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# **Green Building Guidelines**

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2009 Edition

**NEW HOME CONSTRUCTION**



# GREEN BUILDING GUIDELINES



**Build It GREEN**

Smart Solutions from the Ground Up



**2009 Edition**

**NEW HOME CONSTRUCTION**

# **GREEN BUILDING GUIDELINES**

## Green Building in Alameda County

Debris from construction, demolition and landscape projects comprises nearly 11% of the materials disposed in Alameda County landfills. To reduce this waste, Green Building in Alameda County has formed a public/private partnership with the construction and building industries. The program serves three target markets: cities and public agencies in Alameda County; design and building industry professionals; and residents of Alameda County.

The key components of Green Building in Alameda County are:

- Guidelines
- Technical Assistance and Grants
- Education
- Partnerships
- Policy Development
- Case Studies

Green Building in Alameda County endorses the use of:

- **Build It Green's GreenPoint Rated Program and Green Building Guidelines for New Home Construction, Home Remodeling and Multifamily.** This publication is the 2009 edition of the New Home Construction Green Building Guidelines. For guidelines for Home Remodeling and Multifamily, the Builders' Guide to Reuse and Recycling, and other resources, visit [www.BuildGreenNow.org](http://www.BuildGreenNow.org).

### StopWaste.Org Disclaimer

*Green Building in Alameda County and Bay-Friendly Landscaping are programs of StopWaste.Org, which is the Alameda County Waste Management Authority and the Alameda County Source Reduction and Recycling Board operating as one public agency. The information provided in these Guidelines should be considered by contractors, architects and other professionals, as well as owners, in the course of designing and constructing new or modified structures. These Guidelines are provided as a public service by Green Building in Alameda County, in conjunction with Build It Green, in an attempt to provide environmental benefits to the public. The Guidelines are not a substitute for the exercise of sound judgment in particular circumstances and are not intended as recommendations for particular products or processes. The Guidelines are also subject to Build It Green's disclaimer on the following page.*

- **Bay-Friendly Landscape Guidelines and Bay-Friendly Gardening Guide.** Builders in Alameda County are encouraged to meet all the Bay-Friendly Landscaping prerequisites and incorporate additional practices to meet the minimum score required for a Bay-Friendly Landscape. Refer to the Bay-Friendly Landscape Plan Review and Scorecard at [www.BayFriendly.org](http://www.BayFriendly.org).
- **U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Green Building Rating System** for commercial and civic buildings. To learn more, visit [www.usgbc.org](http://www.usgbc.org).



## Bay-Friendly Landscaping

Bay-Friendly Landscaping is a whole systems approach to the design, construction and maintenance of the landscape in order to support the integrity of one of California's most magnificent ecosystems, the San Francisco Bay watershed.

A well-designed and maintained Bay-Friendly Landscape can cost less to maintain in the long run by consuming fewer resources. Bay-Friendly Landscapes embody community values for health, wildlife and the environment, while providing benefits to the homeowners, such as lower water or garbage bills.



## About Build It Green

Build It Green is a professional non-profit membership organization whose mission is to promote healthy, durable, energy- and resource-efficient buildings in California. Supported by a solid foundation of outreach and education, Build It Green connects consumers and building professionals with the tools and technical expertise they need to build quality green homes. Among these tools is GreenPoint Rated, which is an objective, third-party residential green building verification system that offers an array of benefits for different stakeholders. Build It Green fosters collaboration with key stakeholder groups to accelerate the adoption of green building standards, policies, and programs.

In addition to providing these Guidelines for educational purposes, Build It Green offers the following companion resources at [www.BuildItGreen.org](http://www.BuildItGreen.org):

- GreenPoint Rated checklists and manuals
- Innovation checklist for approaches beyond the measures described in the Guidelines
- Professional training to become a Certified Green Building Professional and/or Certified GreenPoint Rater
- Green Product Directory
- Information about new practices and materials or corrections that are identified after publication

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- Cross-referencing use of GreenPoint Rated and the Guidelines by local governments
- Cross-referencing with other residential initiatives (e.g., Energy Star Indoor airPLUS Program, LEED-H, CA Green Builder and the NAHB Guidelines)

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# Foreword

These New Home Construction Green Building Guidelines were developed to:

- provide local governments with an educational tool for city staff, builders and homeowners interested in green residential construction;
- present a range of voluntary practices for builders to choose from when constructing a green home in California;
- create a policy foundation for local governments interested in implementing green building programs and ordinances;
- establish regional consistency in green building guidelines to increase predictability for builders;
- integrate varying residential initiatives in order to achieve greater simplicity and local applicability; and
- offer a set of guidelines developed by an independent, third-party source.

## Guidelines Development Process

Over the years, the New Home Construction Green Building Guidelines have been developed and updated through a collaborative process. They are based on Guidelines first developed in 2000 through a public-private partnership among builders, green building experts, and local government staff in Alameda County. Representatives from major production builders, including Centex Homes, Greenbriar Homes, Ponderosa Homes, Pulte Homes, Shea Homes, Signature Properties, Silverwood Homes, and Toll Brothers, provided input and direction in the development of the original Guidelines.

The Guidelines were updated in 2005 and 2007 to expand its applicability throughout California, address

changes in California's Building Energy Efficiency Standards (Title 24), and incorporate measures from other residential green building initiatives such as the California Green Builder program, National Association of Home Builders guidelines, and the pilot draft LEED for Homes checklist. In 2009, the Guidelines were revised to reflect the 2008 update to Title 24, as well as to incorporate more advanced green building practices.

Build It Green expanded the update process in 2009 to include participants from all sectors of residential building including builders, real estate professionals and product suppliers. Representatives from local jurisdictions and Build It Green's councils, including the Public Agency Council, Builders Council and Rater Council, provided input, and utility representatives provided technical expertise. The update process included outreach to many State of California agencies, including Integrated Waste Management Board, Public Utilities Commission, Energy Commission, Office of Environmental Health Hazard Assessment, Department of Water Resources, Environmental Protection Agency and Air Resources Board.

Publicly available information, scientific data, and third-party standards were referenced in the development of these Guidelines. The Guidelines are intended to be a living document, and will be regularly updated as additional technical and quantitative information becomes available, measurement tools such as Life Cycle Assessment become more accessible, and new green measures are developed.



# Project Team & Acknowledgements

These Guidelines were produced through collaboration between Green Building in Alameda County and Build It Green. Special thanks to the following individuals and organizations for contributing to the 2009 edition of these Guidelines.

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# Chapter One

## Overview of Green Building

*"We have made a strong commitment to building homes that are green and increasingly sustainable. As part of this commitment we have participated in Build It Green's rating program since 2006 to help measure our success and to further shape and improve our green practices."*

—Katia Kamangar, SummerHill Homes

### Overarching Principles Of Green Building

- 1** Build for the long-term.  
Build durable homes & livable communities.
- 2** Build for our children.  
Make their homes, communities & environment safe.
- 3** Build for the planet.  
Use natural resources wisely.

# Introduction

Green building is gaining momentum in California, and for good reason. This holistic approach to homebuilding emphasizes quality construction, reduced greenhouse gas emissions, energy and water efficiency, less waste, good indoor air quality and livable neighborhoods.

In California alone, an estimated 2.6 million new homes will be built by 2020, according to California Energy Commission forecasts. Imagine the demands that all those homes will put on our water and energy supplies, forests, farmlands, recreational areas, roadways and municipal infrastructure.

Green building offers solutions to meeting those demands while minimizing environmental impacts. By building durable, healthy homes that consume less energy, water and other resources, today's green homebuilders are helping safeguard the well-being and prosperity of Californians today and for decades to come.

## Buildings and climate change

Although all sectors of the economy affect the environment, the building sector's impacts are particularly large. Buildings, it turns out, account for nearly half of all greenhouse gas emissions annually in the United States. Green buildings help rein in these emissions because they use less fossil fuel-based energy for heating and cooling, water heating, lights and appliances.

Using energy to keep lights on and air conditioners humming isn't the only way that buildings contribute to global warming. Water use is also intimately tied to the production of greenhouse gases, a result of the tremendous amount of energy used to treat and distribute water. Efforts to reduce residential water

use not only conserve a resource that's in increasingly short supply, they also help reduce greenhouse gas emissions associated with water distribution.

Waste reduction and recycling, two fundamental green building strategies, can also have a profound effect on climate stabilization. Consider green waste, for example, especially the landscaping waste that's created when a new home site is prepared for construction. Preserving existing vegetation on the site instead of sending it to the dump reduces the amount of methane produced when organic materials decompose in landfills. That's important because methane is twenty-one times more potent as a greenhouse gas than carbon dioxide. Recycling and buying recycled-content products also protect the climate because making products from recycled materials typically uses less energy than making goods from virgin resources.

Land use decisions also play a critical role in climate stabilization. Better community planning—including the compact, transit-oriented, mixed-use developments encouraged by green building—has significant potential to reduce the miles that residents drive.

For these and many other reasons, policymakers, building professionals and residents across the state are embracing green building as one of the principal means of reducing greenhouse gas emissions that contribute to climate change.



# Fundamental Objectives of Green Building

There's nothing mysterious about green building—it's really just applied common sense. To move forward with greening your construction project, it is helpful to think of green building as quality design and construction achieved through the convergence of four fundamental objectives:

1. Conserve natural resources
2. Use energy wisely
3. Improve indoor air quality
4. Plan for livable communities

## Conserve natural resources

Conventional building construction and operation consume large quantities of wood, water, metals, fossil fuels and other natural resources. Even though the majority of the materials used to build a home are put to good use, vast quantities of resources are wasted. In fact, building an average 2,000-sq. ft. house produces about 8.5 tons of construction and demolition waste.

Much of this waste is avoidable. Careful management of the construction process makes a big difference.

There are also many well-established homebuilding practices that help protect natural resources. For example, advanced framing techniques can substantially reduce lumber requirements without compromising structural integrity. Using engineered lumber and wood products certified by the Forest Stewardship Council can help protect old-growth forests.

There are many effective building strategies that conserve natural resources, as well as provide benefits such as cost savings. These include using durable products such as roofing materials with 40- or 50-year warranties, and specifying recycled-content or reclaimed products that divert waste from landfills. Recycled-content decking, reclaimed lumber and other products put waste to good use, while providing quality and durability that often exceed conventional materials. For example, decking materials made of recycled plastic mixed with wood waste fibers can last up to five times longer than wood decking, and never need to be treated or painted.

Water is another critical resource. California residences use 5.6 million acre-feet of applied water annually. Our prosperity and ability to meet the needs of our growing population hinge on having adequate supplies of clean, fresh water. Homes built and landscaped to use water wisely make a tremendous contribution to protecting our shared resources. An added benefit is lower expenses for the homeowner. Today's builders can take advantage of a new generation of cost-effective, high efficiency fixtures and landscape water management systems.

## Use energy wisely

New houses in California must be built to the most stringent energy code in the country, but given the state's projected population growth, even this may not be enough to keep demand for energy in check. Generation and use of energy are major contributors to air pollution and global climate change. With homes accounting for roughly 31% of the electricity consumed in the state, it is clear that homebuilders have a significant role to play in helping our society address energy-related concerns now and in the coming decades.

Energy efficiency is the cornerstone of every green home. Improving energy efficiency and using renewable energy sources are effective ways to reduce the potential of energy supply interruptions, reduce the impacts of global warming, and slow the rate at which we need to build new power plants.

Energy efficiency also makes good sense for homeowners: an energy-efficient house saves money by

reducing utility bills year after year, and provides other valuable benefits. Better insulation and double-pane windows, for example, make a home more comfortable and quieter.

### Improve indoor air quality

On average, Americans spend 90% of their time indoors, yet the air in new homes can be ten times more polluted than outdoor air, according to the U.S. Environmental Protection Agency. Children are particularly vulnerable when it comes to air pollution. A report in the *New England Journal of Medicine* states that 40% of children will develop respiratory disease, in part due to the chemicals in their homes.

A common source of indoor air pollution is the offgassing of chemicals found in many building materials. Kitchen cabinets, countertops, shelving and furniture may be made from particleboard or medium density fiberboard. Some of these pressed-wood products are made with adhesives that release urea formaldehyde—a known carcinogen—into the home for years after installation. Also, many paints, floor finishes, adhesives and sealants emit unhealthy volatile organic compounds (VOCs). That “new house smell” is a telltale sign that there are harmful chemicals in the indoor environment.

Fortunately, the building products industry is responding to these indoor pollution problems by developing safer products, including pressed-wood products with no added formaldehyde, and low-VOC paints, cleaners and adhesives. These products are now commonly available from most major suppliers at costs comparable to conventional products. California also now has specifications available for some materials to assure that they are low emitting and safe, including new stringent regulations on formaldehyde emissions from most composite wood materials.

Poor indoor air quality is also often caused by biological contaminants, such as mold that grows as a result of moisture accumulation due to inadequate ventilation, poor design and maintenance, and other factors. Dust, another major source of air pollution inside homes, can be reduced by designing entryways with areas where people can conveniently take off their shoes and by using hard surface flooring materials such as natural linoleum, bamboo, hardwood, concrete or ceramic tile.

### Plan for livable communities

California's homebuilders and homebuyers are making decisions today that will affect the quality of our lives for decades to come. New construction, whether of a single home or a large development, contributes to the state's economic vitality and helps meet our pressing need for more housing. At the same time, every new home places additional demands on our supplies of land, water and energy, and on our infrastructure of roads, sewers and other services.

Green building offers homebuilders, community leaders and California residents sensible solutions that improve an individual home's performance and provide broad-based community benefits. These benefits range from cleaner air to reduced traffic congestion, from more appealing recreational opportunities to greater economic vitality.

For local municipalities, green building can provide many economic benefits. Developments designed to reduce dependence on cars help ease traffic congestion, which can improve business productivity. Infill projects help revitalize older urban areas and allow public funds to be used for upgrading existing services such as schools, transit and sewers, rather than diverting limited funds to the development of new services.

For California residents, developments designed to cluster homes help preserve open space for recreation, views and natural habitats. Pedestrian- and bicycle-friendly neighborhoods provide people with opportunities to exercise and get to know their neighbors. Higher density urban infill developments allow people to live closer to where they work, shop and go to school, which means less time spent driving and more time for family, community and personal activities.

Clearly, green building cannot solve all the social, economic or environmental challenges facing California's communities. Still, green building gives homebuilders a valuable set of strategies for meeting residents' expectations for livable, healthy, sustainable communities.

# Chapter Two

## Building Green Homes

These Guidelines are for developers, builders and homeowners planning to construct one or more single family homes in California. The Guidelines provide a range of green building practices that can be implemented by people who are new to green construction as well as those aiming for higher levels of building performance.

As builders gain experience with green building, many embrace a whole-house systems approach that takes into account the complex interactions of all the building elements. This can result in a higher performing home and cost savings. Many individual green building measures can also reduce costs for both the builder and the homeowner. To give buyers assurance that the home is healthier and more energy- and resource-efficient, builders should consider having their homes GreenPoint Rated.

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*"GreenPoint Rated has developed the high standards we as builders need to make good individual choices. Third-party verification and a built-in improvement process help ensure we're meeting the standards and providing long-term value."*

—Mike Nimon, Wathen Castanos, Inc.

# How to Start Building Green

For building professionals, building green involves new ways of thinking about common building practices. Generally, it is best to build from your existing market base, adding green features as the market evolves and matures. If you start gradually, you are less likely to make expensive mistakes. It is critical to carefully consider the changes you make and the additional costs you might incur. The earlier you start integrating green strategies into your building process, the less it may cost you and the consumer in the long run.

Local governments can facilitate green building by providing educational opportunities and considering incentives for better quality construction. Builders value incentives that save them time in the development process or allow them to differentiate their homes in the marketplace. Incentives can include streamlined or expedited permitting, offering community recognition or partnering with organizations that offer consumer marketing programs.

## Taking steps toward building green

The measures in these Guidelines range from basic, common-sense recommendations such as the use of engineered lumber, to more sophisticated strategies such as installing renewable energy systems.

No matter where you are on the green building spectrum—from novice to expert—you will find resources, design ideas, and real-world advice that you can put to use today.

If you are new to green building, you can start taking steps right away toward creating healthier and more energy- and resource-efficient homes. Inside these Guidelines, you'll find many strategies that are easy to implement and add virtually no cost.

As your team's experience with green building grows, you'll likely find yourselves scaling up to even healthier and more effective design and construction practices. If you are experienced with building green homes, some of the approaches and practices recommended here may already be part of your daily practice. In that case, these Guidelines will help you employ more advanced green-building strategies that will reinforce your organization's leadership position.



# The House as a System

A house is an intricate system made up of interdependent components. Changing one aspect of this system can create a ripple of effects—positive or negative—in other areas. Builders were reminded of this when they began building tighter houses in the 1970s in response to rising energy costs. Tightly sealing the thermal envelope reduced heating and cooling costs but sometimes had unintended results, such as increased indoor air pollution due to inadequate ventilation or problems with mold due to moisture trapped within the structure.

The solution was not to return to the days of leaky, uncomfortable houses that wasted energy. Instead, what grew out of this experience was a new approach to home building, called the whole-house systems approach. In collaboration with building-science researchers, home-building associations and government programs such as the U.S. Department of Energy's Building America, many homebuilders across the nation are now successfully using this approach. It emphasizes strategic planning, systems analysis, and testing and verification to ensure that improvements in one area won't jeopardize health, safety, affordability, durability, profitability and other vital concerns.

Homebuilders should incorporate green building into their practices as part of this whole-house systems approach. This requires taking into account the interaction of many factors: the building's structure and thermal envelope; heating, cooling, water heating and electrical systems; renewable energy systems; the site's climate, topography, landscaping and surrounding structures; aesthetics; health and safety requirements; and how the occupants will use the house.

For example, a green builder concerned with improving the performance of the whole house will not merely select a more energy-efficient heating and cooling system and call it a day. Instead, the builder will look for opportunities to improve the thermal envelope and decrease heating and cooling loads, such as by reducing air leakage, designing and locating ductwork to minimize energy losses, increasing insulation, and performing diagnostic evaluations of the building envelope. These improvements may allow the use of significantly smaller—and less costly—heating and cooling systems. Properly sized HVAC systems also lower the owner's energy costs and provide greater comfort.

## Whole-house approach yields multiple benefits

According to Building America, a whole-house systems approach can reduce the energy consumption of new houses by as much as 40% with little or no effect on the cost of construction. Usually the decisions made as part of a whole-house approach yield multiple benefits.

For example, framing the home with 2×6 studs spaced at 24 inches allows increased insulation compared to conventional 2×4 studs spaced at 16 inches. Increased insulation saves heating and cooling energy and improves comfort. Also, as mentioned above, it may allow the downsizing of heating and cooling equipment. What's more, this framing technique reduces wood use.

The whole-house systems approach requires that the design and construction process be highly integrated. This involves:

- Careful planning and attention to detail from the outset of design through all the phases of construction.
- Understanding building science principles, including the principles of air, heat and moisture movement.
- Good communication among the entire team, including the developers, architects, engineers, builders, trade contractors, and material suppliers.
- Proper sequencing of decision-making and building activities throughout the entire design and construction process.
- Adequate training and supervision to ensure quality construction.
- Testing and verifying performance during and after construction, and establishing a feedback loop to improve future designs based on the testing results.

It's no coincidence that green homes designed with a whole-house systems approach are better homes. Improving building performance takes time and care, but can significantly reduce energy needs, improve health and comfort, and reduce builders' risks and costs.

Building America provides detailed information about the whole-house systems approach on their website, [www.eere.energy.gov/buildings/building\\_america](http://www.eere.energy.gov/buildings/building_america).



# Cost Considerations

## Balancing costs and benefits

These Guidelines recommend methods and materials that range in cost—some of them cost no more or even less than conventional options. In fact, when a home is designed from the outset to be green, it need not cost more than a conventionally built home. While not all measures recommended in these Guidelines will be applicable to every project, the measures included are relevant and reasonable for residential developments built today.

Some of the recommended measures do cost more initially, but this additional cost needs to be evaluated in the context of the longer-term benefits provided: utility cost savings, better indoor air quality for residents, healthier jobsites for workers, and longer building life. When considering green building measures, it is very important to balance upfront design, product and construction costs with these other significant benefits.

## How green building can reduce costs

While the health and environmental benefits of green building are well established, some people still assume that green building costs more. But taking a whole-house systems approach to green building, as described on the previous page, can actually reduce construction and operating costs compared to standard practice. This integrated approach to green building can help steer the design away from expensive solutions and toward cost-effective ones.

