

Part-Load Days More Important than Design-Load Days

As a group, homeowners are overly concerned with extreme weather conditions that occur for a few hours per season and uninformed about the significance of the part-load conditions that occur for thousands of hours per season. This lack of understanding pressures contractors to install oversized equipment and results in systems that are more expensive to install, less efficient, less comfortable for a majority of the season, and less reliable. In addition, the oversized equipment produces an unnecessary load on the electric and gas distribution systems. The solution to this problem is consumer education.

4.1 INDOOR/OUTDOOR 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 Hot water delivery to remote locations aided by installation of:

- A. On-demand water heater at point of use served by cold water only. (Points per unit installed)
- B. Control-activated recirculation system.

Intent:

Reduce water waste by using technologies that provide hot water at the tap with a minimal wait time.

Information / How to Implement:

Install a water heater at the point of use, or a hot water recirculation device that is controlled by the user or an automatic device (e.g., timer or thermostat) to minimize or eliminate the waiting period for hot water at faucets. To save both energy and water, recirculating systems should be controlled by the user at the time of use rather than circulating hot water through the piping system continuously. Typically, in this type of controlled system, a switch or a button located near a fixture activates a small pump that begins circulating hot water when there is demand for it.

Resources:

- Demand Hot Water Heater fact sheet:
www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1318&DocumentID=3206
- Hot Water Recirculation Systems fact sheet:
www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1436&DocumentID=2130
- "An Energy-Saving Product That's Actually Convenient?" Energy Design Update, July, 1997, pg. 8. This article reviews one hot water recirculation product.

4.1.2 Water heater located within 30 feet pipe run of all bathrooms and kitchen.

Intent:

Minimizing the distance between the water heater and major hot water uses reduces the total amount of plumbing pipe installed. This helps reduce the amount of conductive heat loss from the pipe, the amount of time it takes for hot water to reach baths, the laundry area, and the kitchen (helping to conserve water), and the amount of hot water left standing in pipes after a draw (which helps save energy). It has an added benefit of resource efficiency from using less piping material.

Information / How to Implement:

This line item is closely related to the efficient design of the home discussed under the Resource Efficiency section. The first step in minimizing the distance between the water heater and bathrooms and kitchens is to locate those areas in close proximity to one another when designing a home. Once baths, kitchens, and laundry rooms are “clustered” or “stacked,” the water heater can be placed to maximize efficient delivery. The effective implementation of this line item offers material and labor savings during construction as well as water and energy savings throughout the life of the home.

Resources:

- DOE Technology Fact Sheet—Water Heating www.eere.energy.gov/buildings/info/documents/pdfs/26465.pdf

4.1.3 ENERGY STAR water-conserving appliances installed, e.g., dishwasher, washing machine.

Intent:

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

Information / How to Implement:

The ENERGY STAR label identifies appliances that are at least 20% more energy 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 with 40 gallons for standard models. The machine also removes more water during the spin cycle, reducing drying time. 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 much of the guesswork out of selecting energy efficient appliances and equipment, making the selection process easier for builders and homeowners.

Resources:

- 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.



4.1.4 Water-efficient showerhead using conventional aerator or venturi technology for flow rate < 2.5 gpm

Intent:

Save water by installing low-flow showerheads.

Information / How to Implement:

Low-flow showerheads conserve water by cutting water flow to levels below the federal minimum standards for shower-head flow rate.

Resources:

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



4.1.5 Water-efficient sink faucets/aerators < 2.2 gallons/minute

Intent:

Save water by installing aerators that cut flow to levels below the federal minimum standards for faucet flow rate.

Information / How to Implement:

Aerators are a water saving device. Installing aerators in faucets conserves water by restricting the water flow at the faucet outlet. Aerators can be simply screwed into most conventional faucets.

Resources:

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

4.1.6 Ultra-low-flow, (< 1.6 gpm/flush) toilets installed:



- A. Power-assist
- B. Dual flush.

Intent:

Reduce water use associated with toilet flushing.

Information / How to Implement:

Several manufacturers offer toilets that use even less water than the federally mandated 1.6 gallons per flush while still performing reliably. Power-assist toilets with a small, electrically powered pump use either 1.0 or 1.4 gallons per flush depending upon liquid or solid waste. These models require a receptacle near the toilet and have a button on top that allows the user to select the desired flow. One manufacturer estimates water savings of about 2,000 gallons per year. Other new gravity-fed models use as little as 0.8 to 1.4 gallons per flush and maintain quiet operation. Most of these models are set to a particular flow rate at installation, but this setting can be adjusted.

Resources:

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

4.1.7 Low-volume, non-spray irrigation system installed, e.g., drip irrigation, bubblers, drip emitters, soaker hose, stream-rotator spray heads.

Intent:

Minimize outdoor water use by installing irrigation systems that offer the most effective and efficient delivery method.

Information / How to Implement:

Drip irrigation systems provide water directly to root systems where it is most needed, making it more efficient than spray systems. Water runoff 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.

Resources:

- *Turf and Landscape Irrigation Best Management Practices*, Irrigation Association, www.irrigation.org/PDF/IA_BMP_FEB_2004.pdf
- *Landscaping Irrigation Systems*, H2ouse.org., the California Urban Water Conservation Council, www.h2ouse.org/tour/details/element_action_contents.cfm?elementID=68BAD0B5-0C95-4AE8-8EC6EC8D76A4CBE1&actionID=BD9DA9D3-0CFA-4F05-B3CBFEC63E2EEE57&roomID=F80B1F87-C00D-498C-9C1F1E5BE9D04637

4.1.8 Irrigation system zoned separately for turf and bedding areas.

Intent:

Control irrigation to individual areas.

