# Greening a New Home

A case study of how the NAHB Model Green Home Building Guidelines helped turn a conventional home into a Gold-rated green home

PATH
Partnership for Advancing Technology in Housing

PD&R
U.S. Department of Housing and Urban Development
Office of Policy Development and Research

## Acknowledgements

This document was written by the NAHB Research Center (www.nahbrc.org) with funding from the U.S. Department of Housing and Urban Development under the PATH program (www.pathnet.org). Special thanks to the staff of the Lancaster County Career and Technology Center (www.lcctc.org) and Norman L. Graham, Inc. for their contribution to the project and the contents of this document.

## About the Lancaster County Career and Technology Center

Based on identified occupational needs, the mission of the Lancaster County Career & Technology Center is to prepare high school students and adult students to be academically competent, to be occupationally proficient for employment, and to have a sound foundation for continued learning. The Lancaster County Career & Technology Center is accredited by the Commission of the Council on Occupational Education.

## About the NAHB Research Center

Located in Upper Marlboro, Md., the NAHB Research Center promotes innovation in housing technology to improve the quality, durability, affordability, and environmental performance of homes and home building products. Created over 40 years ago as a subsidiary of the National Association of Home Builders (NAHB), the NAHB Research Center has established itself as *the* source for reliable, objective information and research on housing construction and development issues. Through its various testing and certification services, the Research Center seal is internationally-recognized as a mark of product quality and an assurance of product performance.

## About PATH

The Partnership for Advancing Technology in Housing is a public-private initiative dedicated to accelerating the development and use of technologies that radically improve the quality, durability, energy efficiency, environmental performance, and affordability of America's housing. PATH is supported by the U.S. Department of Housing and Urban Development.

# Greening a New Home

**A case study of how the NAHB Model Green Home Building Guidelines helped to turn a conventional home into a Gold-rated green home**

# Table of Contents

## Model Green Home Building Guidelines Background

The National Association of Home Builder's (NAHB's) Model Green Home Building Guidelines (the Guidelines) present a system for objectively assessing the environmental performance of a new home. The Guidelines were designed to be a tool that a mainstream home building company can use to evaluate and improve the environmental performance of its homes. The Guidelines along with an online new home scoring tool and an informative User's Guide containing relevant information and supplemental resources can be found at www.nahbgreen.org.

The Guidelines are organized along seven sections: Site Development; Resource Efficiency; Energy Efficiency; Water Efficiency; Indoor Environmental Quality; Homeowner Education; and Global Impact. The Guidelines assign points to various green home building practices for three possible levels of achievement—Bronze, Silver, or Gold (or no rating). The minimum points required to attain each level are included in the table below.

## Project Background

This case study examines measures from the Guidelines that were adopted to bring an existing ENERGY STAR® home plan to a Gold-level green home. The existing home plan and its energy-efficiency specifications were above the norm for Lancaster County, Penn., and, therefore, resulted in a good baseline score for the home. However, the original design did not qualify for a green rating

**Minimum Points Required for Green Building Rating**

| | BRONZE | SILVER | GOLD |
|---|---|---|---|
| **Section 1–Lot Design, Preparation, and Development** | 8 | 10 | 12 |
| **Section 2–Resource Efficiency** | 44 | 60 | 77 |
| **Section 3–Energy Efficiency** | 37 | 62 | 100 |
| **Section 4–Water Efficiency** | 6 | 13 | 19 |
| **Section 5–Indoor Environmental Quality** | 32 | 54 | 72 |
| **Section 6–Operation, Maintenance, and Homeowner Education** | 7 | 7 | 9 |
| **Section 7–Global Impact** | 3 | 5 | 6 |
| **Additional Points from All Sections Combined** | +100 | +100 | +100 |
| **Total Minimum Points** | **237** | **311** | **395** |

because it lacked the full scope of environmental performance as outlined by the Guidelines.

The revised green home plan, under construction by the students of the Lancaster County Career and Technology Center (the local vo-tech high school), was part of the school's Building Green Community Education Project. The goal of the project, in partnership with PATH (Partnership for Advancing Technology in Housing, a program of the U.S. Department of Housing and Urban Development), was to design and build a home that achieved a high level of environmental performance while demonstrating new technologies and techniques and while allowing students to gain practical hands-on construction experience.

## The Green Process

Meetings were held with LCCTC and NAHB Research Center staff as well as other stakeholders to determine which measures from the Guidelines would be included in the revised home plan. Many of the design changes were chosen because they were easy to implement, inexpensive, or both. However, because the home is part of a community education project, some design decisions were made for reasons other than simply economics and environmental impact. Some technologies were chosen to demonstrate something new and some practices were selected to give the students practical experience. As a result, the minimum requirements for a Gold rating were exceeded by the revised design (395 points are required for a Gold rating, this home received 437 points).

For a mainstream builder for which initial cost is a major driving factor, some of the green features included in this home would not be necessary to achieve a Gold rating. Therefore, a builder wishing to build a green home should not feel daunted by the task based on what was done at the LCCTC site. Rather, a builder can view the process as a tremendous opportunity to take credit for what is already being done, to take advantage of the excellent resources that facilitate the process of shifting toward more sustainable home building, and to make changes in a way that is achievable for the builder and marketable to home buyers.

## Going Green

Although there was a significant effort and expertise devoted to the selection of practices and products for the LCCTC green home design, this effort is streamlined when conducted by a single home building company and not a group of stakeholders. Any builder wishing to "go green" can use the Guidelines, along with its comprehensive User's Guide and supporting resources, to evaluate existing practices and generate ideas for high impact, low cost techniques for greening a home design. The new online scoring tool, being piloted at www.nahbgreen.org, simplifies the evaluation process.

## Using this Report

This report, organized by sections of the Guidelines, summarizes the Model Green Home Building Guidelines scores for the original house design and the revised green home plan. It illustrates how points were allocated, by line item in the Guidelines, for

the original house design and, subsequently, for the green home design. The scoring tables summarize the approach taken for each line item for each home design. The reader may quickly note that many line items from the Guidelines are omitted in this document. Line items were included in this report only if they were implemented in the original and/or green home designs and contributed to the final point allocation of either home. In addition, there are a few required line items in Section 3 of the Guidelines without which a rating cannot be granted. For a complete list of line items, visit www.nahbgreen.org and use the online scoring tool and accompanying User's Guide. This complete list of green practices is essential for any builder wishing to evaluate and improve his own environmental practices.

After each table describing the point allocation, supporting text is provided to describe the advantages of the "greener" approach, any technical support that was required to make the switch, and a list of relevant resources.

At the end of each section, the Scoring Status depicts the total points accrued in the section for each home design, the rating level achieved for each home under that section, and the additional points each home accrued for the section (contributing to the 100 additional points needed to obtain any rating level).

## The Rating Process

For a home to achieve a Gold rating, it must achieve the minimum points for a Gold rating in every section, plus attain at least 100 additional points from all sections combined. For example, a home that meets Silver in the energy efficiency section and Gold in all the remaining six sections must either incorporate measures to attain Gold in the energy efficiency section or be demoted to a Silver rating. Likewise, a home that obtains the minimum points required in all sections for a particular rating, but does not attain 100 additional points must either incorporate measures to earn 100 additional points, or be demoted to a lower rating (or no rating).

# Section 1 Lot Design, Preparation, and Development

| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 1.4.1 | Provide on-site supervision and coordination to ensure green development | 5 | • Builder's quality control procedures are well established and are applied to green development methods |
| 1.4.3 | Minimize on-site soil disturbance and erosion | 6 | • Builder's standard practice includes maintaining a dedicated construction entrance and using a silt fence buried 6 inches<br>• Measures enforced by Lancaster County Conservation District |
| **Section 1 Total** | | **11** | |

The Green Process

| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 1.3.5 | Manage storm water using low impact development techniques | 8 | • Storm water management plan that preserves natural drainage features<br>• Permeable pavement driveway to reduce impervious area<br>• Rainwater harvesting system |
| 1.3.6 | Devise landscape plan to limit water and energy demand while preserving or enhancing the natural environment | 8 | • Local landscaping firm developed landscaping plan in consultation with local native plant expert<br>• Tree trimmings used as mulch for walkway |
| 1.4.1 | Provide on-site supervision and coordination to ensure green development | 5 | • Builder's quality control procedures are well established and are being applied to green development methods |
| 1.4.3 | Minimize on-site soil disturbance and erosion | 6 | • Builder's standard practice includes maintaining a dedicated construction entrance and using a silt fence buried 6 inches<br>• Measures enforced by Lancaster County Conservation District<br>• Soil to be improved by amending with compost and/or mulch |
| **Section 1 Total** | | **27** | |

## Advantages of the Green Approach

The permeable pavement designed to allow natural rainwater infiltration on the site will benefit:

- The municipality by protecting regional flora and fauna and reducing the impact of development on municipal storm drains
- The environment by reducing sediment and nutrient runoff to streams

The rainwater harvesting system will benefit:

- The homeowner by reducing municipal water consumption for irrigation, toilet flushing, and laundry
- The municipality by reducing water consumption needs for new development

Amending the topsoil with compost makes the soil more permeable at the time of seeding. Conventional topsoil loses some permeability due to manipulation during construction and can maintain that reduced porosity for 1 to 2 years after seeding. Incorporating compost before seeding improves infiltration until permeability is restored by the root system and earthworm activity.

