Cold Climate Region
40+% Energy Savings

Whitman "Welcome Home"
Madison, WI

Developer/Owner:	Veridian Homes
Location:	Madison, WI
Building Type:	Single Family Detached
Building Size:	2,324 sq ft 4 bedrooms, 2.5 baths
Price:	$349,900
Status:	1 completed
SWA Contact:	Amanda Magee

After working with CARB and the Wisconsin Energy Conservation Corporation (WECC) to complete a successful prototype in January 2003, Don Simon Homes began implementing many of CARB's recommendations into their production.

In November 2003, Don Simon Homes merged with Midland Builders to become Veridian Homes. Veridian is Wisconsin's largest home builder. CARB approached Veridian Homes in January of 2004 to discuss the possibility of developing and building a second prototype home. With this new prototype, Veridian was interested in demonstrating even greater energy-efficiency and exploring new technologies. In addition, Veridian wanted to keep their design and sales staffs involved in the project. As a production builder, it is important for Veridian to understand how to both build and market these homes. On February 17, 2004, CARB presented these changes to the Veridian design staff and received positive feedback.

With a goal of achieving 40% total source-energy savings over the Building America Benchmark (comparable to mid-1990's construction), Veridian built the Whitman "Welcome Home" prototype based upon the lessons learned through the Building America program. This home featured a solar water heating system and a high performance envelope. It also included high efficiency mechanical equipment, mechanical ventilation, and a number of new products and materials. As-built energy savings were estimated to be at 43%.

Veridian participates in both the Wisconsin Energy Star Homes and Green Built Home™ Program. Green Built Home™ is a green building initiative that reviews and certifies compliance with sustainable building and energy standards. It is a voluntary program under the Wisconsin Environmental Initiative and is sponsored by participating homebuilder associations, leading utility companies, organizations promoting green building and energy efficiency, and the State of Wisconsin.

"In keeping with our green building philosophy, we wanted to push the limits and create an innovative, environmentally friendly concept home. "

Energy Efficient Features

- Poured concrete basement foundation w/ 1" Certainteed Board (R-5) exterior insulation (w/ above-grade finish)
- Corbond spray-in-place polyurethane foam insulation (R-6.75/in)
- 2x6 advanced framing @ 24" on center with Certainteed Optima blown-in fiberglass insulation (R-23)
- Certainteed MemBrain Smart Vapor Retarder
- Space Joist TE Open Web Trusses @ 24" on center
- Weathershield ELC Series, low-e, argon (U-0.29, SHGC-0.29)
- Certainteed Optima blown-in fiberglass insulation (R-50)
- Bryant Plus 90i furnace (94 AFUE)
- 2 ton Bryant Quantum plus (SEER 13)
- Compact duct system sealed with mastic
- Heliodyne 64 ft² solar hot water w/ 80 gal storage tank and back-up Rinnai tankless water heater (EF 82)
- 100% fluorescent lighting
- Whirlpool Energy Star appliances
- ASHRAE 62.2 compliant exhaust-only ventilation (Broan 110 cfm fan controlled by Grasslin pin timer)
- R.AP. Transfer grilles over the doors of each secondary bedroom
- Seal-combustion fireplace

Certifications

- Exceeds 1999 Energy Star® Homes Standards with HERS Score = 91.0

Builder Awards

- National Housing Quality (NHQ) Gold Award (2006)
- Energy Star Partner of the Year (2004, 2005)
- Energy Star Sustained Excellence Award (2006)
- The Federation of Environmental Technologist's Governor's Award for Excellence in Environmental Performance (2006).
- 2007 Energy Value Housing Award Builder of the Year and the Gold Award Winner for custom homes in the cold climate.

Steven Winter Associates, Inc.

www.swinter.com
50 Washington St. 6th Fl, Norwalk, CT 06854 tel 203-857-0200 fax 203-857-0200
307 7th Ave. Ste. 1701, New York, NY 10001 tel 212-564-5800 fax 212-741-8673
1112 16th St., NW Ste. 240, Washington, DC 20036 tel 202-628-6100 fax 202-393-5043

Cost - Neutrality

Whitman "Welcome Home"

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The long-term goal of the Building America program is to develop cost-effective systems for homes that can produce as much energy as they use—a zero energy home. As teams increase the savings targets towards zero energy homes, maintaining cost neutrality is a key component. The added cost of higher efficiency technologies can typically be offset by reducing unnecessary waste in other systems or through utility bill savings.

