KEYSTONE GREEN BUILDING INITIATIVE

User's Guide

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DISCLAIMER

This publication contains guidance for builders engaged in or interested in green building products and practices for residential design, development and construction. This publication is not intended to be exhaustive and all-inclusive and the enclosed guidelines are not to be considered the only method of green building. These guidelines for green building originate from the collective experience of leading personnel in the green building movement (marketplace), but must, due to the nature of the responsibilities involved, be presented only as a guide for the use of a qualified developer, builder, remodeler, or design professional.

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INTRODUCTION

The process of green building is to incorporate environmental considerations into every phase of the home building process. That means that during the design, construction, and operation of a home, energy and water efficiency, lot development, resource efficient building design and materials, indoor environmental quality, homeowner maintenance, and the home's overall impact on the environment are all taken into account.

Now to answer the question, "Why should we care about green building?" There are many compelling reasons for changing the way in which we build and operate homes. Although we cannot avoid impacting the environment when we build a house, green building can work toward minimizing that environmental impact.

These guidelines were designed with the mainstream home builder in mind. We recognize that many home building companies already incorporate some elements of green building into their current practices. However, the purpose of these guidelines is to highlight ways in which a mainstream home builder can effectively weave environmental concerns holistically into a new home and to provide a tool that local associations can use to create a green home building program.

At the time these guidelines were originally created, there were 28 green home building programs in operation throughout the United States. These programs have done a great job at spreading the word about green home building. However, there are numerous other locales that are interested in green home building that do not have the resources but have not had the resources to create a program from scratch. These guidelines are intended to serve as a toolkit for home builder associations to create new programs, and to help those programs expand and flourish.

Guiding Principles

As noted above, during the process of building a green home, a builder takes numerous considerations into account simultaneously and consciously incorporates environmental issues into all decisions. The attached model green home building guidelines consist of a variety of distinct line items that a builder can choose from in creating a green home. For organizational purposes, we have grouped the line items into overarching sections, or guiding principles. Below are the guiding principles addressed in green home building:

Guiding Principle – Lot design, preparation, and development

Resource efficient site design and development practices help reduce the environmental impacts and improve the energy performance of new housing. For instance, site design principles such as saving trees, constructing on-site storm water retention/infiltration features, and orienting houses to maximize passive solar heating and cooling are basic processes used in the design and construction of green homes.

Guiding Principle – Resource efficiency

Most successful green homes started with the consideration of the environment at the

design phase—the time at which material selection occurs. Creating resource efficient designs and using resource efficient materials can maximize function while optimizing the use of natural resources. For instance, engineered wood products can help optimize resources by using materials in which more than 50% more of the log is converted into structural lumber than conventional dimensional lumber.

Resource efficiency is also about reducing job site waste. Invariably, there are leftover materials from the construction process. Developing and implementing a construction waste management plan helps to reduce the quantity of landfill material. The average single-family home in the U.S., at 2,320 ft^2 (NAHB, 2003), is estimated to generate between 6,960 and 12,064 lb. of construction waste. Thus, by creating an effective construction waste management plan and taking advantage of available recycling facilities and markets for recyclable materials, construction waste can be reduced by at least two-thirds, creating potential cost savings for builders and reducing the burden on landfill space.

Lastly, basing the selection of building materials on their environmental impact can be tricky. For instance, a product might be renewable, but on the other hand it takes a relatively great amount of energy to transport the product to a project's job site.

While one way to compare products is to look at a product's or a home's life-cycle environmental impacts through a process called Life Cycle Analysis (LCA). An LCA of a building product covers its environmental impacts "cradle-to-grave" through six basic steps: 1) Raw material acquisition, 2) Product manufacturing process, 3) Home building process, 4) Home maintenance and operation, 5) Home demolition, and 6) Product reuse, recycling, or disposal. There are numerous reasons why building products are not commonly selected via LCAs. One of the issues is the availability of data – there is a lack of data to feed into tools that allow for an LCA on a product or system.

One such tool created by the National Institute of Standards and Technology (NIST) is the Building for Environmental and Economic Sustainability (BEES) software program. BEES has ten impact categories: Acid rain, Ecological toxicity, Eutrophication, Global warming, Human toxicity, Indoor air quality, Ozone depletion, Resource depletion, Smog, and Solid waste. Since information is not available to conduct full LCAs on all available building products, we have instead included an LCA mindset in creating the list of line items in the Resource Efficiency section. Our hope is that in the future the prescriptive line items in the guidelines will eventually be replaced with a full LCA approach for the home as a system and the components therein.

Guiding Principle – Energy efficiency

Energy consumption has far-reaching environmental impacts: from the mining of fossil fuel energy sources to the environmental emissions from burning non-renewable energy sources. And each home consumes energy year after year, meaning that the environmental impacts associated with that use accrue over time. Therefore, energy efficiency is weighted heavily in a green building program.

Energy consumption not only occurs during the operation of a home, but also during the

construction of a home and, indirectly, in the production of the materials which go into the home. Although the energy used to heat and cool a home over its life far outweighs that to manufacture the materials and construct it, the large number of homes built (currently about 1.85 million per year) renders the energy used during the construction phase significant.

On average, a home built between 1990 and 2001 consumed about 12,800 kWh per year for space and water heating, cooling, and lights and appliances. Where natural gas is used, consumption averages 69,000 cubic feet per household annually. Total energy expenditures during a year cost these homeowners about $1,600[1]. Energy efficiency improvements that make a home 20% more efficient--a conservative estimate for many green homes--could significantly reduce a homeowner's annual utility bill expenses.

No matter what the climate, energy efficiency is considered a priority in most existing green building guidelines/programs. Moreover, as the cost to heat and cool a home becomes more unpredictable, it is advantageous to every homeowner to be "insulated" from inevitable utility bill increases. As with all aspects of these guidelines, the greatest improvements result from a "whole systems" approach. Energy performance does not end with increased R-values, the use of renewable energy, and/or more efficient HVAC equipment. Rather, there needs to be a balance between these features and careful window selection, building envelope air sealing, duct sealing, and proper placement of air and vapor barriers from foundation to attic to create a truly high-performance, energy-efficient home that is less expensive to operate and more comfortable to live in than a conventionally-constructed home.

Guiding Principle – Water efficiency

The mean per capita indoor daily water use in today's homes is slightly over 64 gallons. Implementing water conservation measures can reduce usage to fewer than 45 gallons[2]. For this reason, green homes are especially welcomed in areas affected by long- and short-term drought conditions.

The importance of water resources is becoming increasingly recognized, especially in the western third of the country. Choices between sending water to growing urban areas versus making water available for irrigation highlight the issues surrounding the scarcity of this valuable resource.

Green homes often conserve water both indoors and out. More efficient water delivery systems indoors and native and drought-resistant landscaping choices outdoors can help prevent unnecessary waste of valuable water resources. Communities can obtain additional benefits when builders effectively use native species in landscaping. Current research and practice has shown that natural processes can be a successful means of filtering and removing contaminants from storm water and wastewater.

Guiding Principle –Indoor environmental quality

Healthy indoor environments attract many people to green building. After energy

1 2001 RECS data

2 American Water Works Association, *1997 Residential Water Use Summary – Typical Single Family Home*

efficiency, the quality of a home's indoor air is often cited as the most important feature of green homes. Pam Sessions, President of Hedgewood Properties in Atlanta, explained during the 2002 National Green Building Conference that the majority of people interested in green homes in the Atlanta market indicated that indoor air quality was their top issue of interest.

An increase in reported allergies and respiratory ailments and the use of chemicals that can off-gas from building materials have contributed to a heightened awareness of the air we breathe inside our homes. Even though there is no authoritative definition of healthy indoor air, there are measures that can mitigate the effects of potential contaminants including: controlling the source, diluting the source, and capturing the source through filtration.

Guiding Principle – Operation, Maintenance and Homeowner Education

Improper or inadequate maintenance can defeat the designer's and builders best efforts to create a resource-efficient home. For example, homeowners often fail to change air filters regularly or neglect to operate bath and kitchen exhaust fans to remove moist air. Many homeowners are unaware of the indoor environmental quality impact of using common substances in and around the house such as pesticides, fertilizers, and common cleaning agents. By providing homeowners with a manual that explains proper operation and maintenance procedures, offers alternatives to toxic cleaning substances and lawn and garden chemicals, and points out water-saving practices, a builder can help assure that the green home that was so carefully built will also be operated in an environmentally responsible manner.

Guiding Principle – Site planning and land development

The process of green home building should not stop at the house. If a builder is also involved in the development of the community, site planning and land development can be part of the process. Considering the entire community and existing infrastructure in addition to the individual building(s) can amplify the benefits of green home building. For example, by improving a subdivision's storm water management plan and preserving natural resources through careful design and construction practices, a builder can influence not only the resource efficiency of each particular house but also the entire subdivision's overall environmental impact. Low Impact Development (LID), which uses various land planning and design practices and technologies to simultaneously conserve and protect natural resources and reduce infrastructure costs, is one way to approach green development.

How Homeowners Can Benefit from Green Building

The previous section highlighted the environmental benefits of green building practices. However, green building is much more than just reducing a home's environmental footprint. Homeowners can also realize direct benefits by owning a green home. Here are some of the primary benefits that owners of green homes have experienced compared to owners of conventional homes:

- **Lower operating costs** – Homeowners receive less expensive utility bills due to energy and water efficiency measures.
- **Increased comfort** – Green homes have relatively even temperatures throughout the home, with fewer drafts and better humidity control.
- **Improved environmental quality** – By following the attached guidelines, builders pay extra attention to construction details that control moisture, choose materials that contain

fewer chemicals, and design air exchange/filtration systems that can contribute to a healthier indoor environment.

- **Enhanced durability and less maintenance** – Green homes incorporate building materials and construction details that strive to increase the useful life of the Individual components and the whole house. Longer-lived materials not only require fewer resources for replacement but also reduce maintenance and the economic costs of repair. Green homes have lawns that require less weeding and watering, building elements that require less maintenance, and more durable building components that reduce the time needed for upkeep.

It is important to note that a builder can only do so much when it comes to how the home will perform. Homeowners play a big role in the house performance and, therefore, should be instructed on how to operate the green home as it was intended.

Guidelines and User's Guide Development Process

The NAHB Green Home Building Guidelines was developed through a public process that included the following major steps:

1. An extensive review of the existing local green home builder programs – primarily home builder association programs, but also including several public sector and nonprofit programs. All but three of the 28 existing programs are voluntary and market-driven.
2. A review of the voluntary energy efficiency programs endorsed by the National Association of Home Builders (NAHB).
3. A review of the leading life cycle analysis (LCA) tools available for use by residential design and construction professionals in North America (e.g., BEES, ATHENA).
4. Input through an open process from numerous individuals on the NAHB Advisory Group and the Stakeholder Group.
5. Applying certain criteria to each line item in order to give the line items point values.

Each line item in the guidelines has a point value attributed to it. Once the Stakeholder Group members finalized the list of line items for inclusion in the guidelines, the NAHB Research Center team looked at each line item through three different lenses: 1) Environmental Impact, 2) Building Science and Best Building Practices, and 3) Ease of Implementation. The team used publicly available information, experiential data, and other data inputs to assign each line item points via these three criteria. Each line item's final point total was calculated by weighting the criteria. Environmental Impact received the greatest weight, followed by Building Science and Best Building Practices, with Ease of Implementation receiving the least weight.

Environmental Impact – The main purpose of these guidelines is to provide a framework for builders to reduce a home's environmental impact. We assessed how each line item helped make a home more energy efficient, improved indoor environmental quality, and so on. Assigning a value to each line item is an inexact science since all of the necessary data is not available. In addition, some line items had impacts that spanned multiple principles and, in some cases, the impact was positive for one guiding principle while negative for another. With that as background, the NAHB Research Center team took into account all of the above considerations and available data to assess the environmental impact of implementing each line item. Using qualitative and quantitative information, the team assigned value to each line item based on the

positive impact to the environment.

Building Science and Best Building Practices – Certain green building practices dramatically impact how a house operates. For example, the sealing of a home's building envelope has an impact on the home's HVAC system. In addition, some measures such as proper flashing details and installation of weather barriers enhance durability, minimize the possibility of indoor environmental problems, and are considered "best building practices." Line items that help a home perform effectively as a system for the long-term were assigned a higher point value.

Ease of Implementation – Some line items are easier to implement than others. The NAHB Research Center team compared each line item to current home building practices and estimated how difficult it would be for a builder to implement the line item relative to primarily cost and time. For instance, would it take longer to install a new technology? Would subcontractors need to be educated on the use of a new product? Would a new technology cost more to buy? A line item will have a positive environmental impact only if it is implemented. Line items that were relatively easy to implement (and therefore more likely to be implemented) were assigned a greater point value than the items that are more difficult to implement.

The User's Guide (Version 2 of the Guidelines)

Several months into the pilot stage of the program roll-out, participants realized the the guidelines were imperfect and, in response, the Keystone GBI committee formed a sub-committee of Technical Documents to review and revise the guidelines. The goal of the revisions was mainly to clarify the existing documents. Along the way of that, the subcommittee also found a need to 1) add provisions for new points allowances 2) remove redundant or contrary sections and points 3) change points allowances to more accurately reflect the three criteria mentioned above. The subcommittee further determined that a more reasonable schedule of the various levels of certification to the required points attainment.

The document you are currently reading is the culmination of that work and to distinguish it from previous versions and from the other documents used in the program, the name was changed from 'Guidelines' to 'User's Guide.'

Various Levels of "Green"

Homebuilders differ in their relative knowledge and comfort level with green building concepts. Some builders have been building green for years, while others are being introduced to the ideas for the first time. Recognizing this broad range of knowledge, the NAHB Research Center team established various thresholds to delineate different levels of green building effort.

The first step was to identify practices that should be part of any home building project. The first level of green building, Bronze, includes additional line items that in the end show that a builder paid special attention to a project's environmental impact. The next three levels of green home building, Silver, Gold, and Platinum, include additional line items that place increasingly greater emphasis on the home's environmental impact. The "How to Use the User's

Guide" section of this document outlines how to score a home to determine if it meets or exceeds any of the green home building levels noted above.

The Uncertainties of Green Building

It should be noted that although many green building programs have been in existence for 10 years or more, the concept and practice of green building is not clearly defined and straightforward. Many gray areas remain in identifying and quantifying the precise environmental impact for each particular line item. For example, there is very little publicly available information regarding manufacturing processes that document energy consumption, impact on natural resources, or CO2 emissions for each building material.

In addition, a particular guideline may contain trade-offs and carry with it contradictory characteristics. For example, a recirculating hot water system can help save conserve water, but may use a relatively large amount of energy in its operation. Although the guidelines in their current form are based on experiential evidence and the latest independent scientific research available, they still may leave many questions unanswered due to the lack of scientific and quantitative data.

Finally, assigning a particular degree of importance to different criteria undoubtedly involves a certain amount of personal or local value judgment. Life Cycle Assessment (LCA) tools are beginning to sort out such questions, but the tools still remain in their infancy. Therefore, this set of green home building guidelines should be viewed as a dynamic document that will change and evolve as new information becomes available, improvements are made to existing techniques and technologies, and new research tools are developed.

How to Use the User's Guide

The User's Guide is organized by the guiding principles listed above. However, there are two underlying ideas that everyone should keep in mind before undertaking a green home project. First, environmental considerations should be incorporated into the project from the very beginning. It is much harder to weave green home concepts into a project after the house plans are finished. Second, the house should be looked at as a whole as the builder determines which of the green home guideline items to put into the house. For example, making a home's building envelope tighter through air sealing and quality building techniques can affect the way in which the builder designs the home's ventilation system. It is through such a forward-thinking process that builders can gain cost efficiencies.

Two other documents are used in conjunction with the User's Guide.

Keystone GBI Checklist

The first companion document is the Checklist which is an itemization of line items and points. Each section includes the line item title, the point value, and columns to indicate strategies/points that you propose to attain, points one thinks are still possible for this particular project.

It is again recommended that a builder first become familiar with the line items prior to designing a home to help introduce concepts that a builder can incorporate into the home's

design, construction, and operation.

Keystone GBI Handbook

The second companion document is meant to be used in the field and provides a smaller alternative to the User's Guide. The handbook concisely describes points attainment.

To help a builder holistically incorporate green building into homes, the Keystone GBI team established several green building point levels to achieve for each section of the program. The point system is described below.

Point System

There are four different levels of green building available to builders wishing to use these guidelines to rate their projects – Bronze, Silver, Gold, and Platinum. At all levels, there are a minimum number of points required for each of the seven guiding principles in order to assure that all aspects of green building are addressed and that there is a balanced, whole-systems approach.

Section 1 Lot Design, Preparation and Construction

1.1 Select the Site

1.1.1 Avoid environmentally "sensitive areas" as identified through site foot-printing process or existing third party data. (up to 2 points)

Intent: Thoughtful site selection can be the first step to building a green home. By avoiding environmentally sensitive areas, a builder can help preserve land that might function as a wildlife corridor, recreational open space, or habitat sanctuary. Selecting a site that has at any time been identified as an environmentally "sensitive area" will receive no credit for this line item, regardless of the site's classification at the time of construction.

How to Implement: "Sensitive areas" may be identified within a comprehensive plan, by a wetland institute, or by the local jurisdiction. Other excellent sources of detailed information about a site are professionals such as arborists, landscape architects, ecologists, and wildlife biologists. These experts can provide assistance in identifying a potential site's natural resources and environmentally sensitive areas.

Points:

- Elevation lower than 100 year flood plan (FEMA) 0.5 pt
- Habitat area (fed or state threatened or endangered list) 0.5 pt
- Within 100 feet of water (includes wetlands) 0.5 pt
- Prime farmland 0.5 pt

How to Verify: Any one of the following: comprehensive plan; wetland institute; local jurisdiction's guidelines; site foot-printing process results; set of site plans.

1.1.2 Choose an environmentally and community friendly site. (up to 3 points)

Intent: An environmentally friendly & community friendly site can interpreted as a site that is infill, Greyfield, pedestrian-oriented or and EPA-recognized Brown field site. An infill site can effectively conserve resources (e.g. infrastructure) and preserve open space that could be lost from "green field" development. A Greyfield site is defined as "any site previously developed with at least 50% of the surface area covered with impervious material." Greyfield redevelopment allows for the preservation of open space and wildlife habitat in the midst of growth and pedestrian oriented sites are ones that have shopping, community and transportation resources within walking distance reducing the use and need for automobiles. And, remediation of a Brownfield site results in the environmental restoration of a polluted site, a transformation that makes an abandoned site habitable. The U.S. Environmental Protection Agency characterizes Brownfields as "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant."

How to Implement: Infill areas are vacant or underutilized lots of land, served by existing physical installations such as roads, power lines, sewer and water, and other infrastructure. The development of Greyfields, as defined above, can be daunting, but local or national incentives may exist to reward those builders who go through the process. Incentives may include the elimination of development related fees, contribution from the local government in the development of off-site improvements, and tax breaks. For more information, contact the Congress for the New Urbanization, Urban Land Institute, American Planning Association, or

the International Council of Shopping Centers. Grants, loans, and training are available through the U.S. EPA's Brownfield Initiative to assist builders and developers in the remediation and development of Brownfield sites.

Points:

- Infill site 1 pt
- Greyfield site 1 pt
- Pedestrian Oriented 1 pt

  OR
- EPA-recognized Brownfield site 3 pt

How to Verify: Site plan and/or verification from a Federal, state, or local Brownfield's site inventory list or representative that the site is a Brownfield.