## Technical Support Provided during Design and Implementation

- A working group including NAHB Research Center and LCCTC staff and local experts evaluated site development alternatives and weighed the benefits and costs of each.
- Working group experts researched questions (e.g., maintenance of rainwater harvesting systems) to guide the decision-making and approval processes.
- A storm water management plan was developed by Stark Environmental, a local storm water engineering firm. The firm, as well as NAHB Research Center and LCCTC staff, attended township meetings to help gain approval of the plan.
- Installation of the rainwater harvesting system was overseen by an LCCTC plumbing instructor with guidance from Stark Environmental.

## For More Information

Lancaster County Career and Technology Field Evaluation Builders Journal
www.toolbase.org/lcctc/journal

PATH Technology Inventory Summary: Low Impact Development (LID) Practices for Storm Water Management
www.toolbase.org/techlid

*NAHB Green Scoring Tool*
www.nahbgreen.org

*The Practice of Low Impact Development,* U.S. Department of Housing and Urban Development
www.toolbase.org/practicelid

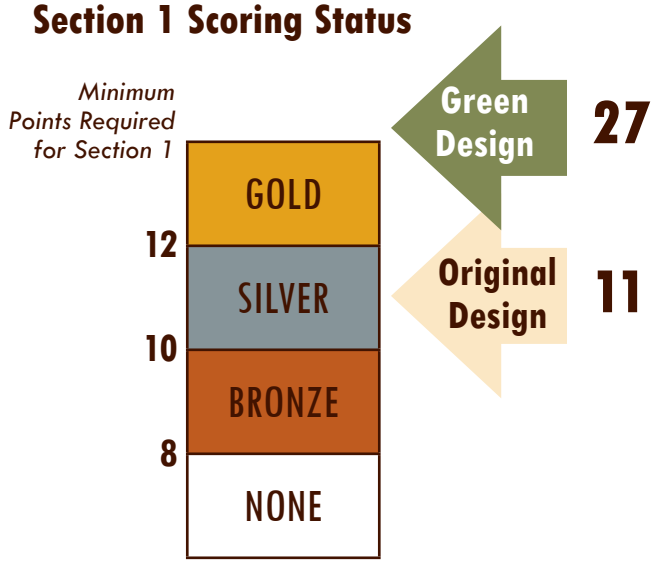
PATH Technology Inventory Summary: Rainwater Harvesting
www.toolbase.org/techrainharvest

PATH Technology Inventory Summary: Permeable Pavement
www.toolbase.org/techpermeablepavement

## Section 1 Point Summary

| Line Item in the Guidelines | Original Design | Green Design |
|---|---|---|
| | Points Awarded | |
| 1.3 | 0 | 16 |
| 1.4 | 11 | 11 |
| **Section 1 Total** | **11** | **27** |

## Section 1 Scoring Status



## ➲2.1 Reduce Quantity of Materials and Waste

| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 2.1.2 | Use advanced framing techniques | 4 | • Exterior walls framed with 2x6 @ 24" o.c.<br>• 24" o.c. roof framing |
| **Section 2.1 Subtotal** | | **4** | |

The Green Process

| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 2.1.2 | Use advanced framing techniques | 8[1] | • 2x4 @ 16" and 24" o.c.<br>• Roof trusses @ 24" o.c.<br>• Two-stud corners with drywall clips<br>• Ladder blocking at interior partition walls<br>• In-line framing<br>• Insulated header (single member header) design with header hangers |
| 2.1.4 | Create a detailed framing plan and material take-offs | 7 | • Detailed material take-offs provided by CAD instructor and construction manager for bidding process |
| **Section 2.1 Subtotal** | | **15** | |

[1] *Builders must apply at least two advanced framing techniques from a list in the Guidelines' User's Guide to get 4 points. An additional point is added for each additional technique employed, to a maximum of 8 points.*

*Stacked, or in-line, framing allows loads to be transferred directly downward and can eliminate the need for double top plates.*

## Advantages of the Green Approach

- Switching to 2x4 framing and using OVE techniques reduced lumber usage over the builder's conventional framing methods by 20 percent.
- The building shell's efficiency is increased due to OVE techniques—including header design, two-stud corners, and ladder blocking for interior partition walls—which permit higher levels of insulation than conventional framing methods.
- Using 2x4 construction with R-5 continuous insulation and cellulose cavity insulation on the exterior provides a whole-wall R-value that is higher than a 2x6 wall with wood sheathing. Continuous insulation reduces "thermal bridging" across wood studs and provides a barrier to air infiltration.

## Technical Support Provided during Design and Implementation

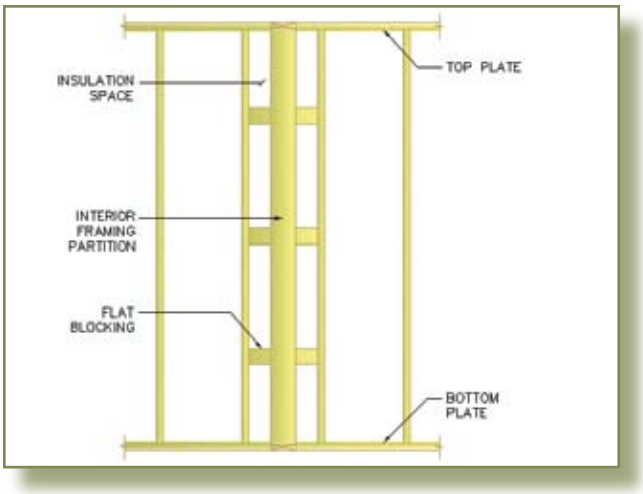
- Span tables for single-header openings were developed by an engineer for the project.
- An engineer conducted an OVE evaluation after the first story was framed and made recommendations for improving the OVE framing on the second floor.
- Detailed material take-offs were provided by the LCCTC CAD instructor in conjunction with the site supervisor for the bidding process.

## For More Information

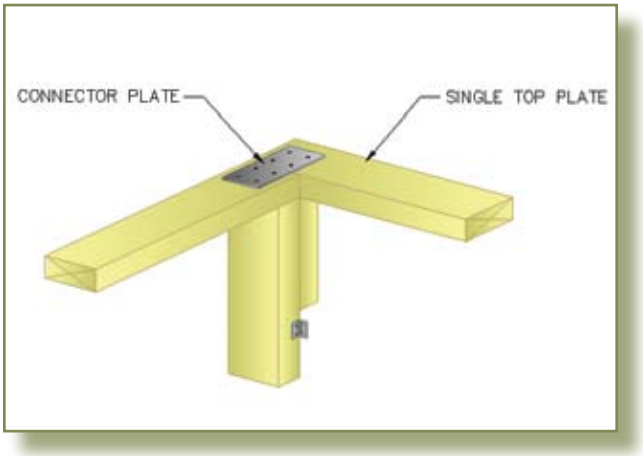
Lancaster County Career and Technology Field Evaluation Builders Journal
www.toolbase.org/lcctc/journal

*NAHB Green Scoring Tool*
www.nahbgreen.org

ToolBase Field Evaluations
www.toolbase.org/fieldeval




*Ladder blocking prevents insulation gaps which can occur at the intersection of interior and exterior walls with conventional framing methods.*




*When using a single top plate, a metal connector plate is used to connect top plate lumber.*

