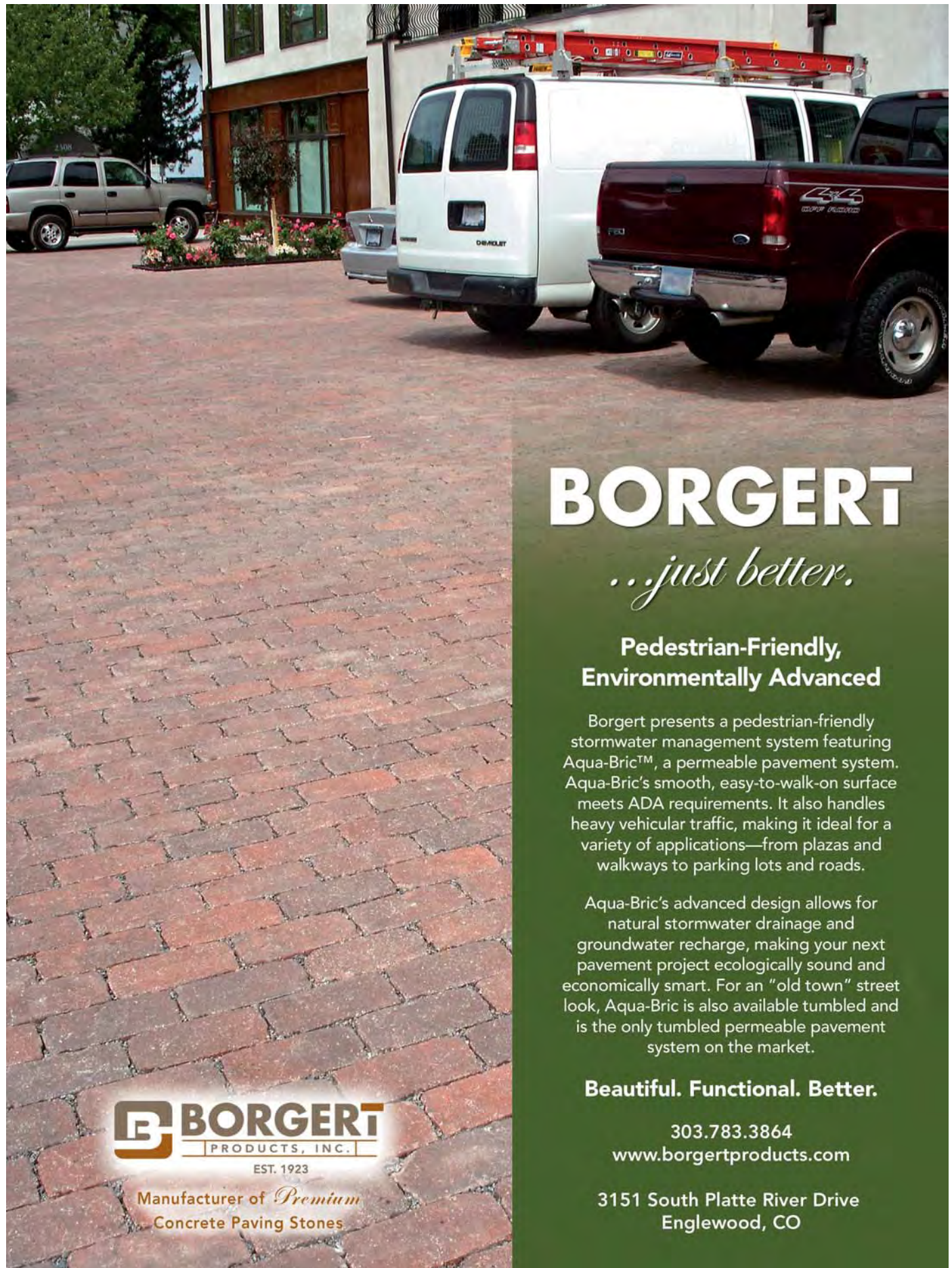
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## Come Grow with Us!

It is with great excitement and enthusiasm that I join the Boulder Green Building Guild (BGBG) as executive director. In the short time I have been with this wonderful organization, I have worked with so many highly skilled, passionate, and enthusiastic green building professionals that I can't help but be energized to take on the many exciting tasks ahead.

I believe BGBG is uniquely well positioned to support our mission of advancing the craft of green building in our community. Consider the updates to both the city of Boulder and Boulder County building codes, as well as the groundswell of support for addressing climate change at the local (city of Boulder's Climate Action Plan), state (Governor Bill Ritter's newly-released Colorado Climate Action Plan), and international (Al Gore's Nobel Prize-winning efforts) level.

Green building is also thriving nationally, in spite of the general housing downturn. According to McGraw-Hill Construction's *2007 SmartMarket Report*, "The Green Homeowner," analysts expect residential green building to grow by an order of magnitude in five years—from \$2 billion in 2005 to \$20 billion in 2010.

The rapid growth of this organization speaks to the timeliness and importance of the role we play. To put the organization's growth in context, consider the fact that it was established 4 years ago this February, when a group of building professionals decided it was time to make a significant, positive impact on the Boulder community. By July of that year, there were 36 members, by January 2006, there were about two hundred members, and today we have over three hundred members.

As we grow, so too do the resources and opportunities we offer our members and the community at large. Some of the highlights you can look forward to in 2008 include:

- Website improvements like more green building information and a more easily searchable database to access our members;
- The continuation of our very popular and relevant monthly brown bag presentations and roundtable discussions, including the addition of a quarterly evening presentation geared to a wider audience;



Incoming BGBG board member Adam Stenftenagel and current board member Julie Hauser share a laugh at the 2008 BGBG membership meeting.

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- More green home tours with a focus on zero-energy homes in our community;
- The 1st Green Building Summit, scheduled for July 12th, will be a day-long event featuring keynote speakers and a series of green building hands-on and "how-to" workshops;
- In conjunction with the Green Building Summit, the 2nd annual Green Products and Services Fair in downtown Boulder will feature more than 30 green companies and organizations;
- More "how-to" workshops, in coordination with the city of Boulder, to ensure building professionals are well positioned to implement the new green building codes;
- The enhancement of our informative bi-monthly electronic newsletter;
- The development of more partnerships that allow us to leverage resources and offer our members benefits such as discounted advertising in relevant publications such

as the *Re-Direct Guide*, *Boulder County Business Report* and *Green Report*, *Boulder County Home and Garden* magazine, *The Smart! Book* directory, and *Colorado Homes and Lifestyles* magazine.

- The launch of the Boulder Green Building Foundation (BGBF), a 501(c)(3) nonprofit organization established to serve as BGBG's educational arm. As a 501(c)(3), BGBF can accept tax-deductible donations and broaden the scope of education beyond Boulder County, including the continuation and expansion of this *Journal*.

I would also like to welcome our 4 new BGBG board members—Ken Bechtel, Kristin Shewfelt, Adam Stenftenagel, and Spenser Villwock. And on behalf of all BGBG members, I bid a fond farewell to outgoing board members Larry Kinney, Kim Master, Maureen McIntyre, Doug Parker, and Beth Powell, and thank them for their excellent service.

BGBG is the successful, dynamic organization it is because of our members and volunteers. To join BGBG and/or get more involved with one of our 5 working committees, visit [www.bgbg.org](http://www.bgbg.org).



**Sustainability Education**  
University of Colorado at Boulder

# building

### Building Partnerships

We are happy to announce our latest partnership with Namaste Solar Electric of Boulder who will be providing instructors for our new Intro to Solar PV courses. We are also working to expand our collaboration with the Boulder Green Building Guild. Guild members currently receive 10% discount off all courses.

### Building Community

Our newly launched online community is aimed at connecting Sustainable Practices students, industry professionals and related groups and associations. It only takes a few minutes to sign up and add your presence to this growing community.

*<http://sustainablepractices.ning.com>*

**Check out our website to get more information, register and see what's new!**  
[colorado.edu/conted/BGBJ](http://colorado.edu/conted/BGBJ)

### Building Educational Opportunities

The Sustainable Practices Certificate Program continues to grow with the addition of six exciting new courses planned for 2008.

In the Spring choose from **Intro to Solar PVI & II** taught by Namaste Solar Electric and the hands-on **Natural Plasters and Finishes** course with Laura Bartels, April 11 – 13.

In the Fall Dan Chiras returns with three 2-day seminar courses; **Passive Solar Heating & Cooling**, **Residential Renewable Energy**, and **Green Building —A Systems Approach**. We also anticipate our first online courses will be available by Summer 2008.

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Old World Charm  
Meets  
High Performance

Old world craftsmanship and innovative materials produce superior indoor environmental quality and exemplary energy efficiency in this Fort Collins home. **BY BRAD DUCKHAM**



*(Left) The mudroom of Merten Homes' new straw bale home in Old Town North, Fort Collins, features a polished concrete floor, natural plaster walls, and a beetle-kill lodgepole pine ceiling.*  
 ©2008 Daniel O'Connor/danieloconnorphoto.com

I grew up flying out of my house every summer in order to build forts and castles in the woods of Westador, Texas. I lost a lot of my father's tools, unearthed a bunch of arrowheads, "borrowed" one too many garage rafters and, all in all, made a timeless, epic mess of my childhood.

But it wasn't all Huck Finn. I was also afflicted with what my pediatrician light-heartedly called "cotton candy lung" (asthma) and, looking back, I often wonder if my condition was at least partly a result of having moved into a brand new house that was offgassing toxins at a greater rate than one of the refineries my father helped engineer.

I have built a comfortable life here in Colorado, but it is the straw bale home Merten Homes recently completed in Fort Collins that has rekindled a whimsical sense of timelessness and—without warning—taken my breath away again. Located in the new urbanist neighborhood of Old Town North, Fort Collins, Merten's first offering (there will be 11 others) embodies everything a high performance home should be—resource conservation, energy efficiency, stunning design, and exceptional indoor environmental quality.

## START WITH NATURAL FINISHES

When visitors pass through the front door and enter the kitchen they often stop and look bewildered.

*"Why doesn't this home have that new house smell? Is this house pressurized? Why is everything so quiet?"*

I enjoy watching people nudge one another, resume breathing, and slowly relax as they wander through the dramatic space of the Tuscan-inspired home.



*The concrete floor, natural plaster, and open floor plan give the living area a spacious, airy feel. The beetle-kill lodgepole pine sills and trim used throughout the house make use of an abundant local material.*

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*Details like tiny alcoves for candles and a “window” into the straw bale walls (facing page, bottom right) add whimsical touches.*



And it is dramatic. With 14-inch-thick walls, 10-foot ceilings on the main level, and an entire interior (walls and ceilings) finished in rich natural plasters, the space exudes a reserved, unassuming elegance, full of texture and light. Yes, the design is striking, but it is the shifting tapestry of natural plaster that produces the unfamiliar, bewitching effect.

The entire exterior and interior shell of the straw bale home contains four layers of plaster—clay slip, high clay earth plaster, low clay earth plaster (either gypsumite or lime plaster), and lime wash as the final coat. The interior walls (ceilings included) are finished with a modified mix, but exhibit the same beautiful, variable patina. The plaster, which contains no volatile organic compounds (VOCs), catches natural light and creates a sense of flowing, organic grace.

And with colors like *Marsh Apricot*, *Walden Stone*, *Crushed Scarlet*, and *Baby Blue*, each room radiates a warmth and ambiance that other wall systems simply can't touch. Plus, the plasters add thermal mass, which helps to regulate heating and cooling loads.

In addition to the zero-VOC building envelope, the kitchen cabinets are made of an extremely low urea formaldehyde medium density fiberboard (mdf). The cabinets are wrapped in a stylish espresso and graham-striped veneer that contains 40 percent post-consumer waste product. The amber and espresso tones of the acid-washed polished concrete slab floor and countertop echo the color theme. Equipped with radiant floor heat, the concrete floors inevitably draw comments from visitors, especially if they happen to be standing in one of the many huge pools of natural light that spill through the triple-paned windows.

*The high ceiling, polished concrete floor, and natural plaster create a sense of understated elegance in the formal dining area.*



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*Colorful tile work and the rich texture and color of natural plaster both enliven the second floor bathroom and contribute to superior indoor environmental quality.*

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And because there is no carpet, the home offers no sanctuary for the dust mites and mold so common in conventional homes. Forgoing carpet also reduces indoor toxin levels, because most carpets offgas an array of chemicals.