The table below shows the incremental cost of each modification of Veridian's standard practice specifications. The incentives received for these upgrades are summarized in the lower table. In some cases, such as the thermidistat, the costs are included in the overall system cost. Although transfer grilles are shown as an added cost, there would be savings found by eliminating individual returns. However, it is difficult to quantify costs on a case by case basis.

These increased costs were partially offset through the use of advanced framing techniques. CARB calculated a savings in lumber of 14% when compared to Veridian's standard practice. Similarly, there were savings associated with shifting the truss spacing from 16 to 24 inches on center. Comparing Veridian's standard practice, which uses an 11-7/8 inch deep TJI floor joist system, the increased spacing would reduce the number of trusses by 34%. However, to simplify the mechanical design, Space Joist TE openweb trusses were used in this home. Although the open-web trusses cost more per lineal foot, the reduction in trusses still resulted in a 6% savings.

An annual mortgage payment increase for improvements was calculated based on a 30 year mortgage with a 7% fixed interest rate. The estimated annual savings was $863 (based on utility rates of $0.0915/kWh and $0.88/therm). The net cash flow was a negative $226 per year. Although, if the WECC incentives are included in this analysis, the net cash flow improves to a positive $32.

Item	Veridian Standard Practice	Welcome Home Prototype	Added Cost
Foundation Insulation	Watchdog w/Dow Board	GMX, Certainteed R-5 energy board	$213.00
Rim/Band Insulation	R-19 fiberglass batt	3" Corebond (R-20.25)	$612.00
Wall Insulation	R-19 fiberglass batt	R-23 Optima, Blown-in	$1,201.00
Ceiling Insulation	R-38 blown-in	R-50 blown-in	$167.50
WeatherSheild Windows	Vision 2000, low E, Argon	ELC, low E, Argon	$2,655.43
Vapor Barrier	4-ml visqueen, poly barrier	Certainteed Smart MemBrain	---
Transfer Grilles	none (individual returns)	RAP Transfer Grilles (3 @$30.75 each)	$92.25
Furnace	Janitrol GMNT, 80,000 BTU	Bryant Plus 90i, #355 MAV, 60,000 BTU	$671.00
A/C	Janitol, 12 SEER, **2-1/2 ton**	Bryant Quantum plus w/Puron, 13 SEER, 2 ton	$400.00
Thermostat	Honeywell Stat (T8112)	Bryant Programmable Thermidistat	---
Bath Fan	Broan S80 UE (3 fans)	Broan, QTXE110 (3 fans)	$75.00
Water Heater	A.O. Smith Powershot, 50-gal	Rinnai Continuum Instant, gas	$146.00
Solar System	None	Installed System	$6,493.00
Light fixtures	Brushed Nickel pkg w/ Incandescent	Sea Gull w/Compact Fluorescent lamps	$777.18
Bath Fan Timer Switch	EFI Fan Delay Timer	Grasslin Pin Timer	$15.00
		Total Additional Cost of the Prototype =	**$13,518.36**
		Total Incentive Amount =	**$3,205.00**
		Total Net Cost of the Prototype =	**$10,313.36**

WECC Incentives	
ECM Furnace Motor	$150.00
SEER 13 A/C	$200.00
Energy-Efficient Bath Fan	$50.00
Solar Rebate of $39/square foot of collector	$2,496.00
Lighting: $15 per 5 bulbs & $10 per fixture	$309.00
Total Incentive Amount	**$3,205.00**