## ➲2.2 Enhance Durability and Reduce Maintenance

| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 2.2.1 | Provide covered entry at exterior doors | 6 | • Front and rear entry doors covered by porch roof |
| 2.2.3 | Install perimeter drain for all basement footings | 7 | • Foundation drainage per Superior Wall installation specifications |
| 2.2.4 | Install drip edge at eave and gable roof edges | 6 | • Metal drip edge installed at eave and gable roof edges |
| 2.2.5 | Install gutter and downspout system to diver water at least 5 feet from foundation | 6 | • Conventional gutter and downspout system installed |
| 2.2.6 | Divert surface water from all sides of building; Slope finish grade | 7 | • Downspouts extend 5 feet from foundation<br>• Finished grade sloped 2% or greater away from foundation |
| 2.2.9 | Provide water-resistant barrier behind exterior siding | 8 | • Typar housewrap is builder standard |
| 2.2.10 | Install ice flashing at roof edges | 5 | • Ice and water shield installed at roof edges |
| **Section 2.2 Subtotal** | | **45** | |

The Green Process

| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 2.2.1 | Provide covered entry at exterior doors | 6 | • Front porch design provides covered front entry<br>• Garage breezeway covers side entry door<br>• Large roof overhang covers rear sliding doors<br>• Basement entry door covered by Bilco-type steel door |
| 2.2.2 | Use recommended size overhangs for climate | 7 | • Eave overhangs were increased to 18 inches (from 12 inches)<br>• 12-inch rake overhangs were added to provide extra moisture protection for the wall system |
| 2.2.3 | Install perimeter drain for all basement footings | 7 | • Form-a-drain system used to manage foundation drainage and as part of radon control system |

(Green Design, cont.)

| | | | |
|---|---|---|---|
| 2.2.4 | Install drip edge at eave and gable roof edges | 6 | • Metal drip edge at eave and gable roof edges |
| 2.2.5 | Install gutter and downspout system to divert water at least 5 feet from foundation | 6 | • Gutter and downspout system is tied to rainwater harvesting system |
| 2.2.6 | Divert surface water from all sides of building; Slope finish grade | 7 | • Surface water will be diverted to rainwater harvesting system<br>• Finish grade to be sloped away from the foundation at 5% or greater slope |
| 2.2.9 | Provide water-resistant barrier behind exterior siding | 8 | • Foam sheathing on exterior topped with textured housewrap—lapped and taped at seams—serves as dual protection against moisture intrusion |
| 2.2.10 | Install ice flashing at roof edges | 5 | • Ice and water shield installed at roof edges and valleys |
| 2.2.11 | Install enhanced foundation waterproofing | 7 | • Dimpled foundation membrane applied to exterior of foundation to reduce hydrostatic pressure on foundation and prevent moisture intrusion |
| **Section 2.2 Subtotal** | | **59** | |

## Advantages of the Green Approach

- Breezeway design created a covered side entry while larger overhangs improved the covering of the rear sliding door.
- Larger overhangs will protect more of the wall area from wetting during rain events.
- The Form-a-drain footer system is an inexpensive approach to forming footers. Footing forms stay in place after the concrete pour to serve as drains and are tied into the radon exhaust system to draw radon gas away from the house.
- The foam sheathing and housewrap will not only protect the walls from moisture intrusion but will greatly improve overall energy efficiency.
- The foundation membrane will reduce hydrostatic pressure on the foundation, therefore reducing the likelihood of moisture in the basement.

## Technical Support Provided during Design and Implementation

NAHB Research Center staff helped identify features that would enhance building durability and, in many cases, provide other benefits such as energy efficiency.

## For More Information

*Durability by Design Guide: A Guide for Residential Builders and Designers*
www.toolbase.org/durabilitybydesign

*NAHB Green Scoring Tool*
www.nahbgreen.org

## ➲2.3 Reuse Materials
## ➲2.4 Use Recycled Content Materials
## ➲2.5 Recycle Waste Materials during Construction
## ➲2.6 Use Renewable Materials

| Original Design | | |
|---|---|---|
| **Line Item in the Guidelines** | **Points Awarded** | **Original Approach** |
| 2.3 through 2.6 | 0 | • No provisions in original design under Sections 2.3 through 2.6 |

The Green Process

| Green Design | | |
|---|---|---|
| **Line Item in the Guidelines** | **Points Awarded** | **Green Approach** |
| 2.3.3 Dedicate and provide on-site bins for sorting or reuse of scrap | 6 | • Nearby bins collect wood, plastic, and metal waste for recycling off site<br>• Drywall stored in shed for recycling |
| 2.4.1 Use recycled content building materials | 5 | • Fly ash concrete in foundation<br>• Cellulose insulation in walls and roof<br>• Cabinetry fabricated from dismantled gym bleacher seats<br>• Steel roofing with recycled content |
| 2.5.1 Develop and implement a construction waste management plan | 7 | • Consulted with local waste management expert to develop construction waste recycling program |
| 2.5.3 Recycle construction waste off site | 6 | • On-site bins simplify sorting scrap while local outlets facilitate recycling |
| 2.6.1 Use materials manufactured from renewable resources or agricultural byproducts | 3 | • Extensive use of engineered lumber products including OSB, I-joists, LVL, and LSL rim board |
| **Sections 2.3 through 2.6 Subtotal** | **27** | |

## Advantages of the Green Approach

- Developing and implementing a construction waste management plan facilitates recycling and reuse of building materials.
- Fly ash is a waste product of coal-fired power production. Using fly ash in the concrete mix reduces the amount of cement needed and diverts fly ash from landfills. It can improve the properties of the concrete.
- Engineered lumber takes advantage of fast-growing trees. Engineered lumber is dimensionally stable, straight, and strong.

## Technical Support Provided during Design and Implementation

- Product information regarding moisture-resistant floor sheathing was obtained and presented.
- A local waste management expert was consulted on the separation of recyclable materials.
- The NAHB Research Center helped investigate on-site grinding of drywall as an option.

## For More Information

*NAHB Green Scoring Tool*
www.nahbgreen.org

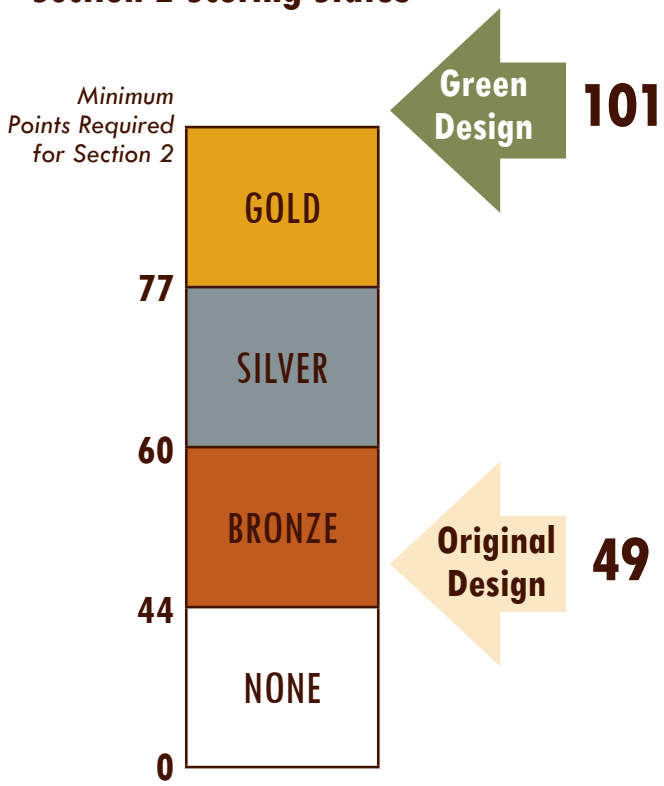
ToolBase Best Practices: Construction Waste (includes *Residential Construction Waste Management: A Builder's Field Guide*)
www.toolbase.org/constructwaste
www.toolbase.org/wastemgmtguide

*Nearby marked bins facilitate the sorting of recyclable construction waste.*

## Section 2 Point Summary

| Line Item in the Guidelines | Original Design | Green Design |
|---|---|---|
| | Points Awarded | |
| 2.1 | 4 | 15 |
| 2.2 | 45 | 59 |
| 2.3 | 0 | 6 |
| 2.4 | 0 | 5 |
| 2.5 | 0 | 13 |
| 2.6 | 0 | 3 |
| **Section 2 Total** | **49** | **101** |

## Section 2 Scoring Status



## ➲ 3.3.1 Building Envelope

| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 3.3.1a | Increase effective R-value of the building envelope | 2 | • Raised heel roof trusses are standard LCCTC approach |
| 3.3.1b | Incorporate air sealing package to reduce infiltration | 10 | • "Super Seal" foam sealant package is builder standard<br>• Typar-brand housewrap specified by builder |
| 3.3.1c | Use ENERGY STAR-rated windows | 8 | • ENERGY STAR-labeled windows specified |
| **Section 3.3.1 Subtotal** | | **20** | |