During schematic design, for example, the team might consider orienting the home on an east-west axis. This can provide multiple whole-house benefits, including facilitating passive solar design, reducing heating and cooling energy and equipment costs, and providing better solar access for rooftop solar electric and solar thermal systems. For many sites, it's a relatively easy to accomplish this during schematic design but it would be a costly change to make once construction documents were underway.

The key to reducing costs is to evaluate opportunities as early as possible in the design process because the range of cost-effective solutions narrows as the design progresses. Consider framing techniques. During schematic design, the design team might decide to incorporate advanced framing techniques. These techniques, as described in the Guidelines, reduce wood and construction costs while maintaining structural integrity and meeting building code. But if framing changes aren't considered until much later in the design or construction process, significant cost and resource-saving opportunities may be missed.

Green building is pushing the design and construction industry to do things that may be new, such as taking a whole-house systems approach to design and construction. Learning new practices sometimes involves an initial outlay of time and money. But green buildings are more than just buildings. They are the end result of collaboration between people on all levels of design and construction who are committed to improving homes for today and the future.

# Earning the GreenPoint Rated Label

GreenPoint Rated is an independent seal of approval that helps green homes stand out from the crowd. The GreenPoint Rated label helps home buyers answer the question, “How can I tell if this home really is green?”

GreenPoint Rated removes the guesswork by having a Certified GreenPoint Rater evaluate a home’s green features, allowing homes to be compared on a level playing field. GreenPoint Rated rewards building professionals and homeowners who create green homes by allowing them to brand their homes with a recognizable, trustworthy seal of approval.

Think of GreenPoint Rated as a report card for a home. A GreenPoint Rated home is graded on five categories: resource conservation, indoor air quality, water conservation, community and energy efficiency. The individual green building measures within these categories correspond to the measures listed in Chapter Three.

GreenPoint Rated offers two rating systems, GreenPoint Rated New Home for newly built single family and multifamily homes, and GreenPoint Rated Existing Home for remodeling single family projects.

For a new single family home to earn the GreenPoint Rated label, the project must meet the minimum point requirements in each category and score at least 50 points on the Single Family GreenPoint Rated Checklist, as verified by a Certified GreenPoint Rater.

The GreenPoint Rated label provides a numerical score that allows buyers to evaluate and compare the environmental performance of different homes. Because GreenPoint Rated homes are evaluated by independent third-party raters, building professionals and homeowners can feel confident that the rating has integrity and value and the home has met a consistent standard.

For local governments, Build It Green provides strategic assistance in developing, promoting and implementing green building policies and programs. GreenPoint Rated can serve as a mechanism for local governments to incorporate green building into their ordinances and help achieve community sustainability goals.

For more information about GreenPoint Rated, including becoming or finding a Certified Green Point Rater, visit [www.BuildItGreen.org/greenpointrated](http://www.BuildItGreen.org/greenpointrated) or call 510.845.0472x604.

Pleasant Hill Cohousing Common House, Pleasant Hill, CA



# Chapter Three

## Green Building Measures

Every green feature in these Guidelines benefits the builder, homebuyer and the environment. This chapter lists each measure, discusses the conditions under which it should be used, and describes the benefits. This chapter also includes brief “Building Basics” articles that review fundamental best practices for green building.

The measures in these Guidelines are not an exhaustive list of all the green elements that could be incorporated into a home. Rather, they are a list of field-tested options that are more likely to be used by custom and production builders. Look for opportunities to go beyond these measures and incorporate innovative techniques and materials that will conserve natural resources and improve the home’s energy efficiency, durability and healthfulness.

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*"We work one-on-one with each client to determine what green features will be incorporated into each custom home we build, directed at maximizing value and comfort."*

–Fred Koch, KOCH Development Inc.

# What's Inside

This chapter contains the heart of these Guidelines—a description of more than 90 measures, or best practices, for building green. The measures are grouped into sections generally corresponding to the various stages of construction. This organization will help you understand which green building measures can be incorporated at appropriate stages of construction.

Although the measures are listed individually, it's essential that each one be considered in terms of its relationship to and effect on the design of the whole house. The Guidelines also include some “Building Basics” articles that provide more details on fundamental concepts.

The sections are briefly summarized below. This 2009 edition includes new measures that reflect advances in green building and the 2008 update to California's Building Energy Efficiency Standards (Title 24); measures that have been adopted as code have been removed from the Guidelines. Significant changes to the Guidelines are noted below.

## A. SITE

Site measures include recommendations for managing the construction process to minimize disruptions to the building site, reduce waste, and prevent pollution of air, soil and waterways. A new measure has been added, Create a Cool Site, with strategies for mitigating the heat island effect.

## B. FOUNDATION

New-home builders have the opportunity to make the buildings green from the ground up. This section includes suggestions for incorporating recycled content in concrete, recommendations for foundation design and crawl space construction, and information on radon mitigation, pest control and moisture management. Two new measures have been added: Install a Foundation Drainage System and Control Moisture in Crawl Spaces.

## C. LANDSCAPING

These measures offer strategies for creating landscapes that use less water, conserve resources, promote healthy soils, create fire-safe landscaping,

and reduce excessive outdoor lighting. A number of new measures have been added, reflecting the increasing urgency of water conservation in California: Install a Rainwater Harvesting System, Use Recycled Water for Irrigation, Use Submeters for Irrigation, and Design Landscape to Meet Water Budget.

## D. STRUCTURAL FRAME AND BUILDING ENVELOPE

These measures provide energy- and resource-efficient strategies for building the structural frame and envelope, including the walls and roof. Following these recommendations will result in more durable buildings and less waste. Two measures have been added: Manage Construction Materials Efficiently and Use Insulated Headers.

## E. EXTERIOR FINISH

This section focuses on siding, roofing and decking materials that are durable and help protect the home from moisture damage and fire. A new measure has been added that emphasizes the importance of quality construction to minimize moisture damage: Specify Flashing Installation Techniques and Verify Installation.

## F. INSULATION

The measures in this section encourage the use of insulation products with recycled content and low or no formaldehyde emissions. Diagnostic evaluations and inspections are now covered in more depth in Section J.

## G. PLUMBING

This section addresses ways in which builders can save water and energy by designing the plumbing system to distribute hot water efficiently, and by installing water-efficient faucets, showerheads and toilets. The measure, Install Water-Efficient Faucets and Showerheads, is new to this edition.

## H. HEATING, VENTILATION AND AIR CONDITIONING

These measures address two main and complementary benefits: energy efficiency and better indoor environmental quality. Included are considerations for furnaces, air conditioners, water heaters, mechanical ventilation, ductwork, and fireplaces. This section contains a new measure that recommends performing

diagnostic tests on the HVAC system. The mechanical ventilation measures have been updated to reflect changes in Title 24.

#### I. RENEWABLE ENERGY

These measures provide information about how to include renewable energy systems (solar electricity, solar thermal, and wind energy) in single family homes.

#### J. BUILDING PERFORMANCE

This section has been significantly updated to reflect more advanced green building practices. It provides recommendations for designing and building energy-efficient homes that exceed California's code requirements and recommendations for third-party home performance testing and certification. It now also includes a recommendation for using certified preparers for Title 24 documentation, a measure addressing utility programs for third-party review of plans, and information on designing and building near zero energy homes.

#### K. FINISHES

Many conventional interior materials, including particleboard, paints and sealants, offgas noxious chemicals into the home. Most of the measures in this section describe healthier options for paints, trim, cabinets and countertops that perform well and are readily available. Other measures promote environmentally preferable materials for interior finishes.

#### L. FLOORING

These recommendations address a wide range of flooring materials that are durable and environmentally friendly.

#### M. APPLIANCES AND LIGHTING

This section recommends choosing dishwashers, clothes washers, and refrigerators that exceed minimum federal efficiency standards, which can significantly cut a home's energy and water use. It also provides information on built-in recycling/composting centers, and includes a new measure recommending the use of high efficacy lighting.

#### N. OTHER

The measures in this section encourage approaches to green building that are not included in the other sections. These practices include GreenPoint Rated documentation, preconstruction team meetings, green building professional certification, homeowners' manuals, and energy and water monitoring systems.

#### O. COMMUNITY DESIGN AND PLANNING

These measures include strategies to help preserve open space and utilize existing infrastructure, design subdivisions for solar access, promote social interaction and community safety, and make homes more accessible to people of all physical abilities. A new measure has been added, Build on Designated Brownfield Sites.

# A. Site

## 1. Protect Topsoil and Minimize Disruption of Existing Plants and Trees

### DESCRIPTION

Soil is a valuable, living resource that should be protected. Through careful planning and construction practices, topsoil as well as mature trees and other plants can be preserved.

### APPLICATION

Limit and delineate the construction footprint; restrict vehicles and heavy equipment that compact soil to areas that are or will be paved or built over.

Design for minimum building and hardscape footprints and minimize grading. When grading

is unavoidable, remove and stockpile any topsoil that's horticulturally suitable for reuse and store it in areas that will be paved later. Protect all soil from erosion.

After construction, evaluate the quality of the stockpiled soil, amend with compost, as appropriate, and re-spread. Any new soil that needs to be added should be similar to existing soil in pH, texture, permeability, and other characteristics, unless soil analysis reveals that a different type of soil is appropriate.

Complete a landscape survey to determine the feasibility of preserving or relocating mature trees, shrubs and native vegetation.

Protect trees and shrubs from construction equipment by placing temporary fencing beyond their driplines. Create or preserve wildlife corridors adjacent to open space, wild lands and creeks.

### BENEFIT

Plants thrive in healthy soil. Healthy soils can also significantly reduce stormwater runoff, reduce fertilizer and pesticide requirements, improve water quality and reduce water needed for irrigation. Protection of existing mature landscape features helps prevent soil erosion, keeps the home and surrounding environment cooler in the summer, preserves nature and adds value to the community.

## BUILDING BASICS

### PASSIVE SOLAR HOMES

Passive solar design can make homes more comfortable and greatly decrease energy used to run heating and cooling systems. Some of the energy benefits derived from passive strategies can be evaluated using California Building Energy Efficiency Standards (Title 24) compliance models.

A list of passive solar strategies follows. Each of these strategies is closely linked to many other aspects of the home's performance; be sure to approach the design process from an integrated, whole-house perspective. For related information about building near zero energy homes, see measure J3 of these Guidelines.

a. Orient homes to optimize solar access.

Plan subdivision lots and street layout to optimize solar access for all homes. Orient the home with the long axis running east-west and minimize east- and west-facing windows to improve passive solar performance. See measure O4 for more information.

b. Improve thermal mass.

Use wall and floor materials that improve thermal mass and moderate temperature swings. For additional information, see measure L2.

c. Improve cross ventilation.

Design windows to catch prevailing breezes and provide cross ventilation. Install high windows, operable skylights or cupolas and securable low windows. This will help create a stack effect to draw in cooler outdoor air from the

lower windows and exhaust rising hot air from the upper openings.

d. Shade the home.

Incorporate roof overhangs, awnings, trellises and shade trees to control solar heat gain through windows. For more information, see measures C5 and D8.

e. Reduce solar gain.

Use light exterior colors or paints with reflective pigments, Energy Star roofing materials, cool roof strategies, and/or radiant barrier roof sheathing. Roofing materials are available that have a reflectance greater than 0.75 and an emittance greater than 0.70. Install energy-efficient windows (double-paned, low-conductivity frames and low-e coating). See the Building Basics article, "Energy Code Compliance," for more information about windows.

## 2. Divert/Recycle Construction Waste (Including Green Waste and Existing Structures)

### DESCRIPTION

Each year, close to nine million tons of construction and demolition (C&D) debris is disposed of in California landfills. This represents 22% of the statewide waste stream, but in newer communities C&D waste sent to landfills can be as high as 50%. Construction waste generally consists of wood, drywall, metal, concrete, dirt and cardboard. It can also include plant debris (green waste). Much of this material can be reused or recycled.

### APPLICATION

Identify the types and quantities of materials generated at the jobsite during both demolition and construction. Determine what can be reused on the current project or

on another project and what can be recycled. Cardboard, concrete, asphalt and green waste can almost always be recycled. At least 50% of the construction materials, including green waste, should be recycled. One strategy is to sort materials on the jobsite and allocate space for recycling bins and storage areas for reusable materials. Train workers on appropriate disposal of materials.

Contact local recycling facilities and haulers to identify terms and conditions required for recycling materials. Contact the California Integrated Waste Management Board ([www.ciwmb.ca.gov](http://www.ciwmb.ca.gov)) for more information on recycling facilities.

Deconstruction of existing buildings is a good way to salvage quality building products that have not yet reached the end of their usable life,

even if the building or part of it has. Salvaged materials may be less expensive, of higher quality, or have more character than new materials.

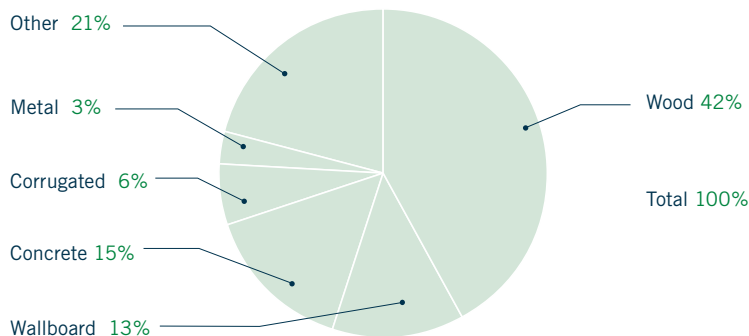
Whole house deconstruction requires a team of workers experienced in dismantling buildings. Locate a demolition contractor who offers deconstruction services or an organization that specializes in deconstruction. In some cases, deconstruction may cost more than demolition, but donating the salvaged materials to a nonprofit may result in a substantial tax deduction that can offset the cost.

Common salvageable materials include timber, doors, sinks, fencing, bricks, tile, hardware and light fixtures. Reclaimed lumber, in the form of studs, beams, flooring and trim, is among the most valuable and available of salvaged building products.

### BENEFIT

Reuse and recycling of construction debris conserves natural resources and reduces the burden on landfills. In addition, builders can save money with lower disposal fees for recyclable materials. Reusing building materials typically generates less waste and pollution than recycling does and eliminates disposal costs.

Construction Waste Generated from a 2,000-Square-Foot New Home



Source: Based on waste generation studies for three residential developments in Alameda County (1999–2004) and compiled by Matthew J. Southworth, P.E., Civil Engineer.

## 3. Use Recycled-Content Aggregate

### DESCRIPTION

Virgin aggregate comes from sources such as riverbeds and

quarries where mining activities disturb the environment. Recycled aggregate consists mainly of crushed concrete and asphalt pavement. Recycled concrete and asphalt crushed to ¾-inch meets the California Department of Transportation's (Caltrans) specification for Class 2 Aggregate Base.

#### APPLICATION

Use wherever Class 2 aggregate is specified; for example, under driveways, sidewalks and building slabs.

#### BENEFIT

Recycled aggregate allows waste materials to be reused, eliminating materials from the waste stream.

### 4. Create a Cool Site

#### DESCRIPTION

The term "heat island" refers to places with large areas of hardscape and buildings. The asphalt and concrete absorb and radiate heat, increasing ambient air temperatures. Cities create heat islands, as do many suburbs. Cool site measures that increase the site's reflectivity and shading help combat the heat island effect.

#### APPLICATION

Install light-colored and/or highly reflective materials for the site's impervious surfaces. Design and install shading elements such as overhangs, trees and shrubs (or preserve existing trees and shrubs) to shade sidewalks, patios, and driveways. Pervious paving or concrete also helps mitigate the heat island effect through

evapotranspiration. Providing covered parking (such as tuck-under parking or a parking area shaded by a trellis) as opposed to uncovered surface parking reduces the hardscape area. Solar electric panels, solar thermal panels, and vegetated roofs may also provide additional shading and cooling.

#### BENEFIT

Cool site measures reduce the heat island effect, which in turn reduces air conditioning use and greenhouse gas emissions. For cool roofing materials, refer to California's Building Energy Efficiency Standards (Title 24) and the Cool Roof Rating Council ([www.coolroofs.org](http://www.coolroofs.org)).

### 5. Carry Out an Environmental Quality Management Plan and Preoccupancy Flush-Out

#### DESCRIPTION

Indoor air at construction sites is often contaminated by toxins from building materials such as adhesives, sealants and paints, as well as by construction dust and other particulates. Carrying out an Environmental Quality Management Plan can improve the air quality at the construction site and protect construction workers' health. A preoccupancy flush-out of the HVAC system can help protect the residents' health.

#### APPLICATION

Write an Environmental Quality Management Plan that specifies

proper sequencing of construction activities, jobsite cleaning, covering and sealing duct registers during construction, and protecting absorptive materials stored on site.

Debris and dust from construction can lodge in HVAC equipment and ducts, potentially causing residents to have allergic reactions and reducing the effectiveness of the blower fan and heating/cooling elements. As soon as the ducts are installed, completely seal each duct register and the HVAC unit to prevent any construction dust from entering the system. Use methods and materials that will stay in place and be maintained throughout the construction process. After construction is completed, clean all ducts by vacuuming the blower unit and duct registers before occupancy. Conduct a preoccupancy flush-out with 100% outside air before the home is occupied.

For more information on best practices for construction environmental quality management, see the U.S. EPA's IAQ Design Tools for Schools ([www.epa.gov/iaq/schooldesign/construction.html](http://www.epa.gov/iaq/schooldesign/construction.html)) and the Sheet Metal and Air Conditioning Contractors' National Association website ([www.smacna.org](http://www.smacna.org)).

#### BENEFIT

These practices reduce the particulates and toxins created and released indoors on the jobsite, and flush the home of air pollutants prior occupancy.



# B. Foundation

## 1. Replace Portland Cement in Concrete with Recycled Flyash or Slag

### DESCRIPTION

Cement production is energy intensive; it accounts for more than 6% of the world's anthropogenic carbon dioxide emissions.

Flyash is a byproduct of coal-burning power plants. It is typically landfilled, but can be an inexpensive and quality substitute for a portion of the Portland cement in concrete. Concrete suppliers routinely replace 10–15% of the Portland cement in their mixes with flyash. Slag, a byproduct of the steel industry, may also be used like flyash to replace some of the cement.

### APPLICATION

Up to 50% of cement can be replaced with flyash or slag in many residential concrete mixes. High volume flyash or slag mixes (35% replacement or more) may require longer cure times and different finishing techniques than standard concrete. Consult a structural engineer for information.

### BENEFIT

Flyash and slag improve the performance of concrete by increasing strength, reducing permeability and reducing corrosion of reinforcing steel. Using flyash or slag also reduces the amount of water and cement needed, thereby decreasing the overall environmental impacts of concrete production.

## 2. Use Frost-Protected Shallow Foundation in Cold Climates

### DESCRIPTION

Foundations in cold climates are typically quite large, sitting deep below the frost line to reduce the possibility of heaving damage from the freeze-thaw cycle. A frost-protected shallow foundation (FPSF) is surrounded by insulation, which, in effect, raises the frost line to just below the surface, allowing reduced excavation and foundation wall depths.

### APPLICATION

This measure applies only to Climate Zone 16. Excavate the foundation perimeter to 16 inches rather than the 36 to 48 inches typical for cold climates. Place insulation horizontally 4 feet extending out from the foundation, against the outside face of the foundation wall, and under the entire slab.

### BENEFIT

An FPSF typically results in a reduction of both concrete use and labor of up to 40%. Reducing excavation activities minimizes compaction and disturbance of the soil by vehicles. Finally, the insulation under an FPSF can significantly moderate the foundation temperatures, making the home more energy efficient and comfortable.

## 3. Use Radon-Resistant Construction

### DESCRIPTION

Radon gas is naturally emitted by some soils and rocks. The U.S. Environmental Protection Agency estimates that exposure to radon may be the second leading cause of lung cancer, after cigarette smoking. In California about 1% of homes have radon levels above the recommended mitigation level (4 picocuries). Most of these homes are located in the Sierra foothills and coastal mountains and foothills.

### APPLICATION

Use radon-resistant construction if building a home in EPA Radon Zone 1 ([www.epa.gov/radon/zonemap/california.htm](http://www.epa.gov/radon/zonemap/california.htm)) or in an area identified by the California Department of Health Services as having above average risk ([www.cal-iaq.org/RADON](http://www.cal-iaq.org/RADON)). Lay a perforated pipe in a 4- to 6-inch layer of large gravel under the foundation slab. Connect this to a solid pipe running to the attic and through the roof for passive radon discharge. To actively discharge radon, attach a fan to this pipe.

Even in areas of medium to low risk for radon, some homes have high radon levels (especially homes with rooms below grade). The U.S. EPA has information about where to purchase inexpensive radon test kits ([www.epa.gov/radon/radontest.html](http://www.epa.gov/radon/radontest.html)).