1.1.3 Urban-oriented site. (up to 3 points)

Intent: The intent of this strategy is simply to maximize the number of units per acre. This increases the utilization of the developed site and reduces the need to develop additional acreage.

How to Implement: Municipalities, zoning and permitting authorities are increasingly aware of this strategy in maximizing the utilization of a given site and creating or preserving open space as a trade-off. This can also increase efficiencies for the builder/developer by reducing infrastructure costs, site development costs and utility fees. Discuss this strategy with zoning and permitting authorities to create awareness of the advantages to the overall community.

Points:

- 7 units per acre 1 pt
- 10 units per acre 2 pt
- 20 units per acre 3 pt

How to Verify: Site plan and/or calculations submitted to permitting authority from civil engineer.

1.1.4 Open Space/Increased Density (over ordinance) (1,3 or 5 points)

Intent: This strategy goes hand in hand with 1.1.3 in that municipalities will often agree to higher densities in exchange for the creation of open space. However, this goes beyond the credits for 1.1.3 in that the builder/developer willfully goes beyond ordinance requirements to create or contribute to public parkland.

How to Implement: Discuss this option with zoning and permitting authorities to create awareness of the benefits and advantages to the overall community as well as adding value to the potential home buyers.

Points:

- 10% of total site 1 pt
- 25% of total site 3 pt
- 50% of total site 5 pt

How to Verify: Site plan and/or calculations submitted to permitting authority from civil engineer.

1.2 Identify Goals with Team (Required)

Intent: One of the earliest challenges for a builder in developing a "green" lot is

assembling an effective team to help the builder implement best "green" practices throughout the process. Those involved in the development phase must understand what the mission of the site is, what it means to be a "green" lot, and why they should follow "green" practices. Once this baseline is established, coordination and communication with and among the various team members is essential to successfully develop a "green" lot.

How to Implement: Before ground is broken, all parties that will be involved in the lot development (the team) should understand that the lot will be developed as a "green" site. Examples of possible team members include staff, site superintendents, utilities, excavators, landscape architects, wildlife biologists, ecologists, arborists and green building professionals. Once the "green" intent of the builder is communicated to the lot development team, the builder should work with the team throughout the development process to identify and delegate responsibilities of different team members, as well as facilitate coordination between the members to achieve best green practices.

How to Verify: Create and submit a written project mission statement, goals, team members and their respective roles in the project.

1.3 Design the Site

1.3.1 Conserve natural resources (up to 4 points)

Intent: on-site natural resources concern such features as solar energy availability, flora, fauna, water, soil, and geological formations. A natural resources inventory should be completed to identify the site's environmental attributes. Based on this inventory, a builder can then identify high priority resources for conservation (e.g. trees, waterway, snags, and micro-habitats) and plan for the conservation of those resources during each stage of site development.

As the frontier of home building continues to expand, sharing the land with wildlife becomes an increasing challenge to builders. Through individual initiative or participation in a wildlife conservation program, home builders can work to create a habitat where both wildlife and humans can thrive – whether in an urban, suburban, or rural setting.

How to Implement: On complex sites, a natural resources inventory may be performed by a qualified professional such as an arborist, wildlife biologist, or landscape architect. Simpler sites, such as previously developed sites or farmland, might be adequately inventoried by knowledgeable, but less qualified individuals. Whoever ultimately conducts the inventory should be able to discern between invasive and regionally appropriate vegetation, understand how to site a house to permit it to achieve its maximum solar energy potential, be able to identify areas important to wildlife habitat, and understand how natural features can be used in managing storm water on-site

A protection and maintenance plan should be drafted to detail how resources identified through the inventory will be protected throughout development. In addition to protecting priority areas from intrusion during development, a maintenance plan should be created to ensure that priority vegetation survives development. Within the maintenance plan, include plans and information on fertilizing and watering trees needed before, during and after development. Where vegetation must be removed, recycle these trimmings either on-site, using it for soil stabilization for example, or off-site within 50 miles.

Examples of programs: USDA National Resources Conservation Service's Backyard Conservation Plan; the Audubon at Home; or the national Wildlife Federation's Backyard Wildlife Habitat Program. Enhance quality of habitat, including food sources, diversity of

habitat, and protective areas, through selective plantings and site design. Leave snags (dead tree or portion that is left for habitat) and provide bird houses.

Points:

- Protect stock piled topsoil (NAHB 1.4.3 D) 0.5 pt
- Stabilize disturbed soils 0.5 pt
- Silt fencing & runoff design (NAHB 1.4.3 C) 0.5 pt
- Protect runoff from steep slopes 0.5 pt
- Protect inlets w/ straw bales, fencing, etc. 0.5 pt
- Recycle trimmings on-site or off-site with 50 miles 0.5 pt
- Participate in local natural resources protection program 1 pt
- Participate in a wildlife conservation program 1 pt

How to Verify: Create a pre- and post-development natural resources inventory; develop a protection and maintenance plan; submit a certificate or letter indicating participation in a local natural resources conservation program. Certificate or letter indicating participation in a wildlife conservation program.

1.3.2 Optimal solar-oriented site planning (up to 4 points single home; 12 points community of twenty or more)

Intent: Thoughtful orientation of a home can allow it to maximize its solar heating potential in the winter and minimize its solar gains in the heat of the summer. Orienting a home to optimize its solar resource inevitably reduces the life cycle pollution caused by a home reducing its energy use.

How to Implement: There are many factors to consider when siting a home. A builder should consider such issues as slope, storm water management, local solar angles, and high priority vegetation in determining the optimal site for each home. The final decision in siting a home will generally involve a compromise between these many factors.

Points:

Single Homes or individual unit: (up to 4 points)

- Facade within 10 degrees of due south to be the longest facade (by 25% minimum) 1 pt
- Fenestration area along facade within 10 degrees of due south to be 10-25% of total floor area 1 pt
- Fenestration along facade within 10 degrees of due south to be to be shaded (using F factor = 2.0) 1 pt
- Fenestration along facade within 10 degrees of due south to be Shaded using deciduous trees/vegetation 1 pt

Communities of Twenty or More Homes: (add up to 8 points)

- Facade within 10 degrees of due south to be longest facade (by 25% minimum) 90% of all homes 2 pt
- Fenestration area along facade within 10 degrees of due south to be 10-25% of total floor area for 90% of all homes 2 pt
- Fenestration along facade within 10 degrees of due south to be shaded (using F factor = 2.0) for 90% of all homes 2 pt
- Fenestration along facade within 10 degrees of due south to be shaded using deciduous trees/vegetation for 90% of all homes 2 pt

How to Verify: Submit house and/or site plans.

1.3.3 Minimize slope disturbance (up to 1 point)

Intent: By not disturbing a slope when siting a home, builders reduce the chances of disturbing natural hydrological drainage and causing long and short-term erosion on the site which can pollute water sources and damage local ecology.

How to Implement: Within these guidelines, steep slopes are defined as those slopes that are greater than or equal to 25%. (Note: points should only be awarded if there are developable steep slopes in the area.)

Reducing cut and fill practices can prevent unnecessary stripping of vegetation and loss of soils and reduce the need for additional resources to be brought in from off-site.

Points:

- Steep slope disturbance (25% of sloped area maximum) 0.5 pt
- Long term erosion control 0.5 pt
- Road/driveway design that minimizes cut/fill 0.5 pt

How to Verify: Hydrological/soil stability study results and/or topographical map/site plan with contour lines.

1.3.4 Minimize soil disturbance and erosion (up to 1 point)

Intent: Sediment and pollutants contained in the sediment are recognized as a reason that water bodies do not meet their intended uses. Exposed soils should be minimized to reduce erosion, promote water quality, and reduce damage caused to native vegetation.

Heavy equipment and excessive digging can result in compaction or loss of topsoil along with the introduction of invasive and problematic flora. By minimizing soil disturbance and erosion you can both reduce stresses on downstream water bodies and you can save valuable topsoil for the site.

How to Implement: NAHB has published a manual on storm water. In addition, many states have voluminous manuals on this topic. Methods include silt fences, sediment traps, vegetated buffer areas, and mulching. More permanent solutions include biomechanical devices such as swales and vegetated buffers. Use alternative means to install utilities, such as tunneling instead of trenching, use smaller equipment, shared trenches or easements, and placement of utilities under streets instead of yards. Demarcate limits of clearing and grading, clearly delineate the no cut/no clear lines on plans and in the field.

By permanently stabilizing the disturbed ares as soon as possible, builders reduce sediment that must be trapped in before it leaves the site. Stabilize using permanent seeding and planting, mulching, geo-textiles, and sod stabilization.

Points:

- Site disturbance plan (<35% of site if over 1/4 acre) 0.5 pt
- Alternate utility installation 0.5 pt
- Stabilize disturbed areas (per EPA) 0.5 pt

How to Verify: Submit sediment and erosion control plans.

1.3.5 Storm water management (up to 6 points)

Intent: Percolation through soil is one of the most effective means for filtering pollutants carried by storm water. By using natural water and drainage features, minimizing impervious surfaces, and distributing storm water flows, builders can reduce harmful pollutants carried off site while safely and effectively managing much of their storm water load on-site

How to Implement: Use open space and natural systems such as vegetative swales,

French drains, wetlands, drywells, and rain gardens that promote water quality and infiltration. Limit impervious surfaces to 50% of site or combine driveway access to two or more homes. Design plantings to stabilize soils, encourage infiltration, and minimize landscape water demand using indigenous and well-adapted, native plant species. Limit the use of turf grasses because of their relatively shallow root structures. Plant one tree or four 5-gallon shrubs per 500 square feet of disturbed construction area

Points:

- Permanent storm water control (swales, terracing, rain barrels or rain gardens) 1 pt
- Limit impervious surface to 50% of site 1 pt
- Tree and vegetation planting 1 pt
- Shared driveways 1 pt
- Use pervious material for minimum 50% paved surfaces 2 pt

How to Verify: Submit storm water management and/or landscape plan.

1.3.6 Water and energy efficient landscaping (up to 3 points)

Intent: Landscaping water can account for up to 50% of a home's total water use needs. Conservation of this valuable resource through such techniques as hydrozoning, reducing turf area, and selecting regionally appropriate plants is a key component to responsible building. Thoughtful selection and placement of plants can also reduce heating/cooling loads of a home, provide habitat for native fauna, and minimize the heat-island effect of developments.

How to Implement: Select landscaping materials and vegetation to fit site conditions. Regionally appropriate plants are hardy plants that can withstand local water and temperature conditions such as freeze, heat, drought and rain. Regionally appropriate plants will also not be overly prolific or invasive and will be able to coexist with other native plants over time. Another important benefit of landscaping with natives is the minimization of maintenance (reduces emissions of equipment) and fosters wildlife habitat. EPA's Mid-Atlantic Region Green Landscaping (http://www.epa.gov/reg3esd1/garden/what.htm).

Limiting the ratio of turf area to total landscaped area due to maintenance requirements of turf versus natives and regionally appropriate trees and vegetation is good practice. In some areas there be restrictions on what percentage of turf the front yard must be. Research has shown that homeowners are comfortable with having as little as 50% of the front yard composed of turf. Fewer regulations are imposed on turf to landscaping ratio in the backyard, so good gains might be made more easily here.

Also, developers may wish to consider enforcing guidelines for the protection of on-site vegetation and care should be taken to grind only regionally appropriate plants as grinding invasive species could increase their propagation and result in the ultimate destruction of native species.

Points:

- Install native drought-tolerant vegetation 1 pt
- Limit turf to sunny areas only 1 pt
- Design trees to shade 50% of hardscaping 1 pt
- Vegetative windbreaks 0.5 pt
- Non-toxic pest control 0.5 pt

How to Verify: Submit landscape plan with list of native plants.

Intent:
How to Implement:

1.4 Develop the Site

1.4.1 Tree/vegetation protection (up to 4 points)

Intent: Minimize disturbance of and damage to trees and other vegetation designated for protection through installation of fencing and avoidance of trenching, significant changes in grade and compaction of soil and critical root zones. Once a builder has identified, during the planning stage, what existing vegetation will be conserved on-site, practical steps must be taken during the development stage to achieve the intended conservation.

How to Implement: Steps include pre-development preparation of the vegetation and protection of the foliage, soil, and root system of designated vegetation. Prepare designated existing trees and vegetation for the impacts of construction through pruning, root pruning, fertilizing and watering. It is required to develop an onsite site development plan and, provide on-site supervision & coordination during clearing, grading, trenching, paving and installation of utilities to ensure that targeted green development practices are implemented.

Points:

- Construction zone fencing/demarcation 0.5 pt
- Improve soil with organic amendments 0.5 pt
- Compaction protection using mulch 0.5 pt
- Coordinate clearing, grading, trenching 0.5 pt
- Relocation of trees (>3")/large shrubbery (> 3'ball) (0.5 per plant) up to 2 pt

How to Verify: Submit protection and maintenance plan and/or site plan.

Section 2 Resource Efficiency

2.1 Reduce Quantity and Waste of Materials

2.1.1 Create an efficient sized home (-10 to + 10 points)

Intent: Designing and constructing an efficiently sized home conserves the initial consumption of resources, reduces operating costs and maintenance costs as well. Good design and forethought can create a well functioning home that is efficient to build, operate and maintain. Promoting smaller homes encourages builders and owners who reverse the trends of bigger houses, increased energy consumption, increased material consumption, and increasing sprawl. Building on a smaller footprint is encouraged in order to reduce the amount of land consumed by the building itself. Making use of basements for living space improves the ratio of living space to footprint.

How to Implement: Assign area based on conditioned space (per ANSI Standard Z765). Basements that have egress and which are, or can be, finished for living space should be assessed at 50%. Basements and crawl spaces without egress which are minimally conditioned simply as a measure to improve the energy performance and durability of the home will not be counted towards the total.

Points:

Single Family Homes (neutral zone/no points or penalty)

- 1 Bedroom – 1600 square feet
- 2 Bedroom – 2000 square feet
- 3 Bedroom – 2400 square feet
- 4 Bedroom - 2800 square feet
- 5 Bedroom – 3200 square feet
- 6 Bedroom – 3600 square feet
- -150 square feet = + 1 point (+10 points maximum)
- +200 square feet = - 1 point (-10 points maximum)

How to Verify: Submit house plans.

2.1.2 Advanced framing techniques (up to 8 points)

Intent: Advanced Framing or Optimum Value Engineering refer to framing techniques that reduce the amount of materials used to build a home while maintaining the structural integrity of the home. Using advanced framing techniques results in using fewer structural resources to erect a building. An optimum value engineered assembly tends to use less energy for space conditioning because the omitted (and redundant) structural components can be displaced with insulation that yields a higher R-value. Exterior wall joints normally are constructed with an abundance of studs to form the corners and create nailers for exterior sheathing and interior drywall. Alternative techniques are used to reduce the number of studs resulting in less material needed, reduction of thermal bridging across the wall, and provide space for insulation. Accordingly, the user will note that some advanced framing techniques receive points for both Resource Efficiency and Energy Efficiency.

How to Implement: Advanced framing elements can be applied independently, or adopted in the entirety, depending upon the specific requirement(s) of the project. Framers unfamiliar with the techniques may need training, and the initial use of these techniques may

temporarily slow down operations. In general, more planning is needed to implement these elements. Some of the benefits of advanced framing include reduced first cost (3-5% of framing cost), improved energy efficiency (2-5% per year) and improved resource efficiency (less wood consumption and waste). Advanced framing uses engineering principals to minimize material usage while meeting model building code structural performance requirements. To maximize material savings, window sizes and placement should be coordinated with the stud layout.

Points:

- Insulation at exterior wall joints — Required
- Two stud corners with drywall clips — 1 pt
- Ladder style connections at wall junctions — 1 pt
- 24" on-center joist, stud and rafter spacing — 1 pt
- Actual-sized headers, insulated at exterior walls — 1 pt
- No headers at non-load bearing openings — 1 pt
- Stacked framing — 1 pt
- Single top and bottom plates — 1 pt
- Windows sized & placed to avoid additional studs — 1 pt
- Cripple-studs for windows placed 24" on center — 1 pt
- Header hangers with single king stud — 1 pt

How to Verify: House framing plans.

2.1.3 12"/24" overall dimensions of building (4 point)

Intent: Use building dimensions and layouts that maximize the use of the resources. Use of standard or modular dimensions in layout will reduce waste by not having to cut materials.

How to Implement: Modular dimensioning was adopted in the late 1960's and is widely used. Adherence to modular dimensioning can reduce waste of material on the job site. Building to a 2' module and using 24" on-center wall and floor framing will maximize framing material resource efficiency and cost savings. Few homes can be entirely confined to a rigid module because typical dimensions such as the width of a tub or corridor are not in two-foot modules.

Points: 4 pt

How to Verify: House framing plans.

2.1.4 Create a detailed framing plan and material take-offs, precuts (2 points)

Intent: Recognize the benefits of careful planning in the design, purchase and installation phases. A framing plan provides a blueprint for the layout of each piece of lumber. A plan eliminates redundant (off-layout) studs at window openings or joists at stair and mechanical chase openings that can act as thermal bridges. The layout provides an accurate count for generating a bill of materials that reduces job site waste.

How to Implement: A detailed framing plan can be as complex as a three dimensional perspective generated in a computer assisted design (CAD) program or as simple as an 1/8" scale drawing detailing the floor, wall, or roof size, lumber or component layout, dimensions for rough openings, headers and girders, and blocking locations.

Points: 2 pt

How to Verify: Framing plan and cut list.

*2.1.5 Efficient building systems (SIPs; ICFs) (*in lieu of 2.1.2/) (up to 8 points)*

Intent: Utilizing materials that do not require additional and/or on-site assembly

optimizes plat manufacturing efficiencies and offers protection from the elements. Building systems such as SIP's (Structural Insulated Panels) and ICFs (Insulated Concrete Forms) meet this criterion. These systems arrive at the site ready to assemble therefore they go together more quickly and efficiently.

How to Implement: Precut material packages arrive at the site marked for their location on a layout plan that is provided on the blueprint or with the package. Delivery can be scheduled for just-in-time delivery to minimize site disturbance and exposure to the elements. Not having to cut or calculate the position of the components speeds assembly, eliminates waste and saves labor. Contractor focused lumberyards and component manufacturers that supply engineered materials will have the resources to provide this value added service.

Points: 2 pt per component (foundation, floor, wall, roof)

How to Verify: Product literature and/or supplier invoice.

2.1.6 Pre-assembled/engineered framing buildings or components (up to 5 points)

Intent: These are additional building components that have virtually the same benefits as those described in the previous section…rapid assembly, protection from the elements and less time and resources spent on-site.

How to Implement: I-Joists engineered and precut for floor and roof systems perform as capably as wide dimension lumber and present opportunities to reduce resources in a home. Panelized wall systems, manufactured in a factory, benefit from efficient purchasing and use of materials, automated cutting and fastening methods, and assembly in an environment that is protected from the elements. Panels are custom manufactured and delivered to meet the builder's schedule. A layout plan aids the carpenter in assembling the walls on site. Using panels can save several days in the critical path of assembly and speed the process of "closing-in" the home. Note that SIPS construction is considered separately from this section (see 2.1.5).