The Green Process

| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 3.3.1a | Increase effective R-value of the building envelope | 12 | • Advanced framing including single member headers, 2-stud corners, ladder blocking, 24" o.c. stud spacing to permit more insulation at exterior walls<br>• Larger roof overhangs raise the height of the truss over exterior walls and create more room for blown cellulose insulation<br>• Foam sheathing for continuous exterior insulation |
| 3.3.1b | Incorporate air sealing package to reduce infiltration | 10 | • Air sealing package includes sill sealer, extensive foam sealing, foam insulation at rim joist and band joist, no ducts or pipes in exterior walls, and exterior foam sheathing plus housewrap taped at seams |
| 3.3.1c | Use ENERGY STAR-rated windows | 8 | • ENERGY STAR-labeled windows specified |
| **Section 3.3.1 Subtotal** | | **30** | |

## Advantages of the Green Approach

- More extensive use of advanced framing provides more space in wall cavities, especially at trouble spots such as building corners and interior partition wall intersections, for higher levels of insulation.
- Continuous foam sheathing provides an R-5 insulation value around the entire building, dramatically reducing thermal bridging through studs. The foam sheathing also serves as part of the exterior air and moisture barrier.
- Although both designs have valid approaches to air sealing, the approach for the Gold design, including spray foam insulation at the rim and band joists, is likely to reduce leakage at critical areas with only a relatively small level of effort.
- Larger roof overhangs create more height for insulation at building exterior walls—allowing the full blanket of blown insulation over exterior walls.

## Technical Support Provided during Design and Implementation

- NAHB Research Center staff used its experience and previous energy simulations on a similar building to determine an optimal framing and insulation package for the project.
- NAHB Research Center staff and a local weatherization expert consulted on the best insulation package to achieve high levels of insulation and air sealing and provided air sealing specifications to the construction manager.

*An insulating concrete form basement is an integral part of the energy-efficient building shell.*

## For More Information

Building America Best Practices Guide—Mixed-Humid Climate
www.eere.energy.gov/buildings/building_america/pdfs/38448.pdf

ENERGY STAR window labeling
www.energystar.gov/index.cfm?c=windows_doors.pr_windows

*NAHB Green Scoring Tool*
www.nahbgreen.org

PATH Technology Inventory Summary: Advanced Framing Techniques: Optimum Value Engineering (OVE)
www.toolbase.org/techadvancedframing

ToolBase TechSpec: Advanced Framing Techniques
www.toolbase.org/tspecadvframing

*Raised-heel roof trusses create ample depth for insulation at exterior walls.*

*OVE framing techniques improve the insulating value of exterior walls.*

## ➲ 3.3.2 HVAC Design, Equipment, and Installation

| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 3.3.2a | Use Manual D to design duct system | 8 | • Builder's HVAC contractor performs this service as part of the HVAC design |
| 3.3.2e | Use certified HVAC installer and service technician | 6 | • Builder's HVAC contractor is NATE-certified |
| 3.3.2f | Fuel-fired space heating equipment efficiency | 6 | • 90 AFUE condensing gas furnace |
| 3.3.2k | Seal ducts, plenums, and equipment | 4 | • UL-181 listed foil tape used to seal ducts |
| **Section 3.3.2 Subtotal** | | **26** | |

The Green Process

| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 3.3.2a | Size duct system using Manual D | 8 | • Builder's HVAC contractor performs this service as part of the HVAC design |
| 3.3.2c | Use Manual S to select equipment | 8 | • In addition to HVAC Manual J and D for load calculation and duct sizing, Manual S is used for equipment selection |
| 3.3.2d | Verify performance of heating/ cooling system with contractor | 8 | • HVAC contractor to document critical performance parameters to verify proper HVAC performance |
| 3.3.2e | Use certified HVAC installer and service technician | 6 | • Builder's HVAC contractor is NATE-certified |
| 3.3.2i | Ground source heat pump installed by certified contractor (EER=19) | 11 | • Installed a ground source heat pump with EER 19<br>• Manual D and S are used in combination with a ground source heat pump |
| 3.3.2j | Ground source heat pump installed by certified contractor (COP 2.7) | 8 | • Installed a ground source heat pump with COP 2.7 |
| 3.3.2k | Seal ducts, plenums, and equipment | 6 | • Butyl-rubber backed, UL-listed, "Foilmastic" used to seal ducts |
| 3.3.2l | For ducts, no panned joist cavities, all ducts and equipment in conditioned space, and no ducts installed in exterior walls | 8 | • The duct system is 100% hard ducted, and designed with a central return and jumper ducts as part of the strategy for keeping ducts in conditioned space |

| | | | |
|---|---|---|---|
| 3.3.2m | Install return ducts or transfer grilles in every room having a door except bathrooms, closets, pantry and laundry | 6 | • Jump ducts connect all bedrooms with hallway where control returns are located |
| 3.3.2p | Use ENERGY STAR-labeled mechanical exhaust in each bathroom | 8 | • Each bathroom is equipped with an exhaust fan that is ENERGY STAR-labeled |
| **Section 3.3.2 Subtotal** | | **71** | |

## Advantages of the Green Approach

- Using a geothermal heating and cooling system will provide very high efficiency, comfortable electric heating and cooling.
- Manual S guides the selection of heating and cooling equipment based on local climate. Manual D helps streamline the duct sizing process. Using Manual D and Manual S is a best practice for any home, but it becomes more critical when the per-ton cost of the mechanical equipment is higher than conventional equipment.
- Verifying system performance helps ensure that the heating and cooling systems are operating at peak efficiency.
- Butyl-backed foil tape combines the convenience of a tape-applied duct sealant with the longevity and durability of the butyl rubber adhesive. The foilmastic is much less likely to be ripped or have its performance otherwise compromised than standard UL-listed foil tape.
- To achieve the ENERGY STAR label, exhaust fans have a maximum noise level (sones) and minimum efficiency (cfm per watt). Therefore, ENERGY STAR-labeled fans tend to operate more efficiently and quietly than non-labeled fans.
- Keeping ducts out of exterior wall cavities reduces condensation potential and increases insulation levels at exterior walls. Using all hard-ducted supply and returns (no panned joist cavities) reduces leakiness of the duct system which can improve not only energy efficiency but also indoor air quality. Keeping ducts and equipment in conditioned space means that when leaks occur, they are at least supplying conditioned air where it is useful.

## Technical Support Provided during Design and Implementation

- The local contractor designed the HVAC and geothermal system, which were reviewed by the NAHB Research Center.
- Overall, very little technical support was needed—the NAHB Research Center spoke briefly with the HVAC instructor regarding best practices.

## For More Information

*NAHB Green Scoring Tool*
www.nahbgreen.org

PATH Technology Inventory Summary: HVAC Sizing Practice
www.toolbase.org/techhvacsizing

PATH Technology Inventory Summary: HVAC Equipment and Duct Installation within Conditioned Space
www.toolbase.org/techductsconditioned

ToolBase TechSpec: Ducts in Conditioned Space
www.toolbase.org/tspecsducts

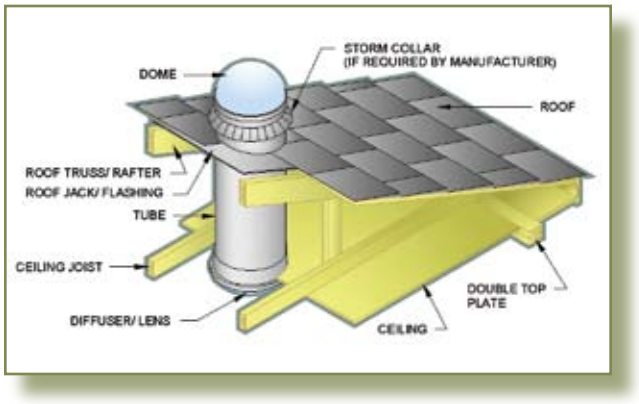
PATH Technology Inventory Summary: Geothermal Heat Pumps
www.toolbase.org/techgeothermal

## ➲ 3.3.3 Water Heating Design, Equipment, and Installation
## ➲ 3.3.4 Lighting and Appliances

| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 3.3.4e | Install ENERGY STAR refrigerator, dishwasher, and washing machine | 11 | • ENERGY STAR-labeled appliances standard |
| **Sections 3.3.3 and 3.3.4 Subtotal** | | **11** | |