## BENEFIT

Installing a radon mitigation system may significantly reduce the residents' levels of radon exposure.

#### 4. Install a Foundation Drainage System

## DESCRIPTION

A comprehensively designed and installed perimeter foundation drainage system will divert surface and subsurface water away from the house, and limit water seepage through the foundation walls or slab and into the crawl space or basement.

## APPLICATION

Best practices for a foundation drainage system include a perimeter drain for all footings and a waterproof membrane and deliberate drainage plane on the exterior of all foundation walls. Specify these design details on the building plans. This measure is appropriate for homes with slab foundations, crawl spaces or basements.

## BENEFIT

A foundation drainage system will increase the durability of the home's foundation by draining water away from the structure.

#### 5. Control Moisture in Crawl Spaces

## DESCRIPTION

A moisture-controlled crawl space reduces the amount of moisture migrating from the soil in the crawl space to the home's structure and interior.

## APPLICATION

Install a continuous vapor barrier with properly sealed, overlapping joints in crawl spaces according to best practice methods. The

vapor barrier should be at least 6-mil, should be white (not translucent), and should cover the floor and extend up the foundation walls. Seal all penetrations in the vapor barrier.

## BENEFIT

Vapor barriers improve indoor air quality and the structure's durability by reducing moisture migration into the home from the crawl space.

#### 6. Use Structural Pest Controls

## DESCRIPTION

Pests are attracted to moisture, darkness, food and rotting wood. Ants, termites and other pests can damage cellulose-based building materials. Some chemical treatments designed to deter pests may also be toxic to humans and other animals. Permanent, structural pest controls can obstruct typical pathways that pests use to enter the home.

## APPLICATION

##### a. Install Termite Shields and Separate All Exterior Wood-to-Concrete Connections by Metal or Plastic Fasteners or Dividers

Install a continuous, durable termite shield around all foundation slab penetrations (such as pipes), at the junction of the foundation or piers and the wall framing, and wherever slab perimeter insulation is installed.

When structural wood elements (such as posts, stairs and decks) are in contact with concrete or soil, they remain moist for prolonged periods. Create a separation to allow water to drain and wood to easily dry out.

##### b. Locate All New Plants At Least 36 Inches from Foundation

Maintaining this minimum distance keeps roots away from the foundation, reduces the chance of pests traveling from nearby branches onto the home, and allows the homeowner to more easily inspect for termite tunnels around the home's foundation wall.

Other effective strategies include making framing materials difficult for pests to reach by keeping the soil adjacent to the foundation away from the home's framing and siding. For new construction, the distance between the soil and the framing/siding materials should be at least 12 inches.

Also consider using low toxicity, borate-based wood preservatives on oriented strand board (OSB), plywood, or lumber to deter pests. Borates are naturally occurring mineral preservatives that are not appetizing to carpenter ants and termites, thus protecting the wood from pest damage. Another option is to use building materials that do not contain cellulose.

## BENEFIT

Physical pest controls are permanent controls that reduce the need to use chemicals. They also increase the durability of the home's structural elements, reducing the time and money needed for repairs. Nontoxic pest controls help protect the building from pest damage while also protecting human health.

# C. Landscaping

## 1. Group Plants by Water Needs (Hydrozoning)

### DESCRIPTION

Hydrozoning is the process of creating irrigation zones, with plants requiring little water placed in zones separate from those requiring more water. The goal is to reduce water use by supplying the appropriate amount of water to each irrigation zone.

### APPLICATION

Group plants into hydrozones by

separating plants with low and high water requirements and creating separate irrigation zones based on these water requirements. Delineate each hydrozone on the site plan, irrigation plan, and planting list. Place plants with higher water needs in relatively small areas and in spots that naturally collect water. Place plants with low water needs throughout the majority of the landscape. Install separate irrigation valves for different zones. Consider

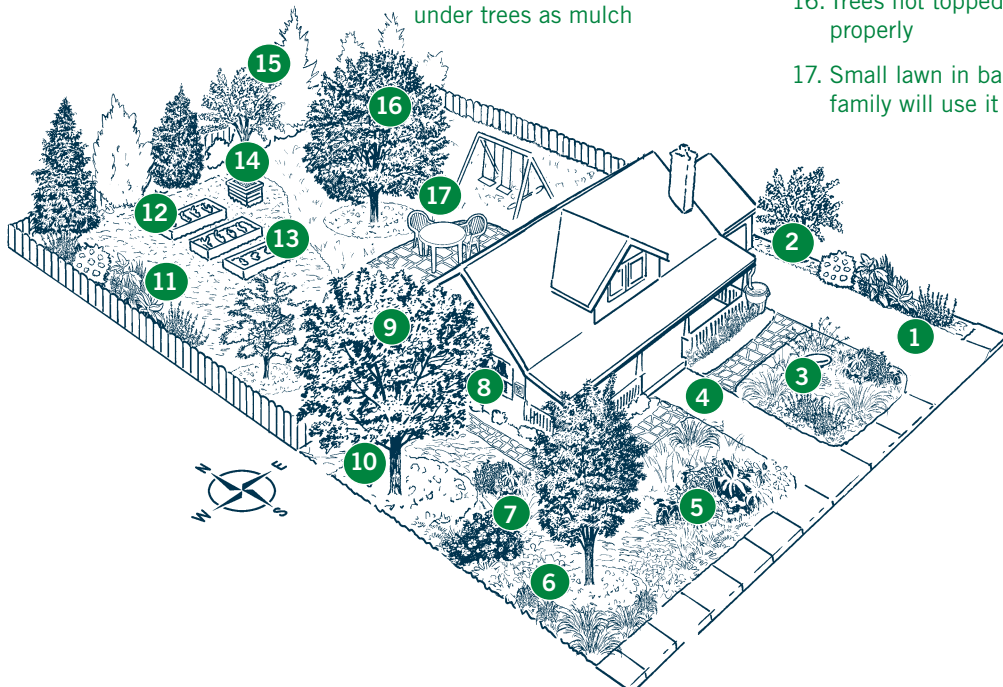
that some California native plants do not tolerate water in the summer after they are established and should be separated from plants that need ongoing irrigation.

### BENEFIT

Hydrozoning matches irrigation to the plants' water requirements, conserving water and fostering resistance to pests and disease. Hydrozoning also reduces plant mortality, which saves time and money.

## Elements of a Sustainable Residential Landscape

1. Permeable paving on driveway and walkway to front door
2. Water from roof channeled to cistern
3. Water for wildlife habitat
4. Pavers with spaces and low water use plants between
5. Front lawn replaced by diverse plantings with many California native groundcovers, shrubs and trees, but no invasive species
6. All plants given the space to grow to their natural size
7. Plants selected to match the microclimates
8. Irrigation controller waters hydrozones according to plant needs, soil moisture and weather
9. Deciduous trees placed to the west & southwest of the house & patio for summer cooling
10. Repository for leaves to collect under trees as mulch
11. Mulched paths keep soil covered
12. Drip irrigation for vegetable beds, shrubs, trees and elsewhere where feasible
13. Raised beds are constructed from plastic or composite lumber
14. Compost bin recycles plant and kitchen debris
15. Evergreen windbreak blocks north winter winds
16. Trees not topped but pruned properly
17. Small lawn in backyard where family will use it



## BUILDING BASICS

### STORMWATER

Land development and construction activities can significantly alter natural drainage patterns and pollute stormwater runoff. Increases in impervious surfaces can reduce water quality in nearby creeks, rivers, lakes and bays. In fact, according to the U.S. EPA, 11 million gallons of oil are carried into U.S. waterways each year from stormwater runoff. That's the equivalent of an Exxon Valdez oil spill!

Controlling stormwater runoff is critical to protecting water quality. Excessive stormwater runoff can erode residential landscapes and local streams, and stress local stormwater drainage systems, increasing flood risks. Keeping sediment and pollutants out of storm drains helps protect local creeks, reservoirs and the ocean.

Many construction projects will need to file a Notice of Intent (NOI) and prepare a Stormwater Pollution Prevention Plan (SWPPP) per the State General Construction NPDES Permit. Be sure to contact your local municipality for during-construction and post-construction stormwater

quality control requirements.

During grading and construction, use stormwater Best Management Practices (BMPs) to control erosion and prevent sediment and pollutants from entering storm drains. Erosion control protects the soil surfaces whereas sediment control traps soil particles after they have been dislodged. Consider implementing these BMPs during construction:

#### a. Plan grading to minimize runoff.

Schedule grading so that disturbed slopes are stabilized and replanted during the non-rainy season. Minimize and delineate the area to be disturbed.

#### b. Control sediment.

Trap sediment on site using a combination of effective erosion and sediment control measures. Place barriers around storm drain inlets to pond water and allow sediments to settle out.

#### c. Store materials properly.

Cover construction materials and stored topsoil exposed to rain; store wastes under cover and dispose of properly.

#### d. Keep concrete out of storm drains.

Install temporary concrete washout areas for use by contractors to prevent concrete waste from entering storm drains.

#### e. Train workers.

Educate on-site workers to follow good housekeeping practices and implement best management practices to prevent stormwater pollution.

#### f. Check and recheck.

Inspect and maintain control measures before and after each rain-storm and throughout construction.

### Low Impact Design

Local municipalities require projects creating or replacing a significant amount of impervious surface area to capture and treat 80 to 90% of runoff. Many builders install manufactured stormwater management products. In most cases, more environmentally friendly alternatives exist, including these low impact, landscape-integrated, distributed strategies:

## 2. Mulch All Planting Beds

### DESCRIPTION

Mulch is protective material placed over the soil, primarily to increase the soil's ability to absorb and retain moisture. Organic mulches such as chipped landscape debris also supply nutrients and provide wildlife habitat; they are preferable to inorganic mulches such as gravel.

### APPLICATION

Apply and maintain a minimum of 2 to 3 inches of natural mulch to all soil surfaces or at least until

plants grow to cover the soil. Do not place mulch directly against any plant stem or tree. Designate areas under trees and away from hardscapes or storm drains as repositories for fallen leaves to remain as mulch. Buy mulch produced from urban plant waste debris, or from local suppliers.

### BENEFIT

Mulch can conserve water, moderate soil temperature, reduce weed growth and simplify maintenance operations.

## 3. Construct Resource-Efficient Landscapes

### DESCRIPTION

Conventional residential landscapes are often designed without regard for climate and soil conditions. Typically, they require high inputs of water and chemicals and produce excessive plant debris from shearing and mowing activities. Invasive plants used in landscaping often escape into natural areas, where they can spread rapidly, crowd out native

a. Increase opportunities for stormwater to percolate into soil.

Minimize the total amount of impervious paved area used for roadways, driveways, walkways, and patios by avoiding large expanses of contiguous impermeable surfaces. If the project includes street design, use curb cuts to allow runoff from the street to enter the landscape area or have the driveway bridge a swale that runs parallel to the street. If applicable, include “Drains to Bay” or “Drains to Creek” signage at drains to discourage people from pouring chemicals into the drains.

b. Choose permeable hardscape surfaces.

For hardscape surfaces, use gravel, pervious concrete, pervious asphalt or other pervious materials, reinforced grass paving, or driveway tire strips rather than a solid concrete driveway so that stormwater can infiltrate into the ground, allowing for groundwater recharge. When choosing a permeable surface, consider Americans with Disabilities Act (ADA) requirements, as well as the anticipated vehicular load. Areas with very high traffic or very heavy loads may not be suitable for pervious paving.

c. Design areas to receive stormwater runoff.

Direct stormwater runoff from hardscapes toward adjacent landscaped areas that are graded to receive excess water; this will help recharge groundwater, filter pollutants, and water vegetation. Keep trees out of the stormwater flow line to prevent their roots from being inundated, and set buildings and hardscaped areas away from waterways.

d. Minimize pollutants on site.

Choose non-leaching roof materials (such as clay/slate tiles, untreated wood shakes, steel, concrete or fiber-cement) rather than leaching materials like copper or asphalt.

e. Direct roof runoff to the soil.

Route the downspout from the roof through permeable landscaping or swales. Instead of connecting the downspout to the storm drain with solid pipe, connect it to a perforated pipe to allow for infiltration into the ground. In urban areas, route the downspout through planters; be sure to include an overflow.

f. Capture rainwater.

Construct rainwater catchment systems such as rain gardens, ponds, cisterns and other rainwater

collection basins. A rain garden is a shallow, depressed garden with an overflow system like perforated pipe or a gravel bed. Production builders may consider creating a living pond, if appropriate, rather than a concrete pond. The pond’s natural chemical, physical and biological processes remove suspended solids, metals and dissolved nutrients.

g. Use biofilters to slow runoff and trap pollutants.

Create a biofilter, such as a vegetated swale, dry swale or filter strip, to slow the flow of stormwater into storm drains and allow pollutants to settle out to reduce sedimentation and other pollutants in the water. Before sizing bioretention and filtration systems, conduct a soil infiltration test. Well-draining, sandy loam soil is ideal. Consider hiring an expert, such as a landscape architect or civil or geotechnical engineer to help with system sizing and design.

h. Control irrigation.

Install irrigation controls with rain sensors to prevent unnecessary runoff from irrigation and erosion of soil.

plants, degrade wildlife habitat and increase the wildfire fuel load. Resource-efficient landscapes use plants and techniques that are better suited to local soils, wildlife, rainfall and climate.

#### APPLICATION

Select drought-tolerant plant species that are appropriate for the site’s soil and microclimates, such as California natives, and Mediterranean or other well-adapted species. Plant a variety of trees,

shrubs and other perennials, and limit annuals. Find out which invasive species are problematic locally; do not include them in the planting palette and eliminate any from the site before planting. See the California Invasive Plant Council website ([www.Cal-IPC.org](http://www.Cal-IPC.org)) for a list of invasive species in your area.

Give plants plenty of room to mature, reducing the need for pruning and shearing. Limit turf to the smallest area that will meet recreational

needs (see Minimize Turf Areas, below). Include a site for composting and mulching plant debris.

#### BENEFIT

A diverse landscape of native species supports beneficial birds, bees and other insects and may resist disease and other pests better than one with little variety. Choosing and placing plants appropriately will also reduce the amount of plant debris sent to landfills and water used for irrigation.

## 4. Minimize Turf Areas

### DESCRIPTION

Lawns (or turf) are useful for recreation and relaxation, but turf requires frequent cutting, watering and application of fertilizers or other chemicals to stay green during California's long dry season.

### APPLICATION

Replace decorative lawns with water-conserving California native groundcovers or perennial grasses, shrubs and trees. If lawns are desired, plant in small areas where they are most likely to be used for play and relaxation. Choose plant species that are native or regionally appropriate and have a water requirement less than or equal to tall fescue. Avoid planting turf on slopes greater than 10% or in irregularly shaped areas that cannot be irrigated efficiently. Avoid turf in isolated areas (driveway strips) or other areas less than 8 feet wide, unless irrigated with subsurface irrigation or micro spray heads.

### BENEFIT

Minimizing turf conserves water. If a 1,000-square-foot lawn needs 1 inch of water per week, reducing it to 500 square feet can save approximately 10,000 gallons of water per dry season. Minimizing turf reduces the need for mowing. Chemical use may also be decreased, thereby protecting the quality of local waterways and aquifers.

## 5. Plant Shade Trees

### DESCRIPTION

During summer months, direct sunlight heats up homes, which makes air conditioners work harder

and drives up peak electricity demand. Large shade trees keep direct sun off the roof, walls, and windows in the summer, thereby lowering cooling costs and increasing comfort while providing an attractive landscape.

### APPLICATION

Augment the existing tree cover on the site, particularly to the west of the building, by planting a variety of California native or Mediterranean tree species that are drought tolerant, appropriate for the site's soil and microclimates, have room to mature, and have limited shearing requirements. Plant trees to shade walls, windows and paved areas. If the building design includes passive solar heating, calculate the shading effects of trees on the home's south side; consider planting deciduous trees (see the Building Basics article, "Passive Solar Homes," in these Guidelines). If the building design includes photovoltaic or solar thermal systems, do not plant trees where they will shade panels now or in the future. Avoid planting trees close to utilities.

### BENEFIT

Shade trees can create a microclimate that is up to 15°F cooler than the surrounding area, and can reduce summer air-conditioning costs by 25 to 40%. Peak electricity demand is at its highest during late afternoons in the summer; shade trees play an important role in reducing this demand. Trees provide numerous additional benefits including absorbing carbon dioxide, retaining and treating stormwater, cleaning the air, creating habitat, providing play places

for children, making neighborhoods more beautiful and increasing property values.

## 6. Install High Efficiency Irrigation Systems

### DESCRIPTION

With increasing demand on supplies of fresh water, efficient landscape irrigation is vital in California. Efficient irrigation systems apply only the amount of water that the plants need, with little or no waste through runoff, overwatering or misting.

Drip and bubbler irrigation technologies apply water to the soil at the plant root zones at the rate the soil can absorb it, and are often more appropriate than overhead sprinklers in areas that are narrow, oddly shaped or densely planted such as parking lots and medians. Low-flow sprinkler heads apply water uniformly and slowly. Smart controllers regulate the irrigation schedule based on current weather data or sensors. A rain sensor overrides the system in the event of rainy weather.

### APPLICATION

Design the irrigation system to meet or exceed the requirements of your local water conservation ordinance. Install drip, subsurface drip or low-flow sprinklers in place of standard systems for all landscape applications.

A smart irrigation controller will provide even more water savings. Choose a smart irrigation controller that has at a minimum the following capabilities: 1) water budgeting feature, 2) automatic periodic adjustments to the irrigation program, accomplished through

external sensors or a provider-supplied weather data signal, 3) multiple start times, 4) run-times able to support low-volume applications, 5) irrigation intervals for days of the week or same-day intervals, and 6) more than one irrigation zone (for example, A=turf, B=shrubs, C=water features). If appropriate, turn off the irrigation system or valve for the landscape or hydrozone that includes only low water use California natives, once the plants are fully established.

#### BENEFIT

High efficiency irrigation systems minimize overspray and evaporation and reduce runoff, dramatically reducing landscape water use while preventing disease and minimizing weed growth that results from overwatering.

### 7. Add Compost to Promote Healthy Topsoil

#### DESCRIPTION

A robust, living soil with sufficient organic content is the foundation of a water-conserving, resource-efficient, thriving landscape. Adding good quality compost before planting brings life to the soil and feeds existing soil organisms, fueling many natural processes that supply nutrients, minimize disease and improve soil quality.

#### APPLICATION

Assess the soil quality on site. Have the soil professionally analyzed for texture, nutrient and organic matter content, and pH, especially if the topsoil was not protected during construction activities. If soil amendments are advised, ask the laboratory to recommend environmentally friendly amendments.

Incorporate 2 to 4 inches of compost into the top 6 to 12 inches of soil, or as much as is required to bring the soil's organic matter content to 3.5% for turf and 5% for planting beds, as appropriate for particular plant species. Use fully stabilized, certified compost as a soil amendment where appropriate (stabilized compost has been properly matured and can be safely handled, stored and applied to the soil). Loosen all planting and turf areas to a minimum depth of 6 inches prior to final landscape grading. Use compost to topdress turf and around established shrubs and trees.

#### BENEFIT

Compost can increase permeability, water retention and plant nutrient availability. This encourages healthy plant growth, improves the ability of the soil to filter pollutants, improves water quality, reduces irrigation needs and lowers water bills.

### 8. Install a Rainwater Harvesting System

#### DESCRIPTION

Rainwater harvesting systems collect and store stormwater from a building's roof and/or site to be used for landscape irrigation. If disinfected and filtered, it can also be used for toilet flushing.

#### APPLICATION

In a simple system, rainwater is collected from the roof downspout into a container such as a cistern or tank. The container has a hose bib at the bottom, which can be used for hand watering. More sophisticated systems have pumps and may be connected to the landscape irrigation system or treated

and filtered to be used to flush the building's toilets.

#### BENEFIT

Rainwater harvesting reduces the use of potable water and reduces demand on municipal water supply and treatment systems. It also decreases stormwater runoff.

### 9. Use Recycled Water for Irrigation

#### DESCRIPTION

Use recycled wastewater supplied by the local municipality for the home's landscape irrigation system.

#### APPLICATION

Install a purple pipe system that takes treated recycled wastewater from the municipality and uses it exclusively for the home's irrigation system. Check with your municipality; recycled water is not yet available in all communities.

#### BENEFIT

Using recycled wastewater for irrigation reduces potable water use.

### 10. Use Submeters for Irrigation

#### DESCRIPTION

An irrigation submeter is a separate water meter that calculates water flow from irrigation or other outdoor water uses, not indoor water use.

#### APPLICATION

Install an irrigation submeter combined with irrigation controllers to measure water use. An irrigation submeter can also help with leak detection and will help maintain a water budget (see measure C11). Check with local utilities for rebates for submetering.