With modular construction entire sections of the home are constructed and transported to the site. Modular housing goes further in reducing waste on the site, since the unit is wired, plumbed, insulated, and has gypsum wallboard installed, etc. Modules are moved onto a site-built foundation, connected, repaired at common junctions and tied in to utilities. Homes can be made ready for move-in within one week.

Points:

- I-Joists floor systems 1 pt
- I-Joists roof system 1 pt
- Panelized wall framing 1 pt
- Panelized roof framing 1 pt
- Pre-cast foundation 1 pt

  OR
- Modular home 4 pt

How to Verify: Framing plan

2.1.7 Foundation material reduction (1 pt)

Intent: Alternative techniques for constructing the foundation can result in less consumption of resources. Constructing a shallow, or slab, foundation requires less excavation and concrete. Foundation systems which do not require footings requires less concrete.

How to Implement: Shallow foundation systems must be protected from frost and thermal bridging by insulating the perimeter to levels required by code or to at least R-5,

whichever is greater. Ideally, insulation is be placed exterior to the foundation Placing insulation behind the stem wall and below the perimeter of the slab is acceptable so long as the stem wall and the slab are thermally broken with R-5 or greater and the under-slab insulation extends at least two feet horizontally. Engineered foundation systems that do not require concrete footings are often custom orders with specific requirements for crushed stone or other material in place of the concrete.

Points:

- Frost-protected shallow foundation 1 pt

  or

- Engineered foundation without concrete footing 1 pt

2.2 Enhance Durability and Reduce Maintenance

2.2.1 Covered entries (all entries 24" +) (1 point)

Intent: A roof over an entry to a home sheds precipitation and sunlight from the opening, protecting door finish and penetration of moisture around jambs, trim and threshold, minimizing the need for maintenance of these areas. Roofs over entries provide a convenience for the occupant during foul weather and are an architectural feature that can enhance the home's visual appeal and provide an outdoor living space.

How to Implement: Designs should include a roof or recessed front opening of a depth equal to or greater than the recommended roof overhang for the region.

Points: 1 pt

How to Verify: House plans.

2.2.2 Region-specific overhangs (south, all openings) (2 points)

Intent: Protect building envelope and enhance the home's durability through the use of overhangs. Use overhangs to shade windows from summer heat gain.

How to Implement: For this region, southeast Pennsylvania, with a climate index of 41-70 the eave overhang should be 18" and the rake overhang should be 12".

Points: 2 pt

How to Verify: House plans.

2.2.3 Moisture protection/durability (up to 5 points)

Intent: Building designs, material choices and installation techniques should seek to minimize the effects of degradation and weathering, enhance life expectancy of the assembly, and lessen the maintenance inputs required. All of the strategies listed in this in this section contribute to the enhanced durability of a home.

How to Implement: Durability may be defined as the ability of a material, product, or building to maintain its intended function for its intended life-expectancy with intended levels of maintenance in intended conditions of use.

Fortunately, many of the best practices intended to improve durability require little more than good judgment and a basic knowledge of the factors that affect building durability. A thorough review of resource publications will provide a solid foundation for addressing

durability during the stages of construction.

Points:

- Perimeter drain — Required
- Water Resistant Barrier — 0.5 pt
- Drip edge (roof overhangs) — 0.5 pt
- Slide backfill 6”/10’ — 0.5 pt
- Enhanced foundation waterproofing — 0.5 pt
- Ice flashing at roof edge — 0.5 pt
- Gutter/downspout leader (5 ft from foundation) — 0.5 pt
- Flashing at all wall openings — 0.5 pt
- Flashing roof at all valleys — 0.5 pt
- Flashing at decks — 0.5 pt
- Drip cap (windows, doors, etc.) — 0.5 pt

How to Verify: House plans; site plan; photo documentation; field inspection.

2.2.4 IPM/Integrated Pest Management (up to 1 point)

Intent: IPM/Integrated Pest Management is an important strategy in assuring the durability of a home. Many pests, including rodents and insects, can severely compromise the durability, comfort and even the overall health of a home and its occupants. It is important to take steps to reduce the risk of infestation and damage that can caused by a wide variety pests.

How to Implement: First, it is important to recognize the potential of pest damage in your specific region. Not all regions have the threat of termites but most every region is vulnerable to some sort of pest that can cause considerable damage to home in a short period of time, particularly if the infestation is not recognized and quickly mitigated. Allowing susceptible materials to dry before they are enclosed reduces their attractiveness to pests. Restricting access is the best prevention and should become common practice in all home construction.

Points:

- Seal all penetrations and access points — Required
- Install continuous & physical termite barrier (in areas of subterranean termite infestation) — 0.5 pt
- Use termite-resistant materials (in areas known to be termite infested) — 0.5 pt
- Keep plantings >24” away from wood — 0.5 pt

How to Verify: Written IPM strategy; field inspection.

2.3 Reuse Materials

2.3.1 Disassemble existing building (25% + salvaged) (1 point)

Intent: Construction activities may be responsible for using as much as 40% of all raw materials extracted from the earth while construction, remodeling and deconstruction are blamed for generating 136 million tons of waste, annually. Some material from the waste side of this equation could easily be refitted back into a structure. The action would decrease both material use and waste. In addition, unneeded transportation costs could be eliminated.

How to Implement: Developing and implementing a plan to use materials prudently, regardless of their origination, is a requirement of this section.

Points: 1 pt

How to Verify: Photo documentation; list of components.

2.3.2 Re-use Salvaged materials (50% + of components) (up to 5 points)

Intent: To minimize the waste stream by re-using materials. Ideally, the salvaged materials should be reclaimed from nearby or on-site demolition or remodel so that transportation is minimized.

How to Implement: Materials can come from the de-constructed building in 2.3.1 or from another source. Salvaged materials can be used for fill material, base for paved areas, or within building(s). This may include, but is not limited to crushed concrete, salvaged wood, steel, brick, salvaged architectural materials such as windows, doors, paneling, cabinets, etc. Salvaged windows and doors should not be used at the expense of energy efficiency.

Disclaimer – Salvaged materials must meet minimum standards for materials, where applicable. In addition, a caveat to this line item is to be careful of lead paint and other potentially hazardous finishes that could be part of existing materials.

Points can be provided if the total cost of the salvaged materials (including material costs and labor costs, i.e. installed costs) is equal to or greater than 1% of construction costs.

Points:

- Windows 1 pt
- Masonry 1 pt
- Plumbing/Fixtures 1 pt
- Framing 1 pt
- Ornaments 1 pt

How to Verify: List of components and photo documentation.

2.3.3 Bin collection system on-site (for scrap reuse) (1 point)

Intent: This practice will establish a central storage area to encourage maximizing usage of all materials on the site. Workers are less likely to waste material that will be subject to future inspection, those same workers are most likely to seek and use scraps if they know where to find them quickly, and the remnants that were not incorporated into the job are already sorted for grinding or recycling.

How to Implement: Trade persons' scopes of work should include the removal of remnants from in and around the building to a designated central area. The re-use area should be well marked or delineated for the size, type, and quantity of material that would be expected, as well as, conveniently located on the job site

Points: 1 pt

How to Verify: Written C & D waste management plan.

2.4 Recycled Materials

2.4.1 Recycled materials (20% per component) (up to 3 points)

Intent: To minimize the impact of home building on the environment.

How to Implement: A builder can obtain two points for this line item if they incorporate at least two different types of recycled-content building materials into the home's construction. An additional point can be obtained for including a finish material composed of recycled material.

Post-consumer means that the materials have been used by a consumer. Post-industrial can include waste materials from within a manufacturing site that is fed back into the manufacturing process as feed-stock AND it also includes materials from outside the plant that is waste elsewhere, has not gone to a landfill or consumer yet, but is along the lines of an eco-industrial park concept.

The results of a CIWMB study on Building Material Emissions indicate that recycled content products should no longer be subject to greater scrutiny. In fact, recycled content products perform about the same as standard products. Both alternative and standard products have the potential to emit chemicals of concern.

Points:

- Framing 1 pt
- Foundation 1 pt
- Finishes (flooring, drywall, carpet) 1 pt

How to Verify: List of components used and photo documentation.

2.5 Waste Reduction

2.5.1 Waste management (up to 4 points)

Intent: Create a C & D (Construction & Demolition) waste management plan that sets goals to recycle or salvage a minimum of 50% (by weight) of construction, demolition, and land clearing waste.

How to Implement: A C & D plan can be a simple spread sheet that covers the materials used or de-constructed on site and the plan for using them on site, again, or recycling, including the name of the hauler, destination, and approximate quantities. A sample plan can be obtained from the city of Agoura Hills, CA in the Resources.

Points:

- 2 lb./SF 1 pt
- 1.5 lb./SF 2 pt
- 1 lb/SF 3 pt
- 0.5 lb/SF 4 pt

How to Verify: Copy of C & D waste management plan.

2.5.2 Recycling (up to 6 points)

Intent: Through a recycling program, divert from the landfill a minimum of 50% (by weight) of construction, demolition, and land clearing waste. Through grinding, divert from the landfill a minimum of 50% (by weight) of construction, demolition, and land clearing waste. Reduce transportation-related environmental costs.

How to Implement: This task may also be part of the builder C & D plan. It involves the successful offsite recycling of materials that might otherwise have been sent to a landfill. Grinding and similar processes that provide on-site processing and reuse of what would otherwise have been waste require cost analysis of the operation. Large homebuilders have reported successful integration of a grinder into their field operations. For small volume builders there may, , be someone locally in business with a mobile grinder operation that could service a small job efficiently.

Points:

- Gypsum wall board recycling 1 pt

- Corrugated cardboard recycling 1 pt
- Metals recycling 1 pt
- Masonry 1 pt
- Lumber & wood products 1 pt
- On-site processing 1 pt

How to Verify: Contractual agreement between the recycling firm and the builder; documentation on materials that have been recycled; list of components recycled. Copy of C & D waste management plan including information on what materials are going to be ground for the project.

2.6 Renewable Materials

2.6.1 Use materials manufactured from renewable resources (up to 12 points)

Intent: Use building products that use carbon sequestration, i.e., made from plants that take carbon from the atmosphere and store it as fiber.

How to Implement: A builder can obtain up to twelve points for this line item, two points per component, if they incorporate up to six different types of renewable resources into the home's construction. Examples of "components" are sub-flooring, exterior sheathing, roof sheathing, interior trim boards, cabinets.

Careful review of the material manufacturer's claims and material specifications is required for this task. Points should be given for each material specified and used. Note: Products that comply with this section of the User Guide should also comply with the IEQ section of the Guide. For example, composite wood or agri-fiber panel products should not contain process added urea-formaldehyde resins or must be third party certified for low formaldehyde emissions. Particleboard, oriented strand board (OSB), medium density fiberboard (MDF) and hardwood plywood substrates must be certified to low formaldehyde emission standards ANSI A208.1, ANSI A208.2 and ANSI/HPVA HP1, respectively.

Similarly, bamboo flooring manufacturers should produce a copy of the lab test results, by an American laboratory, for their products. The results should include a formaldehyde test and a hardness and stability (expansion/contraction) test.

Points:

- 2 pt per component/system (must be at least 75% of component).

How to Verify: List of components used and photos.

2.6.2 Use certified wood products (up to 12 points)

Intent: Preserving our natural resources includes the commitment to best practices in forest management, like practices that maintain and restore the health of the forests and its ecosystems. Forest certification systems provide the producers that assure the reliable supply without damaging the forests.

How to Implement: A comparison list of the North American certifiers is provided by the Forest Certification Resource Center, in Resources. Below is a list of the third-party certified sources applicable to this line item.

- The Sustainable Forestry Initiative(R) Program
- The American Tree Farm System(R)
- The Canadian Standards Association's Sustainable Forest Management System Standards (CAN/CSA Z809)

- Forest Stewardship Council (FSC)
- Program for the Endorsement of Forest Certification Systems (PEFC), and
- Other such credible programs as they are developed and implemented.

Points:

- 2 pt per component (must be at least 75% of component)

How to Verify: Certification certificate(s) or photo documentation

2.7 Optional Solutions

2.7.1 Use locally available, indigenous material (up to 12 points)

Intent: To make the home building process more environmentally acceptable by minimizing transportation and processing costs and using materials that are common in the local region.

How to Implement: A builder can obtain up to twelve points for incorporating locally available, indigenous components into the home's construction. Points can be awarded in this section based on the location of extraction, processing and manufacturing being within a 300-mile radius or within a 1000-mile radius if shipped by rail.

Points:

- 2 pt per component (must be at least 75% of component)

How to Verify: List of components used, source, and photo documentation

2.8 Alternative Technologies

2.8.1 Use products or processes that require fewer resources (up to 2 points)

Intent: Minimize the resources consumed by and environmental impact of building a house.

How to Implement: When specifying materials consider the amount of resources going into the product and whether other alternatives are available. Examples are spec'ing hollow brick, meeting the requirements of ASTM C 652 that are made from less material than those that meet C 216 for face brick. Appearance and durability requirements are identical. Or, engineered wood products, e.g., I-joists that use 35% less fiber material than solid-sawn products, pre-manufactured roof truss systems, etc..

Caveat: even though we are reducing the main feed-stock of a product, e.g., wood fiber in I-joists, we may be using more energy or binders to create the final product. While this may be the case, our intent is to reduce the core source of material going into the product's creation.

Points:

- 1 point per component

How to Verify: List of components used and photos.

2.8.2 Use LCA (Life Cycle Assessment) tool to compare Environmental burden of chosen product (up to 5 points)

Intent: This task would highlight the best use of resources, including cost, to assure that all of the guiding principles have been considered.

How to Implement: A life cycle assessment (LCA) is considered to be a reliable way to calculate and compare the cradle-to-grave environmental effects and costs of common building

materials. Designers can use modeling tools such as Athena™ to examine the life cycle environmental effects of a complete structure or of the individual assemblies, and can experiment with alternative designs and different material mixes to arrive at the best environmental footprint. They can also use a software tool such as BEES (http://www.bfrl.nist.gov/oae/software/bees.html) to identify the life cycle costs of select building components.

The objective of the simulation is to aid the Designer in selecting building assemblies and/or materials with the lowest reported impact in terms of energy consumption, air and water toxicity index, GWP, ecologically weighted resource use, and solid waste emissions.

Alternately, participate in Open Source systems such as "Pharos" which seek to provide community-driven consensus guidance on building materials and make the rating readily understood and usable.

Points:

- 1 pt per individual assembly or component

How to Verify: Provide BEES or ATHENA output to show that they are using an environmentally preferable product. Provide Pharos label or document participation in on-going evaluations.

Section 3 Energy Efficiency

3.1.1 Home is equivalent to IECC 2006 or prevailing energy code (which ever is more stringent) (Required)

How to Verify: Conformance based on plan analysis software such as REScheck.

3.1.2 Space heating and cooling system/equipment shall be sized according to building heating and cooling loads calculated using ANSI/ACCA Manual J 8th Edition or equivalent. Computerized software recognized by ACCA as being in compliance with Manual J 8th Edition may be used. (Required)

How to Verify: Provide Manual J load basis & calculations.

3.1.3 Utilize Manual S (or equivalent) to select HVAC Equipment. (Required)

3.1.4 Utilize Manual D for duct design and installation. (Required)

3.1.5 Conduct third party plan review to verify compliance with Energy Efficiency section. (when multiple homes of the same model are to be built a representative sample of 15% of homes must be reviewed) (Required)

How to Verify: Plan review may be completed by Green Building Program administrator, energy program administrators, architect/engineer, or other party outside of the Builder's company and acceptable to the Green Building Program administrator.

3.2 Performance Strategies

3.2.1 Increase effective R-value by reducing thermal flanking (4 points)

Intent: To enhance the insulating value of the building envelope by attending to building details where thermal bypass, or the movement of heat around or through insulation, frequently occurs due to missing air barriers or gaps between the air barrier and insulation.

How to Implement: Complete the Energy Start Thermal Bypass Checklist (www.energystar.gov).

Points: 4 points

- (Can be used in combination with 2.1.4 & 2.1.5)

How to Verify: Builder certified Thermal Bypass Checklist; visual field inspection; .

3.2.2 Incorporate air sealing package to improve envelope (up to 3 points)

Intent: When building an energy efficient home, it is equally or more important to prevent air infiltration as it is to provide a high R-value wall system. Air can pass through very small cracks, resulting in energy loss and condensation, so it is necessary to be very detail-oriented when it comes to air sealing.

How to Implement: Air leakage can account for as much as 20-30% of energy loss

through the building envelope. Although insulation serves to reduce the energy lost through the building envelope, air infiltration can compromise the efficiency of a building because it brings conditioned air directly outdoors (or outdoor air inside) and bypasses the insulation. In addition, it not only carries heat (or cooling) to the outdoors, but may also create moisture problems as water vapor in the air moves from warmer to colder location and condenses.

To perform air sealing, use a variety of materials such as caulk, foam, and gasket materials. It has been proven that "chinking" with fiberglass insulation does not prevent airflow. Low-expanding foams should be used around windows and doors so that the frame doesn't bind, a common complaint with first-generation, high-expanding foam products.

Some of the critical areas to seal include the area between the foundation and sill plate, bottom plate of exterior walls, band joist cavities, electrical, plumbing and mechanical penetrations (to attic, basement, garage and exterior), cantilevered floors and kneewalls, recessed light fixtures adjacent to unconditioned space and between window/door jambs and framing.

To quantify, conduct an air leakage, or infiltration, test of the home with a blower door. A blower door reading, expressed in air changes per hour at a pressure of -50 Pascals (ACH50) is calculated by dividing the blower door reading of cubic fee per minute at -50 Pascals (CFM50) by the house volume in cubic feet, and then multiplying by 60 minutes per hour.

Alternatively, smaller homes may benefit from using an approach that normalizes leakage based on the surface area of all six sides of the building enclosure. This alternative is known as the Leakage Coefficient and uses the CFM50 per square foot of surface area and comparable rates are shown in parenthesis below.

Proper ventilation is essential from a health perspective and making tighter homes increases the need to plan for providing adequate fresh air. Builders should consult ASHRAE standard 62.2 or other sources to ensure that the home is not under ventilated. Refer to Section 5.2.2.

Points:

- Implement Caulk & Foam air sealing 1 pt
- Achieve 4.5 ACH50 (0.25 CFM50/SF) 2 pt
- Achieve 2.5 ACH50 (0.15 CFM50/SF) 3 pt

How to Verify: Visual field inspection at predrywall stage is required; For more than one point, infiltration test post-construction from third-party is also required.

3.2.3 Energy Star rated windows (up to 4 points)

Intent: To assure building envelope performance. Window area often compromises a substantial portion of the wall area in new homes. Compared to an opaque insulated wall, windows offer only about 15-25% of the wall R-value. In addition, they are a source of direct solar gains in the summer which can add to the cooling load.

How to Implement: Select a window featuring the Energy Star label. Alternately, visit the website of the Efficient Windows Collaborative to see which type of glazing is recommended for our region. Low-E coatings for windows are recommended for almost all regions of the U.S. Generally look for windows with a low a U-value as is affordable – they offer the best insulating value (U-value is the inverse of R-value). Always choose a frame type that provides a thermal break – that is wood, vinyl, or aluminum with a thermal break. Using high efficiency windows can not only enhance thermal performance, but also reduces the risk of condensation on windows.

Points:

- U-Factor 0.35 1 pt
- <U-Factor 0.33 2 pt
- <U-Factor 0.30 4 pt

How to Verify: Provide manufacturer cut sheet and/or rating label from window.