**BUILDING GREEN WITH THE BLUES**

In the interest of resource efficiency, the home also uses a ubiquitous local resource—beetle-kill lodgepole pine. A staple in Merten Homes’ design palette, this local lumber has a number of applications—window ledges, tongue and groove ceilings, kitchen shelving, flooring, stair treads and handrails, fireplace mantles, rough sawn beams, interior trim, and exterior corbels.

Using beetle-kill pine requires no aesthetic compromise. The blighted trees get their blue hue from a fungus that the beetle leaves, and when stained with a zero-VOC water-based clearcoat, the results are nothing less than spectacular.

Merten also used a zero-VOC Timbertek interior stain on some of the wood, and the contrast between the dark and clear finishes offers an appealing contrast. All doors feature a zero-VOC AFM Safecoat finish.

**TUSCAN ZEN**

Visitors will not notice the hum of a furnace or their allergies kicking in, because this home has no furnace and no ducting. A commercial-grade Rinnai instantaneous hot water heater supplies both domestic hot water and radiant floor heat. Broan fans help exchange air. The lack of ducting, coupled with a breathable wall system and low-toxicity finishes provides a unique, eco-informed indoor environment. Plus, without the usual HVAC systems, the home is whisper-quiet.

The focal point of the kitchen is the floating aquamarine slab of polished concrete. This kitchen island, which seats six, functions as the heart of the home. Accented with a slate blue geode insert, the island provides a centerpiece for any wine tasting, dessert sampling, or twilight supper.



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Of course, concrete contains a large amount of embodied energy, and the acid used to stain both the main level floor and kitchen counter can hardly be considered eco-friendly. But having recently used a soy-based stain on a personal project, I'd have to say the acid stain is more vibrant, electric, captivating, and durable. Once the acid has dried, a neutralizing agent is added and the entire surface is coated with an eco-friendly sealer.

The second level features caramelized bamboo floors. Highlights in the master bath include custom tile, a two-person electric sauna, and stylish curved walls and arches. A handsome coffered ceiling in the third bedroom resembles the white sand canvas of a Japanese rock garden, with rippling rake-like patterns.

The stairs to the third level and its entire finish floor are made of beetle-kill pine. Views from this level offer a commanding panorama of downtown, the mountains and foothills, and the growing development of Old Town North.

## BEAUTY BY THE NUMBERS

Yes, it's beautiful—but how energy efficient is it?

In order to have objective energy performance estimates, Merten hired professional home energy raters to assess the home. The raters determined that the straw bale walls provide an insulation value of R-28 and the soy-based foam in the ceilings yields an insulation value of R-72.

## PROJECT DETAILS

**Project Description:** Green built/high performance new construction

**Owners:** Merten Homes

**Designer/Architect:** Merten Homes, Inc.

**Builder:** Merten Homes, Inc.

**Size:** 3036 ft<sup>2</sup>

**List Price:** \$689,000

**Date completed:** December 2007

## SUPPLIERS

**Photovoltaic Panels:** Sanyo

**Photovoltaic Consultants/Installers:** SolSource

**Heating Consultants/Installers:** RPM

**Kitchen Design:** Merten Homes and Red Pepper Kitchen + Bath

**Lighting:** Inlighten Studios

**Plumbing:** RPM

**Electrical:** Courtesy Electric

**Construction Waste Recycling:** Waste-Not Recycling

**Kitchen & Bath Cabinets:** Red Pepper Kitchen + Bath, American Loft

**Pella Windows:** Pella Windows

**Natural Plasters:** Biotexture, LLC

**Landscaping:** Zack George Landscaping

**Polished Concrete Floors:** Western Borders Construction

**Polished Concrete Kitchen Counter:** Gerhard Oehrlich, Concrete Design, LLC

**Energy Rating:** Energy Logic

## GREEN FEATURES

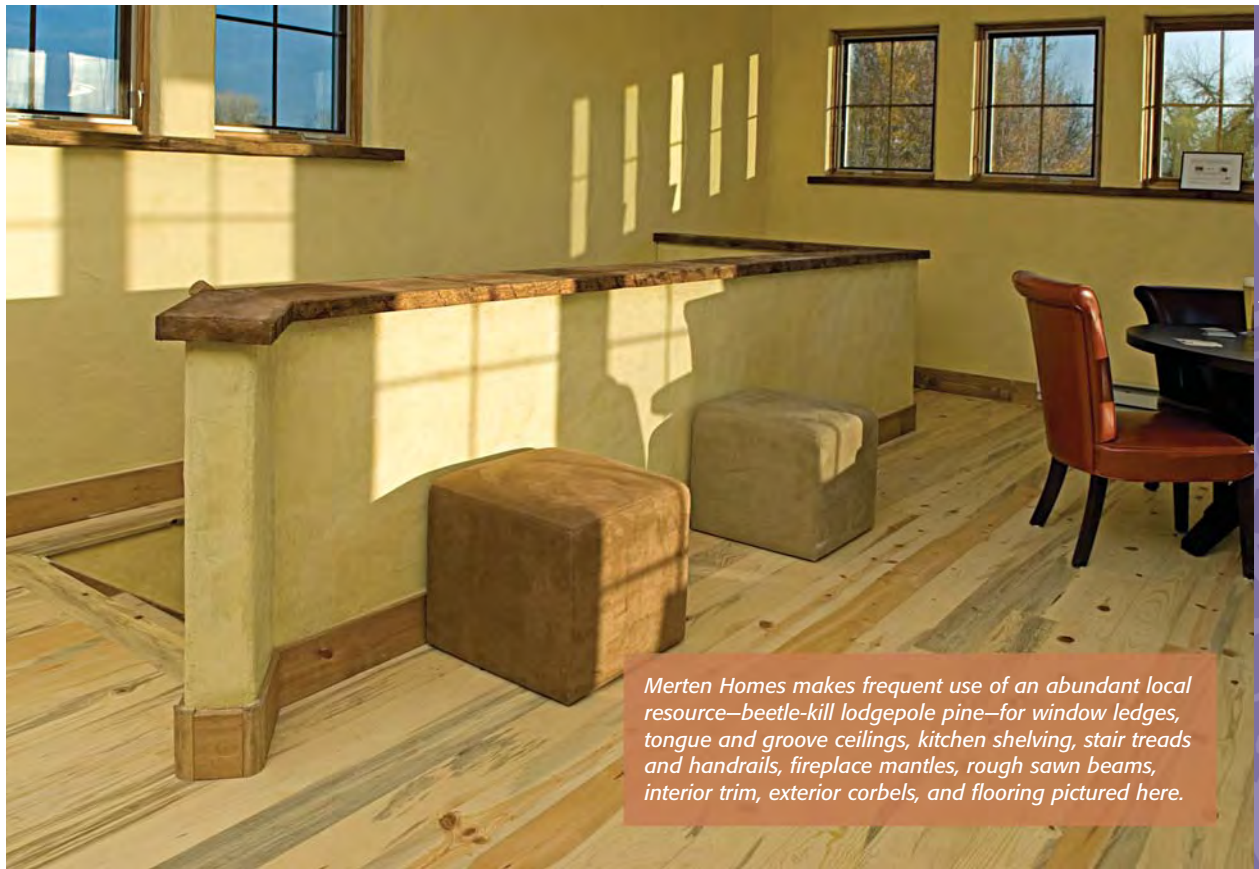
- FSC-certified lumber
- Straw bale exterior walls
- Reclaimed pine
- Reclaimed tile for roof
- Reclaimed beetle-kill pine
- Cabinet veneer with 40 percent post-consumer waste product
- AFM Safecoat paints and finishes
- Timbertek Stains
- Recycled over 20 tons of construction waste
- Dual-flush toilets

## RENEWABLE ENERGY AND ENERGY EFFICIENCY FEATURES

- 2.2 kW grid-tied PV system
- Rinnai instantaneous hot water system
- Radiant floor heat
- Soyfoam insulation
- Insulating concrete forms (ICFs)
- Energy Star appliances
- Compact fluorescent lights (CFLs)
- No mechanical cooling



Merten Homes' new straw bale home in Old Town North in Fort Collins boasts R-28 walls, R-72 ceilings, and a 2.2-kilowatt grid-tied solar electric (photovoltaic or PV) system.



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*Merten Homes makes frequent use of an abundant local resource—beetle-kill lodgepole pine—for window ledges, tongue and groove ceilings, kitchen shelving, stair treads and handrails, fireplace mantles, rough sawn beams, interior trim, exterior corbels, and flooring pictured here.*

Thanks to these high insulation values, combined with radiant floor heat, a 2.2-kilowatt solar electric (photovoltaic or PV) system, the instantaneous hot water system, and high performance windows, the home is expected to have an annual energy bill of \$1296.

The home also earned a 5-Star Plus rating from E-Star™ Colorado, and its HERS rating came in at 63. (A HERS rating of 100 represents the energy use of the “American Standard Building” and a rating of 0 [zero] indicates a net zero energy building.)

By building an eco-elegant luxury home, Merten has made an impressive introductory statement for its rollout of 11 more high performance homes in Old Town North. Rarely does a showing go by that someone doesn’t take me aside and tell me how calm the home is or how quiet it is. I even had an older lady who, under the watchful gaze of her smiling, grown daughter whispered, “Is this one of those net zero gravity homes?”

With careful attention to indoor environmental quality and energy and resource efficiency, this home establishes a tranquil atmosphere in which natural materials and finishes hold zen-like sway over the mechanical and structural elements of the home. A testament to the design and construction skills of the Merten Homes team and its talented affiliates, aesthetics and mechanics merge, rather than compete with and overshadow each other.

The American novelist Thomas Wolfe once said, “You can’t go home again.” But when I step inside this home, the same sense of wonder that I had as a child building my own “masterpieces” returns tenfold and reminds me what’s possible when the responsible use of natural resources is paired with high-performance technology and the unbound human imagination.

*Brad Duckham (bduckham@kw.com, 720.284.2416), EcoBroker, is a Broker Associate with Keller Williams Front Range Properties and a long-time resident of Boulder.*

## RESOURCES

E-Star™ Colorado  
[www.e-star.com](http://www.e-star.com)

The E-Star™ Energy Rating system gives each home a score expressed on a scale from 0 to 100 and from one to five stars.

Merten Homes  
[www.mertenhomes.com](http://www.mertenhomes.com)  
 Merten Homes specializes in the architectural design and construction of beautiful, ultra energy-efficient homes.

Residential Energy Services Network (RESNET®) [www.natresnet.org](http://www.natresnet.org)  
 RESNET provides an energy use index called the HERS® Index. A HERS rating of 100 represents the energy use of the “American Standard Building” and a rating of 0 (zero) indicates a net zero energy building.





Photographer Philip Wegener

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# Build Tight, Ventilate Right

As houses get tighter, building professionals must take care to ensure good indoor air quality in the buildings they design and build. **BY COLLIN TOMB**

Jim Logon Architects



*The doors in this home north of Boulder are finished with hand-rubbed organic mineral pigments and natural dyes, including indigo and cochineal (from ground-up cactus beetles).*

The growing popularity of green building is good news for building professionals and homeowners alike. Builders and designers create better buildings, and homeowners live in houses that are more durable, less expensive to operate, healthier and more comfortable to live in, and less of a strain on the environment.

As green building best practices become common practice, some unintended consequences emerge. For example, the inherent leakiness of older houses limited the buildup of moisture or indoor air pollutants within the living space. In contrast, today's tight, high performance houses often don't dry as readily, can concentrate indoor pollutants, and can suffer pressure imbalances that admit and retain pollutants—all ironic side effects for buildings designed with the health of occupants in mind.

Because we are no longer content to live in houses that whistle in the wind as we shove hot coals into our beds to keep warm, we have to accept that today's high performance home is a finely tuned machine. And like a machine, a tight house requires care in design, construction, and operation.

## GREEN GOING MAINSTREAM

Three major advances in building practice have become standard over the last fifty years. They have also brought us a new generation of indoor air quality issues (and spawned an entire building forensics industry).

First, building professionals have learned the importance of a well-insulated building envelope. They have also learned that the temperature differences between the inside and outside of a properly insulated building can create moisture condensation issues, even in Colorado's relatively dry climate. Dealing with those issues requires thoughtful detailing that takes both the building's climate and the

materials used into account. (The “Information” section of the [www.buildingscience.com](http://www.buildingscience.com) website is an excellent informational source on current best practices.)