The Green Process

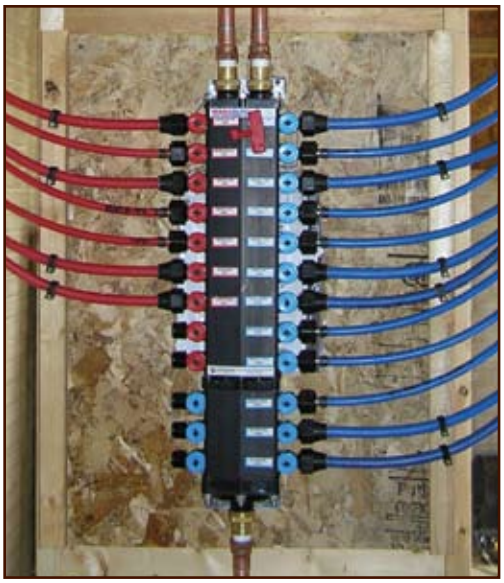
| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 3.3.3b | Install whole-house tankless water heater | 4 | • Two tankless water heaters installed—one to serve master bath only, one for rest of the house<br>• Master bath unit will cut down on energy losses in the pipe serving the remote bath |
| 3.3.3e | Install manifold system with 3/8 " PEX piping | 5 | • PEX piping installed in a manifold configuration |
| 3.3.4d | Install tubular skylights | 2 | • Two tubular skylights installed in hallway |
| 3.3.4e | Install ENERGY STAR refrigerator, dishwasher, and washer | 11 | • ENERGY STAR-labeled appliances standard |
| **Sections 3.3.3 and 3.3.4 Subtotal** | | **22** | |




*Typical tubular skylight installation.*

## Advantages of the Green Approach

- Tankless water heaters provide hot water quickly when it is needed rather than holding a tank full of hot water at a high temperature which continuously loses energy. Due to the distance to the master bath, a second tankless water heater was added to reduce energy losses from the hot water delivery pipe. This hybrid water heating system, combined with solar preheat, is anticipated to provide excellent hot water service (i.e., ample hot water delivered quickly to all faucets) at a very high efficiency.
- Insulated hot water lines help reduce energy losses from the hot water pipes and retain the hot water temperature longer for back-to-back water uses.
- Due to its smaller allowable diameter, a PEX manifold plumbing system delivers hot water more quickly to the outlets and wastes less hot water energy than a conventional trunk-and-branch configuration. PEX is also gaining popularity as an affordable plumbing option.
- Tubular skylights provide daylighting to an otherwise dark hallway. Although there is an energy penalty due to penetrating the insulated ceiling, it is quite small and is likely to be offset by electrical lighting energy savings.
- ENERGY STAR appliances use less energy and water than non-labeled appliances.



*A manifold plumbing system provides an efficient way to distribute hot water.*

## Technical Support Provided during Design and Implementation

- A plumbing system design was provided by the NAHB Research Center.
- A plumbing pipe manufacturer's representative was on site for two days to help the students learn how to run the pipe and make connections.
- The tubular skylight manufacturer helped determine appropriate placement and sizing.

*For the same amount of electricity, a tankless water heater produces more useful hot water than a water heating tank because there are no storage losses.*

## For More Information

*NAHB Green Scoring Tool*
www.nahbgreen.org

PATH Technology Inventory Summary: Cross-Linked Polyethylene (PEX) Water Supply Piping
www.toolbase.org/techpex

PATH Technology Inventory Summary: Plumbing Manifolds
www.toolbase.org/techplumbingmanifold

PATH Technology Inventory Summary: Tubular Skylights
www.toolbase.org/techtubularskylights
www.toolbase.org/techtubularskylights/CAD

PATH Technology Inventory Summary: Tankless Water Heaters
www.toolbase.org/techtankless

ToolBase TechSpec: Tankless Water Heaters
www.toolbase.org/tspecstankless

➲ 3.3.5.2 Solar Water Heating
➲ 3.3.6 Verification

| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 3.3.6.1 | On-site third-party inspection | 8 | • ENERGY STAR inspections conducted |
| 3.3.6.2 | Third-party testing | 8 | • Blower door test for ENERGY STAR certification |
| **Sections 3.3.5 and 3.3.6 Subtotal** | | **16** | |

The Green Process

| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 3.3.5.2 | SRCC-rated solar water heating system, solar fraction greater than 0.5 | 10 | • An SRCC-rated solar water heating system designed to produce more than half the family's hot water needs will be installed on the south-facing roof |
| 3.3.6.1 | On-site third-party inspection | 8 | • ENERGY STAR inspections conducted |
| 3.3.6.2 | Third-party testing (8 points per test) | 24 | • Blower door test conducted<br>• Duct blaster test conducted<br>• Flow hood balancing test conducted |
| **Sections 3.3.5 and 3.3.6 Subtotal** | | **42** | |

## Advantages of the Green Approach

- A solar water heating system will provide more than half of a family of four's hot water, utility-free. Combined with the tankless water heaters and manifold plumbing system, water heating energy consumption will be greatly reduced.
- Adding duct performance tests including leakage and air flows will ensure that conditioned air gets where it needs to go—ensuring comfort and high-efficiency HVAC operation.

## Technical Support Provided during Design and Implementation

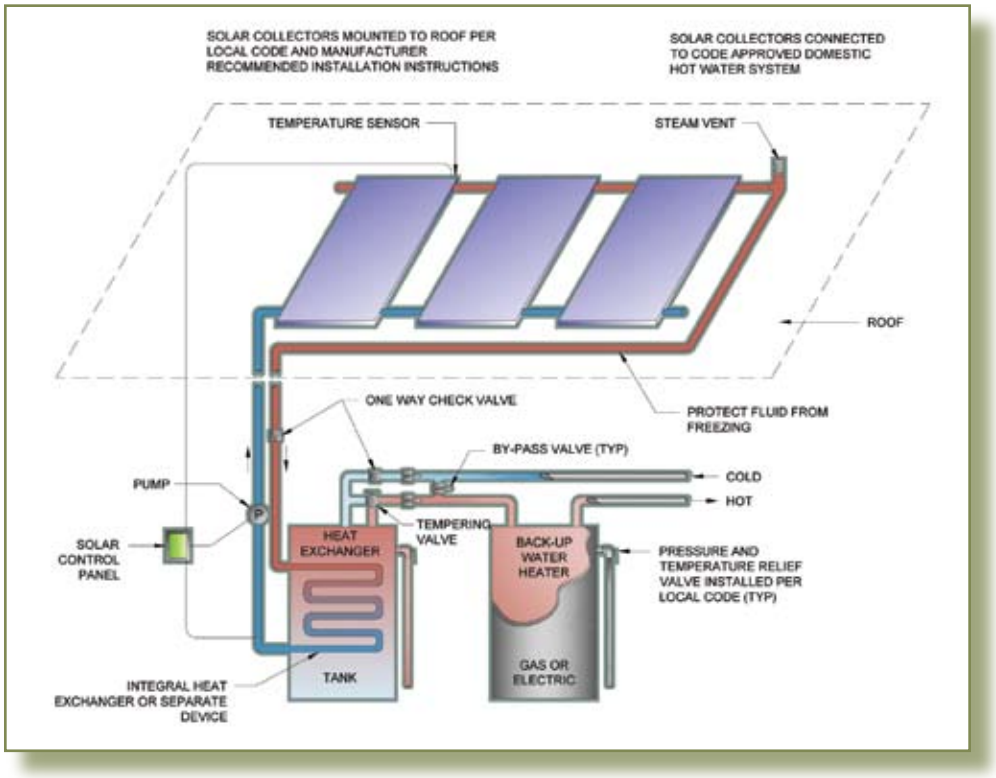
- The NAHB Research Center consulted with LCCTC staff about types of systems available and where to place the water heating panels.
- The manufacturer and a local solar water heating system installer provided the solar water heating system design and specification. A third-party HERS energy rater will conduct verification testing.