## BENEFIT

Irrigation submeters encourage water conservation by allowing the homeowner to monitor how much water the irrigation system uses.

## 11. Design Landscape to Meet Water Budget

## DESCRIPTION

A water budget is an advanced approach to designing a water-efficient landscape. Water budgets take into account variables such as evapotranspiration rates, plant characteristics, irrigation efficiency, and site area. Starting in 2010, the State of California will require local jurisdictions to adopt water budget ordinances that will require new construction to comply with specific requirements for the installed landscape. The ordinance addresses performance standards and labeling requirements for landscape irrigation equipment to reduce inefficient or unnecessary water or energy use.

## APPLICATION

Design and build a landscape with an irrigation system that will be operated at a water budget of  $\leq 0.70$  Reference Evapotranspiration (ET<sub>0</sub>). Landscape professionals must use an approved methodology provided in the ordinance to estimate the amount of water that will be needed by a particular landscape design on a specific site; that design can then be compared to an allowable water use (or water budget). To ensure the water budget is met, incorporate hydrozoning, high efficiency irrigation, a native

plant palette and other best practices described in these Guidelines.

Information about the model ordinance can be found on the Department of Water Resources website, [www.owue.water.ca.gov/landscape/ord/updatedOrd.cfm/](http://www.owue.water.ca.gov/landscape/ord/updatedOrd.cfm/). For more specific technical resources, see the California Irrigation Management Information System website, [www.cimis.water.ca.gov/cimis/welcome.jsp](http://www.cimis.water.ca.gov/cimis/welcome.jsp).

## BENEFIT

Establishing a water budget and taking appropriate measures to meet the performance target will result in a landscape design that can significantly reduce irrigation water use.

## 12. Use Fire-Safe Landscaping Techniques

## DESCRIPTION

California's hot, dry climate makes fire protection an important consideration for landscape design, especially because new home developments are increasingly located adjacent to areas that may be prone to wildfires. Simple landscaping design practices can help defend the homes by reducing fuel accumulation and interrupting the fire path.

## APPLICATION

Check with your local jurisdiction to determine whether the site is in a high-risk area. Map the site, identifying exposure to prevailing winds during the dry season and steep slopes that can increase wind speed and convey heat. Identify

adjacent wildlands or open space, as well as south- and west-facing slopes and their vegetation, particularly species that burn readily.

For sites adjacent to fire sensitive open space or wildlands, create defensible space around buildings; this is an area where vegetation is modified to reduce fuel load and allow firefighters to operate. Use irrigated, low-growing, fire-resistant vegetation, patios, paving stones and other low-risk features in the zone immediately surrounding the structure. Specify plants with low fuel volume and/or high moisture content. Avoid plants with high oil content or that tend to accumulate an excessive amount of dead wood or debris.



Landscape before and after an upgrade that reduced lawn size, increased diversity, improved property values, cut water bills by 50% and reduced maintenance costs by 20%.





Do not plant trees and shrubs at distances where limbs and branches will reach the house or grow under overhangs as they mature. To minimize fire ladders, do not plant dense hedges or space tall vegetation too closely together. Use mulch (except fine shredded bark) and decomposed granite to control weeds and reduce fuel for fires. Construct roofs, siding and decks with fire-resistant materials. Consider alternatives to wood fences, such as rock walls.

#### BENEFIT

Fire-safe landscaping reduces risk of harm to residents and firefighters, and protects valuable personal and community assets.

### 13. Use Environmentally Preferable Materials for Non-Plant Landscape Elements and Fencing

#### DESCRIPTION

Fencing, hardscapes (such as planting beds, patios, walls, walkways and driveways), and other landscape elements (such as edging, benches and play equipment) present many opportunities to use durable products that reduce resource consumption, keep materials out of landfills, and provide a variety of other economic and environmental benefits.

#### APPLICATION

Use FSC-certified, reclaimed, rapidly renewable, finger jointed, recycled or locally manufactured

products for landscape elements and fencing. Consider recycled products such as plastic or composite lumber for fencing or landscape edging (see the Exterior Finish section for more information). If recycled plastic or composite lumber is not appropriate, use Forest Stewardship Council (FSC) certified sustainably harvested wood. Salvaged materials such as broken concrete can be used to make a retaining wall or path, and tumbled glass cullet can be used to create walkways. Specify materials that are extracted, processed and manufactured within 500 miles of the project site.

#### BENEFIT

Environmentally preferable materials provide many benefits. Recycled plastic and composite lumber products, for example, are generally much more durable than wood because they do not rot, crack, splinter or require ongoing wood treatments. For more information about environmentally preferable materials, see the Finishes section.

### 14. Reduce Light Pollution

#### DESCRIPTION

Light pollution occurs when outdoor light fixtures cast light onto neighboring properties and into the night sky.

#### APPLICATION

Avoid outdoor lighting where it is not needed. Rather than leaving outdoor lights on all night, use lighting controls such as motion

sensors, timers and photosensors so that lights are only on when and where needed. Exterior lighting that provides low contrast on critical areas, such as sidewalks and home entrances, is better for visual acuity than overlighting.

Eliminate unshielded exterior light fixtures that cast light skyward or onto neighboring properties, such as floodlights. Look for shielded fixtures certified by the International Dark-Sky Association for light pollution reduction ([www.darksky.org](http://www.darksky.org)).

#### BENEFIT

Reducing light pollution protects neighbors from glare and light trespass, preserves nocturnal habitats for animals, and saves energy.



Recycled concrete wall (urbanite).

# D. Structural Frame and Building Envelope

## 1. Apply Optimal Value Engineering

### DESCRIPTION

Optimal Value Engineering (OVE), also known as advanced framing, refers to techniques that reduce the amount of lumber used to build a home, while maintaining structural integrity and meeting the building code.

### APPLICATION

Implement any number of common OVE techniques including framing on 24-inch centers instead of 16-inch, using headers sized for the load, using only jack and cripple studs required for the load, building two-stud corners and using drywall clips.

### BENEFIT

Using OVE techniques saves wood and construction costs without a reduction in structural strength. Many OVE techniques also allow the wall to be better insulated, which improves energy efficiency and comfort.

## 2. Manage Construction Materials Efficiently

### DESCRIPTION

Order lumber precut from the supplier and/or have structural components assembled prior to delivery. Reduce waste generated from cutting and assembly during construction.

### APPLICATION

Material efficiencies can be achieved through precut and preassembled components. Framing materials including interior and exterior studs, headers, joists, beams, and posts/columns can be delivered to the jobsite precut or preassembled from the supplier.

Preassembled components include prefabricated roofs, floors, walls or other systems. It also includes prefabricated building units such as modular bathrooms, bedrooms, kitchens or other rooms.

### BENEFIT

Offsite cutting and assembly saves time and labor. This practice also reduces waste generated on site.

## 3. Use Engineered Lumber

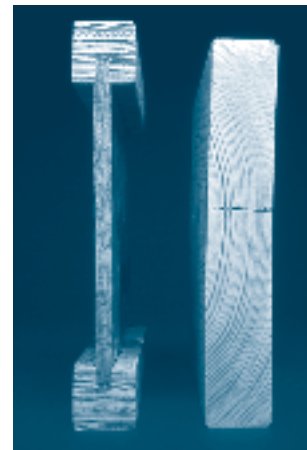
### DESCRIPTION

Solid-sawn lumber in sizes 2x10 and greater typically comes from old-growth forests or large diameter trees. Engineered lumber products, on the other hand, come from small diameter, fast-growing plantation trees. These products include glued laminated timber (glulam), laminated veneer lumber (LVL), laminated strand

lumber (LSL), parallel strand lumber (PSL), wood I-joists, wood floor trusses, finger-jointed studs and oriented strand board (OSB).

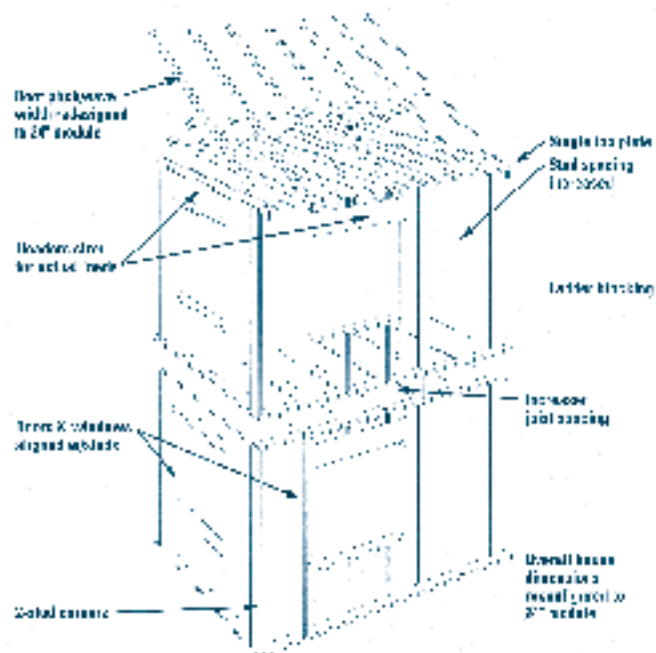
### APPLICATION

Use engineered lumber instead of solid-sawn lumber wherever



I-joists use 50% less wood fiber than solid-sawn lumber.

### Optimal Value Engineering Techniques



Adapted from Building Science Corporation.

applicable. Review structural building plans to make sure that engineered lumber is called out on the plans.

**a. Beams and Headers**

Engineered beams and headers can easily replace any solid-sawn member of similar size or larger.

**b. Wood I-Joists or Web Trusses for Floors and Ceilings**

The typical 2x10 and larger solid lumber used for floor joists can be replaced with engineered lumber in most applications. For floor joists use floor web trusses or I-joists instead of solid-sawn lumber. Web trusses are stronger and lighter than solid beams. I-joists have knock-outs or cavities for

easier installation of ducts, pipes and wires.

**c. Wood I-Joists for Roof Rafters**

Use I-joists instead of solid lumber for roof rafters.

**d. Engineered or Finger-Jointed Studs for Vertical Applications**

Use engineered or finger-jointed studs in place of conventional studs. Finger-jointed studs use

## BUILDING BASICS

### ENERGY CODE COMPLIANCE

The 2008 update to California's Building Energy Efficiency Standards (commonly known as Title 24) goes into effect in January 2010. Compared to the 2005 version, the updated Standards require homes to be approximately 15 to 20% more energy efficient, depending on the climate zone.

Below are some strategies for meeting and exceeding Title 24. Keep in mind that these strategies are interrelated, not independent. When designing and building a house, it's important to understand how the building as a whole will perform, not just its individual components.

Some of the strategies listed here require field verification and testing by a certified California Home Energy Rating System (HERS) rater in order to claim credit in the Title 24 modeling. Check with your local utility company for rebate and incentive information.

**a. Tighten the thermal boundary.**

Identify the home's thermal boundary and seal penetrations between the conditioned spaces and unconditioned and exterior spaces.

Complete this work prior to and/or during installation of the insulation. When tightening the home's thermal boundary, make sure that it is evaluated for adequate ventilation (see Building Basics article, "Mechanical Ventilation"). To receive a Title 24 credit, this strategy requires verification by a HERS rater.

**b. Improve insulation.**

Increased insulation in exterior walls and ceilings can reduce demand for air conditioning and heating and make homes more comfortable. However, insulation must be properly installed to minimize gaps and voids and achieve its stated value. Title 24 has a Quality Installation of Insulation (QII) credit that requires HERS verification; similar protocols are required by the U.S. EPA's Thermal Bypass Checklist. For more information, see measure J1 in these Guidelines.

**c. Install radiant barrier roof sheathing in warm inland climates.**

Radiant barrier roof sheathing has a reflective layer of film or foil applied to its underside. Use radiant barrier sheathing in place of, and install in the same manner as,

conventional roof sheathing. Radiant barrier sheathing can reduce attic temperatures by as much as 30°F on hot days.

**d. Install energy-efficient windows.**

When selecting windows, look for models that have a National Fenestration Rating Council–assigned U-value of 0.4 or less. The cost premium for low-e glass is minimal and typically pays for itself very quickly. There are two types of low-e glazing: heat rejecting (soft coat) and heat receiving (hard coat). The soft coat low-e is more commonly available, and it is effective as a cooling strategy. However, the hard coat low-e is recommended for south glazing in passive solar buildings. Wood, vinyl and fiberglass frames generally insulate much better than aluminum frames.

**e. Install high efficiency HVAC systems and equipment.**

Once the home's thermal envelope is improved to retain conditioned air, properly sized high efficiency equipment can reduce energy use and costs and greenhouse gas emissions. Consider installing the following (see Section H of these Guidelines for more information):

1. **Effective HVAC Ducting.** Studies show that typically installed heating, cooling and ventilation ducts leak as much as 30% of the conditioned air into unconditioned spaces such as attics and crawl spaces. Tight ducts are given credit in Title 24 with HERS verification. Tight ducts also improve indoor air quality.
2. **High Efficiency Furnace.** Furnaces with an AFUE of 90% or higher cost less to operate and reduce air emissions. Furnaces with variable speed fans also use less electricity.
3. **High Efficiency Air Conditioner.** Air conditioning is the greatest contributor to residential peak electricity loads in California. To

reduce peak demand, choose air conditioners with a SEER greater than 14 and a thermostatic expansion valve (TXV). A TXV is a refrigerant regulation device that helps ensure that the air conditioning system operates at maximum efficiency over a wide range of conditions, and can compensate for an incorrect refrigerant charge.

#### f. Install high efficiency water heating equipment.

A significant portion of a home's energy use goes toward heating water, particularly in climates without much need for space heating and cooling. Consider the following strategies to reduce water heating energy:

1. **High Efficiency Water Heater.** Water heaters with an Energy Factor (EF) greater than 0.62 heat water more efficiently and lose less energy through the flue.
2. **Tankless Water Heaters.** Gas-fired tankless water heaters may reduce water heating gas compared to a conventional gas water heater.
3. **Solar Thermal System.** Preheating domestic water with solar heated water provides considerable energy savings.
4. **Pipes and Controls.** Install additional pipe insulation, design for optimal pipe locations, and install recirculation controls. See Section G for more information.

short pieces of 2x4 or 2x6 material glued together to form standard stud lengths, while engineered lumber is typically veneers, strands or flakes of wood glued to form studs. These studs are all dimensionally straight and save on labor and material costs associated with culling crooked lumber and shimming and straightening crooked walls.

#### e. Oriented Strand Board for Subfloor

OSB is a type of engineered wood product manufactured from fast-growing plantation trees. OSB comes in sheets and is used as an alternative to plywood for subfloors.

#### f. Oriented Strand Board for Wall and Roof Sheathing

Use OSB as an alternative to plywood for wall and roof sheathing.

##### BENEFIT

Reducing demand for large dimensional lumber decreases pressure to harvest old-growth or large diameter trees. Most engineered wood products are straighter and stronger than solid-sawn equivalents, eliminating crooked walls.

## 4. Use Insulated Headers

##### DESCRIPTION

Insulated headers consist of insulation sandwiched between two wood panels or two dimensional wood components to create a larger structural member. This results in

a structurally sound header that provides a thermal break.

##### APPLICATION

Insulated headers are a strong, cost-effective alternative to solid headers and provide a much higher insulation value than solid wood headers, which improves the home's energy efficiency. Insulated headers are lighter, straighter and more stable than headers constructed with dimensional lumber, reducing the opportunity for shrinking and warping.

##### BENEFIT

Insulated headers are straighter, more stable and insulate better than solid wood headers.

## Construction Using SIPs



### 5. Use FSC-Certified Wood

#### DESCRIPTION

Forest Stewardship Council (FSC) certification assures that the forest from which the wood was harvested is managed in an environmentally, economically and socially responsible manner. FSC is the only lumber verification rating that maintains chain-of-custody certification throughout the cutting, milling and final delivery of products, thus ensuring that the end product originated from a certified sustainably managed forest.

#### APPLICATION

Use FSC-certified solid wood framing, engineered lumber, oriented strand board and plywood.

#### BENEFIT

FSC certification assures that forests are managed in a way that protects the long-term availability of wood resources, the health of forest ecosystems, and the sustainability of local economies.

### 6. Use Solid Wall Systems

#### DESCRIPTION

Solid wall systems are framing components that have the framing, insulation and sheathing in one convenient assembly. They include structural insulated panels (SIPs), insulated pre-cast concrete, insulated concrete forms (ICFs), autoclaved aerated concrete (AAC), and similar systems that are not constructed of wood studs.

SIPs consist of a layer of rigid foam insulation sandwiched between two sheets of composite wood such as oriented strand board. ICFs are interlocking rigid foam forms with a central cavity for poured concrete. AAC is a porous, cellular concrete that provides insulation as well as structural support, and usually comes in interlocking blocks.

#### APPLICATION

Each of these systems entails its own specialized installation

techniques. Always follow manufacturer specifications.

#### BENEFIT

These walls replace wood stud construction by including structure, sheathing and insulation in a single durable, energy-efficient system. Most solid wall systems improve home comfort and save significant amounts of wood.

### 7. Design Energy Heels on Roof Trusses

#### DESCRIPTION

At the intersection of perimeter walls and the roof framing, there is often increased heat loss, because conventional roof trusses do not allow for full insulation value at the exterior wall. An energy heel is a framing technique that raises the height of the truss at exterior wall top plates to accommodate the full depth of insulation at the home's perimeter.

#### APPLICATION

Install where conventional trusses are used. The increased height may require modifications to exterior soffit and trim details.

#### BENEFIT

Energy heels on trusses allow for full insulation around the perimeter, saving energy and reducing utility bills.

### 8. Install Overhangs and Gutters

#### DESCRIPTION

Overhangs increase a home's durability by protecting it from the

elements and limiting the amount of rain striking walls. Overhangs also shade windows. Gutters provide a pathway for water to run off the roof, reducing the likelihood that water will enter walls or splash back onto the foundation and siding.

#### APPLICATION

Design at least a 16-inch overhang with gutters around the entire roof. Consider adding deeper overhangs where needed to shade walls and windows to provide cooling during summer. Drain gutters at least 24 inches from the home into a rain-water cistern or toward adjacent landscaped areas that are graded to receive excess water so as to recharge groundwater, filter pollutants, and water vegetation.

#### BENEFIT

Overhangs and gutters protect siding, windows and doors from water intrusion, thereby reducing the likelihood of rot and mold issues. Overhangs also provide protection from the sun's harsh UV rays, which can degrade building materials and furnishings.

## 9. Reduce Pollution Entering the Home from the Garage

#### DESCRIPTION

According to the U.S. Environmental Protection Agency (EPA), an attached garage is the biggest contributor to poor indoor air quality in a home. Car exhaust contains many carcinogens that can migrate into living spaces through doors

and cracks in walls and ceilings adjacent to the garage. Other pollutants commonly found in garages include benzene from lawn mowers and power tools, pesticides for gardens, toxic cleaning agents, and chemicals in paints and adhesives.

#### APPLICATION

##### a. Install Separate Garage Exhaust Fan or Build a Detached Garage

Install an exhaust fan in the garage on the opposite wall from the door to the house. The fan can be triggered by an electric garage door and put on a timer to run after the door has been opened or closed.

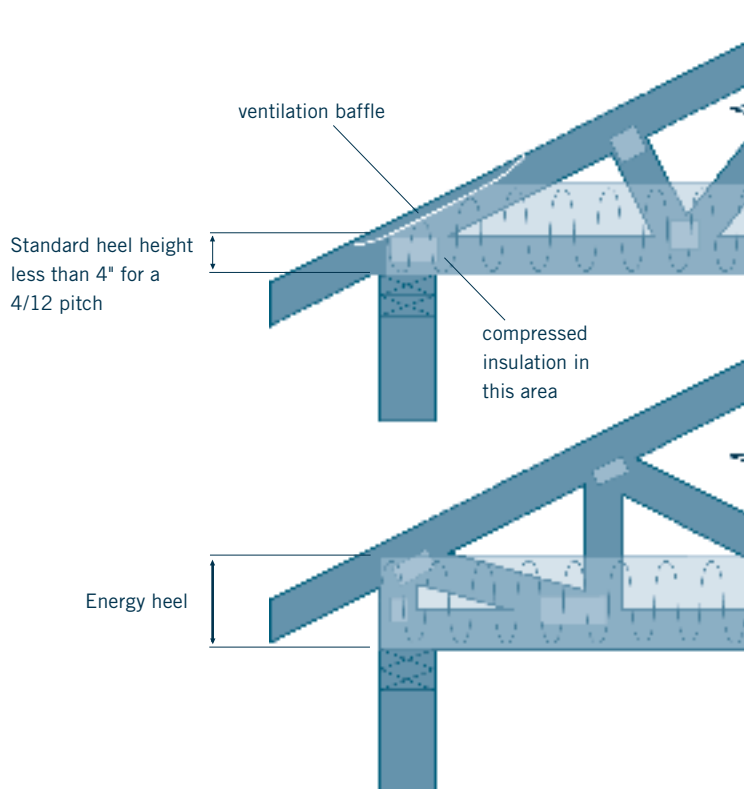
Detached garages provide the most effective means of keeping garage pollutants out of the home.