3.2.4 HVAC Duct system tightness </= 6.0 CFM25 per 100 SF of floor area - Required

3.2.5 HVAC Duct system tightness (use mastic or foil tape) (up to 3 points)

Intent: To assure efficient performance of a forced air HVAC system it is important that the system deliver CFMs (Cubic Feet per Minute) at the designed/specified rates. A tight duct duck system helps to assure that a properly sized and designed system will deliver appropriate CFMs to desired locations by reducing system supply loss and/or reducing pulling return air from undesired locations such as attics or other unconditioned spaces on the return side of the system.

How to Implement: Make sure the HVAC contractor understands the importance of a properly sealed duct system, utilizes mastic or properly installed foil tape, and is aware of the desired duct tightness parameters required in Green building and this program. These levels are very aggressive in relation to current standard practice in the industry. Measurement levels shown below relate to total duct leakage to the outside of conditioned spaces of the house.

Points:

- </= 3.0 CFM25 per 100 square feet of floor area 2 pt
- </= 1.0 CFM25 per 100 square feet of floor area 3 pt

How to Verify: Third party "duct-blaster" test results.

3.2.6 HVAC Ductwork not installed in exterior envelope surfaces Required

3.2.7 Install return ducts, jump ducts and/or transfer grilles in every room having a door (except baths, kitchens, closets, pantry, laundry room) Required

3.2.8 HVAC Duct Air Quality and Performance (up to 4 points)

Intent: Getting the proper amount of airflow to and from each room is as important to comfort and efficiency as the equipment itself. Careful sizing, balancing, and layout according to recognized industry standards is essential to ensuring adequate air delivery and quality and therefore comfort and health. Ductwork located in exterior partitions present several problems: a reduction of available space for insulation, increased conductance of energy between the exterior & the ductwork, increased chance of connecting air leaks in the ductwork to the leaks in the envelope, increased chance of condensation occurring.

Ducting that is formed by wall or floor cavities increases the likelihood of leakage now and in the future. As the various materials expand and contract over time and at various rates, any sealing done now will fail prematurely. Leaks on the return air side will pull air into the ducts in an uncontrolled way which could include picking up unwanted humidity, dust, gases, and fumes depending on where they are located.

How to Implement: Make sure that your HVAC contractor utilizes ACCA manual D to size and layout supply and return ductwork to each area of the home and that he follows as many

of the recommendations listed below as possible.

Points:

- All heating and cooling ducts and equipment installed in Conditioned space 2 pt
- No wall or floor cavities used as duct work 2 pt

How to Verify: Visual field inspection at predrywall stage.

3.2.9 Install Energy Star labeled programmable thermostats Required

3.2.10 Install Geothermal (GHP) (5 points)

Intent: Geothermal Heat Pump systems use 25% - 50% less electricity than conventional heating or cooling systems. This translates into a GHP using one unit of electricity to move three units of heat from the earth.

How to Implement: According to the EPA, geothermal heat pumps can reduce energy consumption – and corresponding emissions – up to 44% compared to air-source heat pumps. GHPs also improve humidity control by maintaining about 50% relative indoor humidity, making GHPs very effective in humid areas. Other benefits include few moving parts, no exposed outdoor compressors, and quiet operation.

Major variations of the GHP system mainly have to do with the type of ground loop & the fluid circulated: open loop, closed loop, direct expansion. Ground loops can be installed vertically or horizontally. Consult with an HVAC professional about the best choice for the particular project.

Points: 5 pt

How to Verify: Provide installer invoice or certification; or field inspection.

3.2.11 Energy Star rated heating and cooling equipment (up to 5 points)

Intent: High efficiency equipment uses less energy to accomplish the same task. The intent of this guideline is to reduce the fuel/energy required to heat and/or cool the home.

How to Implement: Select equipment that carries the Energy Star label, or check the manufacturer's literature for information on SEER (for cooling equipment) and AFUE (for fuel-fired space heating equipment). SEER 13 split-system air conditioning units were federally mandated as the minimum rating as of January 2006. Greater efficiency and performance benefits may accrue from improved design, installation, and commissioning procedures rather than simply installing equipment with a higher efficiency rating. For instance, proper sizing, insulating, and sealing of ductwork can reduce the amount of "lost" energy and increase occupant comfort as well. Even the most efficient equipment cannot make up for deficiencies in the distribution system or inadequate sizing and commissioning. Before simply investing in more efficient equipment, invest in training your HVAC contractor to ensure proper sizing, design, installation, and commissioning of the entire system.

Points:

- Energy Star labeled 0.5 pt per end-use
- Better than Energy Star 1.5 pt per end-use
- Substantially better thanEnergy Star 2.5 pt per end-use

3.2.11 Points	End-Use	Central AC & ASHP	Gas Furnaces	Boilers
Energy Star	Cooling	13 SEER		
	Heating	8.0 HSPF	90 AFUE	83 AFUE
Better	Cooling	14 SEER		
	Heating	8.7 HSPF	92 AFUE	87 AFUE
Substantially Better	Cooling	16 SEER		
	Heating	9.5 HSPF	94 AFUE	90 AFUE

3.2.11 Points	End-Use	Open Loop GHP	Closed Loop GHP	Direct Expansion GHP
Energy Star	Cooling	16.2 SEER	14.1 SEER	15 SEER
	Heating	3.6 COP	3.3 COP	3.5 COP
Better	Cooling	17.8 SEER	15.5 SEER	16.5 SEER
	Heating	4.0 COP	3.6 COP	3.9 COP
Substantially Better	Cooling	19.4 SEER	17 SEER	18 SEER
	Heating	4.3 COP	4.0 COP	4.2 COP

How to Verify: Manufacturer cut sheets and/or contractor certification.

3.2.12 Environmentally friendly refrigerants (2 points)

Intent: Non-CFC refrigerants have been designated by the U.S EPA to be much less detrimental to the environment, specifically the depletion of the ozone layer in the earth's upper atmosphere.

How to Implement: Specify non-CFC refrigerates for all cooling equipment.

Points:

- Use R410A for refrigerant 2 pt

How to Verify: Equipment manufacturer cut sheets and/or supplier or contractor certification.

3.2.13 Water Heating (1 point)

Intent: To increase the efficiency of water heating by installing equipment that provides the same amount of hot water for less energy than standard water heating equipment.

Gas

Size (gallons) Energy Factor
30 0.64
40 0.62
50 0.60
65 0.58
75 0.56

Electric

Size (gallons) Energy Factor
30 0.95
40 0.94
50 0.92
65 0.90
80 0.88
100 0.86
35

Oil

Size (gallons) Energy Factor
30 0.59
50 0.55

How to Implement: The EF represents the percentage of the fuel (electricity, gas, propane or oil) that is useful for heating water; which includes losses through the tank as well as flue losses. Electric tanks have a higher EF than fuel-fired heaters since they do not have flue losses. However, electric tanks can be more expensive to operate than fuel-fired tanks.

This guideline is not intended to steer a builder toward a particular fuel, but rather to encourage the selection of higher efficiency equipment given the fuel that has been selected. Unlike space heating and cooling equipment, there are not dramatic gains in efficiency of tank water heaters between the minimum and maximum efficiency equipment for a given fuel and tank size. Efficiencies also vary with the size of the tank. The efficiency levels in the table above represent a mid-range somewhat between minimum and maximum efficiency. Because of the relatively small range of efficiencies of tank water heaters, there is not an Energy Star label for tank water heaters.

To select high efficiency water heating equipment, compare the Energy Guide labels of similar equipment. Review manufacturer's literature for Energy Factor information – the Energy Factor is usually not prominently displayed on the unit. Alternately, the ACEEE maintains a list of the highest efficiency water heating equipment. Select equipment with an EF equal to or greater than those listed in the table above.

Points: 1 pt

How to Verify: Submit certification from GAMA

3.2.14 Install Tankless Hot Water Heater(s) (2 points)

Intent: To reduce energy use associated with water heating by eliminating standby losses that occur with tank heaters.

How to Implement: Even though newer tank water heaters are better insulated than their predecessors, heat loss from a water heater tank can account for a large portion of hot water energy consumption, especially in homes that use relatively little hot water. By having no reservoir of hot water, tankless water heaters eliminate these standby losses.

For gas tankless water heaters, there are similar flue losses to gas tanks. Both electric and gas tankless water heaters have higher energy factors (EF = 0.62 minimum) than most tank water heaters. All tankless water heaters use large amounts of energy at high flow rates. These large draws often require a larger-than-normal service for electric units or larger pipe diameter for gas units. Evaluate these differences when comparing installed costs and check with local utilities regarding issues related to peak demand. Although peak demand for space heating and water

heating usually do not occur at similar times, your local utility may offer helpful advice regarding selection of whole house water heating appliances.

Points: 2 pt

How to Verify: Manufacturer cut sheets and/or installer certified.

3.2.15 Insulate all exposed hot water lines (1 point)

Intent: To reduce heat losses through hot water pipes and therefore conserve energy used to produce hot water.

How to Implement: Insulate all hot water lines with 1" minimum insulation.

Points: 1 pt

How to Verify: Visual field inspection.

3.2.16 Install manifold plumbing system (2 points)

Intent: To further increase the domestic hot water system by enhancing the speed of delivery to the point of use.

How to Implement: By installing a manifold plumbing system, each point of use is supplied by a "home-run" from the manifold. This is a more efficient delivery system and will reduce the amount of time to supply water to the point of use as well reduce line losses by reducing the amount of unused hot water standing in the line. There are also efficiencies to be gained in the installation process and this type of system virtually eliminates joints between the manifold and the fixture.

Points: 2 pt

How to Verify: Manufacturer cut sheets and/or installer certified.

3.2.17 Install On-demand hot water recirculation pump system (1 point)

Intent: To reduce energy and water waste by delivering hot water quickly and at desired temperatures.

How to Implement: When controlled manually or automatically, recirculation systems reduce the amount of wasted hot water (e.g., water that goes down the drain while the homeowner waits for the desired temperature). If recirculation systems operate continuously, however, they have the potential to use significantly more energy for pumping and for hot water energy lost from the pipes than they save by reducing hot water waste. Recirculating systems should be controlled so that demand is met, then recirculating is shut off. Typical controls are push-buttons & motion sensors. These systems deliver hot water to faucets quickly, adding convenience for the homeowner.

Points: 1 pt

How to Verify: Manufacturer cut sheets and/or installer certified

3.2.18 Day lighting (1 point)

Intent: Reduce overall energy demands by designing day lighting into the home.

How to Implement: Through thoughtful design and the placement of windows, skylights, and tubular skylights energy normally consumed to provide lighting in a home can be reduced; there is a dual benefit in bringing natural light into the home and reducing overall energy consumption. Skylights normally should not be installed on the south-facing side

because of the increased solar gain and potential glare.

Points:

-
- Install Energy Star rated skylights in rooms without natural light 1 pt

How to Verify: House plan and Energy Star label

3.2.19 Install Energy Star Advanced Lighting Package (ALP) (up to 4 points)

Intent: To meet lighting needs with high-quality, aesthetically pleasing light using less energy than conventional incandescent lighting.

How to Implement: Energy Star fixtures use about 1/3 the electricity of standard fixtures to provide equal light. Although, on average, and Energy Star fixture may cost about $30 more than a comparable standard fixture, the fluorescent bulbs will last longer (on average about 7 years) and cost less to operate over their lifetime than incandescent bulbs. Placing 20 Energy Star fixtures in a home in which electricity costs are 10.5 cents per kWh will reap almost $100 in annual savings to the homeowner in energy and bulb replacement costs, after accounting for the increase in the mortgage due to higher initial cost. Today's fluorescent bulbs are dramatically improved over the old technology: not only are there a wide variety of styles available, but the light quality is greatly improved and there is no flicker, hum, or delayed start. Energy Star fixtures also carry a two-year warranty. The fixtures may be easily identified by the Energy Star label.

Points:

- Energy Star Advanced Lighting Package (ALP) 4 pt

  OR
- At least four Energy Star light fixtures 1 pt
- Install compact fluorescent bulbs (CFLs) in 70% of fixtures 1 pt
- Install motion sensor controls on all outdoor fixtures 1 pt
- Energy Star Qualified ceiling fans (100%) 1 pt

How to Verify: Builder-certified.

3.2.20 Install Energy Star appliances (up to 3 points)

Intent: To reduce energy use in the home for appliances.

How to Implement: On average, Energy Star labeled appliances use at least 20% less energy than standard appliances to perform the same duties. Energy Star labeled dishwashers and washing machines also use less water, which contributes to added resource efficiency. Look for the Energy Star label when selecting major appliances or use the yellow Energy Guide label to compare efficiency of similar appliances.

Points:

- Refrigerator 1 pt
- Very efficient clothes washer 1 pt
- Very efficient dish washer 1 pt

How to Verify: Builder-certified.

3.2.21 Renewable Energy (up to 15 points)

Intent: To reduce the amount of non-renewable energy to heat and cool a home through design features which allow for solar heat gains and minimize the potential for overheating.

How to Implement: The Sustainable Buildings Industry Council provides the most

concise and clear-cut guidance on sun-tempered design. The design rules of thumb cited above will provide some solar benefit and prevent overheating in most climates.

A. Use sun-tempered design: building orientation, sizing of glazing, design of overhangs to provide shading are in accordance with guidelines below:

- Long side of the home faces within 30o of south;
- Glazing area > 7% of Finished Floor Area (FFA) on south face
- (Low-E);
- Glazing area < 2% of FFA on west face (Low-E, Low SHGC);
- Glazing area < 4% of FFA on east face (Low-E, Low SHGC);
- Glazing area < 4% of FFA on north face (Low-E);
- Skylights less than 2% of Finished Ceiling Area, with shades and insulated wells;
- Overhangs designed to provide shading on south-facing glass (at a minimum), or adjustable canopies or awnings.

B. Use passive cooling.

- Exterior shading on east and west windows, e.g., shade trees, moveable awnings or louvers, covered porches
- Overhangs designed to provide shading on south-facing glazing.
- (Use supplied charts that indicate length of overhang, amount and period of shading according to latitude.)
- Windows located to facilitate cross ventilation.
- Solar reflective roof or radiant barrier.

C. Install solar water heating system. Must use SRCC-rated system. SRCC uses the Solar Energy Factor (SEF) as the performance rating for solar domestic water heating systems and is similar to the Energy Factor (EF) given to conventional water heaters. The Solar Fraction indicates the portion of total hot water supplied by the solar unit. SEF of 2 or 3 and SF of 0.5 to 0.75 can be expected typically.

Points:

- Passive Solar Heating 5 pt
- Passive cooling 5 pt
- Install solar hot water system 5 pt

How to Verify: Documentation of design process; Builder spec sheet; Installer certified.

3.2.22 Renewable Electricity Generation (up to 15 points)

Intent: To supply a portion of the household's electricity needs by renewable energy sources. To reduce peak electricity demand – peak electricity necessitates power companies to switch on peak generation equipment which generally operates at a lower efficiency than base power load plants.

How to Implement: As demand for electricity increases and costs to build additional generating capacity continue to escalate renewable energy sources such as photovoltaics and wind power become more attractive and more cost effective to consumers and utilities. Local generation of electricity by the sun and wind is a viable option in most regions of the country. Costs of smaller (2 kW t 8 kW) photovoltaic systems are about $8-9 per watt and, in some states incentives are available which bring the cost even lower. Net metering may also be available to your customers in which excess electricity produced at the residence causes the electric meter to spin backwards, effectively crediting the customer full retail value for the electricity sent back to

the utility.

To encourage and facilitate installation of renewable energy systems, provide infrastructure for the installation of future solar or photovoltaic systems. It is relatively simple and inexpensive to install electrical conduit or water piping to the attic or rof area while the home is under construction but can be disruptive and costly when retrofitted at a later date. This measure contributes to the cost effectiveness of the installation of a future renewable energy system.

Points:

- Provide clear unshaded roof area (south) for future — 1 pt
- System installed with no minimum kWh/year — 2 pt
- 2,000 – 3,999 kWh/year — 5 pt
- 4,000 – 5,000 kWh/year — 10 pt
- > 5,000 kWh/year — 15 pt

How to Verify: Manufacturer specifications; Installer certified.

3.2.23 Alternative Technologies (up to 6 points)

Intent: To reduce electricity required for heating domestic hot water and to reduce electricity consumption associated with lighting in unoccupied rooms.

How to Implement: Install a drain water heat-recovery system (these systems recover some of the energy in hot water that has gone down the drain); install a de-superheater in conjunction with a ground source heat pump (a de-superheater recovers heat that is rejected from a geothermal heat pump (GHP)); install occupancy sensors for lighting control; or, some other innovative option not mentioned here. Vestibules (ie. airlock entry) shall have doors at exterior entry and at opening to living spaces.

Points:

- Drain water heat recovery system — 2 pt
- De-superheater with GHP — 2 pt
- Occupancy sensors on interior lights (up to 2 pt) — 0.5 pt/sensor
- Vestibule for primary entrance — 2 pt
- Other innovative option — 0.5 pt

How to Verify: Installer certified.

3.3 Performance Verification (Third party certification required)

3.3.1 Meet or Exceed requirements for Energy Star Homes (up to 16 points)

Intent: To offer builders a flexible, performance based means of achieving higher levels of energy performance than the IEEC 2003. An Energy Star™ home is approximately 15% higher with respect to energy performance than a home that meets the IEEC 2003. These points enhance Section 3.2

How to Implement: The Energy Star Homes program utilizes a rating system known as HERS (Home Energy Rating System). This system utilizes data taken from home plans and building specifications provided by the builder to produce a rating from plans; this is a preliminary rating based on the intended specifications. Inspections verify that the building was

constructed according to plan and testing measures the actual performance of the structures and its systems. A final rating and certification produces a HERS score.

Points:

- Meet requirements for certified an Energy Star Home 5 pt
- 10% more efficient than Energy Star certification 7 pt
- 20% more efficient than Energy Star certification 9 pt
- >25% more efficient than Energy Star certification 11 pt

How to Verify: Provide certification and/or rating from certified HERS rater.

Section 4 Water Efficiency

4.1 Indoor Water Use

4.1.1 Efficient (low-flow) fixtures (up to 3 points)

Intent: Reduce water consumption by installing low-flow fixtures.
How to Implement: Install efficient (low-flow) fixtures in all showers, sinks and toilets.
Points:

- Faucets </= 2.0 GPM 2 pt
- Shower heads </= 2.0 GPM 2 pt
- Toilet < 1.4 GPM 2 pt

How to Verify: Manufacturer specifications; Installer certified.

4.1.2 High efficiency (very low-flow) fixtures (up to 3 pt)

Intent: Further reduce water consumption.
How to Implement: Select high efficiency fixtures and/or EPA-designated WaterSense fixtures
Points:

- Faucets </= 1.5 GPM 1 pt
- Shower heads </= 1.5 GPM 1 pt
- Toilet dual flush or </= 1.3 GPM 1 pt

How to Verify: Manufacturer specifications, WaterSense label, Installer certified.

4.1.3 Motion sensor controls (1 point)

Intent: Reduce water waste by installing a faucet control that allows the water, via a (typically) hands-free method, to turn water on and off without changing temperature. Another possible strategy is incorporate a pedal-activated control for the faucet which would allow one's foot to turn the faucet on/off.
How to Implement: Install options listed above in lavatory faucets and/or toilets.
Points:

- Lavatory faucet 1 pt
-

How to Verify: Manufacturer specifications; Installer certified.