## For More Information

*NAHB Green Scoring Tool*
www.nahbgreen.org

PATH Technology Inventory Summary: Solar Water Heaters
www.toolbase.org/techsolarwater

ToolBase TechNote: Residential Building Diagnostic Tools
www.toolbase.org/tnbuildingdiagnostic

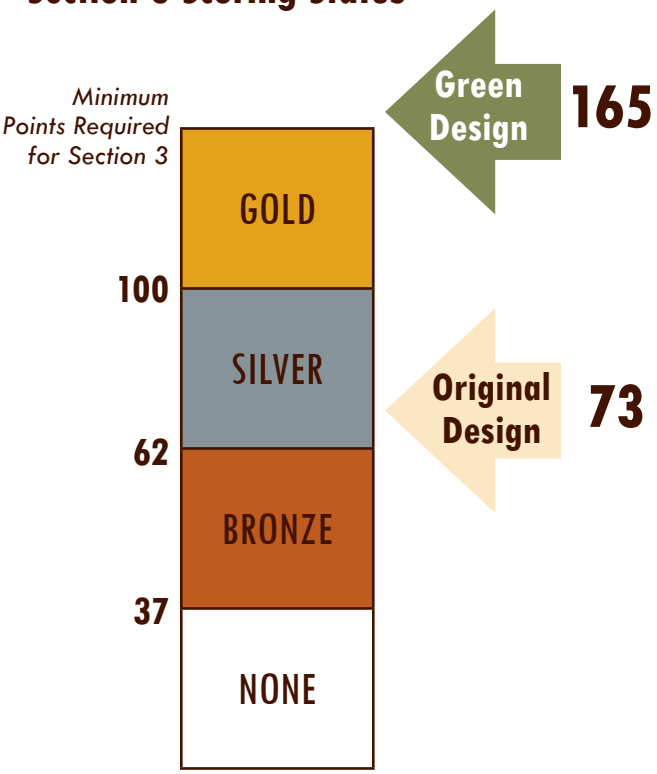



*Solar water heating panels preheat water for domestic use. In the LCCTC System, the solar-heated water is stored in a tank and its temperature is boosted by the tankless heater when necessary.*

## Section 3 Point Summary

| Line Item in the Guidelines | Original Design | Green Design |
|---|---|---|
| | Points Awarded | |
| 3.3.1a | 2 | 12 |
| 3.3.1b | 10 | 10 |
| 3.3.1c | 8 | 8 |
| 3.3.2a | 8 | 8 |
| 3.3.2c | 0 | 8 |
| 3.3.2d | 0 | 8 |
| 3.3.2e | 6 | 0 |
| 3.3.2f | 6 | 0 |
| 3.3.2i | 0 | 11 |
| 3.3.2j | 0 | 8 |
| 3.3.2k | 6 | 6 |
| 3.3.2l | 0 | 8 |
| 3.3.2m | 0 | 6 |
| 3.3.2p | 0 | 8 |
| 3.3.3b | 0 | 4 |
| 3.3.3e | 0 | 5 |
| 3.3.4d | 0 | 2 |
| 3.3.4e | 11 | 11 |
| 3.3.5.2 | 0 | 10 |
| 3.3.6.1 | 8 | 8 |
| 3.3.6.2 | 8 | 24 |
| **Section 3 Total** | **73** | **165** |

## Section 3 Scoring Status



*A geothermal system provides high-efficiency heating and cooling.*

*Foil mastic, which is backed with butyl rubber, provides an excellent seal while being relatively simple to install.*


*Low-e windows are part of the energy-efficient building shell.*

| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 4.1.3 | ENERGY STAR water-conserving appliances | 14 | • ENERGY STAR clothes washer installed<br>• ENERGY STAR dishwasher installed |
| **Section 4 Total** | | **14** | |

The Green Process

| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 4.1.1a | Hot water at remote locations served by point of use heater served by cold water only | 6 | • Master bath served by its own tankless water heater fed by water preheated only by the solar water heating system |
| 4.1.2 | Water heater located within 30 feet of pipe run of baths and kitchen | 9 | • Second tankless water heater added at master bath |
| 4.1.3 | ENERGY STAR water-conserving appliances | 14 | • ENERGY STAR clothes washer installed<br>• ENERGY STAR dishwasher installed |
| 4.1.6 | Ultra low-flow toilets | 6 | • Dual-flush toilets |
| 4.1.10 | Collect and use rainwater | 9 | • 2,600-gallon rainwater harvesting system will supply cold water to hose bibs, laundry, and toilets |
| **Section 4 Total** | | **44** | |

*The rainwater harvesting tanks are placed on a gravel pad to be buried under ground.*

## Advantages of the Green Approach

- A second tankless water heater at the remote master bath will reduce hot water wasted after a draw when heated water is left to cool in the pipe. Water will be heated instantly near the point of use, thereby also reducing water that is sent down the drain while a person waits for hot water to arrive at the faucet.
- Having a shorter pipe length reduces energy lost when hot water cools down in a pipe after a draw and reduces the amount of water wasted while a user waits for hot water at a tap.
- Water-efficient appliances reduce the amount of hot water needed to clean dishes and laundry, thereby conserving both water and energy. Water-efficient faucets and showerheads perform the same task with less water use.
- Dual-flush toilets have two flushing levels to conserve water, typically 0.9 gallons per flush for light-duty and 1.6 gallons for heavier duty flushing.
- The rainwater harvesting system will dramatically reduce household cold water use.

## Technical Support Provided during Design and Implementation

- NAHB Research Center staff consulted with the plumbing instructor on plumbing layout.
- A rainwater harvesting system designer consulted on the rainwater harvesting system design and specification.
- A PEX manifold supplier consulted on design and installation of rainwater re-use within the home.

## For More Information

*NAHB Green Scoring Tool*
www.nahbgreen.org

PATH Technology Inventory Summary: Plumbing Manifolds
www.toolbase.org/techplumbingmanifold

PATH Technology Inventory Summary: Tankless Water Heaters
www.toolbase.org/techtankless

ToolBase TechSpec: Tankless Water Heaters
www.toolbase.org/tspecstankless

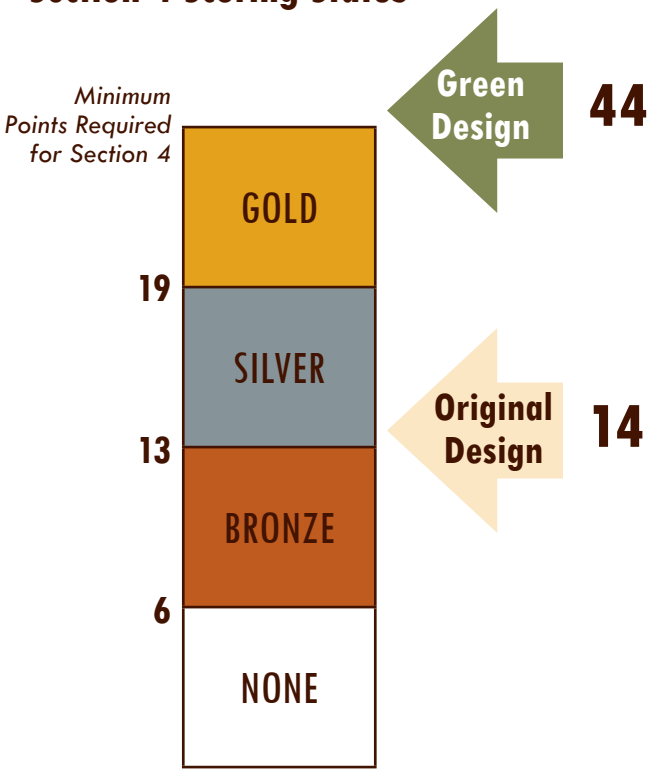
PATH Technology Inventory Summary: High Efficiency Toilets
www.toolbase.org/techhet

PATH Technology Inventory Summary: Rainwater Harvesting
www.toolbase.org/techrainharvest

## Section 4 Point Summary

| Line Item in the Guidelines | Original Design | Green Design |
|---|---|---|
| | Points Awarded | |
| 4.1 | 14 | 44 |
| **Section 4 Total** | **14** | **44** |

## Section 4 Scoring Status



## ➲ 5.1 Minimize Potential Sources of Indoor Pollutants

| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 5.1.1 | Install direct vent appliances | 8 | • Direct vent gas-fired water heater and condensing gas furnace installed |
| 5.1.3 | Direct vent fireplace | 6 | • Gas fireplace is direct vent, sealed combustion |
| 5.1.4 | Continuous air barrier between garage and living area | 9 | • Caulk and foam sealing applied in standard air sealing package<br>• Drywall applied with adhesive and screws |
| 5.1.7 | Mask HVAC outlets during construction and vacuum ducts | 5 | • Ducts are covered during construction and professionally cleaned |
| **Section 5.1 Subtotal** | | **28** | |

The Green Process

| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 5.1.3 | Direct vent fireplace | 6 | • Gas fireplace is direct vent, sealed combustion |
| 5.1.4 | Continuous air barrier between garage and living area | 9 | • Detached garage |
| 5.1.5 | Particleboard, MDF, and plywood certified low formaldehyde emission | 6 | • Advantech subfloor, ZIP system roofing, and OSB sheathing meet ASTM standards for low formaldehyde emissions<br>• Cabinetry made from recycled solid wood |
| 5.1.7 | Mask HVAC outlets during construction and vacuum ducts | 5 | • Ducts are covered during construction and professionally cleaned |
| **Section 5.1 Subtotal** | | **26** | |

## Advantages of the Green Approach

- Having no combustion within the home eliminates the possibility of backdrafting and drawing byproducts of combustion into the home.
- A detached garage eliminates the possibility of air exchange between the garage and the house. Although sealing the wall between the garage and the house can reduce seepage of air from the garage into the house, it does not prevent air exchange when the door leading into the house from the garage is opened.
- Wood products having low formaldehyde emissions reduce the off-gassing associated with those products during the life of the home.
- Masking ducts prevents construction debris from entering the ducts which can clog filters and damage HVAC equipment when the equipment is activated.