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Building Specifications

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Advanced Framing

Through the use of advanced framing techniques on the Whitman prototype, CARB calculated a savings in lumber of 34% over standard 16 inch on center framing. When compared to Veridian's standard practice of 24 inches on center, Advanced Framing techniques saved 14% in lumber. Similarly, there are savings associated with shifting the truss spacing from 16 to 24 inches on center. Comparing Veridian's standard practice, which uses an 11-7/8 inch deep TJI floor joist system spaced at 19.2" on center, the increased spacing would reduce the number of trusses by 34%. However, to simplify the mechanical design, Space Joist TE open-web trusses were used in this home. As denoted in the name, the Space Joist *TE* product has "*T*rim-able *E*nds". This provides flexibility on-site, while minimizing the amount of wasted materials. Although the open-web trusses cost more per lineal foot, the reduction in trusses still resulted in a 6% savings. The open-web trusses cost $2.25 per lineal foot, as compared to $1.55 for TJIs, or roughly 40% more.

Simplified Plumbing Installation

Integrated HVAC System

Window header in floor system

Inline Space Joist floor system

Coordinated Mechanical Chase

24" OC, window header hangers, double top plate

Foundation Insulation

Veridian opted to use a GMX Waterproof System, which combines a 1-inch CertainTeed rigid insulation board with a spray water-proof coating. Shown below (left), the insulation board was extended up to the sill. Extending the insulation up to the sill requires additional effort to cover the above-grade portion of the insulation. The photo below (right) shows the vinyl flashing Veridian installed to protect the insulation and prevent moisture intrusion where the siding terminates.

Foundation Insulation Detail

Foundation Flashing Detail

Rim/Band Joist Insulation & Air Sealing

CARB recommended insulating the rim and band joists with a spray-in-place high density polyurethane foam insulation. In addition to having a higher insulating value per inch then standard insulating methods, this strategy is impermeable to moisture and creates an air barrier. Controlling air and moisture problems is extremely important, particularly at the foundation. Typically, batt insulation is installed at the rim joist. Moisture migrates up from the concrete foundation, where it can accumulate in the fiberglass batt. This reduces the effective R-value of the insulation and can cause the wood to rot. Impermeable polyurethane foam mitigates this moisture concern.

Foaming the rim joist

Foam tightly seals penetrations

Corbond at the first floor band joist

Insulated window headers

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Right-Sized, Compact Ducts

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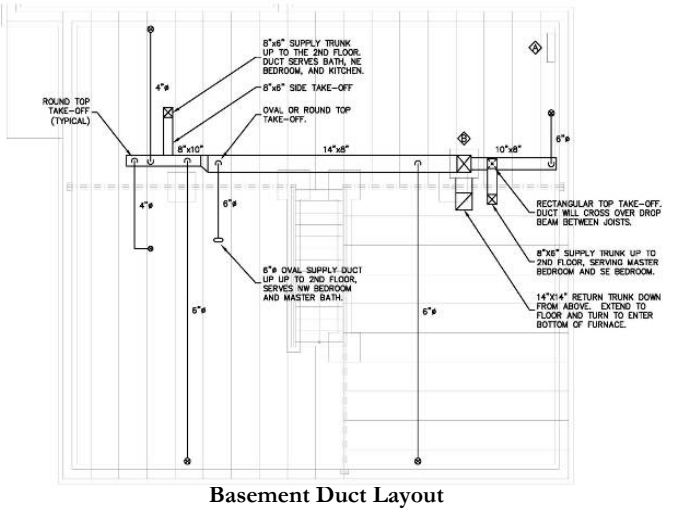
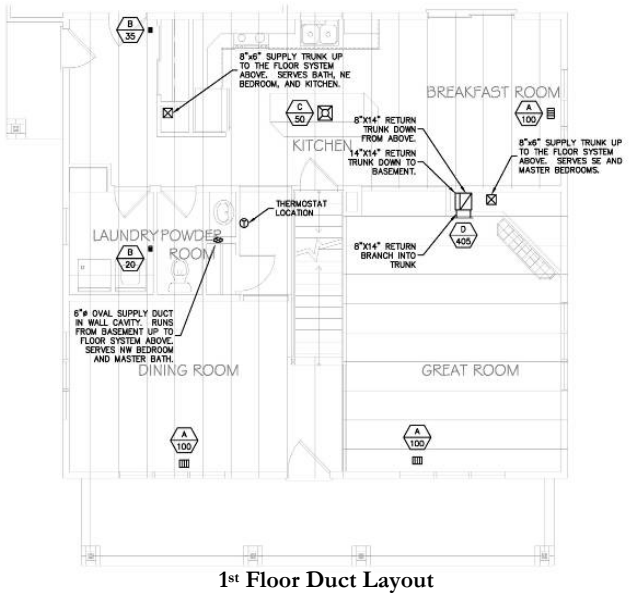
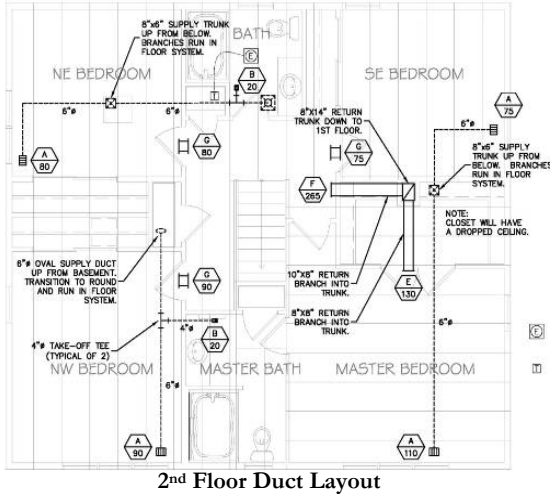
Using Wrightsuite Residential software, the HVAC system and ductwork for the Whitman prototype were sized according to Manual J/S/D load calculation procedures. The system was designed to minimize ductwork, keep all ducts within the conditioned space, and provide balanced supply and return airflows. Chases were provided for supply trunks and central returns, eliminating the need for ductwork in exterior walls. No panned ductwork was permitted and the system was sealed with mastic to reduce total duct leakage. As shown in the duct layouts (right), the prototype home had central returns on the 1st and 2nd floor and a separate return from the master suite.