Second, conscientious building professionals now work hard to make their building envelopes as tight as possible. The widespread use of large sheet goods such as drywall, plywood, OSB, housewraps, and vapor retarders made it easier to reduce building air leaks. Today’s green builders use sealants and foams to further tighten structures.

Third, as forced-air heating became more common, building professionals learned that these systems can introduce pressure differences in a building, and can in fact pressurize or depressurize an entire house if the ducts are leaky. Exhaust fans operating without makeup air also depressurize the areas where they are located.

A well-insulated and tight building envelope retains heat (and coolness in the summer), but can also retain moisture and indoor air pollutants, and can even draw in outdoor pollutants if unevenly pressurized. As the sophistication of the building envelope increases, so too must the machinery that ventilates and pressurizes the building if we are to avoid mold and other indoor air quality problems.

## POLLUTANTS

A tight building can retain and concentrate the toxins given off by building occupants as well as by everything in the house, from formaldehyde in cabinets and furnishings to chemicals in products used by occupants, such as cleaners, adhesives, perfumes, and solvents. In many areas, radon gas, which can enter the home from the soil below, is also a consideration.

“Build tight, ventilate right” is still a rule of thumb for Eric Doub, president of Ecofutures Building, Inc., a zero energy home builder in Boulder. But, he hastens to add, “It turns out there are more syllables to that. We must also reduce indoor emissions.”

To do that, long-time healthy home proponent John Bower suggests that we eliminate, separate, and ventilate. First, we must be mindful of what we bring into our homes, and consciously choose appliances, products, and furnishings that do not contribute to indoor air pollution. Combustion appliances, for example, should be power-vented, and preferably employ sealed combustion, to prevent the back-drafting of combustion products into the home.

If a home already contains pollution sources, we can usually separate the pollutants from the living spaces. For example, sheet goods (particleboard, interior plywood) that contain



Jim Logan Architects

*The materials in this home near Boulder are all natural, and are shown off in their natural state. Walls are adobe brick, rammed earth, or natural plaster, flooring is Colorado spruce, and the upholstery is cotton.*

formaldehyde can be sealed to prevent offgassing, and careful interior drywall sealing can keep the formaldehyde in fiberglass batt insulation in the walls and out of a home’s interior.

The rule of thumb for ventilating tight houses is that below 0.35 air changes per hour under ambient pressures (natural air changes per hour or NACH), we should install mechanical ventilation. Balancing the ventilation is important to prevent pulling exterior pollutants such as vehicle exhaust, fertilizers, pesticides, and radon into the house. This can occur when exhaust-only systems negatively pressurize the house or when simple inside-outside temperature differences cause stack-effect infiltration.

## MOLD AND MOISTURE

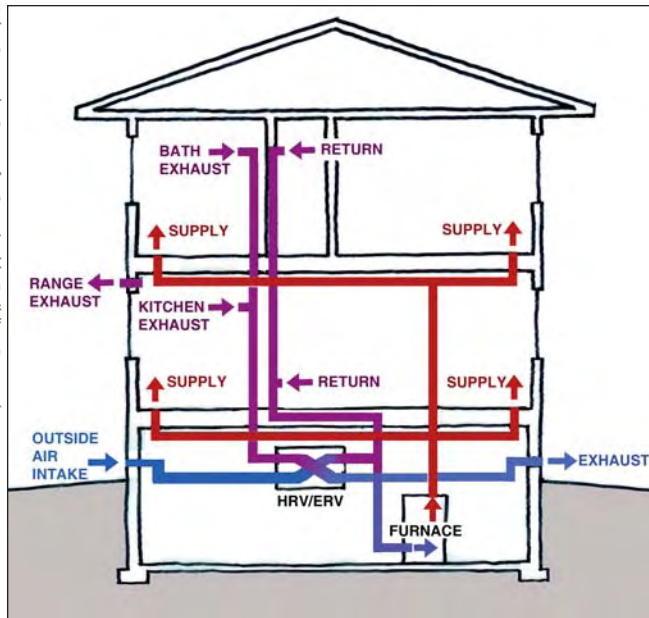
It can take years for the moisture introduced during the construction process to leave a building, and everyday living can introduce even more moisture into the building. In our climate, this moisture usually moves towards the colder, drier outdoors—right through the wall. As building forensics expert Joe Lstiburek loves to remind us, the wall is probably made largely of cellulose (wood), which he calls “mold food—just add water.”

By simply neglecting to use the bath fans, people can quickly end up with a mold farm they can’t even see. Joe Boatman, an indoor air quality specialist at Quality Environmental Services in Boulder, reports that most of the problems he sees in this climate come from moisture building up through normal living, without adequate mechanisms for escape.

Condensation and mold growth can occur at either the interior or exterior face of a wall cavity if moisture is trapped. Often moisture is trapped by a polyethylene vapor barrier behind the drywall or by the housewrap or air barrier covering the sheathing.

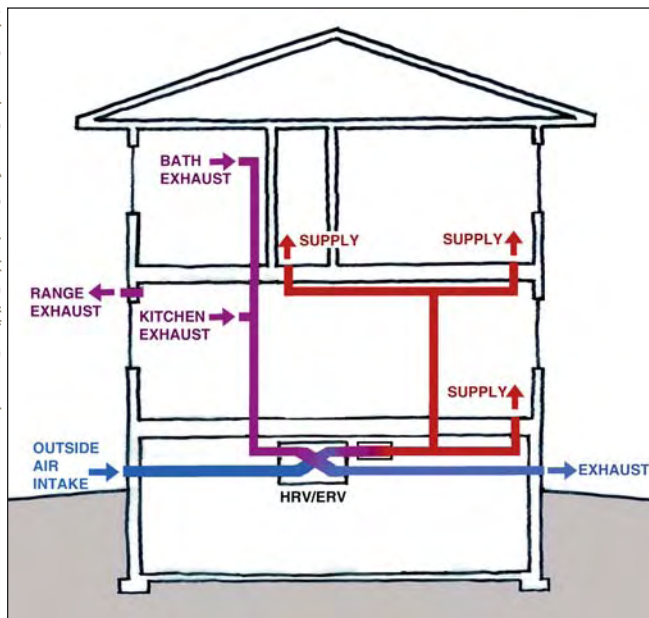


John Cammody, Center for Sustainable Building Research, College of Design, University of Minnesota



Heat or energy recover ventilators in homes with forced air heating and cooling systems can be used in combination with a system of exhaust fans in the baths and kitchen.

John Cammody, Center for Sustainable Building Research, College of Design, University of Minnesota



A heat or energy recovery ventilator installed in a home with no existing ductwork.

The combination of exterior cold and interior humidity causes problems in winter that don't exist in the summer, and problems occur predominantly on the north- and east-facing sides of buildings. The smaller the space, says Boatman, the more severe the problems will be, so they are a particular concern in multifamily structures and hotels. Furthermore, problems occur even in moderately tight houses, so they are a concern for everyone in modern housing.

To prevent mold growth, first prevent moisture from entering from outside. Correct detailing is a corner often cut in production housing.

Next, design the exterior wall to minimize opportunities for condensation. We must consider both the outside-is-colder and the inside-is-colder seasonal conditions.

Finally, provide adequate ventilation to dehumidify the interior environment without pressurizing or depressurizing the envelope. This generally requires a system with powered makeup air.

This last step is the new one for most of us, but it is already standard practice in places like Minnesota that are particularly vulnerable to mold. The state of Minnesota has required powered makeup air in residential construction since 2000.

In his plucky series of *Builder's Guides*, Joe Lstiburek describes all of the practices listed above and many more, in the graphic detail they deserve. The website of his Building Science Corporation ([www.buildingscience.com](http://www.buildingscience.com)) is an excellent resource for anyone interested in high performance buildings.

### BALANCED MECHANICAL VENTILATION

Tight building envelopes become negatively pressurized when bath fans, kitchen range vents, clothes dryers, and other exhaust equipment are in use. A ventilator is a continuously operating fan that "breathes" for the house, bringing fresh air in as it exhausts indoor air to the outside. A "balanced" system has fan-powered exhaust equal to its fan-powered supply, adjusted to achieve the 0.35 NACH sometimes required for healthy indoor air (see *The Green Geek*, page 44). This provides an opportunity to filter the incoming air as well as to exchange heat. Engineers took advantage of this opportunity, and gave us the two main types of ventilators used in energy efficient buildings.

A heat recovery ventilator (HRV) recovers up to 85 percent of the heat in the exhaust air. An energy recovery ventilator (ERV) has the added function of moisture exchange. ERVs are recommended in climates with high cooling loads, and can help dehumidify the air during hot periods, when the ventilation may increase the cooling load. The ERV will also retain some moisture in cold periods, when too much moisture is undesirable, but too little can be uncomfortable or unhealthy.

Ventilators are much less effective when high humidity is allowed to dissipate throughout the house. It is important that these ventilators be used in combination with a system of exhaust fans in the baths and kitchen. An HRV can be built to incorporate small, separately switched "booster" fans in these areas.

An HRV can cost between \$900 and \$2500 in new construction. It may cost more in retrofits due to the difficulty of ducting. An HRV or ERV generally draws between 85 and 225 watts of power, although newer, fancier models consume more. Still, it is much cheaper than not having heat recovery, particularly if controlled to optimize indoor air quality with the lowest possible air flows.

Even in moderately tight, mainstream construction, the potential for problems without ventilation has spawned a huge branch of law dedicated to mold and sick-building lawsuits. For green builders, there is little doubt about the importance of mechanical ventilation.

In his characteristic style, Joe Lstiburek puts it this way: “The most important consideration in making the decision for or against mechanical ventilation is, therefore—how lucky do you feel?”

### EVOLVING STANDARDS

Across the country, building standards are either in place or anticipated that require much higher levels of sealing and insulation than ever before. In the Boulder area, Boulder County’s BuildSmart program requires ambitious HERS ratings that can only be achieved through tight construction. The city of Boulder’s updated Green Points program is less stringent, but also raises the bar. Movement is already afoot to add ventilation requirements to the codes to address indoor air quality issues.

Builders in temperate climates often consider mechanical ventilation to be high technology, but it has become standard practice in Minnesota. According to Minnesota’s 2000 single-family building code, building professionals must build to a high standard of insulation and tightness and provide balanced ventilation (heat recovery isn’t required—this is an indoor air quality measure).

Homeowners who fail to operate their ventilation systems can void the Home Warranty Law provisions under state law (“loss or damage from dampness and condensation due to insufficient ventilation after occupancy”). Homeowner liability for building performance is a recognition of the importance of the homeowner to the operation of building systems. To help homeowners comply, the Minnesota Building Industry Foundation (MBIF), the philanthropic arm of the Builders Association of Minnesota, maintains a website, [www.home-smart.org](http://www.home-smart.org), dedicated to educating homeowners about basic building science.

Nationally, ASHRAE 62.2-2007, Ventilation and Acceptable Indoor Air Quality, requires “a mechanical exhaust system, supply system, or combination thereof” to ventilate the dwelling unit to 7.5 cubic feet-per-minute (cfm) per person. Controls must be accessible to the occupant and be labeled. Bath and kitchen exhaust fans (also required by this standard) are considered to be part of the exhaust system. A system operating

### RESOURCES

Building Science Corporation  
[www.buildingsciencepress.com](http://www.buildingsciencepress.com)  
*Builder’s Guides* (to Cold, Hot/Humid, Hot-Dry/Mixed-Dry, and Mixed-Humid Climates) by Joseph Lstiburek, 2004-2006  
[www.buildingscience.com](http://www.buildingscience.com)  
 Updated information on building best practices.  
 EPA’s ENERGY STAR Indoor Air Package  
[www.energystar.gov/index.cfm?c=bldrs\\_lenders\\_raters.nh\\_iap](http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_iap)  
 Third-party indoor air certification that rewards best practices in mold and pollutant risk reduction.  
 Minnesota’s Consumer Guide  
[www.home-smart.org](http://www.home-smart.org)  
 Website dedicated to educating homeowners about basic building science.

intermittently must operate one hour out of every 12, during which it must meet the specified flow (cfm) requirement.

The U.S. Environmental Protection Agency’s (EPA’s) ENERGY STAR Indoor Air Package (IAP) is an inspection-based indoor air certification that rewards best practices in mold and pollutant risk reduction. IAP specifications vary by climate, but all require

site and envelope drainage, indoor humidity control, radon mitigation, pest deterrence, ductwork efficiency, and whole-house ventilation. Both the Boulder County BuildSmart program and the city of Boulder’s Green Points program suggest the IAP package as a tool for improving indoor air quality.