4.1.4 Composting or waterless toilets (up to 6 points)

Intent: Eliminate water use associated with toilet flushing by installing composting or waterless toilet(s).
How to Implement: Install composting or waterless toilet(s).
Points:

- Composting or waterless toilet(s) 2 pt/fixture

4.1.5 Energy Star dishwasher or clothes washer (up to 2 points)

Intent: Reduce water consumption by selecting water-efficient major household appliances.

How to Implement: The Energy Star label identifies appliances that are at least 20% more efficient than other appliances of similar size and model and use less water than their standard counterparts. An Energy Star washing machine uses approximately 20 gallons of water per load compared to 40 gallons for standard models. The machine also spins the clothes more thoroughly and by removing more water during the spin cycle also reduces the drying time and thus, the energy used by clothes dryer. Energy Star washing machines are available in both top and front loading models. An Energy Star dishwasher uses about 40% less water than conventional models. The Energy Star label takes some of the guesswork out of selecting energy efficient appliances and equipment, making the selection process easier for builders and homeowners.

Points:

- Energy Star clothes washer 1 pt
- Energy Star dishwasher 1 pt

How to Verify: Manufacturer specifications; Installer certified.

4.1.6 High Efficiency water conditioning system (1 point)

Intent: To maximize the efficiency of the equipment utilized for water conditioning when it is required/desired.

How to Implement: Select a system that is more efficient, using less energy and consuming fewer resources, than their standard counterparts.

Points: 1 pt

How to Verify: Manufacturer specifications; Installer certified.

4.1.7 On-Demand Hot Water Recirculating System (1 point)

Intent: To reduce water waste by delivering hot water quickly and at the desired temperature.

How to Implement: When controlled manually or automatically, recirculation systems reduce the amount of wasted water (e.g., water that goes down the drain while the homeowner waits for the desired temperature). If recirculation systems operate continuously, however, they have the potential to use significantly more energy for pumping and for hot water energy lost from the pipes than they save by reducing hot water waste. On-demand systems can be controlled by push button or motion sensor. These systems deliver hot water to faucets quickly, adding convenience for the homeowner.

Points: 1 pt

How to Verify: Manufacturer cut sheets and/or installer certified:

4.2 Outdoor Water Use

4.2.1 Low volume, non-spray irrigation (2 points)

Intent: Minimize water use associated with outdoor water consumption by installing irrigation systems that offer the most effective and efficient delivery method.

How to Implement: Drip irrigation systems provide water directly to root systems where it is most needed, making them more efficient than spray type systems. Water run-off and evaporation are minimized with drip irrigation systems. Drip systems are the preferred irrigation

method in the desert regions of the United States, but are also recommended in any region where lawns and bedding areas require supplemental watering during the growing season. Stream rotators (A.K.A. robot sprinklers) direct the water stream to specific spots. The size and shape of the area are programmed into a computer control. Builders are cautioned that the increased energy use and maintenance may offset the benefit of water savings.

The EPA Water Sense program for landscape irrigation services is voluntary program which certifies that landscape professionals have the ability to assess critical soil/water/plant relationships and resulting impacts on irrigation system efficiency.

Points:

- Drip bubbler or stream rotator 2 pt

  OR
- No irrigation system 2 pt

How to Verify: Installer certified; field inspection.

4.2.2 Irrigation Control (up to 3 points)

Intent: Supply areas that have different irrigation needs with individual control.

How to Implement: Turf and bedding areas have different irrigation needs based on the various types of grasses and vegetation planted in those areas. Zoned irrigation systems allow for distributed control of the flow of water to each individual turf or bedding area. Zoned systems can conserve water by providing irrigation on a selective basis since most plants require 25-50% less water than lawns. The EPA WaterSense plans to develop a specification for labeling weather or sensor-based irrigation control technologies.

Points:

- Zoned system 1 pt
- Weather-based control system (computer) 1 pt
- Rain barrels or cistern (collect 50% of 3/4" rain event) 1 pt

How to Verify: Installer certified; field inspection.

4.3 Waste Water Management

4.3.1 Grey water re-use system (4 points)

Intent: Reduce total household water consumption by reusing greywater, i.e., water used in the laundry, showers, and sinks.

How to Implement: Greywater re-use is the process of recycling laundry, shower and sink water for non-potable uses. Greywater is typically used to irrigate lawns, trees, shrubs and vegetation and can also be used to flush toilets. Re-using gray water can significantly reduce total household water consumption.

Points: 4 pt

How to Verify: Installer certified; field inspection.

4.3.2 Alternative waste water technology (up to 4 points)

Intent: This guideline defers to municipal sewage over waste water systems because of the generally higher level of supervision and control involved with processing municipal sewage. However, if on-site processing is the only option, the builder will be rewarded for using advanced measures that more effectively process waste and reduce constituents such as nitrogen,

which if in plentiful supply, can be harmful to water bodies.

How to Implement: Innovative wastewater systems are a technological advancement over conventional septic systems. These innovative technologies allow on-site wastewater systems to treat wastewater to higher levels that would normally be achieved by using standard septic systems, resulting in cleaner effluent discharge, improved system operation, and lower impact on the environment.

Points:

- Aerobic system 2 pt
- Constructed wetland 4 pt

Section 5 Indoor Environmental Quality

5.1 Minimize potential sources of pollutants

5.1.1 For vented space heating and water heating equipment (required)

Intent: There are concerns that exhaust vents (bathroom, kitchen, etc.) can depressurize a tight home causing by-products from combustion appliances to be drawn into the home. If you install combustion space and water heating appliances, minimize the back drafting potential by choosing direct vent or mechanical/induced draft equipment. All space and water heating appliances must meet these criteria.

How to Implement: Direct vent water heaters remain quite expensive. Mechanically vented or electric water heaters may be the most practical option for many builders wishing to comply with this guideline. Some local codes may require an outdoor source of combustion air for mechanical draft equipment. Alternatives to direct vent equipment include installing electric equipment or isolating combustion equipment from the conditioned space such as constructing a combustion closet. A combustion closet is an area sealed off from the conditioned space. Insulate and seal all walls and the ceiling, install a solid door with weather stripping and a sufficient threshold, and extend ducts outside the building envelope to provide combustion and ventilation air.

Requirement:

- Install direct vent equipment
  OR
- Install induced/mechanical draft combustion equipment in isolated space.

How to Verify: Builder spec sheet; field inspection.

5.1.2 Install direct vent sealed combustion gas fireplace, sealed wood fireplace, or sealed woodstove;

OR

No fireplace or woodstove installed (1 point)

Intent: Direct vent sealed combustion gas fireplaces, or sealed wood burning fireplaces, and sealed woodstoves minimize the risk of smoke and combustion by-products backdrafting into the home. Outdoor air is also supplied directly to the combustion chamber so that indoor air is not required for combustion.

How to Implement: When installing a woodburning stove or fireplace, make sure it is sealed with a gasketed door. Recognize that a wood-burning fireplace is only about 10- 30% efficient. Consider specifying an EPA-certified wood stove which has efficiencies of around 69-78%. EPA-certified woodstoves and gas appliances minimize outdoor air pollution.

Direct vent fireplaces (a.k.a., sealed combustion) are more energy efficient than wood fireplaces and atmospherically-vented gas fireplaces. They use outside air for combustion and exhaust directly to the outside. Like vented gas fireplaces, they typically use a heat exchanger to circulate warm air through the room but keep combustion air separate from room air.

Points: 1 pt

How to Verify: Builder spec sheet; field inspection.

5.1.3 Ensure a tightly sealed door between garage and living area (2 points)

Intent: Walls and ceilings between a garage and the living space should be tightly sealed to prevent car exhaust and other fumes from entering the living space. Pressure differences can cause such fumes to be drawn into the living space through the common walls and the ceilings between the garage and the living space. Providing a continuous sealed air barrier along this wall and sealing all penetrations will greatly reduce the potential for contaminants to enter the home from the garage.

How to Implement: A continuous air barrier aerodynamically decouples garage air from living space air. This can be accomplished in many ways. Before the framed wall is enclosed, seal or caulk all penetrations, gasket or seal sills, caulk inside edges of top and bottom plate, install cavity insulation, and install and air barrier such as rigid foam or a sheet barrier (not vapor retarder) overlapped and taped at joints and corners and attached to the bottom plate, drywall walls and ceiling, tape and spackle all seams. Gasketed drywall or the "airtight" drywall approach may be used. At a minimum you should caulk the drywall to the bottom plate, tape and spackle all drywall seams, and seal all penetrations. Only sealing the plates is not enough: air can enter between the drywall and the bottom plate, move through the stud bays, and out of the corresponding gap on the inside wall.

The air barrier should be verified using tracer gas or by blower door zonal pressurization test.

Points:

- Provide a continuous air barrier between garage and living areas including air-sealing penetrations, walls, ceilings and floor. 1 pt
- Verify air barrier with blower door 1 pt

How to Verify: Builder spec sheet; field inspection; Test results

5.1.4 Ensure low formaldehyde emission standards (up to 2 points)

Intent: Ensure particleboard, medium density fiberboard (MDF) and Hardwood Plywood substrates are certified to low formaldehyde emission standards ANSI A208.1, ANSI A208.2, and ANSI/HPVA HP1, respectively. Composite wood/agrifiber panel products must either contain no added urea-formaldehyde resins or must be third party certified for low formaldehyde emissions.

Products certified as having low formaldehyde emissions have less detrimental effect on indoor air quality. In June of 2004, the International Agency for Research on Cancer, reclassified formaldehyde from a suspected human carcinogen to a known human carcinogen. The glue used to bind materials in wooden board products often contains formaldehyde. Formaldehyde can leach out of these materials over time and into the home.

How to Implement: When purchasing wood panel products, look for materials certified as having low formaldehyde emissions.

Points:

- Per Component 1 pt

How to Verify: Manufacturer's spec sheet; Third-party listing.

5.1.5 Install "Green Label" carpet, carpet pad.(1 point)

Intent: Reduce VOC emissions from carpets by installing carpets certified by a third party testing agency as low emitting.

How to Implement: Install carpet, carpet pad, and floor covering adhesives that hold "Green Label" from Carpet and Rug Institute's indoor air quality testing program or meet equivalent thresholds verified by a third party. The Carpet and Rug Institute administers a testing program to identify low-emitting carpets and carpet pads. Look for the "Green Label" when purchasing carpets. Natural fiber carpets such as cotton or wool are also good options to avoid floor coverings that emit VOCs.

Points: 1 pt

How to Verify: Manufacturer's spec sheet; Third party listing.

5.1.7 Mask HVAC outlets during construction (1 point)

Intent: When possible, do not run ducted HVAC equipment during construction. Remove dust and dirt from supply and return ducts before putting the equipment into operation to minimize air borne pollutants.

How to Implement: Tightly cover openings with material such as cardboard and tape – especially during tasks that create significant dust such as drywall and floor sanding. It is not necessary to professionally clean the ducts in order to comply with this guideline. Rather use a shop vacuum to remove dust and debris close to the openings.

Points:

- Mask HVAC outlets during construction and Vacuum before turning on central heating/cooling system 1 pt

How to Verify: Field inspection.

5.1.7 Use low VOC emitting wallpaper/adhesives and finishes (up to 3 points)

Intent: Use low VOC emitting wallpaper, adhesives and finishes to reduce potentially harmful VOCs from being emitted into the indoor air.

How to Implement: Use materials certified by a third party as having low VOC emissions.

Points:

- Wallpaper 1 pt
- Paint 1 pt
- Finishes 1 pt
- Floor Covering Adhesive 1 pt

How to Verify: Manufacturer's spec sheet; Installer certified..

5.1.8 Install high efficiency drinking water filtration system (1 point)

Intent: To provide clean, high quality drinking water for home occupants.

How to Implement: Install a high efficiency water filtration system at the kitchen sink that will filter the maximum amount of potential pollutants from the water supply.

Points: 1 pt

How to Verify: Builder spec; Manufacturer's spec sheet.

5.2 Manage potential pollutants generated in the home

5.2.1 Install kitchen range vent and exhaust to the outside (required)

Intent: Remove moisture, odors, and combustion by-products.

How to Implement: Install a range hood that is vented to the outside. Because a vented hood requires another puncture in the building envelope, be sure to seal tightly around the penetration. Take caution not to over-ventilate. Large kitchen exhaust fans can increase the potential for backdrafting if there are other combustion appliances in the home. (See 5.1.1 above.) The Home Ventilating Institute recommends a range hood with a minimum rate of 40 CFM per lineal foot for wall-mounted hoods and 50 CFM per lineal foot for island hoods. For cooking that generates heavier steam or smoke, HVI recommends 100 CFM per lineal foot for wall-mounted hoods and 150 CFM per lineal foot for island hoods. Duct length and routing can affect flow rates; be sure to verify the flow rate is as designed.

Points: Required

How to Verify: Builder spec sheet; field inspection, installer certified.

5.2.2 Provide mechanical ventilation per ASHRAE 62.2 (up to 4 points)

Intent: Provide adequate amount of background ventilation to ensure that indoor air is exchanged over desired periods.

How to Implement: It is advantageous from indoor environmental quality perspective as well as for reasons of energy efficiency and comfort to construct a tight building envelope. Air infiltration not only contributes to heat (or cooling) loss but also can lead to mold problems if warmer air condenses when it reaches a cooler surface as it moves through a wall cavity. However, a very tight building shell can give rise to a need for an intentional means of introducing fresh air into the living space. Introducing outdoor air into the home in a controlled manner as needed or desired by the occupants has both energy and IEQ advantages.

Refer to ASHRAE Standard 62.2 for recommended ventilation rates which can be calculated thus: 7.5 CFM X (Number of bedrooms +1) + (Living Area X 0.01) = Required CFM.

Used in combination with exhaust fans in the bath & kitchen, directly adding fresh air in modulated amounts to the forced-air system works well and cost effectively. A Heat Recovery Ventilator (HRV) balances exhaust and supply air while exchanging about 70% of the heat from the exhaust air to the supply air, reducing energy costs of ventilation.

Points:

- Automated 1 pt
- Fresh air motorized damping ducted to return air duct 2 pt
- Heat-recovery ventilator 4 pt

How to Verify: Builder spec sheet; Field inspection, Flow verified by installer or third party.

5.2.3 Install MERV filters on central air or ventilation system(s) (up to 3 points)

Intent: To reduce the amount of airborne particulates.

How to Implement: MERV filters are more effective than standard spun fiber filters. MERV filters would capture dust, but not contaminants such as molds and bacteria which are in the 1 micron range. Some studies have shown that 97% of airborne particles are 1 micron or less. Filters with a greater efficiency are often not recommended for space heating and cooling equipment because they may restrict air flow too much. More efficient filters such as MERV 8 also have a resource efficiency benefit from the standpoint that more dust is captured by the filter and is not deposited on the air handler.

Points:

- MERV 8 1 pt
- MERV 10 2 pt
- MERV 12 3 pt
- MERV 16 or better 4 pt

How to Verify: Builder spec sheet; Installer certified.

5.2.4 Install sub-slab de-pressurization system or infrastructure to facilitate future installation of radon mitigation system. (Required)

Intent: Prevent radon gas from entering the home.

How to Implement: Radon is a naturally occurring gas spontaneously produced from the decay of radium. Radon levels can vary between outdoor air, indoor air, soil, and ground water. Radon is a carcinogen that can enter through voids in a homes foundation and become trapped inside. Radon gas can easily be directed outside of the home with a few basic construction designs.

Points: **Required**

How to Verify: Builder spec sheet; Field inspection.

5.2.5 Verify exhaust flow specifications (up to 2 points)

Intent: To ensure all exhaust flows are operating as designed.

How to Implement: Fans may not exhaust enough air if ductwork is not properly sized and installed. For example, a fan rated at 50 CFM may only exhaust 35 CFM if duct runs are extremely long or if ductwork is kinked during installation. Without the fan operating properly, moisture will not be adequately removed. Properly size ducts in accordance with the manufacturers' recommendation for duct diameter and maximum duct length. Fans should perform within 10% of their rating. After installation, visually inspect the duct length, look for crimped or damaged ducts, check for missing parts, and ensure all connections are secure. A more accurate method of checking the air flow is to use a flow hood or pitot tube and manometer. Ask your exhaust fan installer about methods of checking air flow.

Points: 0.5 pt per room appliance up to 2 pt

How to Verify: Third party flow hood test; installer certified.

5.3 Moisture Management (Vapor, Rainwater, Plumbing, HVAC)

5.3.1 Install Energy Star labeled exhaust fan in bathrooms. (Required)

Intent: Control humidity levels in the house by providing exhaust fans at likely source of humidity.

How to Implement: As buildings become tighter, controlling indoor humidity becomes a greater concern. Bathroom exhaust fans can quietly and efficiently remove humidity after bathing. Energy Star exhaust fans work well in both respects.

Points: Required

How to Verify: Builder spec sheet; field inspection, installer certified.

5.3.2 Control bathroom exhaust fan with a timer or humidistat (up to 2 points)

Intent: Exhaust moisture generated in bathrooms to the outdoors with controls that reduce reliance on input from the homeowner. Also, remove residual moisture from bathrooms after the occupant has left the room.

How to Implement: Often, bath fans are used infrequently because of their noise, a lack of understanding of their importance by the homeowner, or simply because the homeowner is not in the habit of doing so. Installing controllers on fans that encourage their use, especially timers or humidistats that remove residual humidity even after person leaves the bathroom is an effective method for removing interior generated moisture at its source. Timers also prevent the opposite occurrence where the homeowner forgets to turn the bath fan off and it operates longer than necessary, thereby wasting energy.

Timers and humidistats are basically upgraded switches. They are wired-in and mounted much like a typical switch. Timers can typically be set to run from 10 to 60 minutes. Homeowners should be instructed to generally run the bathroom exhaust fans for 20 minutes after a bath or shower. Humidistats will automatically cycle the fan on and off to maintain proper humidity levels; they can be adjusted to operate between 20 and 80 percent humidity. Timers and humidistats cost about $25 and up. Bath fans are also available that already include humidistats and timers.

Points: 0.5 pt per room up to 2 pt

How to Verify: Builder spec sheet; Installer certified.

5.3.3 Install humidistat to control whole house humidification system. (Required if whole-house humidification system is installed.)

Intent: Control excessive humidification, which can result in moisture damage.

How to Implement: Indoor humidity should be between 30 and 60 percent. Indoor humidity below 30 percent causes dry eyes, nose and throat which is not only uncomfortable, but also an invitation for bacteria and viruses. At the other extreme, indoor humidity above 60 percent can contribute to the potential for mold growth. Given temperatures between 40 and 80 degrees Fahrenheit and a food source (wood, paint, dirt, dust) mold will grow within 24-48 hours. Therefore, if a whole-house humidification system is installed, it should have an adjustable humidistat control to avoid excessive humidification.

Points: **Required**

How to Verify: Builder spec sheet; Installer certified.

5.3.4 Install moisture resistant backer board-not paper faced sheathing-under surfaces in wet areas (required)

Intent: To reduce the risk of problems if water gets behind tile surfaces in kitchens and baths.

How to Implement: A cement based backer-board does not contain paper that can deteriorate, swell (potentially causing cracking in the grout), and be a substrate for mold growth when wetted. Cement backer-board is resistant to the deleterious effects of moisture. Builders should also avoid using paper-faced drywall in wet areas, opting instead for the glass-faced drywall which are not as susceptible to mold.