##### b. Tightly Seal the Air Barrier between Garage and Living Area

Use foams, weatherstripping and caulking to create an air barrier between the garage and living areas. Completely seal garage walls and ceilings adjacent to the interior. Doors should have full weatherstripping and sealed thresholds. Spray-applied foam insulation that creates a complete air barrier is recommended.

#### BENEFIT

Properly designed and isolated garages keep polluted air out of the home.



Energy heels on trusses allow more insulation.

# E. Exterior Finish

## 1. Use Environmentally Preferable Materials for Decking

### DESCRIPTION

Environmentally sound alternatives to conventional lumber can extend the life of decks and conserve natural resources.

### APPLICATION

Use environmentally preferable material for decking. Two commonly used materials are recycled-content and FSC-certified decking.

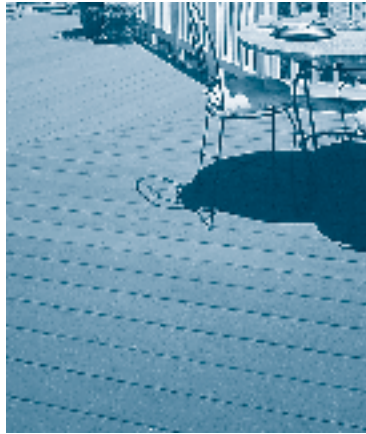
Use recycled-content decking in all nonstructural deck applications. Choose products that contain no virgin plastic. There are two types of recycled-content lumber: recycled plastic lumber, which contains only recycled plastic, and composite lumber, which combines recycled wood fiber and recycled plastic. Both can be used in place of redwood, cedar and pressure-treated lumber for the top planks and railing. These products accept screws and nails, and cut like wood. Follow the manufacturer's installation recommendations.

FSC-certified lumber comes from forests managed in an environmentally and socially responsible manner. Use FSC-certified lumber for all exterior decking applications or as structural deck members in conjunction with recycled-content decking. Choose a species of FSC-certified wood that is appropriate for exterior decking.

### BENEFIT

Recycled-content plastic and composite decking materials are

Recycled-Content Decking



more durable than wood because they do not rot, crack, splinter, or require staining; also, they are not treated with toxic chemicals. Using recycled-content decking also reduces pressure to harvest forests. FSC certification guarantees that forests are managed in a way that will assure long-term availability of wood resources and forest health.

## 2. Specify Flashing Installation Techniques and Verify Installation

### DESCRIPTION

Flashing is a thin layer of impervious material installed underneath exterior siding and roofing materials to prevent moisture from traveling through building joints. Have a third party inspect installed flashing for quality control and to ensure proper installation.

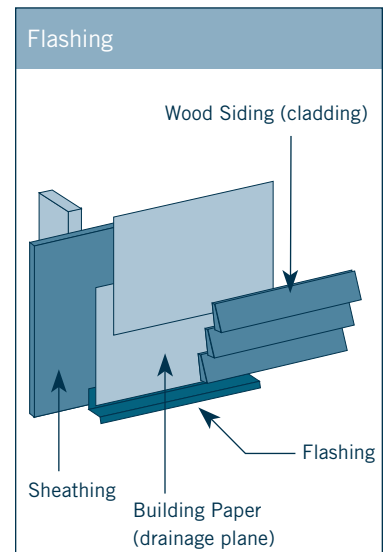
### APPLICATION

Specify flashing details on the building plans for all significant exterior building material junctures,

including siding, roofing, windows, doors, valleys, decks, balconies, ledgers, chimneys, and utility penetrations. Have a third party verify proper installation. A third-party inspector is an individual endorsed as a third-party inspector or risk management consultant by the residential underwriting community.

### BENEFIT

Using best practices for installing flashing protects against building failures due to leaks at the roof, siding, windows, doors and other intersections and penetrations. Third-party inspection of flashing details ensures proper installation methods.



### 3. Install a Rain Screen Wall System

#### DESCRIPTION

A rain screen wall system or ventilated drainage plane is an effective solution to external moisture penetration. It allows for an air space between the siding and wall structure, protecting the home from damaging rain intrusion.

#### APPLICATION

Install siding with a  $\frac{3}{8}$ -in. minimum air space between the siding and the wall sheathing and vapor barrier. Flash all wall openings correctly (see measure E2) and create vent strips at the top and bottom of the wall.

#### BENEFIT

These techniques will provide significant protection from moisture intrusion and associated problems with rot in the wall structure. They

also reduce the potential for indoor air quality problems associated with window and siding leaks, and increase the life of siding materials.

### 4. Use Durable and Noncombustible Siding Materials

#### DESCRIPTION

Sidings made of metal, stone, brick, stucco and fiber-cement offer a durable and non-combustible home exterior.

#### APPLICATION

Use in place of conventional wood siding.

#### BENEFIT

Using these siding materials can reduce repainting and other maintenance needs, protect the home from fire, and possibly lower the homeowner's insurance rates, especially in fire-prone areas.

### 5. Use Durable and Fire-Resistant Roofing Materials

#### DESCRIPTION

Forty- to fifty-year asphalt shingles, tile, slate, fiber-cement, recycled plastic and metal are examples of durable roofing materials. A Class A fire rating offers a home the highest fire protection.

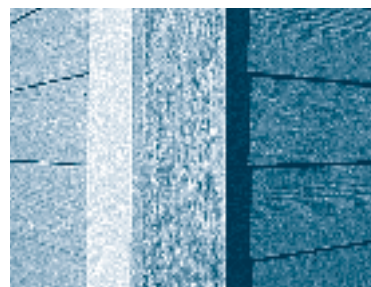
#### APPLICATION

Applicable anytime roofing materials are specified. The Class A fire rating can be achieved through the roofing material itself or through the roof assembly as a whole.

#### BENEFIT

Short-lived roofing materials result in more waste going to landfills and more money spent on roof replacement. In extreme cases, early failure of a roofing material can result in water damage.

Fiber-Cement Siding





# F. Insulation

## 1. Install Insulation with 75% Recycled Content

### DESCRIPTION

Fiberglass insulation typically contains 25 to 30% recycled glass, with a combination of post-industrial and post-consumer content. Insulation made from materials such as recycled cotton or newspaper contain up to 80% post-consumer recycled materials.

### APPLICATION

Choose products with high recycled content, preferably

Damp-Blown Spray Cellulose Wall Insulation



post-consumer recycled content. Post-consumer waste is recovered after a product's useful life has ended and the product is ready to be discarded.

### BENEFIT

Buying products with high post-consumer recycled content reduces reliance on virgin raw materials, closes the loop in the curbside recycling process, and reduces landfill deposits.

Recycled-Content Batt Insulation



## 2. Install Low-Emitting Insulation

### DESCRIPTION

Many insulation products emit formaldehyde and other volatile organic compounds (VOCs). Look for products that have been tested for low emissions by a reputable third-party organization or government agency.

### APPLICATION

Select a product that has been tested for low emissions according to the California "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers." For information about this standard, go to [www.ciwmb.ca.gov/GreenBuilding/Specs/Section01350](http://www.ciwmb.ca.gov/GreenBuilding/Specs/Section01350).

### BENEFIT

Minimizing formaldehyde and VOCs in the home improves indoor air quality.

# G. Plumbing

## 1. Distribute Domestic Hot Water Efficiently

### DESCRIPTION

Much of the energy used to heat water for domestic purposes is lost in long pipe runs from the water heater to fixtures. Locating the water heater close to usage points reduces heat loss, reduces waiting time for hot water, and most importantly, reduces water wasted down the drain while waiting for hot water to arrive at a plumbing fixture. Larger houses may require hot water circulation systems to reduce waiting time; an on-demand circulation pump is a better choice than energy-wasting continuous or timed pumps.

### APPLICATION

#### a. Insulate All Hot Water Pipes

Reduce heat loss, send less water down the drain, and improve service by insulating all hot water pipes in the home.

#### b. Use Engineered Parallel Piping

Often termed home run, manifold, or parallel piping, this alternative to typical branched piping can save water and water-heating energy, if the system is well designed. Small diameter flexible pipes are run directly to the fixtures from a manifold (with branched outlets) located near the water heater. This decreases the volume of water in individual pipes and reduces friction losses and possible leaks at elbows and other fittings.

Parallel piping typically uses cross-linked polyethylene (PEX) pipe, although soft copper or CPVC could be used as well. Use PEX only where codes permit it. With low-flow fixtures,  $\frac{3}{8}$ -in. diameter piping should be adequate for sinks;  $\frac{1}{2}$ -in. piping should be used for other fixtures. Prepare an engineered piping plan to show the location and diameter of hot water pipes. This

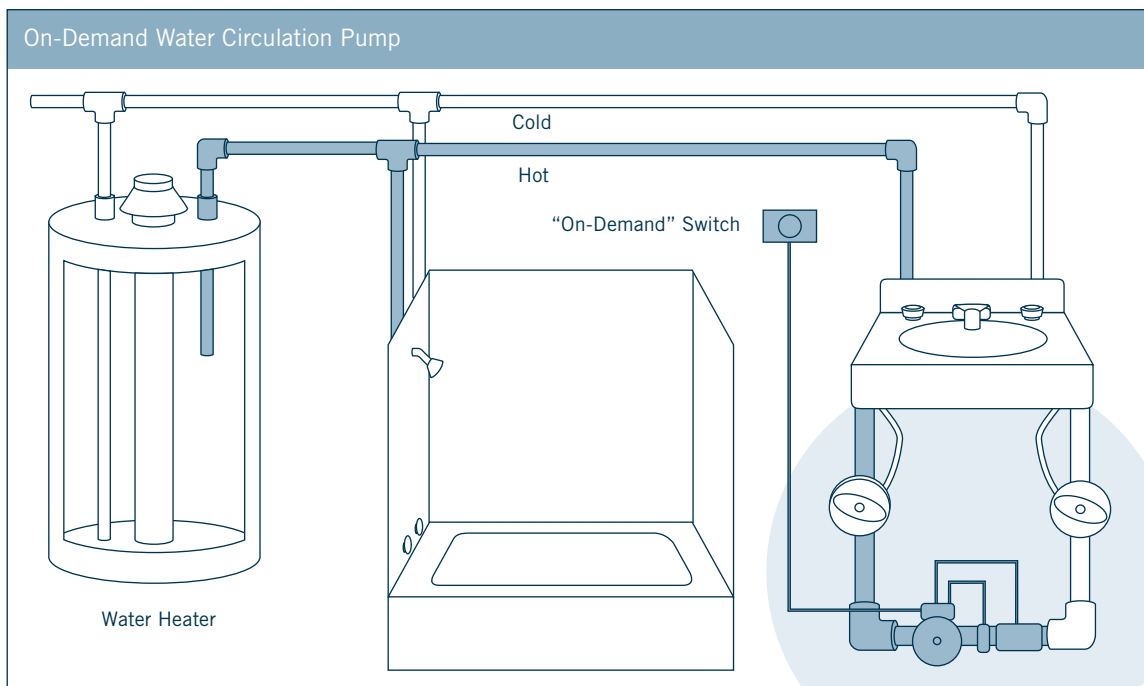
ensures that pipe efficiency is actually gained, that lengths are kept to a minimum, and that sufficient flow will be provided.

#### c. Use Engineered Parallel Piping with Demand-Controlled Circulation Loops

A parallel piping system can still waste water while waiting for hot water to arrive at the fixture. Each time hot water is pulled from a fixture, the plumbing system must discharge the water in the small pipe between the fixture and the manifold as well as the water in the large diameter pipe that connects the manifold to the water heater. To reduce the water loss in the large pipe, install a circulation loop between the water heater and the manifold that is run by an on-demand pump.

#### d. Use Structured Plumbing with Demand-Controlled Circulation Loops

In larger homes with traditional branched piping systems, another way to greatly shorten hot water



delivery times is to install an on-demand hot water circulation system. These systems consist of a pump with on-demand controls (push button or motion-sensor activated) that circulate water from the existing hot water line through the cold line or via a dedicated return loop to the water heater. Only one pump is needed to supply hot water to all fixtures in the same circulation loop. On-demand hot water circulation works for all systems: tank or tankless water heaters, and copper, CPVC or PEX pipe.

The term “structured plumbing,” like the term “engineered” (as used with parallel pipe systems), means that the pipe system is thoughtfully designed from the outset to optimize the circulation system’s service capability.

#### e. Use Central Core Plumbing

The most effective means of reducing energy and water loss, as well as material use, is to locate the water heater very close to (within 15 feet in plan view) all hot water fixtures, including bathrooms, the kitchen and laundry. This can be accomplished by stacking or clustering rooms with water supplies, and creating a central core mechanical space that could house the water heater, furnace and air conditioner.

#### BENEFIT

Efficient design and distribution of domestic hot water saves energy, conserves water, uses less piping, and speeds hot water delivery.

## 2. Install Water-Efficient Faucets and Showerheads

#### DESCRIPTION

Conserve water and water-heating energy by installing low-water use faucets and showerheads. Faucet aerators and laminar flow devices conserve water by restricting the water flow at the faucet outlet. Aerators add air to the water stream to make the flow feel stronger. Laminar flow controls combine many parallel streams of water to produce a clear, solid-looking stream of water. Both give the feeling that water is flowing at a higher rate than it actually is.

#### APPLICATION

Install no more than one showerhead per shower. Choose showerheads that use less than 2 gallons per minute (gpm), bathroom faucets that use less than 1.5 gpm, and kitchen and utility faucets that use less than 2 gpm.

Water-efficient fixtures certified by WaterSense, a partnership program sponsored by the U.S. EPA, are recommended ([www.epa.gov/watersense](http://www.epa.gov/watersense)).

#### BENEFIT

Water-efficient fixtures lower water and water-heating energy use. They also reduce demand on the municipal water infrastructure.

## 3. Install Only High Efficiency Toilets

#### DESCRIPTION

Older toilets typically use 3.5 gallons of water per flush or more. Standard new toilets use 1.6 gallons per flush (gpf). Toilets that use less than 1.3 gpf are called high-efficiency toilets (HETs). HETs are available in dual-flush, pressure-assist and conventional gravity-flush models.

#### APPLICATION

In the past, some models of ultra low-flow toilets performed poorly, but thanks to design improvements the majority of today’s HET toilets perform well. Install HETs that meet or exceed the performance requirements of the Maximum Performance (MaP) testing report or Uniform North American Requirements (UNAR). Download a listing of HETs, MaP reports and UNAR qualifying toilets from the California Urban Water Conservation Council ([www.cuwcc.org](http://www.cuwcc.org)).

Toilets certified by WaterSense, a partnership program sponsored by the U.S. EPA, are recommended ([www.epa.gov/watersense](http://www.epa.gov/watersense)).

#### BENEFIT

HETs perform well and allow residents to reduce their water and sewer costs. Water providers benefit from reduced demand on their water supplies and less wastewater to treat. Check with the local water utility for possible rebates.

# H. Heating, Ventilation & Air Conditioning

## 1. Properly Design the HVAC System and Perform Diagnostic Tests

### DESCRIPTION

Proper design and third-party verification of the heating, ventilation and air conditioning (HVAC) system help ensure that the system performs efficiently and keeps the occupants comfortable. The Air Conditioning Contractors of America (ACCA) has developed a set of calculation manuals—Manuals J, D and S—to determine the appropriate size and design of a home's HVAC system. Diagnostic testing of the air delivery rates completed by a third party can uncover problems and verify proper installation of systems.

### APPLICATION

#### a. Design System

Design and install the HVAC system according to results from Manual J (the home's heat load calculation), Manual D (ductwork design and sizing) and Manual S (equipment selection and sizing).

#### b. Test Air Delivery

A Manual J (room-by-room) heating and cooling load analysis determines the air flow and temperature needed for comfort in each room. A flow hood diagnostic reading at each register will reveal whether the installed system meets the design goals.

Have an experienced home performance professional test each register and match the results to the design calculations. Take corrective action to repair problems and achieve the performance targets.

Also have a home performance professional test the mechanical ventilation rates to ensure they

meet ASHRAE Standard 62.2, a national standard for residential indoor air quality (see the Building Basics article, "Mechanical Ventilation," in these Guidelines). Ventilation flow rates are much lower than heating/cooling flow rates. Ventilation rates are based on the number of bedrooms and the conditioned floor area of the home. Ducts should be tested to ensure that leakage is under 6%.

### BENEFIT

Correctly designing and installing the HVAC system helps ensure energy savings and comfort.

## 2. Install Sealed-Combustion Equipment

### DESCRIPTION

Conventional gas-burning furnaces and water heaters typically use indoor air for combustion. Sealed-combustion systems with direct venting, on the other hand, draw combustion air from the outdoors and pipe the exhaust directly to the outside. This reduces the risk of backdrafting, which is harmful to occupants.

### APPLICATION

Install sealed-combustion units in place of conventional atmospherically vented furnaces or water heaters.

Radiant Floor Heating



### BENEFIT

Sealed-combustion furnaces and water heaters improve indoor air quality and reduce the danger of carbon monoxide contamination. Another benefit is that codes allow sealed combustion furnaces and water heaters to be installed in conditioned indoor spaces, thus reducing heat loss to outdoors.

## 3. Install High Performance, Zoned Hydronic Radiant Heating

### DESCRIPTION

Hydronic radiant heating systems heat homes by circulating hot water through underfloor tubing, wall radiators, or baseboard convectors. The hot water source can be a boiler or conventional water heater and can include a solar thermal system.

### APPLICATION

Hydronic radiant heating is most appropriate in cold climates or in homes where air conditioning is not needed. Hydronic heating can also be used as an efficient solution in combination with a forced air distribution system, which might be more cost effective when a home will also have a cooling system.

Design the system in accordance with Radiant Panel Association guidelines and use an RPA-certified installer ([www.radiantpanelassociation.org](http://www.radiantpanelassociation.org)).

Hydronic radiant systems should be divided into zones; a good rule of thumb is one zone per 500 square feet. In order to efficiently deliver heat where it is needed, choose either variable speed pumping or zoned valving. For an efficient system, pair a radiant hydronic system with a condensing

water heater or boiler rather than an instantaneous (tankless) water heater. For greater efficiency, use outdoor reset thermostats that regulate the water heating system based on outdoor conditions.

California's Building Energy Efficiency Standards (Title 24) require slab insulation for heated slabs. If radiant hydronic heating is being

used on above-ground floors, those floors should be insulated as well. For in-floor systems, it is most efficient to install radiant tubing on top of the subfloor; for joisted floors where a "staple-up" system is being used, use a heat-emitter plate to keep water temperature at or below 140°F.

Most flooring types work with hydronic radiant heating. Avoid high pile carpeting and use sponge rubber rather than dense materials for carpet padding, to allow heat transfer. Hardwood flooring will not be damaged by well-designed hydronic radiant heating, but avoid wide-plank, softwood floors.

## BUILDING BASICS

### MECHANICAL VENTILATION

The 2008 update to California's Building Energy Efficiency Standards (Title 24) requires new homes to have a whole house mechanical ventilation system that meets ASHRAE Standard 62.2. Prior to this update, Title 24 required mechanical ventilation only for unusually tight homes.

In a well-built house, unwanted air infiltration is minimized by pairing a tight building envelope with mechanical ventilation. Mechanical ventilation systems improve indoor air quality by using a fan to exchange indoor air for outdoor air.

An effective mechanical ventilation system:

- Removes air from rooms where moisture and odors are generated
- Delivers fresh outdoor air to frequently occupied rooms
- Runs quietly (1 sone or less) so the residents are less likely to disengage it
- Has the capacity to run continuously to maintain sufficient ventilation rates
- Has programmable controls
- Filters incoming air

- Provides tempered outdoor air
- Is easy to operate
- Is selected to address the site's climatic issues, such as high humidity or very cold winters

ASHRAE Standard 62.2 bases ventilation rates on the number of bedrooms and the conditioned floor area of the home. Single port ventilation systems, which consist of a single fan installed in one location, generally do not effectively achieve whole house ventilation. Multiport systems have multiple distribution points throughout the house, including in common areas and rooms with doors.

Ventilation systems include exhaust, supply, and balanced systems.