### OR...OPEN THE WINDOWS!

All this talk of sealed-and-vented buildings gives the willies to freedom-loving, old-school, “windows-open” people like me. I like to open up the entire house in the mild seasons, and even on warmer days in the winter, to let the breezes refresh the house.

No problem, says Eric Doub, who maintains that mechanical ventilation and open windows “aren’t incompatible—just seasonal.”

The ERV/HRV is likely to become as common as a thermostatically-controlled central heating system. So we can install a switch in a convenient location and when the windows are open, we can turn the ventilator off. More people in the house? The kids are sick? Turn it back on.

### HOME SWEET ORGANISM

Today’s home is no longer just a rain shed—it’s an organism, and we have to be attentive to its care. Just as a building takes in fresh water and goods and sends out wastes, it also breathes. Old buildings breathed through their many cracks and pores. New, tighter buildings need a breathing mechanism to maintain homeostasis and comfort.

As more and more of the construction techniques formerly known as “green building” tactics are adopted into building codes, the interdependence of environmental and human safety becomes more apparent. Fundamentally, every building professional and homeowner becomes an active participant in maintaining the environmental and safety standards that affect us all.

*Collin Tomb ([collin@jlogan.com](mailto:collin@jlogan.com)) specializes in carbon-neutral building at Jim Logan Architects in Boulder.*



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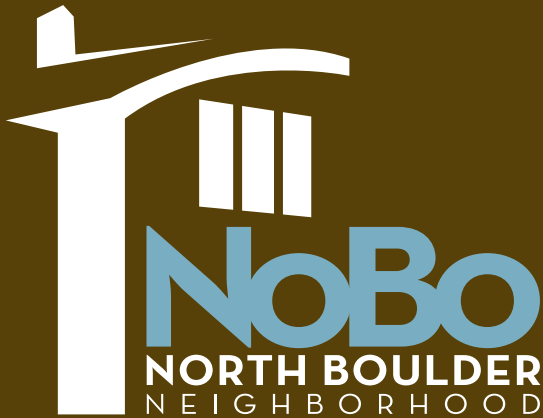
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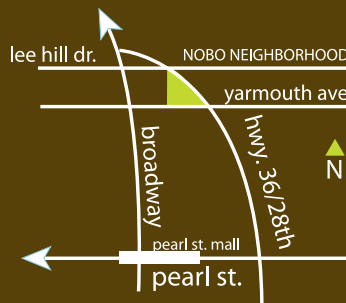
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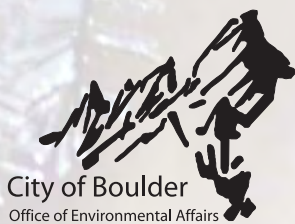




*Afternoon sun backlights the ice encrusting a Douglas fir branch on the Royal Arch trail near Boulder.*



# City of Boulder News



## **ClimateSmart Program Information** City of Boulder Office of Environmental Affairs Winter 2008

### **CLIMATESMART GOALS FOR 2008**



The city of Boulder's Climate Action Plan (CAP) calls for a commitment to reduce greenhouse gas emissions to 22 percent below 2006 levels by the year 2012.

ClimateSmart programs are managed by the city's Office of Environmental Affairs and are funded by the 2006 CAP tax, with additional financial support from Boulder County.

The ClimateSmart team took note of results from a city-sponsored January 2008 survey asking Boulder residents about quality of life issues. The availability of "energy conservation and energy efficiency programs" ranked highest in the first year that energy efficiency was included in the survey—higher even than traffic congestion and acquisition of open space. The survey results seem to reflect residents' growing concern over climate issues, and their desire to see the city continue to provide the programs and services that will allow us to meet the Climate Action Plan goals.





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## City of Boulder News

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In addition, City Council named the Climate Action Plan among its four top priorities for 2008 and is asking our team to pursue more aggressive strategies and outreach methods. Look for invitations to join us in creating the roadmap for how we will get there—every resident and business has a role to play. Sign up for our monthly e-newsletter for information at [www.BeClimateSmart.com/eNews/](http://www.BeClimateSmart.com/eNews/).

The city's [www.BeClimateSmart.com](http://www.BeClimateSmart.com) website also offers resources, tools, and tips about our programs (like free and subsidized energy audits) and things we can each do on our own.

We want your ideas and suggestions, so don't hesitate to contact our marketing and outreach coordinator, Beth Powell, at [powellb@bouldercolorado.gov](mailto:powellb@bouldercolorado.gov) or 303.441.1846 about your experience using our website and its carbon calculator. Also very important...please tell your friends and neighbors what you are doing to reduce your energy use and why you feel it is necessary that we all take action.

### **CLIMATESMART SOLAR GRANT FUND PROGRAM**

In December 2006, Boulder's City Council approved a solar rebate ordinance that requires a portion of the sales tax on each purchased solar system in the city be funneled into a renewable energy fund. A portion of this fund is available for rebates to residents and businesses that install solar systems in the city and the other portion is dedicated to the ClimateSmart Solar Grant Fund. The ClimateSmart Solar Grant Fund is accepting applications for free solar photovoltaic (PV) or solar thermal projects on affordable housing units and on the facilities of site-based nonprofits operating in Boulder. The grant has two cycles for the year—proposals are due March 15th and August 15th.

Visit [www.BeClimateSmart.com/news/](http://www.BeClimateSmart.com/news/) or [www.environmentalaffairs.com](http://www.environmentalaffairs.com) for application information.

### **HOME ENERGY MAKEOVER OPEN HOUSE**

Watch the Boulder Green Building Guild (BGBG) e-news and [www.BeClimateSmart.com/events/](http://www.BeClimateSmart.com/events/) for details on an upcoming open house at the Home Energy Makeover's winning Boulder home. You'll see how over \$20,000 in donated energy efficiency improvements were made to an inefficient North Boulder house. The 1902 home had an initial HERS rating (a measure of relative energy efficiency) of 383, 283 percent worse than a home built to code. The home also had 550 percent more air leakage than the average Front Range home.

Meet the homeowners (they happen to be BGBG members!) and product and service sponsors, learn about how the products and services save energy, and meet the

2007 contest sponsors (Xcel Energy, Colorado Energy Science Center, and the city of Boulder's ClimateSmart team). The open house is currently planned for March or April 2008.

### **NEIGHBORHOOD CLIMATE ACTION AND RECOGNITION**

As you may know, Boulder neighborhoods are starting to organize to reduce individual and neighborhood carbon footprints. The Shanahan Neighbors for Climate Action group, established over a year ago, received an award for their greenhouse emissions reduction efforts on February 1st at the Center for ReSource Conservation's annual fundraiser. Shanahan's efforts and action inspired the Newlands neighborhood in late 2007 to organize a "Greenlands" committee, and this group has just initiated a "Biggest Carbon Loser" competition within and between the two neighborhoods.

Anyone can join this easy competition, which tracks household Xcel bill data in 2008 compared to 2007 numbers. Details and downloadable forms can be found at [www.BeClimateSmart.com/news/](http://www.BeClimateSmart.com/news/). The ClimateSmart campaign can support neighborhood groups with presentations, ideas, free compact fluorescent lights (CFLs), help organizing events, and a small budget. We hereby challenge three more neighborhoods in 2008 to organize. Contact Beth Powell at 303.441.1846 for more information.

### **SUBSIDIZED HOME ENERGY AUDITS**

Many homeowners call BGBG member contractors for quotes and information on remodeling projects. The city of Boulder's Office of Environmental Affairs encourages all homeowners to have an energy audit performed first so that energy efficiency improvements can be included in any major remodel project. The Residential Energy Audit Program (REAP) is the easiest and most effective program we offer to help households save money and reduce individual household greenhouse gas emissions. The REAP is available in many cities throughout Boulder County. Call 303.441.3278, ext. 24, for more information.

### **DISCOUNTED CFLS**

Xcel Energy began a compact fluorescent light (CFL) promotion with King Soopers stores in its Colorado electric service on February 13, 2008. The promotion offers a four pack of CFLs for \$3.99 at participating stores, and will continue while supplies last. Xcel Energy has contracted to sell 200,000 units. Check Xcel's February bill insert for more information. The Office of Environmental Affairs does not have additional information.





## City of Boulder News

### INTERNS

The Office of Environmental Affairs wishes to thank our 2007-2008 interns and volunteers. Danielle Koffler is a senior at the University of Colorado at Boulder majoring in environmental studies, Monica Christ is a senior at Colorado State University in Fort Collins, working towards a BS in biology, and Joe Mulder is a city of Boulder employee who manages the South Boulder Recreation Center. Kudos to all three for their creative and meaningful contributions.

Green Points Program requirements went into effect February 1, 2008. Residential building permits triggering Green Points submitted to the city's Planning & Development Services (P&DS) office on or after February 1, 2008, are subject to the new program requirements.

To review either ordinance, visit [www.bouldergreenpoints.com](http://www.bouldergreenpoints.com) or [www.boulderplandevlop.net](http://www.boulderplandevlop.net).

### CODE WORKSHOP

P&DS held a series of workshops to highlight the differences between previous codes and the recently adopted 2006 codes. The final workshop is on International Mechanical, Plumbing, and Fuel Gas codes, and will be held from 12 to 1:30 pm, Wednesday, February 27, 2008, at the Spice of Life West Ballroom, 5706 Arapahoe Avenue. Pre-registration is required, and a fee of \$10 will be collected at the event (cash or check, payable to the city of Boulder). RSVP with your name, phone number, and the workshop's name to Jennifer Gray, [grayje@bouldercolorado.gov](mailto:grayje@bouldercolorado.gov), 303.441.4161, or stop by the front desk reception area at the P&DS Center, 1739 Broadway, third floor.

### P&DS 2007 NUMBERS

P&DS strives to support the desired long-term future of the natural and built environment in the city of Boulder. It also strives to serve its customers and maintain an exceptional service standard.

In support of this mission, P&DS measured the services provided to customers during 2007 and here are a few of those numbers:

- Approved 3523 building permits over-the-counter (approved 59 percent of building permits over-the-counter), including right-of-way, water, wastewater, floodplain, fire, and elevator permits.
- Performed 26,304 building inspections, 987 right-of-way inspections, and 735 water and wastewater inspections.
- Staffed 10 Board of Zoning Adjustment meetings, 17 Landmarks Preservation Advisory Board meetings, 51 Landmarks Design Review Committee meetings, 4 Downtown Design Advisory Board meetings, and 33 Planning Board meetings.
- On average, each day, 47 customers met with a Project Specialist, 18 customers conferred with a Project Specialist on the telephone, 45 cashier transactions were processed, and 113 building inspections were performed.

Wendy Marie Stuart, © Cloud Photography Ltd.



*An American Dipper in an icy stream at Sawhill Ponds near Boulder.*

## Planning & Development Services News

### NEW CODES ADOPTED

On October 30, 2007, the 2006 International Building Residential, Fire, Mechanical, Fuel, Gas, Energy Conservation, and Plumbing Codes and the 2005 Electric Code were adopted in Ordinance 7566 by reference and locally amended (into the Boulder revised Code) by City Council. The updated building code requirements were implemented January 2, 2008. Residential building permits are now subject to the new code requirements.

Also, on November 13, 2007, updates to the Green Points program were adopted by City Council. The Green Points policy is established in Ordinance 7565—Green Building and Green Points Program. The program applies to residential (single and multi-unit) new construction, remodels, and/or additions. New Green Points booklets and applications are currently under development for the city's residential building permit customers. The updated





## City of Boulder News

### P&DS CENTER CLOSURES

The Planning & Development Services Center, 1739 Broadway, will be closed periodically for staff in-service days as well as P&DS center renovations. Customers can visit [www.boulderplandevlop.net](http://www.boulderplandevlop.net) for up-to-date closure information.

On these days, services center staff will not be available to answer phones. Staff uses in-service days to focus on the review of building permits and land use applications, and to address other operational and training needs. The P&DS Services Center will reopen at 8 am on the day following the closure. For more information on this and other P&DS center closures, call 303.441.1880.

## Green Building and Green Points Code

### NEW GREEN POINTS REQUIREMENTS

Residential building permits triggering Green Points submitted on or after February 1, 2008, are subject to the new Green Points program requirements. The program applies to residential (single and multi-unit) new construction, remodels, and/or additions.