Points: **Required**

How to Verify: Builder spec sheet; Installer certified.

5.3.5 Install vapor retarder directly under slab (6-mil) or crawl space floor (8-mil). In crawl space extend poly up wall and affix with glue and furring strips, or damp proof wall below grade. (joints lapped 12 inches) (required)

Intent: To prevent moisture migration from the ground through wicking action (through slab) or by vapor movement (in crawl space).

How to Implement: A vapor retarder should be continuous with joints lapped 12 inches and taped, if possible. Any penetrations or other areas where vapor retarder has been compromised should be sealed with tape or caulk.

Points: **Required**

How to Verify: Builder spec sheet.

5.3.6 Protect unused moisture-sensitive materials from water damage (required)

Intent: Prevent wetting of building materials through proper storage techniques during construction. Wetting of building materials can lead to dimensional instability, deterioration, and mold growth.

How to Implement: Lumber should be inspected upon delivery for moisture and mold. Delivery should be scheduled so that lumber is used soon after it is received at the site. Lumber should not be stored in direct contact with the ground: it should be elevated to allow air circulation and to prevent absorption of ground moisture. Lumber that is stored outside should be covered in an open area in a way that will protect the wood from rain and snow but also allow water vapor to escape, such as by covering it with housewrap (plastic sheeting can trap moisture). Interior architectural items such as flooring, trim, and cabinets should be stored indoors until they reach equilibrium with interior moisture levels. This guideline is also a cost effective measure. By protecting materials from weather, waste due to warping, shrinking, and swelling can be avoided.

Points: **Required**

How to Verify: Builder's moisture management plan.

5.3.7 Check moisture content of wood before it is enclosed on both sides (1 point)

Intent: Because wood's ability to dry out is compromised when it is subject to free airflow, moisture content should be acceptable before the wood is enclosed in a wall or floor joist cavity. Reduce the risk of shrinkage and mold on lumber by ensuring the moisture content of dimensional lumber is below 19% before enclosure. For hardwood flooring, the average moisture content of framing members and subflooring should be below 12-14% before delivery of the flooring.

How to Implement: Ensure moisture content of subfloor/substrate meets the appropriate industry standard for the finish flooring material to be installed. Use a moisture meter (preferably a probe-type meter which is more accurate than the scanning type) for determining the moisture content of wood. A sample of wood materials can be checked relatively quickly before installing finish materials that will enclose them.

Points: 1 pt

How to Verify: Builder's moisture management plan.

5.3.8 Keep plumbing supply lines out of exterior walls (1 point)

Intent: Reduce the potential for condensation on supply pipes by keeping pipes in

conditioned space (where pipes are not exposed to large temperature and humidity differentials). Also reduces the consequences of a potential plumbing leak - which could lead to wetting of structural members, insulation, and interior finishes.

How to Implement: Try to cluster bathrooms and other hot water uses together – e.g., "stacked" bathrooms – to minimize the need for running supply lines on exterior walls. One can also use chases designed for keeping ducts in conditioned space for water supply lines. When piping must be located in exterior walls, insulation should be placed between the exterior sheathing and the pipe, but not between the pipe and the interior wall (to prevent freezing).

Points: 1 pt

How to Verify: Filed inspection; Installer certified.

5.3.9 Insulate cold water pipes in unconditioned spaces (1 point)

Intent: Reduce the potential for condensation on cold-water supply pipes located in unconditioned space by insulating the pipes. Cold water piping installed in crawl spaces can pose a condensation problem in colder regions during the summer months.

How to Implement: Insulate cold-water piping with 1/2" foam insulation or other coating that comparably prevents condensation. Foam insulation for insulating pipes is readily available and easy to install.

Points: 1 pt

How to Verify: Builder spec sheet; field inspection.

5.3.10 Insulate HVAC ducts, plenums, and trunks in unconditioned basements and crawl spaces to avoid condensation (1 point)

Intent: To prevent condensation on the outside of cold HVAC ducts located in unconditioned basements and crawl spaces that can lead to moisture problems in those areas.

How to Implement: After sealing ductwork, use spray foam or wrap a flexible insulation product (e.g. reflective insulation) around metal supply ducts, plenums and trunks in basement and crawl spaces. Do not use flexible ductwork in crawl spaces, as it can be an entry point into the home for vermin.

Points: 1 pt

How to Verify: Field inspection; installer certified.

5.3.11 Insulate & minimally condition unfinished basement/crawl spaces (2 pt)

Intent: Increase the efficiencies of mechanical equipment and distribution systems, and reduce chances of condensation, in the below grade spaces.

How to Implement: Basements and crawl spaces should be fully draped with insulation (minimum R-5) at the foundation walls and crawl spaces, Insulation material may need to have a fire-resistant facing or covering. Crawl spaces should not be vented to the exterior. Provide a small amount of conditioned air using a supply & return-air path to keep the space dry.

Points: 2 pt

How to Verify: Builder specifications, field inspection, photo documentation.

5.3.12 Fully insulate under slab (1 pt)

Intent: Allow the basement slab to stay warmer to reduce issues caused by condensation.

How to Implement: Install one or more inches of XPS rigid foam board under the entire slab and turn up the insulation at the foundation wall to provide a thermal break. The slab can then be poured over the insulation. When a vapor barrior is used, the barrier will be installed under the insulation.

Points: 1 pt

How to Verify: Builder specifications, field inspection, photo documentation.

5.4 Alternative Technologies (up to 2 points)

Intent: To encourage the utilization of advanced technologies and provide an opportunity to gain additional points by incorporating alternative technologies into the home.

How to Implement: Install an integrated central vacuum system or motion-sensor controlled exhaust fan in garage (if attached to house).

Points:

- Integrated central vacuum system 1 pt
- Install motion-sensor controlled exhaust fan in garage 1 pt

How to Verify: Builder spec sheet; Installer certified; field inspection.

Section 6 Homeowner Education

6.1 Provide Homeowner Maintenance Manual (2 points)

Intent: Help your home owners to "live green" in their green built home.

How to Implement: Gather information for homeowners from local and national resources (see Resources). Include information about the green features of the home as well as tips for living in the home with less impact on the environment. Ask your local Green Building program if they offer a sample Green Homeowners' Manual.

Manual must include all items listed below:

- Sustainability description;
- Keystone Green Building Initiative certificate;
- Provide homeowner with information and enrollment materials on purchasing green or renewable power;
- Warranty, operations and maintenance instructions;
- Recycling program information (local municipality);
-
- Description: Benefits of compact fluorescent bulbs;
- Provide list of habits/reasons to optimize water & energy use;
- Local transportation information (maps, schedules, contact info.);
- Clearly label safety valves/controls.

Points: 2 pt

How to Verify: Copy of the Home Manual.

6.2 Additional information to include in the Manual (1 point)

Intent: Provide further information about maintenance and operation of a green home and the surrounding site.

How to Implement: Must include all items listed below:

- List of local service providers for maintenance items;
- Photo records of framing w/utilities installed;
- User friendly maintenance checklist;
- Contact information for local disposal of hazardous materials;
- Information on organic pest control, fertilizer, de-icers;
- Directions to maintain 30-60% room humidity in home.

Points: 1 pt

How to Verify: Copy of the Home Manual.

6.3 Use and care homeowner education (required)

Intent: At the walk through, demonstrate the turning on and off and controlling of all mechanical systems in the home. Demonstrate how to use all controls such as thermostat, lighting controls and fan controls.

How to Implement: Instruct homeowners/occupants about the building's goals and strategies and occupant impacts on costs of operating the building. Provide training to owners/occupants for all control systems in the house. This training should be at least 1 1/2 hours.

Points: Required

How to Verify: Builder certified.

6.4 Solid waste (1 point)

Intent: Encourage homeowners/occupants to recycle by providing built-in space in the home's design for recycling containers.

How to Implement: Include a recycling center in or near the kitchen either under the sink, in an island near the sink, or in a pantry; may include an in-counter compost bin, also. Hardware is available for recycling bins to rest on slides. Most under-sink recycling systems can fit two bins under one side of the sink: allowing plenty of room for the other typical under-sink items.

Points: 1 pt

How to Verify: Builder spec sheet; field inspection.

Section 7 Innovation in Design and Construction

7.1 Innovation (1 point per item; up to 9 points)

Intent: To provide the builder with opportunities to receive points for design and construction innovations that is not covered in these guidelines and is in the spirit of the program and green building principles.

How to Implement: Submit a written description of the innovation with an explanation as to how it is outside the guidelines but is in the spirit of green building principles.

Points: (1 point per item) up to 9 pt

How to Verify: Builder spec sheet; manufacturer specifications; installer certified; field inspection…as required to verify.

7.2 Additional innovations may be submitted by the builder to the Keystone GBI Committee for review and possible additional points.

RESOURCES

Section 1: The Site

1.1 Select The Site

1.1.1 Avoid Environmentally Sensitive Areas

- American Society of Consulting Arborists, http://www.asca-consultants.org/why.html.
- American Society of Landscape Architects, http://www.asla.org/members/pigroups.cfm.
- International Society of Arboriculture, http://www.isa-arbor.com/home.asp.
- Society of American Foresters, http://www.safnet.org/certifiedforester/.
- The Ecological Society of America, http://www.esa.org/.

1.1.2 Choose an Environmental and Community Friendly Site

- Policy Link, Equitable Development Toolkit, Infill Incentives, http://www.policylink.org/EDTK/Infill/.
- Northeast-Midwest Institute and Congress for the New Urbanism, *Strategies for Successful Infill Development* (2001), http://www.nemw.org/infillbook.htm.
- U.S. Environmental Protection Agency, Brownfields Cleanup and Redevelopment: http://www.epa.gov/Brownfields/index.html.
- U.S. Environmental Protection Agency has introduced two Web-based tools to give the public additional access to information about Brownfield properties and cleanup efforts. The tools allow residents to locate Brownfields in their area and provide access to information about cleanup grants. - www.epa.gov/Brownfields/bfwhere.htm

1.1.3 Urban Oriented Site

- Congress for the New Urbanism, www.cnu.org.
- Urban Land Institute, www.uli.org.
- American Planning Association, www.planning.org.

- International Council of Shopping Centers, www.icsc.org.

- Congress for the New Urbanism and PricewaterhouseCoopers, *Greyfields into Goldfields:*

- *From Falling Shopping Centers to Great Neighborhoods* (February 2001), http://www.cnu.org/cnu_reports/Executive_summary.pdf.

- Congress for the New Urbanism and PricewaterhouseCoopers, *Greyfield Regional Mall Study* (January 2001), http://www.cnu.org/cnu_reports/Greyfield_Feb_01.pdf.

1.1.4 Open Space/Increased Density

1.2 Identify Goals with Team

- American Society of Consulting Arborists, http://www.asca-consultants.org/why.html.

- American Society of Landscape Architects, http://www.asla.org/members/pigroups.cfm.

- International Society of Arboriculture, http://www.isa-arbor.com/home.asp.

- Society of American Foresters, http://www.safnet.org/certifiedforester/.

- The Ecological Society of America, http://www.esa.org/.

1.3 Design The Site

1.3.1 Conserve Natural Resources

- American Society of Consulting Arborists, http://www.asca-consultants.org/why.html.

- American Society of Landscape Architects, http://www.asla.org/members/pigroups.cfm.

- International Society of Arboriculture, http://www.isa-arbor.com/home.asp.

- Society of American Foresters, http://www.safnet.org/certifiedforester/.

- Article on preserving trees during construction: http://www.umass.edu/bmatwt/publications/articles/preserving_trees_during_construction.html

1.3.2 Optimal Solar Site Plan Operation

1.3.3 Minimize Slope Disturbance

- Article on preserving trees during construction: http://www.umass.edu/bmatwt/publications/articles/preserving_trees_during_construction.html

1.3.4 Minimize Soil Disturbance

- Sediment and Erosion Control (EPA) http://epa.gov/region8/water/stormwater/downloads/sediment.pdf
- National Association of Home Builders (NAHB), *Storm Water Permitting: A Guide for Builders and Developers,* 2004, http://store.builderbooks.com or 800-368-5242 x8163.
- King County Department of Natural Resources, King County, Washington Surface Water Design Manual Appendix D: Erosion and Sediment Control Standards (Seattle: September 1998), ftp://ftp.metrokc.gov/ddes/acrobat/esa/kcswdm-d.pdf.
- Dr. James R. Fazio, National Arbor Day Foundation, *Trenching and Tunneling: A Pocket Guide for Qualified Utility Workers* (Nebraska City, Nebraska: 1998),
- http://www.arborday.org/shopping/merchandise/merchdetail.cfm?id=62.

1.3.5 Storm Water Management

- The Practice of Low Impact Development, U.S. Department of Housing and Urban Development (HUD); http://www.huduser.org/publications/destech/lowimpactdevl.html
- Tom Schueler, Center for Watershed Protection, *Site Planning for Urban Stream Protection*, Ellicott City, MD, 1995, http://www.cwp.org/SPSP/TOC.htm.
- Lisa Austin, Washington State Department of Ecology Water Quality Program, *Stormwater Management Manual for Western Washington* (Publication 99-12), September 2001, http://www.ecy.wa.gov/pubs/9912.pdf.
- Betty Rushton, Southwest Florida Water Management District, *Low Impact Parking Lot Design Reduces Runoff and Pollutant Loads: Annual Report # 1,* Brooksville, Florida, 1999.

1.3.6 Water and Energy Efficient Landscaping

- Audubon International, *Audubon Cooperative Sanctuary System,* http://www.audubonintl.org/programs/acss/. Audubon Cooperative Sanctuary System's Treasuring Home Initiative.

- Center for Plant Conservation, http://www.mobot.org/CPC/.

- Lady Bird Johnson Wildflower Center, Native Plant Information Network National Suppliers Directory, http://www.wildflower2.org/NPIN/Suppliers/suppliers.html.

- New England Wildflower Society, Native Plant Societies of the United States and Canada, http://www.newfs.org/nps.htm.

- NAHB Research Center Inc., *Onsite Grinding of Residential Construction Debris: The Indiana Grinder Pilot*, February 1999.

1.3.7 Maintain Wildlife Habitat

- Audubon International, *Audubon Cooperative Sanctuary System,* http://www.audubonintl.org/programs/acss/. Audubon Cooperative Sanctuary System's Treasuring Home Initiative.

- Become a certified participant in the National Wildlife Federation's Backyard Wildlife Habitat Program. https://secure.nwf.org/backyardwildlifehabitat/certify/page1.cfm

1.4 Develop The Site

1.4.1 Tree/Vegetation Protection

Section 2: Resource Efficiency

2.1 Reduce Quantity & Waste of Materials

2.1.1 Create an Efficient Sized Home

- Oikos®, *Small, Efficient and Beautiful,* 17 Space Design Tips. http://oikos.com/esb/52/smallefficient.html

- There are many resources available to help a builder create efficient home floor plans. For example, Sarah Susanka's *Not So Big House* series of books can assist in home design. *The Not So Big House* (The Taunton Press, 1998); *Creating the Not So Big House* (The Taunton Press, 2000).

- GreenBuilder, *Sustainable Building Sourcebook,* http://www.greenbuilder.com/sourcebook/

- Environmental Building News and BuildingGreen.com, *GreenSpec Directory* http://www.greensage.com/BOOKS/GreenSpecs.html

2.1.2 Advanced Framing Techniques

- NAHB Research Center, *Advanced Framing Techniques: Optimum Value Engineering*, http://www.nahbrc.org/tertiaryR.asp?TrackID=&DocumentID=2021&CategoryID=70.

- HUDUSER, *Prescriptive Method for Residential Cold-Formed Steel Framing*, http://www.huduser.org/publications/destech/pm2.html

- Building American, DOE, *Optimum Value Engineering Best Practices*, (September, 2002), http://www.ibacos.com/pubs/OptimumValueEngineering.pdf.

- DOE, *Advanced Framing for Walls and Ceilings*, http://www.energy.state.or.us/code/respub/res10.pdf

- International Code Conference, *2003 International Residential Code*®, Panel Box Headers, Table R602.7.2, pg. 123, and Fig. R602.7.2, pg. 124.

2.1.3 12”/24” Overall Dimensions of Building

- NAHB Research Center, PATH technology list, *Advanced Framing Techniques: Optimum Value Engineering (OVE)*, http://www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2021&CategoryID=70

2.1.4 Framing Plan: Material Take-offs, Precuts

2.1.5 Efficient Building Systems

2.1.6 Pre-assembled/Engineered Framing

- NAHB, Building Systems Council, *Fast Facts: Systems-Built Housing*, http://www.nahb.org/generic.aspx?sectionID=455&genericContentID=10216 and www.buildingsystems.org

- U.S. HUD, *Builders’ Guide to Residential Steel Floors*, http:www.huduser.org/Publications/PDF/steelfloor.pdf

2.1.7 Frost-protected Shallow Foundation

- NAHB Research Center, Revised Guide to Frost-Protected Shallow Foundations http://www.toolbase.org/docs/SubsystemNav/Foundations/4495_RevisedFPSFGuide.pdf

2.2 Enhance Durability & Reduce Maintenance

- NAHB Research Center for PATH, *Durability by Design*, http://www.huduser.org/publications/destech/durdesign.html

- Canadian Architect, *Measures of Sustainability*, http://www.cdnarchitect.com/asf/perspectives_sustainibility/measures_of_sustainablity/measures_of_sustainability_durability.htm

- The Residential Moisture Management Network is working on addressing issues related to moisture management in homes, http://www.rmmn.org/

- Installation details for wood framed construction that will minimize moisture intrusion into the building envelope can be found at http://www.buildabetterhome.org. Publications on foundations, roofs and walls can be downloaded by going to each of those sections under the "builder tips" and then clicking on "get the brochure."

2.2.1 Covered Entries

2.2.2 Region-specific Overhangs

- Canadian Wood Council, *Termite Control and Wood-Frame Buildings: Slab and Foundation Details*, http://www.cwc.ca/publications/building_performance/termites/structural.php

- **NAHB Research Center for PATH, *Durability by Design*,** http://www.huduser.org/publications/destech/durdesign.html

2.2.3 Moisture Protection

2.2.4 Insect Resistance

- Canadian Wood Council, *Termite Control and Wood-Frame Buildings: Slab and Foundation Details*, http://www.cwc.ca/publications/building_performance/termites/structural.php

- NAHB Research Center, *Termite Baiting*

http://www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1402&DocumentID=2153

- University of Kentucky Entomology, *Termite Baits: A Guide for Homeowners,* http://www.uky.edu/Agriculture/Entomology/entfacts/struct/ef639.htm
- Termiticide fabric and mesh manufacturers, http://www.impasse.com/ and http://www.termi-mesh.com/
- Durable-Wood.com, Forintek Canada Corp., *Termite Control and Wood-Frame Buildings* http://durable-wood.com/termites/termitecontrol-e.pdf
- Western Wood Preservers Institute, http://www.wwpinstitute.org
- *Terminate the Termites*, www.steelframingalliance.com

2.3 Material Reuse

2.3.1 Disassemble Existing Building

- Inform, Inc., *Community Waste Prevention Toolkit: Construction and Demolition Fact Sheet*, http://www.informinc.org/fact_CWPconstruction.php#basics
- California Integrated Waste Management Board (CIWMB), http://www.ciwmb.ca.gov
- CIWMB, *Recycled-Content Product Directory*, http://www.ciwmb.ca.gov/RCP/Product.asp?VW=CSI&CATID=269
- NAHB Research Center, ToolBase Services, *Construction Waste Management,* http://www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=34
- Whole Building Design Guide, *Construction Waste Management Database*, http://www.wbdg.org/ccbref/cwm.php
- Washington State Department of General Administration, Construction Waste Management Guide, http://www.ga.wa.gov/EAS/CWM/ContractorsGuide.doc
- Government of Hawaii, *Minimizing Construction and Demolition Waste,* http://www.hawaii.gov/health/environmental/waste/sw/pdf/constdem.pdf

2.3.2 Reuse Salvaged Materials

- Jennifer Corson, *The Resourceful Renovator: A Gallery of Ideas for Reusing Building Materials* (Chelsea Green Publishing Company, December

2000).