Basement Duct Layout



1st Floor Duct Layout



2nd Floor Duct Layout

Reducing leakage at the boots

Mastic coating the Supply/Return trunks

Compact main trunk

High central return & transfer

Low central return

2nd floor returns

1st floor central return

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Miscellaneous Electric Loads (MELs)

Nearly 48% of the estimated source energy electrical usage cannot even be directly effected by the builder. Lighting and Appliances are already at or near the highest levels of efficiency possible with today's market-ready technologies, and plug loads weren't altered for analysis purposes. Those three areas are 46% of the total electric load (heating is by natural gas).

To confirm that miscellaneous electric loads were as large a portion of the remaining building load as estimated, CARB installed an in-home energy monitoring system in the Veridian Whitman prototype home. The installed system was initially developed by Whirlpool to monitor and control appliance loads. The system records, stores and reports home electric usage data and provides occupants with a visual display of current and historical energy consumption and operating costs.

Separately from the Whirlpool monitor, CARB collected and documented the electrical energy use in the occupied home of the air handler, air conditioner, solar domestic hot water system, and auxiliary water heater. This data was combined with the appliance and plug load data to assess the overall electrical energy use of the home. The "other" unidentified misc. electric loads were roughly 50% of the total consumption.

Duringa site visit, CARB learned that an unmonitored dehumidifier, refrigerator and freezer were operating in the basement of the home. The remaining unmonitored loads still comprise almost 20% of the total electrical usage of the home.

Plastic Ducts

Veridian partnered with CARB and CDC Enterprises on a test home in which QA Ducts replaced the standard sheetmetal ductwork located in the unfinished basement. QA Ducts are a pre-insulated plastic ducting system that meets the stringent UL-181 requirement for use as an above ground heating and cooling distribution system. Plastic ducts are more commonly used in below ground duct installations. The impacts of this are: (1) quicker installation as the plastic ducts can be cut with a utility knife and are joined by gasket/clamp, (2) a tighter duct system to ensure the required cfm is delivered to the individual rooms, (3) a low static pressure drop to assist in designing a compact system and (4) a mold and mildew resistant duct system to maintain indoor air quality over time.

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