Key changes to the program include:

- Mandatory requirements for construction waste management.
- Compliance for energy efficiency above code must be verified by a Home Energy Rating System (HERS) Index Score from a RESNET accredited rater (applicable to new construction only).
- Home Energy Audit Certificate from an auditor registered with the city must be submitted with building plans (applicable to remodels and/or additions of more than 500 square feet only).

To review the ordinance visit [www.bouldergreenpoints.com](http://www.bouldergreenpoints.com)

### FREE GREEN POINTS TRAININGS

To help building professionals comply with the new Green Building and Green Points Program updates, the city of Boulder's Office of Environmental Affairs is providing free trainings to the public at a variety of times and a number of convenient locations, a few of which are listed below. Visit [www.bouldergreenpoints.com](http://www.bouldergreenpoints.com) for future dates and times.

#### *Making Homes More Energy Efficient—Building Science Basics and HERS Ratings*

The intent of this training is to address the technical side of new construction with an eye toward meeting the

new mandatory requirements for increased energy efficiency. The presentation will address building science basics in energy efficient construction, as well as how an energy rater calculates a home's HERS index score and how building permit holders use the score to comply with Green Points requirements.

Presenters include Rich Moore and Paul Kriescher. Rich has worked in the field of residential energy conservation, performing energy audits, weatherization services, training, and consultation for homeowners and builders since 1984. Paul is a principal with Lightly Treading, Inc. Energy & Design, a Colorado-based company that works to improve the energy efficiency, safety, environmental impact, and comfort of homes and small commercial buildings. Both trainers are RESNET accredited HERS Raters.

- Monday, March 3, 11:30 am–1:30 pm  
REI BOULDER Community Room, 1789 28th Street
- Thursday, March 13, 11:30 am–1:30 pm  
REI BOULDER Community Room, 1789 28th Street
- Cost: Free

For more information or to register, please email [karpk@bouldercolorado.gov](mailto:karpk@bouldercolorado.gov). Space is limited, so pre-registration is required.

#### *Easy Green Building Techniques—An Introduction to Integrated Building Strategies*

This is an entry-level workshop geared for designers, builders, and members of the public who are unfamiliar with green building. The focus is on general principles, vocabulary, basic techniques, and common products for energy efficient building to help someone building a modest-sized home comply with the city of Boulder's Green Building and Green Points Code.

Presenters include Scott Rodwin and Ron Flax. Scott is the Principal of Rodwin Architecture, and was recently named "AIA Young Architect of the Year" for the U.S. Western Mountain Region in recognition of his work in sustainable design. Ron has been a member of the building community for the past 12 years, and is currently a project manager for Rodwin Architecture. He has been working on many green building projects, including a near-net-zero LEED home in Boulder.

- Thursday, February 28, 11:30 am–1:30 pm  
REI BOULDER Community Room, 1789 28th Street
- Cost: Free

For more information or to register, please email [karpk@bouldercolorado.gov](mailto:karpk@bouldercolorado.gov). Space is limited, so pre-registration is required.





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# Home Safe Home

A woman with extreme chemical sensitivities describes the challenges of maintaining a healthy home in a world full of toxins. **BY JILL SVERDLOVE IWASKOW**

Imagine you're sitting comfortably in your home and you look up to see your wife walk into the bathroom, then rush out moments later in a panic, blood trickling from one nostril and motioning to her throat because she can't breathe. This is the scene my husband had to endure a few years ago in our condominium, one that you can be sure he is none too anxious to repeat.

Because I have extreme chemical sensitivities, we had eliminated fragrances and toxic substances from our condo. So in this emergency, although we were all too familiar with *what* was happening, we had no idea *why* it was happening.

But we knew that as long as we were sharing walls with other people, we were at the mercy of their choices. In this case, our neighbor had plugged in four air fresheners and left town. Within hours, the pungent cloud of synthetic fragrance filled our entire downstairs.

The chemicals in these products are designed to cling and stay around, "freshening" the air. They include chemicals like benzene, naphthalene, and formaldehyde, which are known carcinogens. Because they fall into the fragrance industry's category of "trade secrets" and are protected by law, they remain unregulated and undisclosed.

There was nothing we could do but leave.

## INSIDIOUS POISONS

I wasn't always so sensitive. Exposure to the dust in New York City after September 11, and living in a moldy rental house put me over the edge. The list of products and materials that triggered my sensitivities rapidly began to expand—from molds and chemicals to fragrances and foods. And just as quickly, my reactions grew more severe—unclear thinking, difficulty speaking properly, inability to spell or recall words.

Fortunately, my mother didn't dismiss me as crazy, which is what happens to many chemically sensitive people. She quickly helped me find treatment. I was diagnosed with chemical injury, a permanently impaired detoxification system, and toxic encephalopathy, confirmed through radiologic



We're the canaries in the mine, sniffing out danger before other people notice it.

studies and neurocognitive assessments. I went through an intensive detoxification protocol that has gotten me to where I am today—not cured, and requiring daily treatment, but much better.

Now I avoid toxic substances with a vengeance, which is my most important treatment. As long as I'm not exposed, my body is relatively stable. But as the condo incident demonstrates, until I'm completely in control of the materials in and around my home, I'm not safe. This is the greatest barrier to health for most chemically sensitive people—lack of a healthy home.

Research shows that chemical sensitivity is more widespread than most realize, and the prevalence is likely increas-

ing in tandem with other analogous illnesses (asthma, allergies, and Alzheimer's, for example). A number of federal and state agencies including the National Academy of Sciences, the California Department of Health Services, and the New Mexico Department of Health, have concluded that about 11 to 16 percent of the population reacts adversely to low levels of chemicals. Although not all sensitive people experience major life disruptions, studies also indicate anywhere from 3.5 to 6 percent of the population experience debilitating or life-threatening reactions.

### SEARCHING FOR SAFETY

That day in the condo was a turning point. I didn't want to have to count on sleeping in a tent or a car every time someone unconsciously added a toxic substance to my environment. It was time to find a safe home, far from neighbors' walls, renovations, dryer fumes, secondhand smoke, and lawn care products. But the search was no easy task.

We slept overnight in many potential homes only to discover that my reactions, from hives to anaphylaxis, continued. With existing houses, I couldn't tolerate previous owners' product residues.

And, as they say, "old means mold," even in Colorado, where water from leaky roofs or crawlspaces can support mold growth. Gas heat, proximity to major road fumes, new paint, new carpet, chemically cleaned old carpets, new cabinets—any and all of these can trigger severe reactions. New construction causes similar offgassing problems.

We were hopeful, though, because the green building community has taken big strides, primarily in linking indoor construction materials, products, and finishes to the health of occupants. But we found there are still very few truly nontoxic green homes available. Bamboo flooring can have toxic glues and sealers. Recycled wood can be moldy. Most green built homes used gas heat and oriented strand board (OSB). And owners use toxic cleaning chemicals, laundry soaps, and herbicides.

After interviewing hundreds of people with this condition, we finally realized our only solution was to build from scratch. We would need to research and personally test every material that went into the house, because products that cause no reactions for one sensitive person might not be tolerated by another.

We purchased three acres of land in the mountains and I spent the next few months sleeping with a different building material every few nights. I sealed off a sample in a glass jar so it would off-gas. I opened the jar, took a big whiff, then observed how I felt. If I was okay, I slept with it next to my head to see how I would feel in the morning. Then I would do it all over again, just to be sure.

### THIS IS A SIGN WE DEVELOPED THAT WILL BE POSTED ON OUR JOBSITE:

#### THIS IS A HEALTHY HOUSE PROJECT

This house is being constructed as a healthy house for owners who have extreme chemical sensitivities and need a place to live. All products were chosen to safeguard the health of the owners and workers.

The following procedures must be followed at all times to protect this project. If you have questions, contact owner (303.801.7848) or builder.

- NO Smoking: Smoking, or use of tobacco products, is prohibited anywhere on or near the jobsite.
- Workers must do their best to be fragrance-free (owners will supply information and products).
- All workers must wear special clothing (provided) inside buildings to prevent possible contamination.
- Every material and procedure used on this job site must have prior approval by owner. NO SUBSTITUTIONS without owner authorization.
- All materials are to be protected from contamination and/or moisture damage during storage and after installation.
- DO NOT use gas (propane) or kerosene-fired machinery or heaters within or near the building.
- NO insecticides, herbicides, or any chemicals other than those specified by the owner may be used on the jobsite. This includes cleaning products.
- Avoid spills. If one occurs, report to project manager or owner for proper cleanup procedure.
- No materials will be buried or burned on site.
- Throw all food, packaging, and construction debris into proper outdoor trash containers to be removed daily.

Thank you for helping us by respecting these rules. It is very important to our health. We appreciate your understanding!

Matthew & Jill, owners

### DEVILISH DETAILS

The mission doesn't end with the building materials. Chemically sensitive people can even react to substances brought in by the building crew, ranging from fragrances in their personal care products to cigarette smoke. Anything involving the building process and materials has to be closely monitored. There can be no unapproved product substitutions and no gas heaters. Spill cleanup must be impeccable. Delivery trucks, which are routinely sprayed with pesticides that can contaminate construction materials, must be clean.

In addition to advice from others, the best resources were nontoxic home building guidebooks. Our favorites are *Prescriptions for a Healthy House* by Paula Baker Laporte et al., *The Healthy House*, by John Bower, and *Building Materials for*



*the Environmentally Hypersensitive* by the Canada Mortgage and Housing Corporation.

Ultimately, I created 35 pages of detailed Healthy House Specifications for our planned home. Each section carefully described the materials to use, where to buy them, and ordering and installation procedures. Among the materials we chose were heavy-metal-free autoclaved aerated concrete, in-floor radiant heat, concrete and tile floors, fiberglass windows, Douglas or hem-fir exterior grade plywood, poplar for wood trim, aquarium grade silicone and AFM caulk for glue and caulking, C-Cure grout and thinset, Murco M-100 drywall mud and interior wall finish, standing seam metal roofing, Benjamin Moore EcoSpec for paint, wheatboard for cabinet interiors, and a whole-house heat recovery ventilation (HRV) system. Our design also took into account the location of electromagnetic fields, such as large electric circuits, and we made sure they are away from the bedrooms. Plus we have kill switches in the bedrooms to shut off current while we are sleeping.

## NEXT STEPS

Developing the specifications turns out to be the easy part. Now we have to find a builder. Some builders, concerned about liability, were hesitant to work with us, even though we agreed not to hold them legally responsible if the house didn't work out, as long as they followed the specifications.

Our goal is to find someone open to working as a team. We need a builder who understands that I have to test every material and that there can't be any unapproved changes. One small detail can make a house intolerable for someone like me.

Like many people with this condition, our other hurdle is financial. We've already lost a lot of money to failed living situations, emergency housing expenses, special products, and medical bills. And then we ran into problems finding well water on the land, which caused a huge financial setback. We're only building because we have to, and we don't have a large budget, so we hope to find an affordable builder, too.

But in the bigger picture, there is good news. People with extreme chemical sensitivities alert everyone else to the dangers of toxins in building materials and home furnishings. I



Jackie West

*The author and her husband, Matthew Iwaskow, at the future site of their healthy home, a building lot in the mountains near Boulder.*

might react immediately, but these chemicals affect everyone over time. In a sense, we're the canaries in the mine, sniffing out danger before other people notice it.

As more builders and homeowners request nontoxic materials, these products will become more affordable and easier to find. Builders will gain confidence about working with the chemically sensitive, and the rules of the game will be clearer for both parties.

For now, we're still in the market for the right builder, and optimistic that the house will be my safe haven once it's built.

In the meantime, we're back in our condo. The neighbors have agreed not to freshen their air with plug-ins and to use the safe fabric softener we bought them, and the homeowners' association has agreed to use organic lawn care around our building. For now, we're safe in our sealed up, air-filtered condo.

And we pray there won't be any more surprises.

*Jill Sverdlow Iwaskow is a freelance writer living in Boulder, Colorado. She can be reached at [jiwaskow@gmail.com](mailto:jiwaskow@gmail.com).*

## RESOURCES

Rocky Mountain Environmental Health Association  
[www.RMEHA.org](http://www.RMEHA.org)  
Local support group for the chemically sensitive.  
Publish a newsletter.