- Greater Vancouver Regional District Policy and Planning Department, *Old to New Design Guide Salvaged Building Materials in New Construction 3rd Edition* (January 2002), http://www.buildsmart.ca/pdfs/DesignGuideMaster.pdf.

- Used Building Materials Association, http://bcn.boulder.co.us/environment/ubma/index.html.

2.3.3 Bin Collection System

2.4 Recycled Materials

2.4.1 Recycled Materials

- King County (WA), *Environmentally Responsible Carpet Choices*, http://www.metrokc.gov/procure/green/carpet.htm

- U.S. Environmental Protection Agency (EPA), *Comprehensive Procurement Guidelines*, http://www.epa.gov/cpg/.

- EPA, *Environmentally Preferable Purchasing.* http://www.epa.gov/oppt/epp/tools/toolsuite.htm

- Green Building Source, *Green Product Information* http://oikos.com/products/index.lasso

- California Integrated Waste Management Board, Recycled Product Directory, *Products Category: Construction*, can provide a baseline for total recycled content (TRC) that is achievable with some products, http://www.ciwmb.ca.gov/RCP/Product.asp?VW=CAT&CATID=257

- Details on the Composite Panel Association's Environmentally Preferable Product (EPP) Specification CPA 1-02 and a list of certified manufacturers, http://www.pbmdf.com/AboutCPA/EPP.asp

- Carpet America Recovery Effort[SM], http://www.carpetrecovery.org/

- Steel Recycling Institute, http://www.recycle-steel.org/construction.html

2.5 Waste Reduction

2.5.1 Waste Management

- City of Agoura Hills (CA), *Construction and Demolition Debris Recycling Program, Waste Reduction/Recycling Plans*, http://ci.agoura-hills.ca.us/Modules/ShowDocument.aspx?dpci,emtod=2842

- NAHB Research Center, Inc., Residential Construction Waste information, http://www.epa.gov/epaoswer/non-hw/debris/mgmt.htm

- U.S. Environmental Protection Agency Solid Waste and Emergency Response, Building Savings, Strategies for Waste Reduction of Construction and Demolition Debris from Buildings (EPA-530-F-00-001) (June 2000), http://www.epa.gov/osw

- Institute for Local Self-Reliance. http://www.ilsr.org/recycling/buildingdebris.pdf.

2.5.2 On-site Recycling/Grinder

- Waste Handling Equipment News, *Major Home Builders Benefit from On-site Recycling*, http://www.wastehandling.com/july/major.html

- NAHB Research Center, ToolBase Services, *RESIDENTIAL CONSTRUCTION WASTE: FROM DISPOSAL TO MANAGEMENT*, http://www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=34&DocumentID=2301

2.5.3 Off-site Recycling

- American Forest and Paper Association, National Wood Recycling Directory, http://www.afandpa.org/Content/NavigationMenu/Environment_and_Recycling/Recycling/Wood_Recovery1/Wood_Recycling_Directory1/Wood_Recycling_Directory_Intro.htm.

- California Integrated Waste Management Board, http://www.ciwmb.ca.gov/.

- Corrugated Packaging Council, How to Recycle Corrugated, http://cpc.corrugated.org/Recycle/RecyHowTo.aspx.

- U.S. Environmental Protection Agency Municipal and Industrial Solid Waste Division Office of Solid Waste, *Characterization of Building-Related Construction and Demolition Debris in the United States* (EPA530-R-98-010) (June 1998), http://www.epa.gov/epaoswer/hazwaste/sqg/c&d-rpt.pdf.

- Steel Recycling Database, http://www.recycle-steel.org/database/main.html

- The U.S. General Services Administration (GSA) has recently updated its online Construction Waste Management Database to assist the building industry in reducing construction and demolition waste. Recyclers of construction and demolition waste may advertise their services free on this site. Access the

database at http://cwm.wbdg.org.

2.6 Renewable Resources

2.6.1 Use materials Manufactured From Renewable Resources

2.6.2 Use Certified Wood Products

- Forest Certification Resource Center, *Comparison of Forest Certification Systems,* http://www.certifiedwood.org/search-modules/compare-systems/comparison-of-systems/comparison-of_systems.htm
- The Canadian Standards Association's Sustainable Forest Management System Standards (CAN/CSA Z809) http://www.sfms.com/welcome.htm
- Forest Stewardship Council (FSC) http://www.fsc.org/fsc
- Program for the Endorsement of Forest Certification Systems (PEFC) http://www.pefc.org/internet/html
- The Sustainable Forestry Initiative® Program, http://www.aboutsfi.org/
- The American Tree Farm System® http://www.treefarmsystem.org/

2.7 Optional Solutions

2.7.1 Use Locally Available, Indigenous Materials

2.8 Alternative Technologies

2.8.1 Use Products That Contain Fewer Resources

2.8.2 USE LCA Tool for Chosen Materials

- National Institute of Standards and Technology, *Building for Environmental and Economic Sustainability software*, (http://www.bfrl.nist.gov/oae/software/bees.html)
- The Athena™ Sustainable Materials Institute, http://www.athenasmi.ca/news/down/LCI_Database_Project_News_1.pdf

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- National Institute of Standards and Technology, *Building for Environmental and Economic Sustainability software*, (http://www.bfrl.nist.gov/oae/software/bees.html)

- The Athena™ Sustainable Materials Institute, http://www.athenasmi.ca/news/down/LCI_Database_Project_News_1.pdf

3.1.1 Home is Equivalent to IECC or Local Energy Code

3.1.2 Utilize Manual J 8th Edition for Heating/Cooling Loads

3.1.3 Utilize manual S to Select HVAC Equipment

- ACCA Manual S®, *Equipment Selection,* available for purchase at www.acca.org.
- U.S. DOE fact sheet, *Right Size Heating and Cooling Equipment*, http://www.toolbase.org/docs/MainNav/Energy/4073_doe_hvacsizing.pdf

3.1.4 Utilize manual D for Duct Design and Installation

- *ACCA Manual D®, Residential Duct Systems* (available for purchase at http://www.acca.org)

3.1.5 Conduct Third Party Plan to Verify Compliance With Section 3

- ***REScheck*** is a free software tool that can be downloaded at http://www.energycodes.gov/rescheck/.
- ***Manual J 8th Edition*** is available through the Air Conditioning Contractors of America and can be purchased online at http://www.accaconference.com/Merchant2/merchant.mv?Screen=SFNT&Store_Code=ACCOA . Also, see www.acca.org for additional approved third-party software providers.
- *Heat Loss Calculation Guide H-22*, Hydronics Institute Division of GAMA, 2001.
- *International Energy Conservation Code (IECC) 2003.* Available from the International Code Council, http://www.iccsafe.org
- Third party plan review: A Certified Home Energy Rating System (HERS) rater. A directory of Home Energy Raters can be found on the ENERGY STAR® website at www.energystar.gov.

3.2 Performance path (Option A)

3.2.1 Energy Star Homes Certification

3.3 Prescriptive Path (Option B)

3.3.1 Increase Effective R Value by Reducing Thermal Bypass

- *Advanced Framing Fact Sheet*, U.S. DOE: http://www.toolbase.org/docs/MainNav/WoodFrameConstruction/3949_advancedwallframing1.pdf
- Advanced framing: http://www.buildingscience.com/housesthatwork/advancedframing/default.htm
- *Cost Effective Homebuilding: A Design and Construction Handbook*, 1994, NAHB Research Center, available for purchase at: http://www.nahbrc.org/tertiaryR.asp?TrackID=&DocumentID=2584&CategoryID=917

3.3.2 Incorporate Air Sealing Package

- *Advanced Air Sealing* (book available for viewing online): http://oikos.com/library/airsealing/index.html
- U.S. DOE's fact sheet, *Airtight Drywall Approach* (no diagrams), http://www.eere.energy.gov/consumerinfo/fact sheets/bd8.html
- Southface Energy Institute's fact sheet, *Airtight Drywall Approach* (contains diagrams), http://www.southface.org/web/resources&services/publications/fact sheets/24ada_drywal.pdf
- Energy & Environmental Building Association http://www.eeba.org/resources/criteria.htm

3.3.3 Energy Star Rated Windows

- www.efficientwindows.org
- *Improve Energy Efficiency with High Performance Windows*, ENERGY STAR fact sheet, http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/BuilderGuide3E.pdf
- Efficient Windows Collaborative, http://www.efficientwindows.org. Recommends U-value and Solar Heat Gain Coefficient (SHGC) by climate region.
- ENERGY STAR Website www.energystar.gov for list of stores that sell

ENERGY STAR labeled windows

- www.energystar.gov for a list of manufacturers searchable by type of window, type of frame, and climate.

- The National Fenestration Rating Council (NFRC) labels windows for U-value and Solar Heat Gain Coefficient and has searchable directory of windows meeting specific criteria on their Website at http://www.nfrc.org

3.3.4 HVAC Duct System Tightness

- *ACCA Manual D®, Residential Duct Systems* (available for purchase at http://www.acca.org)

- *Air Distribution System Design* (U.S. DOE fact sheet) http://www.toolbase.org/docs/MainNav/Energy/4074_doe_airdistributionsystemdesign.pdf

- *A Builder's Guide to Placement of Ducts and HVAC Equipment in Conditioned Spaces*, 2000, NAHB Research Center. Available for $5 from NAHB Research Center bookstore at http://nahbrc.org/tertiaryR.asp?TrackID=&DocumentID=2570&CategoryID=110

- *Design and Construction of Interior Duct System*, Florida Solar Energy Center, (2002) http://www.fsec.ucf.edu/bldg/baihp/pubs/Papers/interior_ducts.pdf

3.3.5 HVAC Duct Air Quality and Performance

3.3.6 Ventilation

3.3.7 Install Energy Star Labeled Programmable Thermostat

3.3.8 Energy Star Rated Equipment

- American Council for an Energy-Efficient Economy's list of most energy efficient appliances http://www.aceee.org/consumerguide/mostenef.htm

- http://www.energystar.gov for a list of equipment meeting ENERGY STAR standards

- *Gas Appliance Manufacturer's Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment.* http://www.gamanet.org

- Manufacturers' Websites.

3.3.9 Environmentally Friendly Refrigerants

3.3.10 Water Heating

- *The Most Energy Efficient Appliances*, (list from Consumer's Guide to Home Energy Savings), American Council for an Energy Efficient Economy, http://www.aceee.org/consumerguide/mostenef.htm

- *Gas Appliance Manufacturer's Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment*. www.gamanet.orghttp://www.toolbase.org/docs/SubsystemNav/Plumbing/3946_waterheating.pdf

3.3.11 Install Tankless Hot Water Heater(s)

- *The Most Energy Efficient Appliances*, (list from Consumer's Guide to Home Energy Savings), American Council for an Energy Efficient Economy, http://www.aceee.org/consumerguide/mostenef.htm

3.3.12 Insulate All Hot Water Lines

- *Water Heating: Energy-Efficient Strategies for Supplying Hot Water in the Home* (U.S. DOE fact sheet), http://www.toolbase.org/docs/SubsystemNav/Plumbing/3946_waterheating.pdf

3.3.13 Install Manifold Plumbing System

3.3.14 Maximize Daylighting

- Tubular Skylights (NAHB Research Center technology fact sheet) http://www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1282&DocumentID=2024.

3.3.15 Energy Efficient Light Fixtures

- Tool to estimate lighting energy savings of Advanced Lighting Package: http://www.energystar.gov/ia/partners/manuf_res/Savings_Look-up_ChartsLR.pdf

- ENERGY STAR Program information for builders: http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.ALP

_Builder

3.3.16 Install Energy Star Appliances

- List of ENERGY STAR labeled ceiling fans (fan only) http://www.energystar.gov/ia/products/prod_lists/ceiling_fans_only_prod_list.pdf
- List of ENERGY STAR labeled ceiling fans (fan and light) http://www.energystar.gov/ia/products/prod_lists/ceiling_fans_with_lighting_prod_list.pdf
- List of ENERGY STAR labeled ceiling fan (light kits only) http://www.energystar.gov/ia/products/prod_lists/ceiling_fans_lightkit_prod_list.pdf
- List of products meeting ENERGY STAR criteria: http://www.energystar.gov/ia/products/prod_lists/vent_fans_prod_list.pdf
- *Spot Ventilation: Source control to improve indoor air quality* (U.S. DOE fact sheet), http://www.toolbase.org/docs/MainNav/Energy/3947_spotventilation1.pdf
- http://www.energystar.gov for list of appliances meeting ENERGY STAR criteria and list of local stores that sell ENERGY STAR appliances. The Website also includes a calculator to show prospective homeowners how much they will save and how fast the upgraded appliance will pay for itself over time.

3.3.17 Renewable Energy

- *Passive Solar Heating and Cooling: Natural Cooling*, Arizona Solar Center fact sheet, http://www.azsolarcenter.com/technology/pas-3.html
- *Cooling Your Home Naturally*, (U.S. DOE fact sheet) http://www.eere.energy.gov/consumerinfo/pdfs/coolhome.pdf
- *Passive Solar Design Strategies*, Guidelines for Home Building, Sustainable Building Industries Council, www.psic.org.
- For a list of Solar Rating and Certification Corporation's certified solar water heating systems, see www.solar-rating.org
- *Solar Water Heaters* (NAHB Research Center technology fact sheet), http://www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2136&CategoryID=68
- Download Solar Fraction Calculator for Rated Systems

http://www.energy.ca.gov/title24/sf_calculator/CF-SR300.xls

- EERE Consumer's Guide: Solar Water Heater Energy Efficiency http://www.eere.energy.gov/consumer/your_home/water_heatin/index.cfm/mytopic=12900?print

- Summary of SRCC Certified Solar Collector and Water Heating System Ratings www.solar-rating.org/SUMMARY/Dirsum_20070702.pdf

- Database of State Incentives for Renewable Energy, www.dsireusa.org

3.3.18 Renewable Electricity Generation

- http://www.dsireusa.org - provides information about areas offering incentives that promote renewable energy and information about net metering rules.

- State Energy Office—directory of state energy offices at http://www.naseo.org/members/states.htm

- Photovoltaics, U.S. DOE fact sheet, http://www.eere.energy.gov/RE/solar_photovoltaics.html

3.3.19 Provide Clear Unshaded Roof Area for Future Solar Application

3.3.20 Alternative Technologies

- Department of Energy - http://www.eere.energy.gov/consumerinfo/energy_savers/virtualhome/508/shower.html

- *Drainwater Heat Recovery*, NAHB Research Center technology fact sheet, http://www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2134&CategoryID=947

Section 4: Water Efficiency

4.1 Indoor Water Use

General Resources:

All aspects of water conservation:

www.awwa.org/waterwiser/

Water Resources of the United States:

http://water.usgs.gov/

4.1.1 Efficient/Low Flow Fixtures

- PATH Technology Inventory: *Low Flow Plumbing Fixtures* www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1316&DocumentID=2135
- Plumbing materials and supplies: www.plumbingworld.com

4.1.2 High Efficiency Fixtures

- EPA, *Low Flow Toilets*: www.epa.gov/owm/water-efficiency/toilets.htm
- Arizona Cooperative Extension: http://www.sahra.arizona.edu/programs/water_cons/home/bathroom_toilet.htm#3

4.1.3 Shut-off Valve or Pedal-activated or Motion Sensor Controls

- U.S. DOE, Greening Federal Facilities, Showers, Faucets and Drinking Fountains http://www.eere.energy.gov/femp/pdfs/29267-6.3.pdf

4.1.4 Composting or Waterless Toilets

- EPA, Technology Fact Sheet, *Composting Toilets*: http://www.epa.gov/owm/mtb/comp.pdf
- Sustainable Building Sourcebook, *Composting Toilets*: http://www.greenbuilder.com/sourcebook/CompostToilet.html
- What is a composting toilet? http://www.oikos.com/library/compostingtoilet/
- Composting Toilets: http://www.compostingtoilet.org/

4.1.5 Energy Star Dishwasher and/or Clothes Washer

- List of ENERGY STAR -rated appliances: www.energystar.gov/index.cfm?c=appliances.pr_appliances

- Vertical Axis (Top Loading) Energy-Saving Clothes Washers: www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1280&DocumentID=2004

- Energy Efficient Appliances, DOE Technology Factsheet: www.toolbase.org/Docs/MainNav/Energy/4070_doe_energyefficientappliances.pdf?TrackID=&CategoryID=1280&DocumentID=4070

- *"Dishing Out Dollars," Consumer Reports*, March, 1998, pg. 37. A comprehensive review of energy and water-efficient dishwashers.

4.2 Outdoor Water Use

4.2.1 Low Volume, Non-spray Irrigation

- *Turf and Landscape Irrigation Best Management Practices*, Irrigation Association, http://www.irrigation.org/PDF/IA_BMP_FEB_2004.pdf

- *Landscaping Irrigation Systems*, H2ouse.org., the California Urban Water Conservation Council, http://www.h2ouse.org/tour/details/element_action_contents.cfm?elementID=68BAD0B5-0C95-4AE8-8EC6EC8D76A4CBE1&actionID=BD9DA9D3-0CFA-4F05-B3CBFEC63E2EEE57&roomID=F80B1F87-C00D-498C-9C1F1E5BE9D04637

- PATH Technology Inventory, *Rainwater Harvesting*: www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1315&DocumentID=2129

- *Harvesting Rainwater for Landscape Use*: http://ag.arizona.edu/pubs/water/az1052/harvest.html

- Garden supply houses

4.2.2 Irrigation Control

- *Turf and Landscape Irrigation Best Management Practices*, Irrigation Association, http://www.irrigation.org/PDF/IA_BMP_FEB_2004.pdf

- University of Nebraska drought monitoring site by U.S. state, http://drought.unl.edu/dm/monitor.html

- *Soil type and classification*, Association of American State Geologists, http://www.kgs.ukans.edu/AASG/AASG.html

4.3 Waste Water Management

4.3.1 Grey-water Re-use System

- PATH Technology Inventory: http://www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2137&CategoryID=1002

- Greywater: www.greywater.com/

- Arizona Department of Environmental Quality, *Using Gray Water at Home*: www.deq.co.pima.az.us/water/Water%20PDFs/graywater.pdf

4.3.2 Innovation Waste Water Technology

- United States Environmental Protection Agency, Office of Water, Office of Research and Development, *Onsite Wastewater Treatment Systems Manual*, EPA/625/R-00/008, February 2002, http://www.epa.gov/ORD/NRMRL/Pubs/625R00008/html/625R00008.htm.