## Technical Support Provided during Design and Implementation

- LCCTC students revised the house plans to create a detached garage with a breezeway leading to the house.
- NAHB Research Center staff researched emissions ratings from engineered wood products.

*A detached garage prevents the garage from compromising indoor environmental quality.*

## For More Information

*NAHB Green Scoring Tool*
www.nahbgreen.org

Tech Set 9: Indoor Air Quality
www.toolbase.org/tsindoorair

*An integrated approach to moisture management helps minimize the potential for moisture problems in the future.*

## ➲ 5.2 Manage Potential Pollutants Generated in the Home

| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 5.2.1 | Vent kitchen range exhaust to outside | 7 | • Kitchen range vented to outside (now mandated by local code) |
| **Section 5.2 Subtotal** | | **7** | |

The Green Process

| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 5.2.1 | Vent kitchen range exhaust to outside | 7 | • Kitchen range vented to outside (now mandated by local code) |
| 5.2.2 | Provide mechanical ventilation | 10 | • Heat recovery ventilator installed |
| 5.2.6 | Verify that exhaust flows meet design specifications | 9 | • Flow hood test conducted |
| **Section 5.2 Subtotal** | | **26** | |

## Advantages of the Green Approach

- A heat recovery ventilation system will replenish the indoor air with fresh air at controlled levels. Incoming fresh air is preheated (or precooled) by the outgoing air stream, thereby reducing the energy penalty associated with conditioning the incoming fresh air stream.
- Verifying that all exhaust airflows meet design standards ensures that installed exhaust systems are functioning properly and will remove moisture and odors from the home as intended.

## Technical Support Provided during Design and Implementation

- The HRV system was designed and installed by a local company.
- A HERS rater performed testing.

## For More Information

*NAHB Green Scoring Tool*
www.nahbgreen.org

Tech Set 9: Indoor Air Quality
www.toolbase.org/tsindoorair

PATH Technology Inventory Summary: Energy and Heat Recovery Ventilators (ERV/HRV)
www.toolbase.org/techhrv

## ➲ 5.3 Moisture Management

| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 5.3.2 | Install moisture-resistant backerboard under tile in wet areas | 6 | • Cement backer-board used as floor underlayment in baths |
| 5.3.3 | Install 6 mil vapor retarder under slab | 9 | • Vapor retarder laid on gravel prior to slab pour |
| 5.3.5 | No plumbing supply lines in exterior walls | 5 | • No plumbing pipe in exterior walls |
| 5.3.7 | Insulate ducts, plenums, and trunk lines in unconditioned space | 4 | • Insulated flex duct and fiberboard used in unconditioned area |
| **Section 5.3 Subtotal** | | **24** | |

The Green Process

| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 5.3.1 | Control bathroom exhaust fan with timer or humidistat | 6 | • Timers on all bath fans for simple and inexpensive control |
| 5.3.2 | Install moisture-resistant backer-board under tile in wet areas | 6 | • Cement backer-board used as floor underlayment in baths |
| 5.3.3 | Install 6 mil vapor retarder under slab | 9 | • Vapor retarder laid on gravel prior to slab pour |
| 5.3.4 | Protect unused moisture-sensitive materials from water damage | 6 | • Materials stored inside home and outside on raised support, covered by tarp |
| 5.3.5 | No plumbing supply lines in exterior walls | 5 | • No plumbing pipe in exterior walls |
| 5.3.7 | Insulate ducts, plenums, and trunk lines in unconditioned space | 4 | • No ductwork located in unconditioned space |
| 5.3.8 | Check moisture content of wood before enclosed | 4 | • Use moisture meter to ensure wood (and insulation) is below 19% before drywall |
| **Section 5.3 Subtotal** | | **40** | |

## Advantages of the Green Approach

- Cement backerboard, an inorganic material, is not subject to deterioration from repeated wetting.
- A vapor barrier under the slab can not only prevent moisture wicking into the slab from the ground, but it can also be part of a radon mitigation system.
- Keeping building materials off the ground and covered during construction helps keep them dry. Wet building materials are subject to warping, swelling, and mold growth.
- Keeping plumbing pipe out of exterior wall cavities reduces the potential for condensation in the wall cavity, which can lead to moisture problems. Plumbing pipes in exterior wall cavities also have the potential to freeze.
- Having ducts and pipes in unconditioned spaces can lead to surface condensation on the ducts or pipes, which can create moisture issues. In certain circumstances, condensation could form inside leaky ducts if unconditioned air is drawn into the duct.
- If enclosed, wood above 19 percent moisture content could cause moisture issues in the wall cavity. Checking moisture content reduces the likelihood that problems are hidden behind the walls.

## Technical Support Provided during Design and Implementation

- The NAHB Research Center provided information about techniques for managing moisture in the home.

## For More Information

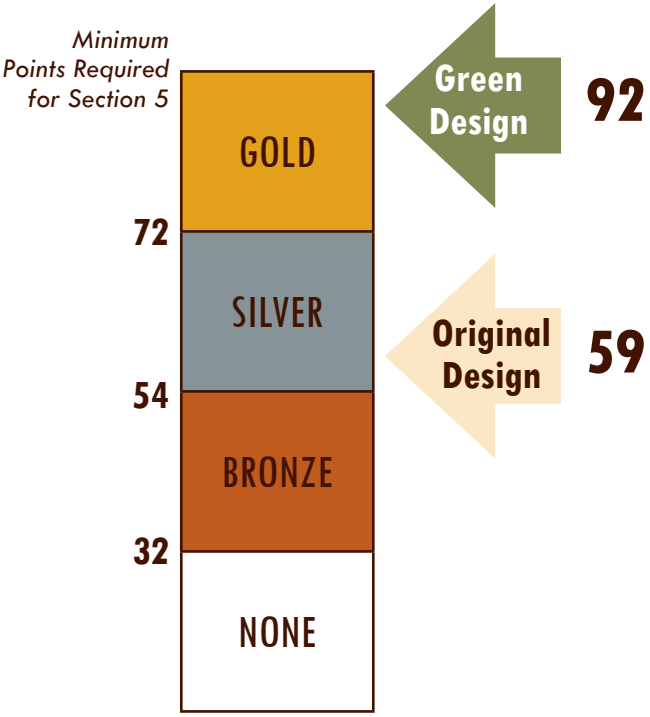
*NAHB Green Scoring Tool*
www.nahbgreen.org

ToolBase Home Building Topics: Mold and Moisture
www.toolbase.org/topics/mold

## Section 5 Point Summary

| Line Item in the Guidelines | Original Design | Green Design |
|---|---|---|
| | Points Awarded | |
| 5.1 | 28 | 26 |
| 5.2 | 7 | 26 |
| 5.3 | 24 | 40 |
| **Section 5 Total** | **59** | **92** |

## Section 5 Scoring Status



# Section 6 Operation, Maintenance, and Homeowner Education

| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 6.3 | Provide education to homeowner on use and care of dwelling | 7 | • Homeowner walk-throughs and manual provided |
| **Section 6 Total** | | **7** | |

The Green Process

| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 6.2 | Optional information in home manual | 2 | Homeowner's manual will include:<br>• List of GBG items included in the home<br>• A photo record of mechanical systems during construction<br>• A maintenance checklist<br>• Information about caring for native and low-water plants<br>• A copy of the local Green Pages which will help the homeowner find organic pest control, specialty maintenance companies, and other green building services |
| 6.3 | Provide education to homeowner on use and care of dwelling | 7 | • Homeowner walk-throughs and manual provided |
| 6.4 | Encourage homeowner to recycle by providing built-in space for recycling | 1 | • Dedicated recycling area in kitchen |
| **Section 6 Total** | | **10** | |

## Advantages of the Green Approach

- Including information in the homeowner's manual about the green features of the home can facilitate the proper care of the home.
- Having a homeowner's manual that describes how to use and care for the green features of the home can help ensure that systems perform as intended.
- Built-in recycling areas make it easier to recycle.