Chemical Injury Information Network  
[www.CIIN.org](http://www.CIIN.org)  
National group. Publishes *Our Toxic Times* magazine.

Human Ecology Action League, Inc. (HEAL)  
<http://members.aol.com/HEALNatnl/index.html>  
National group. Publishes articles and newsletters.



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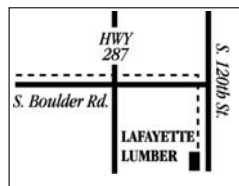
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# Bringing It All Back Home

A deconstruction contractor describes the environmental and financial benefits of deconstructing rather than demolishing houses. **BY KURT BUSS**

Today's builders and consumers face a dizzying array of green products and services when they build or remodel a home. But if the project requires preparatory demolition for all or part of the building, there is really only one green option—deconstructing the structure and reclaiming the materials for reuse and recycling.

Nationwide, construction and demolition (C&D) debris constitutes anywhere from 25 to 40 percent of the material going into landfills. Because the volume is so huge, some jurisdictions are developing waste reduction plans that mandate the reuse and recycling of C&D materials. If these programs are effective, it will represent a big step toward diverting construction waste from landfills.

In Boulder, the city's Waste Reduction Master Plan (WRMP) has goals of 60 to 85 percent diversion for the years 2007 through 2017. Other components of the WRMP include an initial examination report that assesses the current local market and recommends increased reuse and recycling of building materials through the Green Points program, a C&D bond, and a recycling facility for C&D waste—primarily wood, metal, and masonry.

Deconstruction is just beginning to get some traction in the building industry, although hand demolition of structures and material salvage goes back to the Stone Age. Even a Neanderthal knew it was better to keep the mastodon tusk that served as a building material than to get a new one when remodeling the cave.

When project specifications call for the removal of a structure, mechanical demolition has been the most prominent practice for the past half-century or so. Increasingly, however, building professionals view structures slated for demolition as sources of materials rather than simply something that needs to “go away” before the project begins.

## UNBUILDING A BUILDING

The best way to define deconstruction is to describe the process of construction in

reverse. Deconstruction is *unbuilding* a structure using many of the tools and techniques used to build it, with the intention of recovering all the reusable and recyclable materials that are cost- and time-effective to salvage. Generally, the last items to go into the building during construction are the first items to be removed during deconstruction.

Deconstruction contractors first remove reusable electrical and plumbing fixtures, along with cabinets, interior doors, and other non-structural items. Then they remove floor, wall, and ceiling coverings, usually salvaging wood floors and wall paneling for reuse if it's practical. Sometimes previous owners have sanded floorboards too many times or used adhesives that make it impossible to reuse or recycle the flooring materials. Thanks to a pilot program sponsored by the city of Boulder's Office of Environmental Affairs, Boulder residents can even recycle carpet.

At this point in the deconstruction process, deconstruction workers may bag the insulation. Next, they strip the outside layer of the building of its roofing and siding, and remove the windows and entry doors by cutting or prying the fasteners.



*The sequence of whole-house deconstruction typically follows the reverse order of construction.*

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(Top left) If wood flooring—in this case, Douglas fir—is in good condition, it is worth salvaging for resale.

(Top right) Tongue and groove wood flooring must be removed in the reverse direction of the installation.

(Bottom) When removing flooring, always start from the tongue side, pry close to the nail, and pry up and out to minimize damage.



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Asphalt shingles cannot be recycled locally, but successful programs in other parts of the country are encouraging. Masonry roof tiles are easily removed and reused, although the process requires equipment to remove the pallets of tiles from the roof. Cedar shake shingles are also easily recyclable, as long as they are not contaminated with felt paper.

Wood siding is more difficult to recover for reuse, although redwood or cedar lap siding is often worth the extra effort. Even if it's painted or stained on one side, the backside is often undamaged and beautiful. Aluminum siding is certainly worth recycling, although vinyl is currently not. Asbestos siding, along with anything else containing asbestos, needs to be removed by professional hazardous waste handlers, because it is a known carcinogen and can cause severe respiratory problems if workers inhale the airborne particles. Cement siding hasn't been on the market long enough to be a noticeable part of the C&D waste stream, but will hopefully have places to go other than a landfill when it becomes more of an issue.

Workers then remove roof and wall sheathing, all of which should be reusable or recyclable. Once the building has been taken down to the framing, the deconstruction crew removes the mechanical systems and conduits for reuse or—more often—recycling. At this point, all that remains is the wooden structure.

The crew then removes partition walls and other non-load-bearing components before taking down rafters or trusses. At this point, they can cut exterior walls free and drop them onto the floor for relatively easy disassembly by knocking off top and bottom plates with a sledgehammer and picking up the studs like firewood. Subfloor removal is more difficult if it's been glued to the floor joists, although new tools

and techniques are making this process easier.

When the wood structure—nearly all of which should be reusable or recyclable—is completely dismantled, workers can reclaim any steel posts, beams, furnaces, boilers, or other large mechanical items left in the basement, usually with the help of a piece of equipment such as a skid steer loader or extension forklift.

The concrete foundation is now all that's left. It can either be used for the new construction, removed by an excavator for recycling, or sometimes simply knocked down and backfilled.

### A BETTER WAY

In a traditional demolition, nearly everything above the foundation would be destroyed and hauled to a landfill. Demolition contractors will usually recycle concrete and steel if there are local recycling facilities.

Concrete and other masonry materials usually can be recycled at little or no cost. The rubble is pulverized in huge crushers that can magnetically remove rebar and other metal reinforcement. The runways at Stapleton Airport were recycled by a company in Arvada in what was described at the time as the world's largest recycling project. The finished product is typically used as road base or in other aggregate applications, reducing the need for gravel mining. Metal is the world's most recycled material, and currently enjoys record prices, thanks largely to the fact that China is purchasing all that it can for use in its massive hydroelectric and other infrastructure projects.

In a typical deconstruction, most of the material above the foundation would find its way to reuse and recycling facilities, with 80 to 90 percent going somewhere other than the dump. Items that were delicately dismantled and can be reused might find their way to the ReSource sales yard on 63rd Street, or one of the local Habitat for Humanity ReStores in the area, or the new reclaimed material yard operated by The ReUse People in Lafayette. Craigslist, eBay, and other web-based marketplaces are also very popular outlets for architectural salvage.



Mark Bowen, who has been selling reclaimed materials at the ReSource sales yard in Boulder since 1996, and has arguably seen and lifted more reclaimed materials than anyone in the area, has certainly noticed a change over the years.

“I remember when we first opened, nobody used the word ‘deconstruction,’ and we weren’t very busy at the yard most of the time,” he says. “Now, it seems more people are deconstructing, and the yard is *always* busy. I don’t think the people who started this ever expected us to be around this long, or they would have called it ReSource 3000 instead of ReSource 2000.”

### COSTS AND BENEFITS

There are certain factors that make deconstruction difficult or cost-prohibitive, such as the time involved in hand dismantling as opposed to using heavy equipment. What a trackhoe operator and a dump truck driver can do in a couple of days would take a crew of six deconstructionists a couple of weeks.



A reciprocating saw is an essential tool on a deconstruction site for cutting nails and wood, especially in tight places.

With remodeling projects such as interior strip-outs, pop-tops, and add-ons, however, hand dismantling is usually required, because removing a roof or knocking down some walls while leaving others intact is not possible with heavy equipment. In these cases, deconstructionists would systematically unbuild the areas to be removed by cutting, prying, and unfastening reusable components, as opposed to smashing everything with a sledgehammer so that it fits in a trash container. Deconstruction is about leverage, not impact—it’s Archimedes, not Hercules.

### THE ECONOMICS OF DECONSTRUCTION

The example below is a composite based on actual jobs and is used here to make an economic comparison between deconstruction and demolition. This composite is a single story, 2200 square foot house plus garage, with 3 bedrooms, 2 baths, raised foundation, composite shingles, single-paned windows, carpeting, hardwood floors, and a 12 x 40 wood deck. The costs do not include removal of concrete slabs, sidewalks, foundations, or asphalt, but do include the site being left in a rake clean condition (no debris).

In the machine demolition scenario, the owner pays \$10,100, but in the ReUse People (TRP) deconstruction scenario, the homeowner receives \$4,702 in after tax benefits. In other words, the owner would be financially better off to the tune of \$14,802 (\$4,702 received in tax benefits vs. paying \$10,100 in demolition costs).

Now for the disclaimers: Figures vary depending on location, age, and condition of the home and materials, topography, type of siding and interior walls, distance from the closest TRP deconstruction contractor, landfill rates, etc. Still, the economics almost always favor TRP deconstruction over demolition.

	TRP Deconstruction	Demolition
Physical lowering of house	\$17,238	\$6,000
Disposal of trash and debris	\$4100	\$4100
Appraisal of salvaged materials	\$3000	\$0
<b>TOTAL COSTS</b>	<b>\$24,338</b>	<b>\$10,100</b>
Donation value*	\$88,000	\$0
Tax savings* (after-tax value of donated materials)	\$29,040	\$0
<b>TOTAL COSTS</b>	<b>\$24,338</b>	<b>\$10,100</b>
<b>After-tax benefit</b>	<b>\$4702</b>	<b>\$0</b>
<b>Out-of-pocket cost</b>	<b>\$0</b>	<b>\$10,100</b>

\*Total materials (lumber, plywood, cabinets, plumbing and electrical fixtures, doors, windows, etc.) would generally appraise for \$77,000 to \$112,000 in good usable condition. Assuming a tax bracket of 33 percent (federal only—this will be larger in states with an additional income tax), the after-tax cash value, based on a typical appraisal value of \$88,000, is \$29,040. The after-tax difference between the two methods is \$14,802—not counting the “feel good” factor.

Deconstruction will almost always be more expensive than demolition. In a dollar per square foot analysis, demolition costs range from \$4 to \$6 per square foot and a full deconstruction costs about twice that.

This is where being able to donate the materials to a 501(c)(3) nonprofit company for a tax-deductible receipt comes into play (see The Economics of Deconstruction, this page). For homeowners in a higher tax bracket who are removing a perfectly good structure because they want to build their dream house in its place, the tax deduction can easily offset the additional costs of deconstruction, if not the total costs.

Here in Boulder, where quality of life is high but empty building lots are scarce, new homeowners often face the conundrum of buying the lot they want in the neighborhood they desire, but not wanting to keep the existing building for reasons of personal choice. This is an ideal scenario for

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deconstruction, and it happens more often than you may think.

According to city of Boulder records, there are currently about 150 demolitions per year that could be candidates for whole or partial deconstruction. Of that number, about 25 to 30 of the projects did involve some level of deconstructing in 2006, from complete deconstruction of the building to “soft-stripping” of interior components to prepare for a remodel. Capturing a higher percentage of these tear-downs and major remodeling projects will be essential to meeting the city of Boulder’s waste management goals.

**THE MULTIPLE BOTTOM LINE**

What Eco-Cycle does with household recyclables, we can also do with our houses. It’s the same process—you just use bigger containers.

Deconstruction has many benefits beyond just keeping stuff out of the landfill. In this part of the country, we have plenty of potential landfill sites, and, as a result, the cheapest disposal fees in the country by far. Fortunately, the good reasons to choose deconstruction go beyond landfill fees.

Deconstruction creates jobs, helps small business development, teaches valuable trade skills, provides affordable materials for affordable housing, and preserves architectural history. Salvaged materials also have lower embodied energy and reduce a building project’s carbon footprint.

But that little bit of Neanderthal that we all carry in our DNA gives us sufficient insight into how we should go about redoing our dwellings. The notion of throwing something away just because it’s been used once is, after all, a bit silly.

As long as there are the local businesses, organizations, government agencies, and community values necessary to make deconstruction, reuse, and recycling practical and affordable, we shouldn’t be seeing all the good mastodon bones getting buried. And here in Boulder, we have all of those things.