**Exhaust ventilation systems** rely on a fan to pull air out of the home. They are most effective for small tightly built homes with open floor plans. Exhaust systems, which can be either single port or multiport, do not filter incoming air and may draw air from unconditioned spaces like the attic or crawl space. Exhaust systems can depressurize a home.

**Supply ventilation systems** provide filtered outdoor air to the home through the HVAC system

or an independent distribution system. The incoming air can be tempered or filtered prior to distribution. Because ventilation air flow rates are much lower than heating/cooling air flow rates (100 cfm for ventilation versus 1200 cfm for heating/cooling), the system must be designed to allow for ventilation at the appropriate rate when heating or cooling is not needed. A supply system will slightly pressurize a home and can minimize the potential for backdrafting of gas appliances.

**Balanced ventilation systems** use fans to exhaust and supply similar volumes of air. This balances the pressure of the home so that it is neither pressurized nor depressurized. To save energy, balanced ventilation systems can be equipped with heat recovery ventilation (HRV), which removes heat from exhausted air and transfers to it the incoming air. Energy recovery ventilation systems (ERV) exchange moisture as well as heat. HRVs and ERVs are most cost effective in climates with high heating or high cooling loads, and may not be economically justifiable in most California climate zones.

## BENEFIT

Many people find radiant heating to be more comfortable than forced air heating. Radiant heating can provide even heat throughout a room, reduce drafts and eliminate duct leakage. Hydronic radiant heating systems can save energy when supplied by a high efficiency water heating source, such as a condensing boiler or solar water preheat system. They also eliminate fan energy use associated with forced air systems. Hydronic radiant heating systems are easily zoned, which allows residents to turn off the heat in areas of the home that aren't being used.

#### 4. Install High Efficiency Air Conditioning with Environmentally Responsible Refrigerants

## DESCRIPTION

Energy-efficient air conditioning equipment saves homeowners money and reduces demand for electricity from power plants. Environmentally sound refrigerants reduce the risk of damage to the ozone layer.

Air conditioners are rated according to Seasonal Energy Efficiency Ratio (SEER) and Energy Efficiency Ratio (EER). Higher SEER and EER ratings mean greater energy efficiency.

## APPLICATION

Choose an air conditioner with a SEER of 14 or higher or an EER of 11 or higher. While these units usually cost more to buy, they are a good investment because they

reduce electricity costs. Many utilities offer rebates for higher efficiency units.

Air conditioners should have a thermostatic expansion valve (TXV), which is a refrigerant regulation device that helps ensure the system operates at maximum efficiency over a wide range of conditions. Some air conditioning equipment comes with a factory installed TXV and others accept a TXV that can be installed by an HVAC contractor.

Another good strategy for energy efficiency is a zoned central air conditioning system, which allows the residents to only cool the spaces they are using and set different temperatures for those spaces.

Install AC units that don't use hydrochlorofluorocarbon (HCFC) refrigerants. HCFCs can destroy the ozone layer if the refrigerant leaks out of the air conditioner. R-22 (HCFC-22) is an HCFC refrigerant commonly used in many residential cooling systems. The Federal Clean Air Act requires that HVAC manufacturers discontinue using R-22 in new air conditioners by 2010.

Alternatives to R-22 refrigerant include R-410a, R-134a, or R-407C. Some common trade names for these refrigerants are Puron, Suva 410A, Genetron AZ-20, and Duracool.

Make sure that refrigerants are handled properly and the AC unit is properly charged. Always select a reputable dealer that employs

service technicians who have been EPA certified to handle refrigerants.

## BENEFIT

Air conditioning systems with high SEER/EER ratings, zoned controls, and a TXV save energy and reduce peak electricity demand. If the refrigerant leaks during replacement, a non-HCFC refrigerant will not damage the ozone layer.

#### 5. Design and Install Effective Ductwork

## DESCRIPTION

Poorly designed and installed ductwork lowers heating and cooling system efficiency and capacity, and can contribute to poor indoor air quality and comfort problems.

## APPLICATION

##### a. Install HVAC Unit and Ductwork within Conditioned Space

Install the HVAC unit and all heating and cooling ductwork inside the home's thermal envelope. The unit and duct runs may be installed in closets, chases, and soffits purposefully designed to accommodate them, or they may be installed in an unvented attic that is insulated at the roof deck.

##### b. Use Duct Mastic on All Duct Joints and Seams

Leaks in the joints between ducts have been shown to allow, on average, 20 to 30% of conditioned air to leak out. Leaky air ducts can cause pressure imbalances in a home. Negative pressure in the house may draw outdoor and indoor contaminants into the home,

including carbon monoxide from gas water heaters and furnaces. Duct tape is not code approved to seal ducts; it loses its effectiveness in a few years. To maintain a tight seal for decades, use a water-based mastic at every duct joint and seam or have professionally installed aerosol sealant sprayed into the ducts.

#### c. Pressure Relieve the Ductwork System

When a bedroom door is closed, it reduces or cuts off the return airflow path. This restricts air movement, leading to comfort problems and a pressure imbalance, with the bedroom pressurized and the rest of the house depressurized. This may cause infiltration of contaminated air from the attic or crawl space, or backdrafting of combustion appliances. Install an additional return duct in the master bedroom and other large rooms that can be closed off with a door. Or install a jump duct or transfer grille between the hall or main living area and these rooms with doors. Provide an offset in the transfer duct to minimize sound transmission.

#### BENEFIT

Properly designing and installing ductwork is one of the most cost effective means to improving HVAC system performance. It reduces energy loss, minimizes indoor air quality problems and improves comfort.

## 6. Install High Efficiency HVAC Filters

#### DESCRIPTION

HVAC filters remove particulates from the air. An air filter's efficiency is rated with a Minimum Efficiency Reporting Value (MERV), a scale ranging from 1 to 20. The higher the MERV number, the more efficient the filter is at removing particles.

#### APPLICATION

Use HVAC air filters rated at MERV 6 to 10. These filters are recommended for cleaner air without compromising the performance of standard mechanical systems. Because filter media can restrict air flow, choose a filter designed for the HVAC system installed in the home. For example, only use a filter with a MERV greater than 10 if the HVAC system is specifically designed for it.

#### BENEFIT

The U.S. EPA has identified microparticulates as a leading cause of respiratory discomfort. By reducing these particles in the indoor air, a high efficiency filter protects the HVAC equipment and ensures healthier air is delivered to the living space.

## 7. Don't Install Fireplaces or Install Efficient Gas Fireplaces

#### DESCRIPTION

Gas fireplaces are installed in a large percentage of new homes mostly for decorative use. Many have efficiencies as low as 13%, yet homeowners depend on them

to meet some percentage of the heating load. Though there are no U.S. or state standards regulating their efficiency, efficiency listings are required in Canada and are available for many models sold in the United States.

#### APPLICATION

Natural gas and propane fireplaces shall be sealed combustion (not using any indoor air for combustion) and have a permanently fixed glass front. Do not install gas fireplaces unless their listed efficiency (from Natural Resources Canada) exceeds 60%.

Note that some jurisdictions restrict the use of wood burning fireplaces or wood stoves.

#### BENEFIT

Efficient gas fireplaces consume less gas and reduce heating costs compared to less efficient models.

## 8. Install Energy Star Bathroom Fans Vented Outdoors, on Timer or Humidistat

#### DESCRIPTION

Excessive moisture resulting from poor ventilation is one of the main causes of mold issues and building failures. Bathrooms produce odors and a lot of moisture that can cause problems if the rooms are not properly ventilated. A fan vented to the outside and set to operate regularly will help regulate the home's indoor air quality.

#### APPLICATION

Choose Energy Star-qualified bathroom fans; quieter fans will have a rating of 1.5 sones or less.

Exhaust all bathroom ventilation fans to the outdoors. Bathroom fans should be controlled by a timer or humidistat to ensure proper run-time to adequately remove moisture from the room. Timers are triggered when the lights are turned on, and then run for a set time; 15 to 30 minutes usually works well. Humidistat controllers are even better, as they automatically switch on when moisture in the air reaches a threshold level, and shut down when the moisture level subsides. If the bathroom fans serve as the home's mechanical ventilation system, be sure that they meet ASHRAE Standard 62.2 requirements (for more information see the Building Basics article, "Mechanical Ventilation," in these Guidelines).

#### BENEFIT

Energy Star-qualified bathroom ventilation fans have durable, high performance motors. On average, they use 65% less energy than non-Energy Star models. Bathroom

fans controlled by timers or humidistats will ensure proper use and reduce moisture problems.

## 9. Install Mechanical Ventilation System for Cooling

#### DESCRIPTION

Ceiling fans improve a home's comfort by circulating air. Energy Star-qualified models are energy efficient due to improved motors and blade designs and fluorescent lights. They can be operated to either draw warm air upward in the summer or push it downward in the winter.

Whole house fans are used as an alternative to an air conditioner to cool a house at night. They exhaust warm indoor air and bring in large volumes of cool outdoor air. However, they require open windows to admit air, and they do not filter the air.

Another option is an integrated ventilation cooling system combined with heating and cooling equipment. These are

automatically controlled, do not require open windows, and deliver filtered outdoor air.

#### APPLICATION

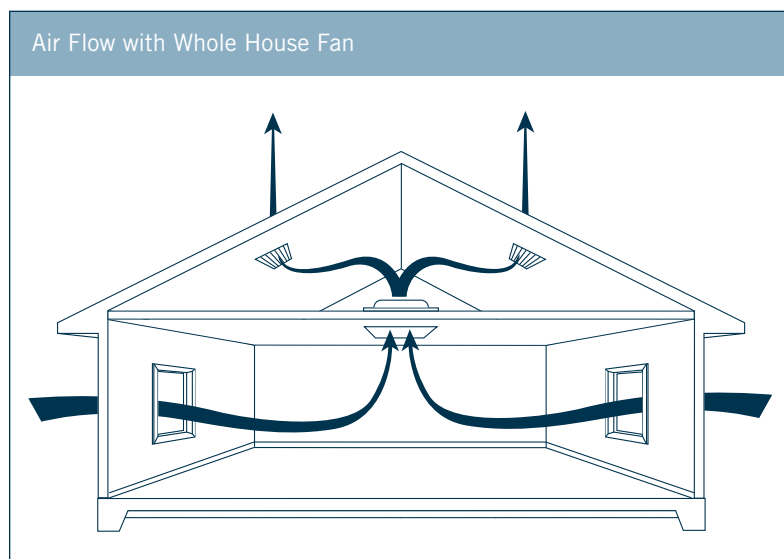
Install Energy Star ceiling fans in areas where occupants tend to spend more time, such as bedrooms and family rooms. For fans with built-in lights, select models with Energy Star-qualified compact fluorescent light fixtures. If the fan does not include lighting, purchase an Energy Star-qualified light kit.

A whole house fan is appropriate for single-story and multi-story homes. To be effective, in a multistory home it must be mounted in a hallway on the top floor. An insulated, airtight cover is necessary to prevent air leakage when the fan is not operating. Fans should be sized to produce between four to five air changes per hour and should have at least two speeds: low speed for continuous ventilation and high speed for higher cooling needs. When the fan is running, you must keep a few downstairs windows open to allow outdoor air in and to avoid backdrafting from gas appliances.

Ventilation cooling systems should be sized for four to six air changes per hour, and should have at least two speeds. Integrated ventilation cooling systems that combine with variable speed furnaces or air handlers use less fan energy and offset more air conditioning energy.

#### BENEFIT

Energy Star-qualified ceiling fans can make residents feel more comfortable while cutting back on their use of heating and air condi-





tioning systems and providing greater energy savings.

An average whole house fan uses one-tenth the electricity of an air conditioner. Moving large volumes of air can achieve indoor comfort at higher temperatures without air conditioning.

An integrated system can filter and condition air delivered throughout the home.

## 10. Install Advanced Mechanical Ventilation for Indoor Air Quality

### DESCRIPTION

Mechanical ventilation improves indoor air quality by providing a controlled exchange of indoor air for less polluted outdoor air. A highly effective mechanical ventilation system should be designed to remove indoor air from rooms with moisture and odor considerations and supply outdoor air to all high use rooms.

### APPLICATION

California's 2008 Building Energy Efficiency Standards (Title 24) require mechanical ventilation to meet ventilation rates based on the number of bedrooms and the conditioned floor area, as established by ASHRAE Standard 62.2. In addition to meeting these requirements, there are some best practices that will help ensure an effective system.

A good system should be continuous, quiet, and automatic to ensure it will be used. A system

with a maximum of 1 sone is quiet enough that the residents will be unlikely to disengage it. Provide the homeowner with an operations and maintenance manual that clearly explains the benefits of the ventilation system and how to maintain the system for good indoor air quality.

Mechanical ventilation can be provided using an exhaust, supply or balanced system (see the Building Basics article, "Mechanical Ventilation," in these Guidelines). Not all ventilation systems are whole house systems. A balanced whole house distribution system delivers fresh air to high occupancy areas like bedrooms and living rooms rather than exhausting or supplying air from one point. A balanced whole house system also yields a higher rate of air exchange.

Distribution systems with a fan rated to operate at a continuous or intermittent low rate are more efficient and effective at delivering the appropriate amount of ventilation air than systems that operate at a higher rate but less frequently.

Building ventilation should be addressed in conjunction with building tightness to reduce unwanted infiltration of outside air, improve building performance and increase comfort. Ventilation rates should be tested to verify performance (see measure H1).

### BENEFIT

Mechanical ventilation systems reduce moisture and dilute indoor

air pollution by providing fresh outdoor air. Balanced systems introduce fresh air into the home while reducing energy loss by capturing heat from the exhausted air stream and transferring it to the incoming air.

## 11. Install Carbon Monoxide Alarm

### DESCRIPTION

Carbon monoxide (CO) is emitted from fuel-burning appliances such as stoves, cooktops, water heaters, furnaces and fireplaces, as well as from cars and some landscape equipment. If a home is tightly built for energy efficiency but has leaky HVAC ducts, the air leaks may depressurize the home and reverse the flow of exhaust from vent pipes. This can introduce carbon monoxide from fuel-burning appliances back into the home, a process known as backdrafting. Also, fuel-burning appliances that are burning inefficiently can contribute carbon monoxide to the living space.

### APPLICATION

Install a carbon monoxide alarm per manufacturer's instructions. Alarms must comply with UL 2034 and/or CSA 6.19 standards. Alarms must be replaced every three to five years, as they lose their sensitivity over time.

### BENEFIT

A carbon monoxide alarm provides an added level of home safety.

# I. Renewable Energy

## 1. Pre-Plumb for Future Solar Water Heating Installation

### DESCRIPTION

Preparing for the installation of solar water heating (also known as solar thermal systems) will reduce the cost of future installation and adds little cost at the time of construction.

### APPLICATION

Installing insulated pipes and sensor wiring between the attic and the water heater location will facilitate future installation of a solar water heating system. To accommodate “active” systems, provisions should be made for a water storage tank (with pressure relief drain line) and an electrical outlet for a pump. Provide at least an 8 ft. by 8 ft. clear section of south-facing roof for future installation of the solar collectors.

### BENEFIT

Pre-plumbing for solar hot water will make it easier and less expensive to install a solar water heating system in the future.

## 2. Install Wiring Conduit for Future Photovoltaic (PV) Installation

### DESCRIPTION

Making provisions during construction for installing future solar electric systems (also known as photovoltaic or PV systems) can lower the cost when systems are installed later.

### APPLICATION

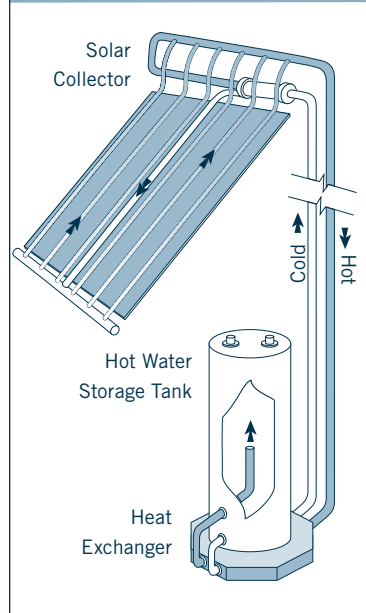
Maintain a 200-square-foot or larger section of south or west roof area clear of vent pipes and other obstructions to allow for the

installation of modules. Install  $\frac{3}{4}$ -inch or larger conduit with pull boxes as needed to run wire from the attic to a junction box near the main panel and meter. Provide the owner with a roof plan with the preferred location for PV modules and the conduit location clearly marked, and provide structural information on what added loads the roof can accommodate.

Installing Solar Water System



Solar Hot Water and Space Heating System



### BENEFIT

Planning ahead for solar electricity will make it easier and less expensive to install a photovoltaic system in the future.

## 3. Offset Energy Consumption with PV, Solar Thermal or Wind Energy

### DESCRIPTION

Renewable energy technologies, including photovoltaic systems, solar thermal systems and wind turbines, can be installed on site to offset energy consumption. Federal tax credits and state and local incentives are available for some types of renewable energy systems.

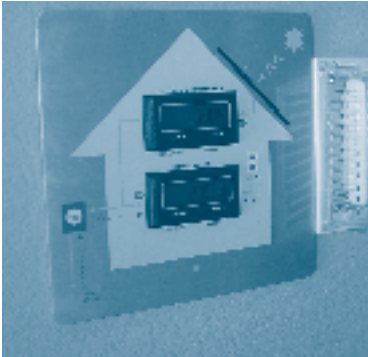
### APPLICATION

#### Photovoltaics

PV systems convert solar energy into electricity. Most residential systems are grid connected. If the PV system generates more power than the home uses, additional electricity is fed back into the utility grid. This effectively spins the home's electricity meter backward in what is known as net metering. When the home requires more electricity than is generated by the PV system, the home draws power from the grid.

Adding battery back-up to the PV system is expensive but allows the homeowner to keep some electrical systems running during power outages; batteries are also used with off-the-grid systems.

The best location for PV modules is on south or west-facing roofs. South-facing modules produce more energy annually, but west-facing modules can take better advantage of time-of-use rates that



Power meter showing the amount of solar electricity generated and used.

are available from some utilities, and help reduce the electricity grid's peak load.

#### Solar Thermal

Solar water heating systems use solar collectors and a water storage tank to provide hot water for domestic use and/or space heating. Solar water heating systems are typically used to deliver preheated water to a water heater. Solar water heating is more cost effective than ever, as a result of new technologies, reliable products, and rising energy prices.

Use only solar water heaters certified by the Solar Rating and Certification Corporation (SRCC). Ensure that there is sufficient south-facing roof area for collectors, that the roof structure will accommodate the system's weight, and that there is adequate area near the water heater for additional mechanical equipment such as storage tanks, pumps, pipes and controllers.

#### Wind Turbines

Wind energy can be converted into electricity through the use of an onsite wind turbine. The wind turns two or three turbine blades around a rotor, which is connected to a shaft and spins a generator. The generator converts mechanical power (which the wind turbine converted from kinetic wind energy) into electricity.

Residential wind turbines can make sense in areas with average annual wind speeds of at least 10 miles per hour. To determine wind speeds for an area, go to [www.windpoweringamerica.gov/wind\\_maps.asp](http://www.windpoweringamerica.gov/wind_maps.asp).

Wind power, though intermittent, can help reduce electricity costs

for grid-connected homes. For homes on remote sites, the cost of installing a wind turbine may be less than the cost of running a power line from the grid. As electricity costs increase, wind energy may be increasingly cost competitive with grid energy.

#### BENEFIT

Onsite renewable energy systems reduce transmission losses, peak electricity demand and reliance on the grid system, which may reduce the need to build new power plants and improve national energy security. These systems offset the homeowner's utility costs and don't produce greenhouse gases and other air pollutants.

Photovoltaic System, Centex Homes, Livermore, CA



# J. Building Performance

## 1. Perform Building Envelope Diagnostic Evaluations

### DESCRIPTION

Homes designed to be very energy efficient may still perform poorly if the building envelope components are not installed properly. Diagnostic evaluations and inspections can help uncover errors and fix potential problems.

### APPLICATION

Test the thermal envelope's effectiveness. Inspection and diagnostic evaluations should include Quality Insulation Installation (QII) and Thermal Bypass Checklist protocols, as well as tests for air infiltration and combustion safety backdrafting.

Studies show that poorly installed insulation severely decreases the material's insulating value. Use best practices to air seal and insulate the home's thermal envelope. Consider installing insulation above the minimum levels required by California's Building Energy Efficiency Standards (Title 24).

Pay proper attention to installation detail and quality assurance. Install insulation with no gaps or voids. Insulation should fill the cavity side-to-side, top-to-bottom and front-to-back and be cut to fit around wiring and plumbing without compression. Compared to batts, blown-in fiberglass, blown-in cellulose or medium density closed cell spray-foam insulation typically do a much better job of filling gaps and sealing around pipes. Don't be

tempted to skip the insulation of cavities that are difficult to access.