- University of Minnesota Extension Service: www.extension.umn.edu/distribution/naturalresources/DD7734.html

- *Alternative Individual Wastewater Systems* fact sheet: www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1325&DocumentID=2258

- *Onsite Sewage Disposal Systems* fact sheet: www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1291&DocumentID=4063

- Aerobic Wastewater Treatment Systems http://www.toolbase.org/Technology-Inventory/Plumbing/aerobic-wastewater-treatment

Section 5: Indoor Environmental Quality

General Resources

- The Sustainable Building Sourcebook, http://www.greenbuilder.com

- The Healthy House Institute, http://www.hhinst.com

- For Volatile Organic Compounds, http://www.concretenetwork.com/concrete/finished_basements/a_word_about_vo

cs.htm

- For Building Material Emissions Study, http://www.ciwmb.ca.gov/Publications/GreenBuilding/43303015.doc

- For spot ventilation, see the fact sheet *Spot Ventilation—source control to improve indoor air quality* http://www.toolbase.org/Docs/MainNav/Energy/3947_spotventilation1.pdf?TrackID=&CategoryID=1004&DocumentID=3947 (Sept 2004)

- EPA. *A Guide to Indoor Air Quality*, http://www.epa.gov/iaq/pubs/insidest.html (Sept 2004)

- *Mold in Residential Buildings*, http://www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1554&DocumentID=2944 (Sept 2004)

5.1 Minimize Potential Sources of Pollutants

- Koontz, M.D., N.L. Nagda. *Depressurization-Induced Backdrafting and Spillage: Implications of Results from North American Field Studies.* ASHRAE Winter Meeting; January 12–16, 2002, Atlantic City, New Jersey. AC-02-3-2. Atlanta, GA: American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc., 2002.

- National Fire Protection Association, *American Gas Association. National Fuel Gas Code*. 2002 Edition. NFPA 54-2002. ANSI Z2223.1-2002. Section G2406 (303) Appliance Location

- American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. *ASHRAE Standard 62-1989*

- Lstiburek, J., *Builder's Guide: Hot-Dry & Mixed-Dry Climates*. Westford, MA: Building Science Corporation, September 2000.

- Lstiburek, J., *Builder's Guide: Hot-Humid Climates*. Westford, MA: Building Science Corporation, January 2002.

- Lstiburek, J., *Builder's Guide: Hot-Humid Climates*. Westford, MA: Building Science Corporation, February 2002.

- http://www.epa.gov/iaq/homes/ Search for: "Preventing Problems with Combustion Equipment" and "What You Should Know About Combustion Appliances and Indoor Air Pollution"

5.1.1 Install Sealed Combustion or Mechanical Draft Combustion Equipment

5.1.2 Combustion Equipment Isolated With Outside Combustion Air

- Efficiency and Renewable Energy, U.S. Department of Energy. *Combustion Equipment Safety: Provide Safe Installation for Combustion Appliances*. Page 3, Combustion Closet Design chapter

5.1.3 Install Direct Vent Gas/Wood Fireplace or Sealed Woodstove

- U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Consumer Energy Information: EREC Reference Briefs. *Air Pollution from Wood-Burning Appliances and Fireplaces* http://www.eere.energy.gov/consumerinfo/factsheets/ja3.html.
- Hearth, Patio, and Barbecue Association (HPBA). http://hpba.org
- HPBA fact sheet on EPA-certified wood burning http://www.hpba.org/communications/FactSheets/Fact03-EPAWoodBurn3.pdf
- HPBA fact sheet *Wood Burning Fireplaces* http://www.hpba.org/communications/FactSheets/WoodBurningFireplace.pdf
- HPBA fact sheet, *Gas Fireplaces* http://www.hpba.org/communications/FactSheets/GasFireplace.pdf
- National Fireplace Institute. http://nficertified.org. Find a certified installer. NFI Certification identifies those individuals who have passed an exam based on the knowledge needed to properly plan and install hearth products and their venting systems.
- U.S. EPA Compliance Monitoring, *Woodstoves*: http://www.epa.gov/compliance/monitoring/programs/woodstoves
- For fireplace venting options, http://www.fireplacenow.com/_content_/VentingOptions.htm (Sept 2004)

5.1.4 Ensure Air Barrier Between Garage and Living Space

- Super Good Cents Builders Field Guide – Chapter 9 – Air Tightening Specialist
- Building Science Corporation: Figure 19.

http://www.buildingscience.com/housesthatwork/hotdry/tucson.htm

- Wilber, M.W. and S.R. Klossner. 1997. A Study of Undiagnosed Carbon Monoxide Complaints. Healthy Buildings/IAQ '97: Global Issues and Regional Solutions, Vol. 3, Bethesda, Maryland, Sept 27-Oct, 1997.

- Bohac, D.L. and T. H. Brown. 1997. Results from IAQ Evaluations on Cold Climate Single Family Houses Undergoing Sound Insulation. Healthy Buildings/IAQ '97: Global Issues and Regional Solutions, Vol. 3, Bethesda, Maryland, Sept 27-Oct, 1997.

- http://oikos.com/library/airsealing/rim_joists.html

5.1.5 Ensure Materials Are Low Formaldehyde Emitting

- IARC *Monographs on the Evaluation of Carcinogenic Risks to Humans* - http://monographs.iarc.fr/htdocs/announcements/vol88.htm

- http://www.buildinggreen.com - GreenSpec Directory

- The Composite Panel Association (CPA) Environmentally Preferable Product (EPP) Certification Program, http://www.pbmdf.com/AboutCPA/EPP.asp

- http://www.eppbuildingproducts.org/specifications/draftspecs/RevisedCP.attachment/30/EPPD_Composite_Panels_052405.pdf This work is currently underway and may not be completed as of the printing of these guidelines.

- GreenGuard certifies products for low emissions. As of September 2004, only one engineered wood product was listed. http://www.Greenguard.org

- For formaldehyde-free MDF, check http://www.advancedbuildings.org/main_t_finishes_formaldehyde.htm, Sept 2004.

5.1.6 Install "Green Label" Carpet, Pad and Adhesives

- http://www.carpet-rug.com/drill_down_2.cfm?page=8&sub=4&requesttimeout=350

- Wargocki, P., D.P.Wyon, Y.K.Balk, G.Clausen and P.O.Fanger. 1999. Perceived Air Quality, Sick Building Syndrome Symptoms and Productivity in an Office with Two Different Pollution Loads. Indoor Air 1999, vol. 9: 165-179.

- Environment Protection Agency. http://www.epa.gov/iaq/formalde.html. (Sept 2004)

5.1.7 Protect and Clean HVAC Outlets Prior to Activation

5.1.8 Use Low VOC Emitting Wallpaper, Adhesives and Finishes

- http://www.greenguard.org
- *Green from Wall to Wall* by Environmental Design+Construction, http://www.edcmag.com/CDA/ArticleInformation/coverstory/BNPCoverStoryItem/0,4118,128601,00.html (Sept 2004)
- *Paints and Wall Coverings* by DOE, Energy Efficiency and Renewable Energy. http://www.eere.energy.gov/femp/pdfs/29267-7.1.6.pdf (Sept 2004)

5.2 Manage Potential Pollutants Generated in the Home

5.2.1 Vent Kitchen Range Exhaust to the Outside

- Home Ventilating Institute, http://www.hvi.org
- American Society of Heating, Refrigeration and Air-Conditioning Engineers, ASHRAE Standard 62-1989
- 2003 IRC page 302, Section M1506.3 Ventilation Rate
- State of California. *Reducing Indoor Air Pollution,* http://www.arb.ca.gov/research/indoor/rediap.htm (Sept 2004)
- Doiron, Jacques, *Cleaner cooking*. http://www.canadianhomeworkshop.com/quickfix/kitchen_vent.shtml (Sept 2004)
- Miltner, Karen, *Keeping Kitchen Smells Fresh*. http://www.democratandchronicle.com/homes/buyersguide/1010G221OKH_HOODS11_Homes.shtml (Sept 2004)

5.2.2 Provide Mechanical Ventilation at a Rate of 7.5 CFM

- American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. ASHRAE Standard 62-1989

5.2.3 Install MERV Filters on Central Air or Ventilation Systems

- National Institute for Occupational Safety and Health. Guidance for Protecting Building Environments from Airborne Chemical, Biological, or Radiological Attacks. http://www.cdc.gov/niosh/docs/2003-136/2003-136c.html (Sept 2004)

- CHMC " What a Furnace Filter Can Do For You" http://www.cmhc-schl.gc.ca/en/burema/gesein/abhose/abhose_ce22.cfm (September 2004)

5.2.4 Install Humidistat to Control Whole-house Humidification System

- ToolBase Website. Humidity-Sensing Control Device http://www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2096&CategoryID=960 (Sept 2004)

5.2.5 Install Infrastructure for Radon Mitigation System

- 2003 IRC page 559

- HBA: Use radioactivity maps from USGS, state geological surveys, colleges/universities to better know the dangerous radon zones in your area. http://energy.cr.usgs.gov/radon/georadon/4.html

- Radon map for Prince George's and Montgomery counties from USGS http://energy.cr.usgs.gov/radon/georadon/4.html

- EPA's map of radon zones by county http://www.epa.gov/radon/zonemap.html

- HBA: EPA also recommends contacting your state radon representative. EPA has a list of contacts on their Website at: http://www.epa.gov/iaq/whereyoulive.html

- http://www.epa.gov/radon/

- *Radon Resistant New Construction* - http://www.epa.gov/radon/construc.html

- 2000 IRC, page 564, *Radon-resistant construction details for four foundation types*.

- For Radon remediation, check http://www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1174

5.2.6 Verify Exhaust Flow Specifications

- ACCA Manual D http://www.cmhc-schl.gc.ca/en/burema/gesein/abhose/abhose_ce17.cfm

- Flow hood equipment - http://www.energyconservatory.com/products/products1.htm

5.3 Moisture Management (Vapor, Rainwater, Plumbing, HVAC)

- Lstiburek J., and J. Carmody, *Moisture Control Handbook, Principles and Practices for Residential and Small Commercial Buildings*, Wiley, 1996.

5.3.1 Control Bathroom Fans with Timer or Humidistat

- http://energyoutlet.com/res/fan/

- http://www.cmhc-schl.gc.ca/en/burema/gesein/abhose/abhose_ce17.cfm

- *Moisture Control in Bathrooms* by Home Energy Magazine Online. http://hem.dis.anl.gov/eehem/98/980310.html (Sept 2004)

- *Spot ventilation—source control to improve indoor air quality*. http://www.toolbase.org/docs/MainNav/Energy/3947_spotventilation1.pdf (Sept 2004)

5.3.2 Install Moisture Resistant Backer Under/Behind Tile in Wet Areas

- Backerboard manufacturer Websites for installation information (e.g., WonderBoard, Durock)

- Tile Council of America, 2003-2004 *Handbook for the Installation of Ceramic Tile*, http://www.tileusa.com.

5.3.3 Install Vapor Retarder under Slabs and/or on Crawl Space Floors

- Carter, Tim. *Vapor Retarders Will Stop Odors and Moisture*. http://www.askthebuilder.com/printer_279_Vapor_Retarders_Will_Stop_Odors_and_Moisture.shtml (Sept 2004)

- Makela, Eric, et al. *How to construct unventilated crawlspace to meet the provisions.* USDOE. http://www.holtonhomes.com/webcast_04_crawlspaces.pdf (Sept 2004)

- *Crawlspace Moisture Control*, fact sheet by Dominion Power, http://www.dom.com/customer/efficiency/res/answers/pdf/crawlspaces.pdf%20

- *EEBA Builders' Guides (for Cold, Mixed-Humid, Hot-Dry/Mixed-Dry, and Hot-Humid Climates),* available from the Energy and Environmental Building Association's Website at http://www.eeba.org/mall/builder_guides.asp

5.3.4 Protect Moisture Sensitive Materials from Water during Construction

- *Panel Selection, Handling, Storage. OSB Design and Construction Guide.* March 2000. PFS Research Foundation. Madison, WI.

- Forest Products Laboratory. 1999. *Wood handbook—Wood as an engineering material. Gen.* Tech. Rep. FPL-GTR-113. Madison, WI. U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 463 p. see Section 12, page 18. Design Factors Affecting Dimensional Change.

- ToolBase. http://www.toolbase.org/docs/ToolBaseTop/Research/3464_HelpingHomebuyeresUnderstandMold.pdf (Sept 2004)

- *Proper Lumber Storage*, Southern Pine Council, http://www.southernpine.com/lumberstorage.shtml

- *Proper Storage and Handling of Glulam Beams,* APA—The Engineered Wood Association, http://www.apawood.org/pdfs/managed/R540.pdf

- *Storage and Handling of APA Trademarked Panels,* APA—The Engineered Wood Association, http://www.apawood.org/pdfs/managed/U450.pdf

- *Storage, Handling, and Safety Recommendations for APA Performance Rated I-Joists*, http://www.apawood.org/pdfs/managed/Z735.pdf

- (Just-In-Time Delivery) *Industrializing the Residential Construction Site*, 2000. Center for Housing Research, VPI. Available from the U.S. Department of Housing and Urban Development.

5.3.5 No Plumbing Supply Lines in Exterior Walls

- *Builder's Guide to Placement of Ducts and HVAC Equipment in Conditioned Space*, 2000, NAHB Research Center. Available at http://www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2570&CategoryID=110

- Lewis, Bill. *Preventing Frozen Water Pipes*. http://homerepair.about.com/cs/plumbing/a/frozen_pipes_b3.htm (Sept 2004)

5.3.6 Insulate Cold Water Piping in Unconditioned Spaces

- *Preventing and Thawing Frozen Pipes*. http://www.prepare.org/basic/frozen.htm (Sept 2004)

- Do It Yourself. http://www.diynet.com/diy/diy_kits/article/0,2019,DIY_13787_2275412,00.html (Sept 2004)

5.3.7 Insulate HVAC Duct System in Unconditioned Spaces

- Energy Outlet information on duct sealing, available at http://www.energyoutlet.com/res/ducts/insulating.html

- *Crawlspace Condensation* by Home Energy Magazine Online http://hem.dis.anl.gov/eehem/01/010304.html (Sept 2004)

- *Insulating Ducts for Efficiency*. http://www.bobvila.com/ArticleLibrary/Subject/HVAC/Insulation/InsulatingDucts.html (Sept 2004)

5.3.8 Ensure Moisture Content of Wood is Appropriate before Enclosure

- National Wood Flooring Association, *Hardwood Flooring Installation Guidelines*, http://www.nwfa.org.

- The Wood Flooring Manufacturer's Association, *Installing Hardwood Flooring*, http://www.nofma.org/installation1.htm

- *Electric Moisture Meters*, ToolBase Services fact sheet, available at http://www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2120&CategoryID=1013Golden, J.A., 1998, *Moisture Testing Guide for Wood Frame Construction Clad with Exterior Insulation and Finish Systems,* p. 7-8. Available at http://www.toolbase.org/docs/MainNav/MoistureandLeaks/876_protocol5A.pdf

- *Computing Moisture Content of Wood*. http://www.woodbin.com/ref/wood/emc.htm (Sept 2004)

- EPA Moisture Content Calculation. http://www.epa.gov/athens/learn2model/part-

two/onsite/mc.htm (Sept 2004)

Section 6: Homeowner Education

6.1 Provide Homeowner Maintenance Manual

- Fannie Mae's, *Home Performance Power: Fannie Mae's Guide to Buying and Maintaining a Green Home.* For a copy, call Fannie Mae's Consumer Resource Center at 1-800-7FANNIE (1-800-732-6643).
- NAHB's *Your New Home and How To Take Care of It.*
- *The National Home Maintenance Manual*, by California Building Standards.
- Your local HBA's Green Building Program office. List of local Green Building Programs at http://www.toolbase.org (click on "Green Building")
- Various manufacturers
- City, county, or township recycling information
- U.S. DOE's Green Power Network: http://www.eere.energy.gov/greenpower/
- Lighting energy savings calculator at http://www.goodmart.com/light_bulb_energy_saving_calculator.aspx
- Water saving tips at http://www.h2ouse.org/. Energy Saving tips: http://www.eere.energy.gov/consumerinfo/energy_savers/ and http://www.aceee.org/consumerguide/chklst.htm
- Metropolitan area, city, county, township, or private public transit information (usually listed in the front matter of the phone book)
- *Homeowner's Manual—At last, an owner's manual for your new home*. By CMHC. http://www.cmhc-schl.gc.ca/en/bureho/buho/buho_002.cfm (Sept 2004)
- National Environmental Services Center, http://www.nesc.wvu.edu/nsfc/NewReleases/nsfc_NR_11_14_03.htm (Sept 2004)
- Community Associations Institute, http://www.caionline.org/about/homeowner_education.cfm (Sept 2004)
- Massachusetts Housing Partnership, http://www.mhp.net/homeownership/education.php (Sept 2004)
- How-To Publications by Family Resource Management, College of Agriculture & Home Economics. http://www.cahe.nmsu.edu/pubs/_g/ (Sept 2004)

- Papolos, Janice. *The Virgin Homeowner: The Essential Guide to Owning, Maintaining, and Surviving Your Home*, Penguin Books. ISBN: 0140274766.

- For earthquake safety. http://www.seismic.ca.gov/pub/CSSC_2002-04_HOG.pdf (Sept 2004)

- For fire preventionhttp://www.ofm.gov.on.ca/english/FirePrevention/FireSmart%20Communities/pdf/User%20guide.pdf (Sept 2004)

- For soil-lead hazard. http://www.epa.gov/region01/leadsafe/pdf/chapter8.pdf (Sept 2004)

- For septic system by University of Minnesota Extension Service. http://www.extension.umn.edu/distribution/naturalresources/DD6651.html (Sept 2004)

- For pest control and pesticide safety, http://pep.wsu.edu/psp/scripts/documents.asp?qryType=new, and http://scholar.lib.vt.edu/ejournals/JPSE/v5/v5hipkinsra2.pdf (Sept 2004)

- For HVAC. http://www.healthgoods.com/Education/Healthy_Home_Information/Space_Heating_and_Cooling/sizing_heat_and_ac.htm (Sept 2004)

6.2 Additional Information to Include in Manual

- Home*a*Syst, *An Environmental Risk-Assessment Guide for the Home, Healthy Home Tool*, available at http://www.uwex.edu/homeasyst/

- Local Green Building Checklist, or other documents

- EPA document: http://www.epa.gov/epaoswer/non-hw/househld/hhw.htm

- Check with the local or state environmental or solid waste agency to see if there is a hazardous waste drop-off day. Local recycling information may cover hazardous wastes. County or state may have Cooperative Extension fact sheets geared toward your municipality (see, for example, http://www.epa.gov/grtlakes/seahome/housewaste/src/open.htm)

- Local Cooperative Extension office should have printed information. Also, organic-based lawn services, such as NaturaLawn, usually have printed information.

- County or state Cooperative Extension publications

- Cooperative Extension publications for information about termite tubes, where to

look for them, and what they look like. See, for example, http://www.uky.edu/Agriculture/Entomology/entfacts/struct/ef604.htm

6.3 Use and Care Homeowner Education

- National Association of Home Builders, *Your New Home and How to Take Care of* It. Washington, DC: BuilderBooks, 2001, 60 pages.
- Provide homeowners these pages and pages of tips on maintenance to help keep their new home performing at its peak. In the back there are pages on which to note maintenance dates and remarks.
- http://www.builderbooks.com
- 800-223-2665
- Manuals from manufacturers for reference.

6.4 Solid Waste/Recycling Center

- http://www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1280&DocumentID=2001

Section 7: Innovative Options