*Kurt Buss (kurtbuss@thereusepeople.org) is the Colorado regional manager for The ReUse People. For more information, visit [www.thereusepeople.org](http://www.thereusepeople.org) or the Boulder Warehouse at 10500 Isabelle Road, Lafayette, Colorado, 303.666.8094, Thursday through Saturday, 10 am to 6 pm.*



*A small, thin prybar is indispensable for removing delicate trim from both the interior and exterior of a house during deconstruction.*



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**RESOURCES**

**Deconstruction Organizations**

Colorado Hauling  
303.682.3024  
Patrick@ColoradoHauling.com  
[www.coloradohauling.com](http://www.coloradohauling.com)

Deconstruction Services  
303.931.7398  
russcallas@aol.com  
[www.haulawayrecycling.com](http://www.haulawayrecycling.com)

ReSource  
303.419.5427  
decon@resourceyard.org  
[www.ResourceYard.org](http://www.ResourceYard.org)

The ReUse People  
720.226.5646  
kurtbuss@thereusepeople.org  
[www.thereusepeople.org](http://www.thereusepeople.org)

**Building Material Reuse Stores**

Habitat for Humanity ReStores  
*Longmont:*  
455 Weaver Park Road  
303.776.3334  
[www.stvrainhfh.org](http://www.stvrainhfh.org)  
*Broomfield:*  
6900 West 117th  
303.404.2008  
[www.flatironsthrift.com](http://www.flatironsthrift.com)

ReSource Sales Yard  
*Boulder:*  
2665 63rd Street  
303.419.5418  
[www.ResourceYard.org](http://www.ResourceYard.org)

ReUse Home  
Improvement Center  
*Lafayette:*  
10500 Isabelle Road  
303.666.8094  
[www.thereusepeople.org](http://www.thereusepeople.org)

**Publications**

**Design Books**  
*The Resourceful Renovator: A Gallery of Ideas for Reusing Building Materials*, Jennifer Corson. Order online from [www.renovators-resource.com](http://www.renovators-resource.com). \$28.95 (Canadian dollars)

*New Old House: Designing with Reclaimed Materials*, Ed Knapp. Order online from [www.oikos.com](http://www.oikos.com) \$18.95 (US dollars)

**Reference Books**

*Unbuilding: Salvaging the Architectural Treasures of Unwanted Houses*, Bob Falk and Brad Guy. Order online from [www.taunton.com](http://www.taunton.com) \$30.00 (US) \$38.00 (Canadian)

*Directory of Wood-Framed Building Deconstruction and Reused Building Materials Companies, 2005*. USDA Forest Products Laboratory. Download PDF file from [www.buildingreuse.org](http://www.buildingreuse.org) or go to [http://www.fpl.fs.fed.us/documnts/fplgtr/fpl\\_gtr150.pdf](http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr150.pdf)

*2007 Guide to Architectural Antiques and Antique Lumber Companies*. Order online from [www.architecturalsalvagedirectory.com](http://www.architecturalsalvagedirectory.com).

**Periodical**

*Architectural Salvage News*, [www.architecturalsalvagenews.com](http://www.architecturalsalvagenews.com).



## PV Grant Program

Boulder-based Namaste Solar Electric recently launched a cutting-edge grant program designed to make solar electricity affordable for nonprofit organizations. Under the program, Namaste donates 1 percent of revenue annually in solar photovoltaic (PV) installations. Because Namaste is an employee-owned business, the grant program is funded by each of Namaste Solar's employees.

Namaste Solar grants are currently awarded to registered 501(c)(3) nonprofits serving the greater Denver/Boulder area with missions that reflect values of positive social and environmental change. Recent recipients include the Colorado Coalition for the Homeless and Alliance for Sustainable Colorado, both in Denver.

Annual deadlines for grant applications are in January and June. The next grant application deadline is June 27, 2008.

Namaste offers two kinds of grants. Under the matching grant program, the nonprofit's contribution can be secured through specific grants, fundraisers, angel donor/s, or with general operating funds. The matching grant amount calculates the retail price of the solar system, deducts the utility rebate amount (generally 50 to 60 percent), and Namaste Solar contributes 50 percent of the remaining amount. Under the full grant program, Namaste Solar donates 100 percent of the remaining amount after rebates are deducted.

Applications for full and matching grants from Namaste Solar Electric are available online at [www.namastesolar.com/matching\\_grant.pdf](http://www.namastesolar.com/matching_grant.pdf) and [www.namastesolar.com/full\\_grant.pdf](http://www.namastesolar.com/full_grant.pdf).



*The PV awning system Namaste Solar Electric donated to KGNU Community Radio helps offset the station's operating expenses.*



*Namaste Solar Electric collaborated with the Center for ReSource Conservation to install a 10.5-kilowatt solar PV system on the Boulder Shelter for the Homeless, which supports its mission to provide safe shelter, food, and self-sufficiency services for the homeless in the community.*



## ENERGY STAR Indoor Air Package

The U.S. Environmental Protection Agency (EPA) created the ENERGY STAR Indoor Air Package (IAP) to help builders meet the growing consumer preference for homes with improved indoor air quality and energy efficiency. By constructing homes that meet EPA's stringent specifications, forward-thinking builders can distinguish themselves by offering homes that have earned this designation. EPA developed the IAP specifications based on the best available science and information about risks associated with indoor air quality problems, and balanced with practical issues of cost, builder production process compatibility, and enforceability. Both the Boulder County BuildSmart program and the city of Boulder's Green Points program suggest that builders use the IAP package as a tool for improving indoor air quality.

Go to [www.energystar.gov](http://www.energystar.gov) and search for indoor air package to download the free current specifications.

## Free Green Building Course

The International Association of Certified Home Inspectors (InterNACHI) is offering a free online *Green Building* course. This course is designed to educate inspectors and real estate professionals about what green building is, why it's important, and how to recognize green systems and features in homes. It addresses the three main aspects of green building—energy efficiency, sustainable materials and practices, and healthy homes. This course, developed by local InterNACHI member Kenton Shepard, also helps teach inspectors to be safe during a home

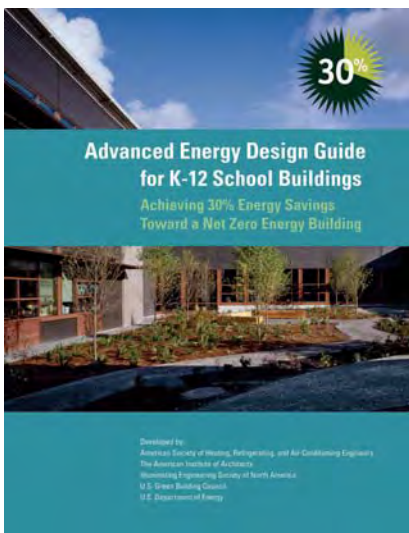
inspection. In keeping with InterNACHI's commitment to continuing education, this course is free to all, open to all, and can be taken again and again.

For more information, go to [www.nachi.org/greenbuildingcoursereleased2007.htm](http://www.nachi.org/greenbuildingcoursereleased2007.htm).

## ASHRAE Goes Green

### Free Design Guides

To encourage energy efficient design in a range of building types, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and its partnering organizations are making the Advanced Energy Design Guide series available for free. Electronic versions of the newest book in the series, *Advanced Energy Design Guides for K-12 School Buildings*, as well as the existing guides on small office and small retail buildings are available for free download at [www.ashrae.org/freeaedg](http://www.ashrae.org/freeaedg). Future guides, including one focused on warehouses to be published this spring, will be available for free electronic download as well.



ASHRAE's Advanced Energy Design Guide for K-12 School Buildings.

The guides provide a sensible, hands-on approach to design through use of products that are practical and commercially available as “off-the-shelf” technology. They offer designers and contractors the tools needed for achieving a 30 percent energy savings compared to buildings that meet the minimum energy efficiency requirements of Standard 90.1-1999.

Hard copies of all of the guides are also available for purchase.

For more information, visit [www.ashrae.org/freeaedg](http://www.ashrae.org/freeaedg).

### High-Performing Buildings Magazine

Targeted at building owners, facility managers, architects, and engineers, *High Performing Buildings* features working case studies of exemplary buildings developed by leading practitioners in the sustainability movement. Also included is a “lessons learned” section in each article where building designers and

operators explain what went right, what went wrong, how problems were resolved, and what could have been done better.

To learn more or to subscribe, visit [www.HPBmagazine.org](http://www.HPBmagazine.org). The quarterly magazine is distributed in print and digitally. The digital version of the current issue is available for free at the website.

## New EPA Greenhouse Gas Calculator

The U.S. Environmental Protection Agency's (EPA's) new Greenhouse Gas Calculator is a tool to help state and local governments translate their greenhouse gas savings estimates into more easily understood terms. The calculator converts greenhouse gas-related savings estimates, typically presented in “million metric tons of carbon dioxide equivalents,” into familiar terms such as the greenhouse gas emissions that would result from:

- Driving a particular number of cars for a year.
- Using a particular amount of gasoline or barrels of oil.
- Using a particular number of tanker trucks' worth of gasoline.
- Providing energy to a particular number of homes for a year.
- Growing trees across a particular number of acres for a year.
- Recycling a particular quantity of waste instead of sending it to the landfill.
- Generating electricity from a particular number of coal fired power plants for a year.

Users can enter savings in emissions, electricity consumption, gallons of gasoline, or number of vehicles into the calculator and determine up to 13 different ways to express the magnitude of the savings. The calculator uses the latest emission factors, approaches, and statistics available through 2007.

To use the calculator: <http://epa.gov/cleanenergy/energy-resources/calculator.html>

## Free Technical Briefs

E Source, a local Boulder company, has teamed up with the California Energy Commission's PIER program to make technical briefs on a variety of topics available for free on their website. Each brief distills volumes of research results into a two-page summary of the problem addressed, the solution, and the benefits of implementing that solution. The briefs currently available cover lighting, HVAC, the building envelope, commissioning and design, roofing, benchmarking, and controls.

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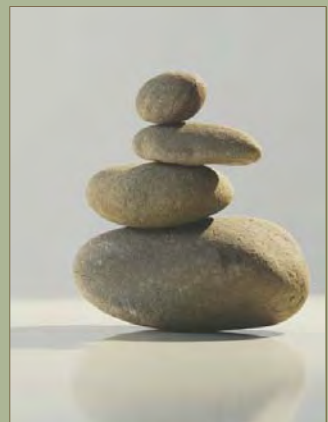
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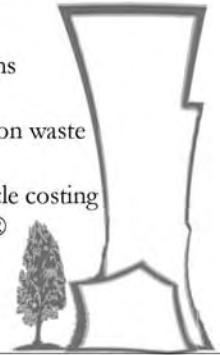
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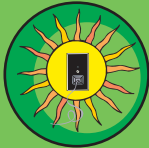
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# Build a Thermos and Ventilate with Care

Two weatherization experts explain how to create a tight, well-insulated house with good indoor air quality. **BY TOM WILSON AND LARRY KINNEY**

Everybody wants a healthy, comfortable, durable, safe home with close to zero energy bills and a tiny carbon footprint.

Can it be done? Yes, but it takes care and attention to detail.

Although air sealing is critical to the success of every genuinely green home, getting it right is not easy and requires different strategies in different parts of the house. The simple admonition to “caulk and weatherstrip” is not enough guidance for most homeowners.

The details are critical, although they are rarely discussed. Here is a quick look at some of those details. A more comprehensive document is available at [www.bgbg.org/Images/AirSealingHomes.pdf](http://www.bgbg.org/Images/AirSealingHomes.pdf). Note that the numbers below correspond to the graphic on page 45.

## ATTIC

### 1 Dropped Ceiling/Interior Soffit

Cover opening with sheetrock or reinforced cardboard (or plywood for large openings) caulked and nailed to joists, taking special care to seal ends with similar material. Insulate to standard depth. Alternately, fill cavity full with blown insulation.

### 2 Recessed Lights

Replace leaky and fire-prone older recessed lights with surface-mounted fixtures appropriate to the home’s era or install Underwriters’ Laboratory (UL)-approved I.C. (insulated ceiling) rated recessed fixtures. Seal around the rims when installing.

### 3 Chimney Chase

Fire code calls for an air space between the chimney and any combustible building materials. Seal the opening in the attic with metal flashing caulked and nailed to the surrounding joists and seal the flashing to the chimney with high temperature caulk. Establish a barrier at least 2 inches from the chimney to hold back any insulation. Air leakage up a fireplace can be controlled using glass doors, but a chimney top damper is far more effective. The combination is better yet. Fill unused holes or openings in masonry chimneys with a compatible cement-like material.

### 4 Electric Wires and Boxes

Fill wire holes through framing members with gunnable urethane foam or acrylic latex caulk with silicon. Seal boxes that penetrate ceiling.