Title 24 offers a compliance credit for QII if inspected by a certified Home Energy Rating System (HERS) rater (for more information see the Building Basics article, "Energy Code Compliance," in these Guidelines). Additional energy efficiency and improved comfort can be achieved by meeting Energy Star Qualified Homes for California criteria, which includes the QII protocol and the Thermal Bypass Checklist. Thermal Bypass practices encompass measures to ensure a continuous thermal envelope to prevent air and heat transfer, practices that are not addressed by the QII protocol.

Use a blower door test to estimate the interior natural air changes per hour (NACH) for the whole house. The NACH should be close to or less than 0.35; if it isn't, make any necessary improvements to meet this threshold and test again.

Perform a combustion safety backdraft test if needed to ensure carbon monoxide is not backdrafting into the home from an open-combustion fireplace, water heater or furnace.

### BENEFIT

Third-party home performance testing is vital to ensure that homes perform as intended. Effectively installed insulation creates a more comfortable home and reduces the owner's utility costs.

## 2. Design and Build Energy-Efficient Homes

### DESCRIPTION

California's Building Energy Efficiency Standards (Title 24) set energy efficiency requirements for residential and nonresidential construction. Title 24 merely establishes minimum standards required by law; green homes are designed and built to exceed Title 24 requirements. For more information, see the Building Basics article, "Energy Code Compliance," in these Guidelines.

### APPLICATION

Identify opportunities where exceeding Title 24 will be cost effective or will provide other significant benefits, such as improved comfort, indoor air quality or durability. Homes whose energy performance exceeds Title 24 by at least 15% due to more efficient space heating and cooling or water heating may be eligible for the Energy Star label. Energy Star has additional requirements that address Quality Installation of Insulation (QII) and duct leakage.

### BENEFIT

Homes built to exceed Title 24 requirements may be more comfortable, have lower energy costs, and have higher quality construction than homes that merely meet code.

### 3. Design and Build Near Zero Energy Homes

#### DESCRIPTION

In a near zero energy home, the amount of energy produced onsite is approximately equal to the amount of energy needed on an annual basis. This is achieved through a combination of passive solar and energy-efficient design, onsite renewable energy generation, and the residents' energy conservation practices.

#### APPLICATION

To achieve a near zero energy home, minimize the building's energy consumption as much as possible, and then supply the remaining demand for energy through onsite renewable systems. These are the basic strategies:

1. Utilize passive design strategies, including orientation for solar gain, shading, thermal mass and natural cross-ventilation.
2. Optimize the performance of the building envelope; specify insulation with appropriate R-values and windows with appropriate U-values and solar heat gain coefficients (SHGC).
3. Select high efficiency appliances. Make sure mechanical systems (HVAC and water heating) are well designed and tested for performance.
4. Encourage the homeowners to reduce their energy use by installing control and monitoring systems.

5. Use renewable energy sources like PV, solar thermal and wind power to produce the remainder of energy needed.

The measures in these Guidelines address specific strategies that can result in a near zero energy home. For additional guidance, refer to the U.S. Department of Energy's Building America standards ([www.eere.energy.gov/buildings/building\\_america](http://www.eere.energy.gov/buildings/building_america)) or the Passive House Institute US program ([www.passivehouse.us](http://www.passivehouse.us)).

#### BENEFIT

Compared to homes that merely meet Title 24 requirements, near zero energy homes result in fewer greenhouse gas emissions, less energy consumption and lower utility bills.

### 4. Obtain EPA's Indoor airPLUS Certification

#### DESCRIPTION

The U.S. Environmental Protection Agency's Indoor airPLUS program provides specifications for constructing a home with improved indoor air quality. The Indoor airPLUS program requires a tightened thermal envelope, balanced air pressure, fresh air, pest control measures, and reduction of indoor contaminants; it also addresses all major moisture issues. The program is designed to be complementary with the Energy Star New Home program.

#### APPLICATION

Only Energy Star-qualified homes are eligible for the Indoor airPLUS label. To earn the Energy Star, a home must exceed Title 24 by at least 15% and meet HERS diagnostic performance tests for reduced duct leakage, right-sizing of air conditioning, and the QII/Thermal Bypass Checklist protocols. Utility incentives may be available to help offset the cost of high efficiency equipment and home performance testing.

To earn the Indoor airPLUS label, the home must meet and fulfill all the requirements on the program's checklist and have the measures verified. For more information, visit [www.epa.gov/indoorairplus](http://www.epa.gov/indoorairplus).

#### BENEFIT

Energy Star-qualified new homes provide greater comfort, durability and energy savings for the homeowner, and reduce greenhouse gas emissions. New homes that qualify for the EPA's Indoor airPLUS program provide a healthier indoor environment. Building professionals can differentiate themselves by marketing their homes with these two labels.

### 5. Use a CABEC Certified Professional for Title 24 Documentation

#### DESCRIPTION

Title 24 analysts who complete code compliance documentation for building permit applications are not required to be certified, so the

quality of modeling done for Title 24 compliance is variable. The California Association of Building Energy Consultants (CABEC) has created Certified Energy Plans Examiner (CEPE) and Certified Energy Analyst (CEA) certifications to differentiate Title 24 analysts who have demonstrated knowledge and experience with the code.

#### APPLICATION

Choose a CEPE or CEA to prepare the Title 24 compliance documents.

#### BENEFIT

A CEPE or CEA may model the building more accurately than an uncertified Title 24 analyst. The CEPE or CEA may be able to recommend alternative technologies or strategies for the most cost-effective approach to compliance.

## 6. Participate in Utility Program with Third-Party Plan Review

#### DESCRIPTION

While energy-efficient building equipment and renewable energy systems save money in the long run, they can be expensive to purchase. Many utilities offer incentives to help builders afford energy-efficient equipment, onsite renewable energy systems, and other energy efficiency measures. Programs such as the New Solar Homes Partnership (NSHP) encourage comprehensive whole building performance that combines high levels of energy efficiency and solar energy systems.

#### APPLICATION

Participate in an energy efficiency incentive program or a renewable energy program with a third-party

plan review offered by your local utility. Pacific Gas & Electric Company, Southern California Edison and San Diego Gas & Electric Company offer the NSHP program in their service areas. Similar programs are offered by local publicly owned utilities.

#### BENEFIT

Developers and homeowners benefit from the technical assistance provided by these programs and by the reduced upfront cost of purchasing higher efficiency equipment and building components. These programs also require a third-party plan review of California's Building Energy Efficiency Standards (Title 24) documentation and solar installation design, which results in more accurate energy savings estimations and real-life energy savings.

# K. Finishes

## 1. Design Entryways to Reduce Tracked-In Contaminants

### DESCRIPTION

Up to two-thirds of dust and particulates in homes are tracked in on shoes. These tracked-in particulates contaminate the home with everything from soil and pesticides to abrasive sand, mold, road grime and bacteria.

### APPLICATION

The most effective way to avoid tracking contaminants into the home is for people to remove their shoes upon entering. Provide features near entryways that encourage the removal and storage of shoes and outerwear, such as benches or a mudroom. For entryways, avoid carpet, and choose easily cleaned flooring with a hard surface, such as hardwood, bamboo, concrete, ceramic tile or natural linoleum.

### BENEFIT

The home will be cleaner, with less dirt and other pollution tracked in.



Shoe Storage Near Entryway.

## 2. Use Low-VOC or Zero-VOC Paint

### DESCRIPTION

Most interior paints contain volatile organic compounds (VOCs), a major class of indoor and outdoor air pollutants. Besides affecting indoor air quality, certain VOCs react with other chemicals in the atmosphere, producing ground-level ozone (smog) that can affect human health. Low- and zero-VOC paints reduce these sources of pollution.

### APPLICATION

Interior paints with low or zero levels of VOCs are available from most major manufacturers and are applied and perform like conventional paint. According to South Coast Air Quality Management District thresholds, low-VOC paints contain less than 50 grams per liter (gpl) of VOCs for both flat and nonflat finishes. Paints that contain less than 5 gpl of VOCs are classified as zero VOC.

### BENEFIT

Low- or zero-VOC paint reduces the emissions of VOCs, improving indoor air quality and reducing smog.

## 3. Use Low-VOC Wood Finishes

### DESCRIPTION

Conventional petroleum-based wood finishes can offgas for months and can be particularly harmful to children and chemically sensitive individuals. Offgassing means the solvents in the product are released into the air, contaminating indoor

air quality. Low-VOC finishes, such as waterborne urethane and acrylic or plant-based oils, are lower in toxic compounds compared to conventional oil-based finishes and provide similar durability.

### APPLICATION

Use wood finishes, stains or coatings with less than 250 grams per liter of VOCs. For specific types of coatings, use the VOC limit set by the South Coast Air Quality Management District's Rule 1113 ([www.aqmd.gov/rules/reg/reg11/r1113.pdf](http://www.aqmd.gov/rules/reg/reg11/r1113.pdf)). If oil-based wood finishes must be used, apply them offsite or allow them to offgas completely (three to four weeks) prior to occupancy.

### BENEFIT

Using low-VOC wood finishes reduces offgassing, improves indoor air quality and reduces smog.

## 4. Use Low-VOC Caulk and Construction Adhesives

### DESCRIPTION

Unlike conventional caulks and construction adhesives that may offgas toxic compounds for months, low-VOC products reduce toxic gases such as aromatic hydrocarbons or other petroleum solvents that contribute to indoor and outdoor air pollution.

### APPLICATION

Use caulks and adhesives with VOC concentrations of less than 70 grams per liter in place of standard caulks and adhesives for all interior applications such as



Salvaged wood countertop.

installation of framing, subfloors, finish flooring, countertops, trim, wall coverings, paneling and tub/shower enclosures. Or use the appropriate VOC standard for the specific product according to the South Coast Air Quality Management District (SCAQMD) Rule 1168 (2005 amendments version) standards ([www.aqmd.gov/rules/reg/reg11/r1168.pdf](http://www.aqmd.gov/rules/reg/reg11/r1168.pdf)).

#### BENEFIT

Low-VOC caulks and adhesives work as well as or better than conventional products, emit fewer pollutants and reduce the risk of potentially harmful health impacts.

## 5. Use Recycled-Content Paint

#### DESCRIPTION

A number of manufacturers have developed high quality recycled-content latex paint and primers. The recycled portion (ranging from 20 to 100%) comes from unused

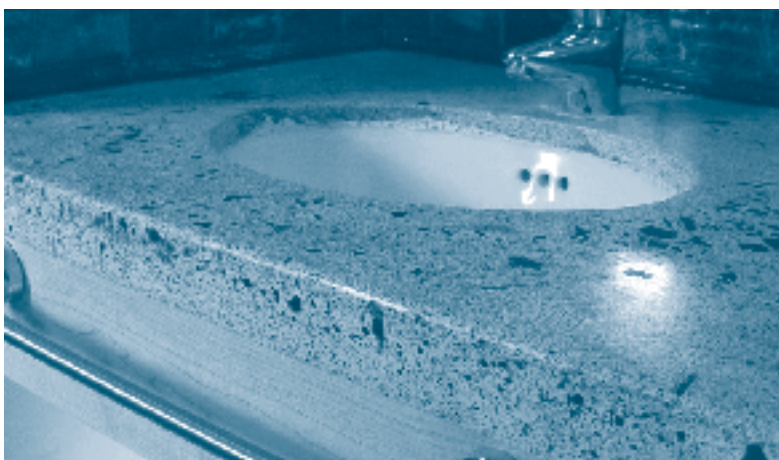
consumer or industrial stock, as well as paint recovered from household hazardous waste collection facilities. The paint is checked for quality and then sent to paint manufacturers for recycling and blending with new paint.

#### APPLICATION

Latex paint with recycled content is applied like conventional paint. Due to the blended nature of the paint, it tends to come in a limited range of colors. Look for products that are certified by Green Seal to meet quality, performance, safety and environmental standards

#### BENEFIT

Recycled paint is often less expensive than new paint. It also reduces the need to manufacture new paint and supplies a market for unused paint, rather than putting it into the waste stream.



Recycled glass and concrete bathroom counter.



## 6. Use Environmentally Preferable Materials for Interior Finish

Environmentally preferable options for interior finishes include materials that are FSC-certified, are reclaimed or refinished, are rapidly renewable, contain recycled-content, are finger-jointed, or are locally sourced and manufactured.

### a. Use FSC-Certified Materials

#### DESCRIPTION

Forest Stewardship Council (FSC)–certified wood comes from forests managed in accordance with stringent sustainable forestry practices, including a complete chain of custody tracking system and third-party verification.

#### APPLICATION

Use FSC-certified wood and wood products in any application that normally calls for conventional plywood or solid wood materials, such as cabinets, trim, doors, shelving and window frames.

#### BENEFIT

FSC certification assures that forests are managed in a way that protects the long-term availability of wood resources and the health of forest ecosystems and local economies.

### b. Use Reclaimed Materials

#### DESCRIPTION

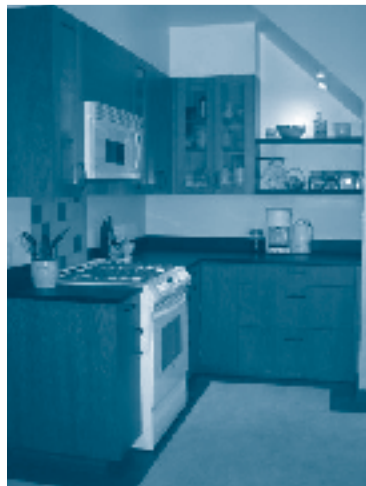
High quality finish materials, including dimensional lumber, can often be salvaged from other buildings that are being deconstructed or sourced from a reclaimed material distributor.

#### APPLICATION

Use reclaimed material instead of new material. Commonly used salvaged products include reclaimed lumber for nonstructural applications, such as mantles, nonstructural beams, casing, trim, cabinets, doors and wood flooring. Reclaimed lumber may be used for structural applications if it has been re-graded and engineered for such purpose. Also look for sinks, tubs, electrical products and fixtures, and roofing materials.

#### BENEFIT

Reclaimed materials reduce resource consumption and landfill deposits. Reclaimed lumber and many other salvaged materials are often of higher quality than new products.



FSC-certified cabinets, countertop made from wood fibers harvested from sustainable forests and linoleum flooring.

### c. Use Rapidly Renewable Materials

#### DESCRIPTION

Rapidly renewable materials are made from agricultural crops that grow quickly and can be harvested on a relatively short cycle compared to slower-growing wood. Rapidly renewable resources can be defined as plants that grow to harvestable size in 10 years or less. Examples include bamboo, a fast-growing grass that can be harvested in three to five years, and straw, the stalk of wheat, rice, barley and other grains.

#### APPLICATION

Instead of using solid wood, plywood, wood-based medium density fiberboard (MDF) or particleboard for interior finishes, consider rapidly renewable materials such as straw-based MDF and bamboo plywood.

#### BENEFIT

Rapidly renewable materials are attractive, durable and reduce pressure to harvest forests that have a slower growth cycle. Properly seasoned bamboo is as durable as most hardwoods.

### d. Use Recycled-Content Materials

#### DESCRIPTION

Some recycled-content interior finishes, such as molding or other decorative components, are made from recycled polystyrene or other plastics. Recycled-content countertops include recycled glass tiles, terrazzo-like materials that blend recycled glass and concrete and natural fiber composites derived from rapidly renewable or recycled

resources. Recycled-content products are available for kitchen and bathroom applications such as countertops, backsplashes, shower walls and vanity tops.

#### APPLICATION

Choose products with high recycled content, preferably post-consumer recycled content.

Use recycled-content finish materials in any application where virgin materials are typically used.

#### BENEFIT

Recycled-content products reduce demand for virgin materials and keep valuable resources out of the waste stream.

#### e. Use Finger-Jointed Materials

##### DESCRIPTION

Finger-jointed trim, studs and fascia are manufactured from short pieces of wood glued together to create a finished material.

##### APPLICATION

Use finger-jointed materials in any application where it can replace solid lumber and where materials are to be painted.

##### BENEFIT

Finger-jointed elements are straighter and more stable than conventional wood, and use wood more efficiently, reducing the waste stream and using less larger-diameter lumber.

#### f. Use Locally Sourced and Manufactured Materials

##### DESCRIPTION

Choose materials that have been extracted, processed and manufactured within a 500-mile radius of the project site.

##### APPLICATION

Specify materials that are produced locally. In California, options include FSC-certified wood, ceramic tiles, and some recycled-content materials.

##### BENEFIT

Using locally extracted, processed, and manufactured materials reduces transportation costs and associated fossil fuel use and pollution. Locally sourced materials also promote local economic development, and heightened community awareness of the environmental impacts of materials sourcing.

### 7. Reduce Formaldehyde in Interior Finishes

##### DESCRIPTION

Formaldehyde is carcinogenic. Formaldehyde is often used as a binder in home-building products such as plywood, particleboard and other composite wood products. These binders come in two basic forms: urea and phenol. Urea-formaldehyde binders are common in interior-grade products. Phenol-

formaldehyde binders are used in exterior applications because they are more water resistant. This water resistance quality makes phenolic glues offgas more slowly and in lower quantities than urea glues, reducing some of the harmful effects on indoor air quality.

##### APPLICATION

Whenever possible, use interior materials (including subfloor and stair treads, cabinets and countertops, interior trim and shelving) that emit little or no formaldehyde. Select materials that have been tested for low emissions according to the California “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers.” (For information, go to [www.ciwmb.ca.gov/GreenBuilding/Specs/Section01350](http://www.ciwmb.ca.gov/GreenBuilding/Specs/Section01350).)

##### BENEFIT

Reducing formaldehyde exposure helps protect the health of residents, particularly children and other people who are more affected by indoor air pollution.

# L. Flooring

## 1. Use Environmentally Preferable Flooring

Environmentally preferable flooring options include FSC-certified wood, reclaimed, rapidly renewable or recycled-content materials, exposed concrete slabs, and local materials.

### a. Use Forest Stewardship Council (FSC)–Certified Wood Flooring

#### DESCRIPTION

FSC-certified wood flooring comes from forests managed in an environmentally, economically and socially responsible manner. FSC is the only wood verification rating system that maintains chain-of-custody certification throughout the cutting, milling and final delivery of products, thus ensuring that the end product originated from a certified sustainably managed forest. FSC-certified products are available in a wide variety of domestic and exotic species.

#### APPLICATION

Use FSC-certified hardwood in place of conventional hardwood flooring.

#### BENEFIT

FSC certification assures that forests are managed in a way that



protects the long-term availability of wood resources, the health of forest ecosystems, and the sustainability of local economies.

### b. Use Reclaimed Flooring Materials

#### DESCRIPTION

High quality salvaged wood flooring or other salvaged flooring products can often be reclaimed from deconstructed or remodeled buildings.

#### APPLICATION

Use low-VOC sealers when refinishing reclaimed wood floors. Find salvaged flooring from building materials reuse stores or through online resources such as Craigslist.org and Freecycle.org. The California Integrated Waste Management Board ([www.ciwmb.ca.gov](http://www.ciwmb.ca.gov)) also provides information about material reuse.

#### BENEFIT

Reclaimed building materials reduce resource consumption and landfill deposits. Many salvaged products are of higher quality than new materials.

### c. Use Rapidly Renewable Flooring Materials

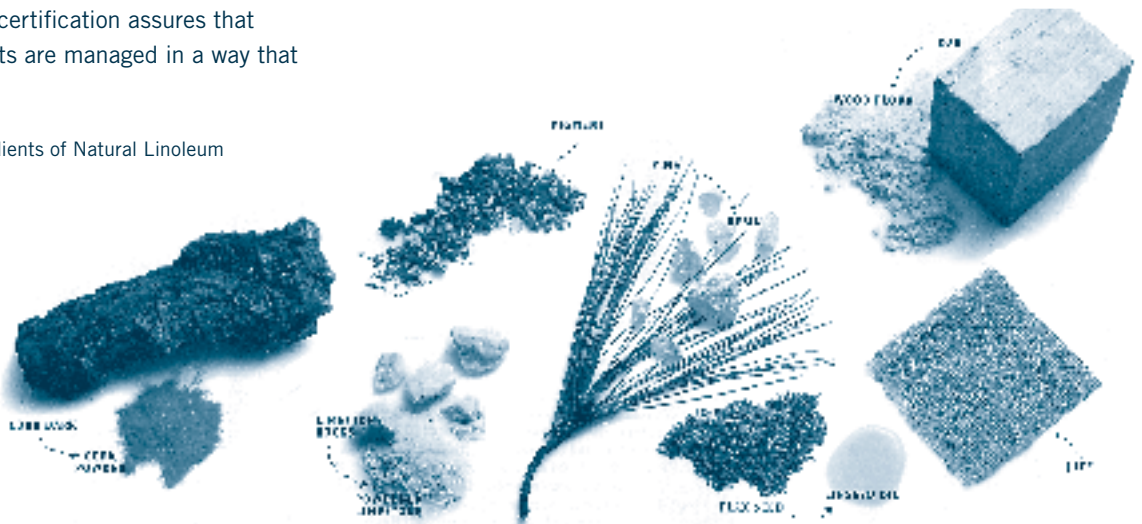
#### DESCRIPTION

Bamboo, cork and natural linoleum flooring are alternatives to conventional hardwood, carpet or vinyl flooring. Properly seasoned bamboo, which is as durable as most hardwoods used for floors, is a fast-growing grass that can be harvested in three to five years. Cork is harvested from the outer bark of the cork oak tree; the tree regenerates its bark within 10 to 15 years. Natural linoleum is manufactured primarily from renewable materials such as cork, jute, wood flour and linseed oil.