## Technical Support Provided during Design and Implementation

The NAHB Research Center evaluated the home according to the Model Green Home Building Guidelines and provided a list of line items included in the home.

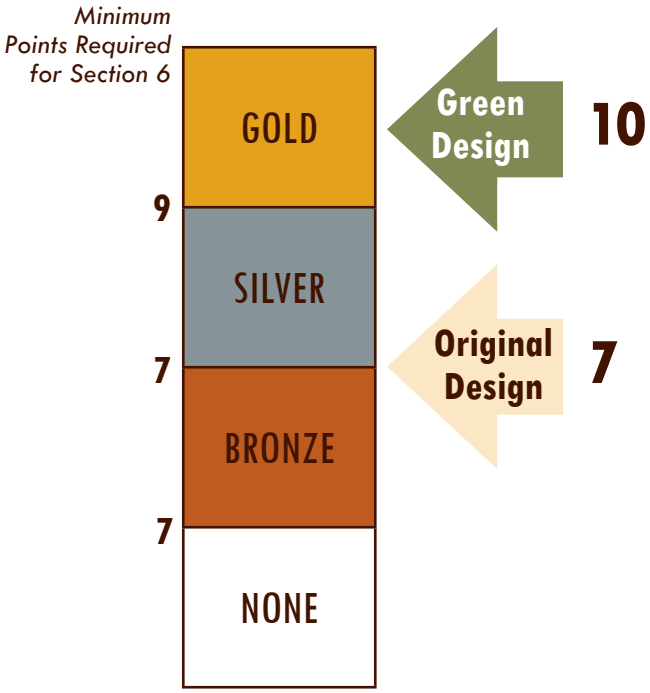
## For More Information

*NAHB Green Scoring Tool*
www.nahbgreen.org

## Section 6 Point Summary

| Line Item in the Guidelines | Original Design | Green Design |
|---|---|---|
| | Points Awarded | |
| 6.2 | 0 | 2 |
| 6.3 | 7 | 7 |
| 6.4 | 0 | 1 |
| **Section 6 Total** | **7** | **10** |

## Section 6 Scoring Status



| Original Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Original Approach** |
| 7.1.2 | Use low- or no-VOC indoor paints | 6 | • No-VOC paints applied indoors |
| **Section 7 Total** | | **6** | |

The Green Process

| Green Design | | | |
|---|---|---|---|
| **Line Item in the Guidelines** | | **Points Awarded** | **Green Approach** |
| 7.1.2 | Use low- or no-VOC indoor paints | 6 | • No-VOC paints applied indoors |
| 7.1.3 | Use low-VOC sealants | 5 | • Low-VOC caulk and adhesives applied indoors and outside |
| **Section 7 Total** | | **11** | |

## Advantages of the Green Approach

- Using low- or no-VOC paints, stains, and sealant reduces the emissions of VOCs which, in turn, helps the global environment. VOCs in paints and adhesives are not typically detrimental to indoor air quality because they no long emit VOCs once dry.

## Technical Support Provided during Design and Implementation

- None required.

## For More Information

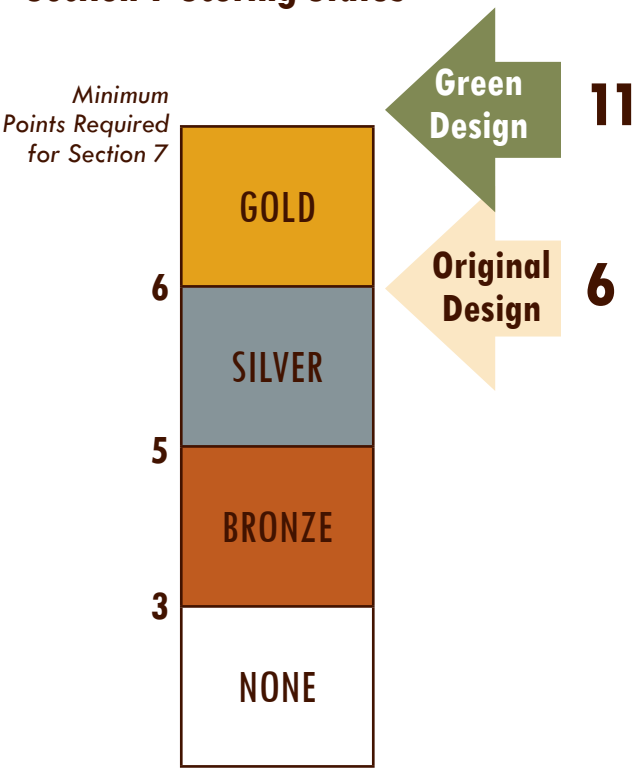
*NAHB Green Scoring Tool*
www.nahbgreen.org

PATH Technology Inventory Summary: Low- or No-VOC Paints and Finishes
www.toolbase.org/techlowvoccoatings

## Section 7 Point Summary

| Line Item in the Guidelines | Original Design | Green Design |
|---|---|---|
| | Points Awarded | |
| 7.1 | 6 | 11 |
| **Section 7 Total** | **6** | **11** |

## Section 7 Scoring Status



## Summary

| Scoring Summary Final Score | Original Design | | Green Design | |
|---|---|---|---|---|
| | Points Earned / Rating | Additional Points Earned over Minimum Required | Points Earned / Rating | Additional Points Earned over Minimum Required |
| Section 1 Lot Design, Preparation, and Development | 11 / BRONZE | +3 | 27 / GOLD | +15 |
| Section 2 Resource Efficiency | 49 / BRONZE | +5 | 101 / GOLD | +24 |
| Section 3 Energy Efficiency | 73 / BRONZE | +36 | 165 / GOLD | +65 |
| Section 4 Water Efficiency | 14 / BRONZE | +8 | 44 / GOLD | +25 |
| Section 5 Indoor Environmental Quality | 59 / BRONZE | +27 | 92 / GOLD | +20 |
| Section 6 Operation, Maintenance, and Homeowner Education | 7 / BRONZE | +0 | 10 / GOLD | +1 |
| Section 7 Global Impact | 6 / BRONZE | +3 | 11 / GOLD | +5 |
| Overall | 219 / NO RATING | +82 | 450 / GOLD | +155 |

- A home must meet the minimum point requirements for a green home rating in all sections in order to attain a rating. The lowest rating achieved for any section is the highest possible rating for the home (e.g., if Silver is received in six sections, but Bronze is achieved in one section, the home can only qualify for Bronze).
- In addition to the minimum points required for each section, all homes (at all rating levels) must accumulate 100 additional points across all sections.

## Summary

The NAHB Model Green Home Building Guidelines were used to transform an ENERGY STAR-labeled home design into a Gold-rated green home. The unique nature of the project, which combined the educational goals of the Lancaster County Career and Technology Center (LCCTC) with the demonstration and research focus of the PATH program, led to the construction of a home that greatly exceeded the minimum requirements for a Gold rating under the Guidelines. If the goal had been simply to meet the minimum requirements for a Gold rating, the home would have attained that goal with less expense and, quite possibly, without the support of a team of experts.

For a mainstream home building company that wants to construct a green home, it is unlikely that some of the technologies and techniques which were challenging to implement in this demonstration home would be attempted. Yet, the Guidelines remain flexible so that a company could earn a green home rating while keeping many of its standard practices. In fact, with only a few minor modifications (totaling 18 points), the original design would have qualified for a Bronze-level green home rating.

The Model Green Home Building Guidelines served as an excellent resource for the project organizers to learn about green home building practices and to determine which practices and technologies were suitable for the project. Through the process of implementing these practices in this first home, the teachers, students, staff, and other project participants gained valuable experience with incorporating green building practices into new home construction. Based on this experience, three subsequent homes will be built over the next several years by the students and staff at the LCCTC. These homes serve as examples to the community of state-of-the-art, environmentally-sustainable home building practices. The performance of the advanced features of this first home will be monitored by the NAHB Research Center and results will be posted on www.toolbase.org/lcctc.

**HUD USER**
P.O. Box 23268
Washington, DC 20026–3268

Official Business
Penalty for Private Use $300

Return Service Requested

FIRST-CLASS MAIL
POSTAGE & FEES PAID
HUD
PERMIT NO. G-795


January 2008