### 5 Balloon-Framed Walls

Older houses may have balloon-framed walls that are typically open to both the attic and the basement. Fill exterior walls with high density blown cellulose insulation. Some can be reached from the attic. Seal interior walls with cardboard caulked and stapled in place or seal walls at the top and bottom with fiberglass-filled plastic trash bag “pillows.” Seal around the edges of these polybags with urethane foam. In some cases, interior walls can be blown full of cellulose insulation.

### 6 Attic Entrance

Consider this opening as important as your front door. Weatherstrip with appropriate material and use hardware to secure door. Caulk trim on interior and insulate the back if practical.

### 7 Partition Wall Top Plate

Seal seams at plate and plaster/sheetrock with urethane caulk (or urethane foam if gaps are large).

### 8 Plumbing Vent Chase

Seal around pipe with clamps and special neoprene collars designed for that purpose or use plastic sheeting mechanically fastened around pipe and seal to ceiling with staples and acoustical caulk.

### 9 Exhaust Fan

Extend vent hose (metal pipe is better) through gable end of roof and install a good-quality back-draft damper/vent hood. Seal edges of fan unit to ceiling with urethane or acrylic latex caulk with silicone. Kitchen and bathroom exhaust fans should also have a back-draft damper, and be installed so air cannot leak around the fan housing. Piping should extend to a dedicated vent hood through the roof, out a soffit, or through a sidewall. The pipe should be solid metal ducting or metal expansion hose drawn tight so there are no sags to collect condensed water vapor or crimps or bends to restrict the flow. The pipe should be insulated where it passes through unheated spaces. Buy a high-quality fan with the lowest sone rating (noise level) available.

## BASEMENT OR CRAWLSPACE

### 10 Dryer Vent

Replace the vent hood with an improved design unit that ensures a positive seal. Seal pipe connections with *metallic tape*,



not duct tape, and caulk other building penetrations with a high-performance sealant.

### **11 Plumbing/Utility Penetrations**

Seal dryer vents, water pipes, gas pipes, oil filler pipes, Freon lines to outside condensers, TV cables, and other penetrations using standard practices. Where practical, seal all penetrations from the inside.

### **12 Sill Plate**

Seal to foundation with urethane caulk where most accessible.

### **13 Rim Joist**

Use appropriate types of caulk and sealant for bonding dissimilar surfaces. Polyurethane caulk is often appropriate for this joint unless it is larger than 1/4 inch, in which case urethane foam is a good choice. Contractors can seal and insulate the entire rim joist with two-part urethane foam, but this is usually not a job for a do-it-yourselfer.

### **14 Bathtub Opening**

Block air movement with reinforced cardboard, caulked and stapled to floor members.

### **15 Basement Windows and Doors**

Make operable but air seal as with doors and windows in living space. In terms of energy usage, such openings are more important than the front door because stack-effect infiltration forces are greater toward the bottom of the conditioned envelope (see graphic, page 46).

### **16 Block Wall Cavities**

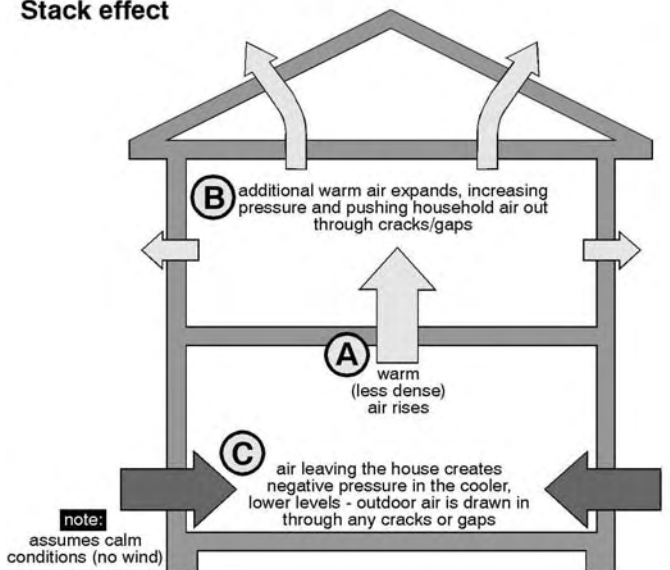
Fill tops with urethane foam or mortar plaster.

### **17 Water Heater/Furnace Flue Connections**

Replace deteriorated flue pipe and secure joints with stainless steel hex head screws. Seal at chimney with non-asbestos furnace cement or high temperature caulk. Consider replacing appliances with closed-combustion systems to eliminate the



## Stack effect



need for the chimney and combustion air inlets otherwise required by codes and to avoid the dangers of back-drafting appliances and carbon monoxide poisoning.

### 18 Ductwork

Mechanically close all open seams and reconnect open ducts, boots, and registers—both supply and return. Clean with alcohol solution and seal with dead-soft aluminum tape (not duct tape) or seal all joints with a combination of duct mastic and fiberglass mesh tape. Insulate all ductwork passing through unconditioned spaces.

### 19 Plumbing Chase

Seal around pipe with urethane foam, duct wrap, or polyethylene as practical. If the pipe is plastic, it will expand and contract with temperature changes. To ensure a thorough seal while allowing noiseless movement of the pipe, apply a thin coat of oil or petroleum jelly around the pipe before applying foam.

### 20 Leakage Between Basement and Crawlpace

Seal with urethane foam, caulk, weatherstripped hatches, etc., as appropriate to the situation.

### 21 Floor Over Unconditioned Crawlspaces

Consider insulating the walls of the crawlspace and putting down a sealed vapor barrier on the floor of the crawlspace. Alternately, install unfaced batt insulation beneath the floor. Fill the entire cavity. Support the insulation with high tensile strength permeable air barrier material (Tyvek™, Typar™, or equivalent), sealed carefully around edges with acoustical sealant and battens. Protect barrier material from ultraviolet radiation. Alternately, seal the floor from the interior by putting down a new floor surface (plywood, vinyl, etc.) over building paper/air barrier.

## LIVING AREA

### 22 Windows

Control air leakage that occurs at windows that separate a heated/conditioned space from unconditioned space. Usually older windows can be repaired or brought back into working

*Stack-effect infiltration forces are greater toward the bottom and at the top of the conditioned envelope, and there is typically a neutral pressure plane in the middle of the house. Ironically, air sealing efforts often focus on the middle of the envelope because it is more accessible and has a lower “yuck” factor—fewer spiders, cobwebs, rodent droppings, etc. Yet sealing at the bottom and top of the envelope is much more effective in lowering convective losses in homes.*

*Carson, Dunlop & Associates Ltd., [www.carsondunlop.com](http://www.carsondunlop.com), with permission from Dearborn Home Inspection*

order without the aid of common weatherstripping materials. Make sure the windows close all the way, are free of accumulated paint buildup, and sash locks are closed.

### 23 Laundry Chutes

Seal with appropriate gasket material.

### 24 Stairwell

Caulk risers, treads, and sidewall junctions as needed. Consider blowing inaccessible stairwell sections with high-density cellulose insulation.

### 25 Attic Knee Wall/Framing Intersection

Isolate the knee wall from the living space with a tight-sealing door or panel. Insulate sloped roof/ceiling section with high-density blown insulation. Insulate vertical knee walls with fiberglass batts or rigid insulation. Insulate the floor with high-density blown insulation, being sure to seal off the floor cavity between living spaces with tightly-packed insulation or polybags as described in item 5, “Balloon-Framed Walls.”

### 26 Built-In Dresser

In an unconditioned space, build bureau with cardboard or plastic stapled and caulked to drawer-guide framing members. Insulate and seal at roof rafters.

### 27 Chimney Penetration

Seal with high-temperature caulk and sheet metal.

### 28 Built-In Cabinet

Caulk perimeter of cabinet and interior hardware slots with siliconized acrylic latex. Alternately, remove cabinet, seal wall chase, and replace cabinet.

### 29 Holes in Plaster Walls

Patch smaller holes with Durabond™ patching plaster or a fiberglass-reinforced patch kit. Large deteriorated sections can be covered with sheetrock screwed through to framing members.

### 30 Furnace Registers

Reinforce large gaps with sheet metal and screws. Clean surfaces with alcohol solution and seal with J-channel, dead-soft aluminum tape, or duct mastic.

### 31 Doors

Weatherstrip all doors leading directly to the outside or unconditioned porches, attics, cellars, hallways, etc.

### 32 Baseboards, Coves, and Interior Trim

Seal gaps between the bottom plate of the wall and the floor, including leakage behind baseboards. Caulk on interior with clear acrylic latex caulk with silicone.

### **33 Plumbing Access Panel**

Weatherstrip if possible. If not, caulk with silicone caulk using bond-breaker tape on one surface and screw in place.

### **34 Sink Plumbing Penetrations**

Seal gaps around utility penetrations where they penetrate exterior or interior walls. Never surround electrical wiring with urethane foams, because their insulating properties and flammability could create a fire hazard.

### **35 Dropped Soffit**

Caulk all open seams from the interior or try to seal from above with board stock and urethane foam or caulk. If covering is impossible, consider filling with blown insulation, unless the soffit contains light fixtures.

### **36 Electrical Outlets**

Detail electrical receptacles (switches and outlets) to prevent air leakage or enclose them in plastic airtight boxes designed for that purpose. Seal the edges of existing electrical boxes to the finished wall surface. Install foam switch plates, receptacle gaskets, and childproof plugs on all fixtures without airtight boxes. Do not place foam, sealants, or insulation materials inside electrical boxes.

### **37 Electrical Fixtures**

Replace recessed lighting fixtures with UL-approved I.C. rated units or surface-mounted fluorescent box fixtures. Caulk fixtures to interior surfaces with clear acrylic latex caulk with silicone.

## **EXTERIOR**

### **38 Porch Framing Intersection**

If the blower door test indicates that the porch is connected thermally to the home's conditioned envelope, gain access and blow all connecting cavities with high-density cellulose.

### **39 Missing Siding and Trim**

Restore or replace damaged sections with matching replacement siding, prime all sides of wooden materials, and caulk for water penetration.

### **40 Additions, Dormers, and Overhangs**

Take special care to understand framing details and fill all cavities with high-density blown insulation. Seal interior surfaces as required—the more complex the profile, the greater the likelihood of overlooking an important detail or air leakage path.

### **41 Unused Chimney**

Stop airflow with a fiberglass-filled polybag stuffed down to ceiling line even with the insulation in the attic. Cap off top with sheet metal. Seal at bottom as appropriate.

### **42 Floor Joist**

Fill with high-density cellulose insulation.

## **VENTILATE CAREFULLY**

Given excellent air sealing, an effective indoor air quality strategy requires eliminating sources of pollutants as much as possible and installing an excellent, carefully-controlled ventilation system. As regards sources of pollutants, don't use building materials that offgas chemicals you shouldn't breathe. Don't store volatile organic compounds inside the conditioned envelope. Make it hard for radon and other soil gases to come into the envelope.

The best ventilation strategies exhaust stale air as close to the source as possible—the cook stove, the shower, the toilet. Fresh air must be introduced carefully to ensure that the home is neither depressurized nor pressurized to achieve comfort and safeguard indoor air quality. Bringing in fresh air through diffusing grilles in bedrooms, family rooms, and the like is usually best, but dampers should be closed when there's no need for ventilation.

Heat recovery ventilators (HRVs) are highly recommended for tight homes so that incoming fresh air is pre-heated by exhaust air in the winter and pre-cooled in the summer. Energy costs for a well-controlled system are on the order of \$50 per year for an average size home in Boulder's climate at current costs of natural gas and electricity.

We are not in favor of trying to meet ventilation standards by turning on fans or, even worse, air handlers on forced air systems that introduce outside air for some fixed number of minutes per hour. At 3 am on a cold night, there's rarely any need for ventilation at all, whereas during a dinner party, ventilation rates may be unduly low. Electric costs for running a furnace fan 24/7 over the heating season are also high, roughly \$150 per winter.

Ideally, the system would sense when the home requires ventilation and how much, and controls would supply the right amount of ventilation at just the right time. We anticipate that systems in excellent green homes will soon employ sensors—already in wide use in commercial buildings—that, for example, adjust ventilation rates to maintain CO<sub>2</sub> at less than 900 parts per million. Used in conjunction with humidity sensors set to actuate ventilation at 45 percent relative humidity, CO<sub>2</sub> sensors can achieve excellent indoor air quality while keeping energy costs to a minimum. Of course, manually-operated switches over the stove and in bathrooms with associated occupancy sensors or timers will continue to play a role in well-designed ventilation systems.

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