#### APPLICATION

Use these rapidly renewable flooring materials in place of

Ingredients of Natural Linoleum



Used with permission from *This Old House*.

## Bamboo Flooring and Recycled-Content Carpet



conventional hardwood, carpet or vinyl flooring.

Cork can also be used as an underlayment for hard-surfaced flooring to reduce impact noise between rooms.

### BENEFIT

Rapidly renewable flooring materials reduce pressure to harvest forests. Cork and linoleum are naturally fire- and moisture-resistant as well as sound absorbent.

### d. Use Recycled-Content Flooring

#### DESCRIPTION

Flooring can be made from a variety of recycled materials. Recycled-content ceramic tiles can contain up to 70% recycled glass or other materials. Recycled-content carpet is made from recycled plastic bottles, recycled nylon and wool, or recycled cotton.

#### APPLICATION

Install recycled-content tiles wherever conventional tiles are specified. Recycled-content carpet can be used in all applications where conventional carpet is specified, and is comparable in appearance, performance and price to conventional synthetic carpet made from virgin materials.

#### BENEFIT

Recycled-content products keep valuable resources out of the waste stream. Each square yard of recycled-content carpet uses approximately 40 two-liter soda bottles.

### e. Use Exposed Concrete as Finished Floor

#### DESCRIPTION

With slab-on-grade construction, the concrete can be polished, scored with joints in various patterns, or stained with pigments to create a finished floor. This approach is especially appropriate for use with in-floor radiant heating systems and passive solar design.

#### APPLICATION

Use this approach for slab-on-grade construction. The finish must be designed and constructed when the slab is being poured, and well protected throughout construction.

#### BENEFIT

Using the slab as a finished floor eliminates the need to use other flooring materials, reducing overall material demand. It is also durable and easy to clean.

### f. Locally Sourced and Manufactured Flooring Materials

#### DESCRIPTION

Choose materials that have been extracted, processed and manufactured within a 500-mile radius of the project site.

#### APPLICATION

Specify flooring that is locally sourced, such as wood grown within 500 miles.

#### BENEFIT

Using locally extracted, processed, and manufactured materials reduces transportation costs and associated fossil fuel use and pollution. Locally sourced materials also promote local economic development, and heightened community awareness of the environmental impacts of materials sourcing.

## 2. Increase Thermal Mass of Floors

### DESCRIPTION

Flooring materials like concrete can improve thermal mass for passive cooling and heating.

### APPLICATION

Low-cost thermal mass includes using hard flooring such as tile and finished concrete slabs. Wood flooring over a concrete slab also provides reasonably good thermal mass.

### BENEFIT

Increasing thermal mass will reduce heating and cooling energy use and will moderate indoor temperature swings, keeping the home more comfortable.

## 3. Use Low-Emitting Flooring

### DESCRIPTION

Flooring products may emit formaldehyde and other volatile organic compounds. To protect indoor air quality, look for products that have been tested and approved for low-emissions by a reputable third-party or government organization.

### APPLICATION

Choose carpet that meets or exceeds the CRI Green Label Plus requirements ([www.carpet-rug.org](http://www.carpet-rug.org)). Choose flooring products that are FloorScore Certified ([www.rfci.com/int\\_FloorScore.htm](http://www.rfci.com/int_FloorScore.htm)) or that have been tested for low emissions according to the California “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale

Environmental Chambers” ([www.ciwmb.ca.gov/GreenBuilding/Specs/Section01350](http://www.ciwmb.ca.gov/GreenBuilding/Specs/Section01350)).

### BENEFIT

Minimizing formaldehyde and volatile organic compounds in the home improves indoor air quality.



Concrete floor.

# M. Appliances and Lighting

## 1. Install Energy Star Dishwashers

### DESCRIPTION

Energy Star–qualified dishwashers reduce energy use by at least 41% compared to the federal minimum standards. Some dishwashers are more water-efficient than others, even among Energy Star–qualified models. As of August 2009, Energy Star is changing its requirements to not only address energy efficiency but also water use. To meet the new Energy Star requirements, a standard-sized dishwasher can use no more than 324 kilowatt-hours per year and no more than 5.8 gallons per cycle.

### APPLICATION

Select water- and energy-efficient dishwashers that use an internal water heater to boost temperatures inside the dishwasher. This means that household water heaters can be turned down to 120°F, saving water-heating costs. Find Energy Star–qualified models at [www.energystar.gov](http://www.energystar.gov).

### BENEFIT

High efficiency dishwashers reduce water and energy use.

## 2. Install Energy Star Clothes Washers with Water Factor of 6.0 or less

### DESCRIPTION

Energy Star–qualified clothes washing machines use 50% less energy and 45 to 60% less water while performing as well as a standard washer.



Horizontal axis washing machines.

### APPLICATION

Choose models with a water factor rating of 6.0 or less and a modified energy factor of 2.0 or greater. Note that not all Energy Star models meet this level of water and energy efficiency.

Most Energy Star washing machines save energy and water through a front-loading design (horizontal axis) that tumbles clothes in a small amount of water. Most models also include a high-speed final spin cycle that extracts more moisture than standard washers. Less moisture means less drying time, which saves additional energy. Find qualifying models at [www.energystar.gov](http://www.energystar.gov) or [www.cee1.org](http://www.cee1.org).



### BENEFIT

Energy Star–qualified washing machines use substantially less water and energy than conventional washers.

## 3. Install Energy Star Refrigerators

### DESCRIPTION

Refrigerators and freezers are among the largest users of electricity in most homes. They can account for up to 25% of household energy use. Energy Star refrigerators save at least 10% over the federal minimum standards.

### APPLICATION

Select an Energy Star–qualified refrigerator that has less than 25 cubic feet of capacity (refrigerator and freezer). For a list of qualifying models, visit [www.energystar.gov](http://www.energystar.gov).

### BENEFIT

Energy Star refrigerators can reduce the total annual electricity bill by more than 10%. Choosing a model no larger than 25 cubic feet will further reduce electricity costs.

## 4. Install Built-In Recycling and Composting Centers

### DESCRIPTION

Built-in recycling and composting centers provide bins for separated recyclables, compostables and trash.

### APPLICATION

Install a built-in recycling area in the kitchen's base cabinets. Some waste haulers allow recyclables to be mixed, while others require



Built-in recycling center.

that glass, paper, plastic or other materials be separated. Check local requirements and design the built-in recycling area accordingly.

Design a kitchen compost bin that is protected from pests and is odor-resistant. Food scraps can be added to a backyard compost pile or bin. Some cities collect food scraps via a curbside food recycling program and provide a designated food scraps bin.

#### BENEFIT

Recycling and composting reduce the amount of material entering landfills and can save money for homeowners through reduced disposal fees (many waste haulers charge a lower fee for smaller garbage bins). Composting creates high quality soil amendments useful in gardens.

## 5. Install High Efficacy Lighting

### DESCRIPTION

Lighting efficacy refers to the amount of light (typically measured in lumens) produced per watt of power used. Incandescent fixtures have an efficacy of less than 20 lumens per watt, while fluorescent and LED fixtures typically have lumen per watt efficacy values above 50 and sometimes as high as 100.

### APPLICATION

#### a. Choose High Efficacy Bulbs and Fixtures

For all permanently installed lighting fixtures in the home, install lighting with an efficacy of at least 40 to 60 lumens per watt.

High efficacy fluorescent and LED bulbs and fixtures come in a variety of sizes, shapes, color temperatures, and mounting and control options. Where applicable, consider installing controls such as occupancy sensors and photocells to ensure that lights are turned on only when necessary.

#### b. Follow Lighting Design Best Practices

Install a lighting system designed to deliver appropriate ambient, task and accent lighting to meet the needs of each space in the home. Homes are often designed

with excess ambient lighting in hallways and living rooms, and not enough task lighting in areas such as the kitchen. Consult the Illuminating Engineering Society (IES) Lighting Handbook or Lighting Ready Reference for appropriate footcandle measurements throughout the home ([www.iesna.org](http://www.iesna.org)).

Consider consulting with a Lighting Certified (LC) professional to help with bulb wattage choices and lighting fixture placement to maximize lighting and control glare (to find an LC professional, go to [www.ncqlp.org](http://www.ncqlp.org)). Many utilities have lighting experts on staff to evaluate plans or physically evaluate spaces.

### BENEFIT

A well-designed lighting system that combines high efficacy lighting, controls, and daylighting uses less energy, reduces energy costs and improves the quality of the indoor environment.

## 1. Incorporate GreenPoint Rated Checklist in Blueprints

### DESCRIPTION

Attaching the Single Family GreenPoint Rated Checklist to the blueprints makes it easier for everyone involved—including the building professionals, home buyer and municipality—to see which green features are included.

### APPLICATION

In one of the first pages of the project blueprints, include the GreenPoint Rated Checklist, with the applicable points checked off. To make verification easier, next to each checklist item note the blueprint page number that corresponds to that particular item and make an obvious note on that blueprint page.

### BENEFIT

Including the GreenPoint Rated Checklist in the blueprints raises the visibility of green building. This may encourage builders to incorporate more green features. It also provides a quick reference and benchmark for the builder, buyer and municipality.

## 2. Hold a Preconstruction Kick-Off Meeting

### DESCRIPTION

A preconstruction kick-off meeting entails an in-person meeting between owners, GreenPoint Raters, contractors, subcontractors, architects, landscape architects, and others involved in the project during the construction phase.

### APPLICATION

Hold the preconstruction kick-off meeting before construction begins, preferably on site. Review the GreenPoint Rated process and the expected roles of each team member. To help ensure that the project's green building and rating goals will be met, make sure each team member's scope of work and contract reflects their roles and responsibilities. In the documentation of this meeting, outline the GreenPoint Rated process for the specific project; keep the documentation for reference throughout the project development.

### BENEFIT

When all parties are aware of their role in the GreenPoint Rated process from the beginning of construction, they will be more prepared to meet the project's objectives. Important records, such as documentation of construction waste generated, are more likely to be produced and retained if contractors and subcontractors are aware of the value of this information to green building certification.

## 3. Management Staff Are Certified Green Building Professionals

### DESCRIPTION

The homebuilder's management staff and other building professionals can take a Build It Green course to become Certified Green Building Professionals (CGBP).

### APPLICATION

Build It Green offers a two-day CGBP course in locations throughout California. By taking the course and passing a test, participants become certified and may add the CGBP designation to their business credentials.

### BENEFIT

Management team members who understand the goals and practices of green building can more effectively integrate them into the company's operations and products.

## 4. Develop a Green Homeowner's Manual and Conduct Walk-throughs

### DESCRIPTION

A green homeowner's manual describes the home's green features and their benefits. It also gives important information about maintaining and operating the home. Provide walk-throughs for new homeowners to inform them about basic and advanced home operations and maintenance procedures.

### APPLICATION

Develop a green homeowner's manual or include a green section in the standard manual. Include the following information:

- Description of the home's green building features
- Explanation of the importance of maintenance and operations to achieve ongoing green building benefits
- Warranty, operation and maintenance



nance instructions for equipment and appliances

- Ways to save water and energy
- Clear labeling of safety valves and controls for major house systems
- Information about keeping gutters clean and checking crawl space for pests and termite tubes
- Information on nontoxic pest control and gardening practices, and healthier cleaning products
- Information on proper landscaping maintenance
- Information on household recycling, and proper handling and disposal of hazardous chemicals

#### BENEFIT

Manuals and walk-throughs help homeowners maximize their investment by maintaining their home and landscaping in a healthy and environmentally responsible manner. Manuals and walk-throughs may reduce maintenance problems and call-backs.

### 5. Install Energy and Water Monitors, or Participate in a Demand-Response Program

#### DESCRIPTION

People are better able to regulate their resource consumption when they have information about their usage patterns. Home energy monitors provide real-time feedback on electricity and/or gas use. Home water monitors give customers a more detailed understanding of their water consumption.

Demand–response programs help consumers reduce electricity use during times of peak demand, which may help prevent electric supply shortfalls.

#### APPLICATION

##### Home Energy Monitors

These are typically plug-in devices that give a digital read-out of a home’s energy usage in real-time. The read-out may provide kilowatt-hour data, cost data, or both. More sophisticated devices allow residents to use their personal computer to monitor their electricity consumption. Some devices allow users to view energy use for the whole house and for individual appliances. Most home energy monitors need to be installed by a licensed electrician.

##### Home Water Monitors

These measure flow, quantity and temperature of water used in the home. They may be installed separately or in combination with a home energy monitor. Water monitors are generally hard-wired and should be installed by qualified contractors. Wireless systems are available but are more expensive.

##### Demand–Response Programs

Customers who participate in utility demand–response programs are informed of real-time changes in the price of electricity so they may curtail their usage when demand and rates peak. With a time-of-use price structure, the customer pays less for electricity when demand is low and more during peak demand

hours. Or they may agree to have their electricity use automatically reduced during critical times when the electricity grid is approaching capacity. One type of residential demand–response program involves installing a thermostat on the air conditioner that communicates electronically with the utility. During times of very high demand, the utility can automatically adjust the thermostat’s temperature setting to reduce air conditioning use. Contact your utility for information.

#### BENEFIT

Home energy and water monitors encourage conservation by making residents more aware of their usage. They can also be used to help diagnose home performance issues by providing information about energy and water usage patterns over time. With demand–response programs, customers can save money by using less energy at peak times, and utilities are able to curtail peak usage and reduce greenhouse gas emissions.

# O. Community Design and Planning

## 1. Develop Infill Sites

### DESCRIPTION

Infill developments reclaim abandoned and underutilized sites and buildings, utilize existing services, and reduce pressure to develop greenfields such as open space and farmland.

### APPLICATION

When selecting a development site, choose built urban settings where public infrastructure is already in place. Give preference to locations that are: in a downtown area, targeted for revitalization, close to major employment centers, and/or within an urban growth boundary or designated for development by the local jurisdiction. Also, locate the project within walking distance of a major transit stop; look for locations where good transit service already exists or work with officials to bring public transit to the area.

### BENEFIT

Urban infill allows public funds to be used for maintaining or upgrading existing services such as schools, transit and sewers, rather than diverting limited funds to the development of costlier new services.

## 2. Build on Designated Brownfield Sites

### DESCRIPTION

Brownfields are properties that have the presence or potential presence of a hazardous substance, pollutant, or contaminant, as specified by the U.S. Environmental Protection Agency. Brownfields include properties such as gas stations, manufacturing facilities, and industrial yards.

### APPLICATION

Use underutilized lands by building

on a designated brownfield site. The State of California, the U.S. EPA, and some local governments offer grants, loans and training to help property owners safely develop brownfields for residential use.

### BENEFIT

The EPA estimates that there are more than 450,000 brownfields in the U.S. Cleaning up and reinvesting in these properties increases local tax bases, facilitates job growth, utilizes existing infrastructure, takes development pressures off of undeveloped open land, and improves and protects the environment.

## 3. Cluster Homes and Keep Size in Check

### DESCRIPTION

On a given site, there are often many options for locating and orienting homes. Paying careful attention to land use and home size can help conserve natural resources.

### APPLICATION

#### a. Cluster Homes for Land Preservation

Two strategies for minimizing developed areas are clustering homes and building upward instead of outward. Besides preserving open space, certain

clustered designs may also use building materials more efficiently if there are shared walls or roofs.

#### b. Conserve Resources by Increasing Density

Developments that allow for more homes on a given site reduce pressure to develop greenfields or open space. Where there is access to public transit or commercial activities, dense developments offer the advantage of shorter commutes, less dependence on cars, and walkable communities.

#### c. Home Size Efficiency

Homes can be designed to be comfortable and spacious without being excessively large; smaller, more compact homes conserve land, building materials and energy.

### BENEFIT

Minimizing the development footprint and providing permanent open spaces can help protect the local ecosystem and enhance the community. Homes that are clustered and not overly large may cost less and require fewer resources to build.

## 4. Lay Out and Orient Subdivisions for Shading and Solar Access

### DESCRIPTION

Planning strategies that take shading and solar access into account can reduce energy use by providing natural cooling in the summer, allowing for passive solar heating in the winter, and making unshaded space available for solar electric and solar thermal systems.

### APPLICATION

Orient homes on an east–west axis to facilitate passive solar design, reduce heating and cooling energy



Sacramento Street Cohousing, Berkeley, CA.

use, and facilitate placement of rooftop solar electric and solar thermal systems. Use alley ways, greenbelts, and other methods to provide good solar access to the homes.

Plan streets and lot layouts to provide for shading of streets by trees to reduce the heat island effect. Keeping streets narrow will make them easier to shade and will contribute to traffic calming, improving safety.

#### BENEFIT

Planning for solar access and shading can create more pleasant neighborhoods, lower homeowners' energy bills, and reduce reliance on fossil fuel-based energy.

### 5. Design for Walking and Bicycling

#### DESCRIPTION

Walking and bicycling are inexpensive forms of transportation but they are often incompatible with conventional car-based development patterns. Convenience, safety and aesthetics are key factors in promoting travel by foot and bicycle.

#### APPLICATION

#### a. Provide Pedestrian Access to Neighborhood Services

Build pedestrian-friendly communities that combine residential and commercial spaces so that people can shop, play and meet their daily needs close to where they live.

#### b. Include Pedestrian Pathways That Connect to Recreation

Many new home developments include plans for new roadways and pedestrian paths. Where applicable, connect walkways to places of interest, such as parks, stores, and recreation areas. Walkways should be separated from roadways.

#### c. Design Traffic-Calming Elements to Encourage Walking and Bicycling

Design 10-foot vehicle travel lanes with bike lanes, rather than the standard 12-foot vehicle travel lanes. Consider rumble strips, bulb-outs and raised crosswalks to reduce speeding.

#### BENEFIT

Walking and bicycling are inexpensive, healthy forms of physical activity, transportation and neighborhood interaction. Traffic-calming measures reduce pedestrian accidents and increase neighborhood economic activity and public safety.

### 6. Design for Safety and Social Gathering

#### DESCRIPTION

Design buildings and landscapes to deter crime and promote safety through casual observation and community interaction.

#### APPLICATION

Design all home entrances so that outside callers can be seen from inside the home. Place tall windows with low sill heights at front doors, or use transparent panels in the doors so any occupant, including children and the disabled, can view all visitors.

Orient porches to streets and public spaces to provide natural surveillance. Help keep the community safe and neighborly by orienting windows so that residents can easily view and feel comfortable using nearby areas such as outdoor benches, pathways, pocket parks, children's play areas and other features that promote socializing.

Include community gathering areas such as play structures, parks or gardens. To encourage community gardening and consumption of

healthy, local food, provide a shared area for a vegetable garden.

#### BENEFIT

While it may be possible to deter some crime with tall fences, gates, video surveillance and bright lights, these elements also deter outdoor play and neighborliness. Creating a greater sense of community in residential areas results in safer and more inviting places to live.

### 7. Design for Diverse Households

#### DESCRIPTION

Simple universal design elements make it much more likely that residents can remain in their homes as they age, if they become temporarily or permanently disabled, or if they wish to have relatives join their household.

#### APPLICATION

Design homes so that at least one prominent entrance (not from a garage) has a zero-step clearance, with less than a ½-inch difference in height. Design all main-floor interior doors and passageways to have a minimum 32-inch clear passage space to accommodate disabled persons. Locate at least a half-bath on the ground floor with blocking in the walls for grab bars. Ideally, also locate a bedroom on the ground floor. Consider providing a fully functional, independent unit that would allow extended family members to reside at home yet maintain independence.

#### BENEFIT

Over the long term, money can be saved and remodeling waste minimized if homes are designed from the outset to accommodate changing occupant needs and a wider range of physical abilities.