Information / How to Implement:

Turf and bedding areas have different irrigation needs based on the various types of grasses and vegetation planted. 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% to 50% less water than lawns.

Resources:

- *Turf and Landscape Irrigation Best Management Practices*, Irrigation Association, www.irrigation.org/PDF/IA_BMP_FEB_2004.pdf
- *Landscaping Irrigation Systems*, H2ouse.org., the California Urban Water Conservation Council, www.h2ouse.org/tour/details/element_action_contents.cfm?elementID=68BAD0B5-0C95-4AE8-8EC6EC8D76A4CBE1&actionID=BD9DA9D3-0CFA-4F05-B3CBFEC63E2EEE57&roomID=F80B1F87-C00D-498C-9C1F1E5BE9D04637

4.1.9 Weather-based irrigation controls, e.g., moisture-sensor, computer-based weather record.

Intent:

Conserve water by providing irrigation on an “as needed” basis.

Information / How to Implement:

The portion of household water used outdoors varies by climate but can be up to 60% of all household water use. Currently, most irrigation systems are controlled by automatic timers. The systems operate at a particular time each day regardless of whether it has rained recently. Often, assessing the need for watering by visual observation or surface conditions can be difficult since watering needs are based on conditions at the roots. The recommended method for irri-

gation control is to use sensors that activate irrigation based on soil moisture content. This not only saves water but also provides the optimum conditions for the turf grass or plants in question since over-watering can be as detrimental to healthy plant growth as insufficient water.

Computer-based controls use historical local weather data to project anticipated weather patterns and time outdoor watering accordingly.

Resources:

- *Turf and Landscape Irrigation Best Management Practices*, Irrigation Association, 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, www.kgs.ukans.edu/AASG/AASG.html

4.1.10 Collect and use rainwater as permitted by local code. (Additional credit for distribution systems that use a renewable energy source or gravity.)

Intent:

Reduce water needs for irrigation by collecting and using rainwater.

Information / How to Implement:

Rainwater collection systems store rainwater for future watering and irrigation needs. Collecting rainwater keeps rainwater onsite, thus lowering the impact on storm water collection and conveyance systems and helping to replenish aquifers. See Resources for information about how to construct a rainwater harvesting system and related code issues. Many types of rainwater collection systems are also available commercially.

Resources:

- 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

4.1.11 Innovative wastewater technology as permitted by local code, e.g., constructed wetland, sand filter, and aerobic system.

Intent:

Communities often rely on municipal sewage treatment systems rather than onsite wastewater systems because of the generally higher level of supervision and control. However, if onsite processing is the only option for a builder on a lot, 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.

Information / How to Implement:

Innovative wastewater systems are a technological advancement over conventional septic systems. These technologies treat wastewater to higher levels, resulting in cleaner effluent discharge, improved system operation, and lower impact on the environment.

Resources:

- 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, 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

4.2 INNOVATIVE OPTIONS

4.2.1 Shut-off valve or pedal-activated faucet to enable intermittent on/off operation.

Intent:

Reduce water waste by installing a faucet control that allows the user, via a (typically) hands-free method, to turn water on and off without changing the temperature.

Information / How to Implement:

Motion-sensor devices automatically control on/off operation of the faucet. Pedal-activated faucets allow individuals to use their feet to control the faucet. Both systems conserve water by reducing the duration of a water flow event.

Resources:

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



4.2.2 Separate and reuse greywater as permitted by local code.

Intent:

Reduce total household water consumption by reusing greywater, i.e., water generated from the laundry, showers, and sinks.

Information / How to Implement:

Greywater reuse 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. Reusing greywater can significantly reduce total household water consumption.

Resources:

- PATH Technology Inventory:
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

4.2.3 Composting or waterless toilet installed as permitted by local code.

Intent:

Eliminate water use associated with toilet flushing by installing composting or waterless toilets.

Information / How to Implement:

Composting or waterless toilets do not use water.

Resources

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

GENERAL RESOURCES

- The Sustainable Building Sourcebook, www.greenbuilder.com
- The Healthy House Institute, www.hhinst.com
- For Volatile Organic Compounds, www.concretenetwork.com/concrete/finished_basements/a_word_about_vocs.htm
- For Building Material Emissions Study, www.ciwmb.ca.gov/Publications/GreenBuilding/43303015.doc
- For spot ventilation, see the fact sheet *Spot Ventilation—source control to improve indoor air quality* www.toolbase.org/Docs/MainNav/Energy/3947_spotventilation1.pdf?TrackID=&CategoryID=1004&DocumentID=3947 (Sept 2004)
- EPA. *A Guide to Indoor Air Quality*; www.epa.gov/iaq/pubs/insidest.html (Sept 2004)
- *Mold in Residential Buildings*, www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1554&DocumentID=2944 (Sept 2004)

5.1 MINIMIZE POTENTIAL SOURCES OF POLLUTANTS.

5.1.1 For vented space heating and water heating equipment:

A. Install direct vent equipment.

Or

B. Install induced/mechanical draft combustion equipment.

Intent:

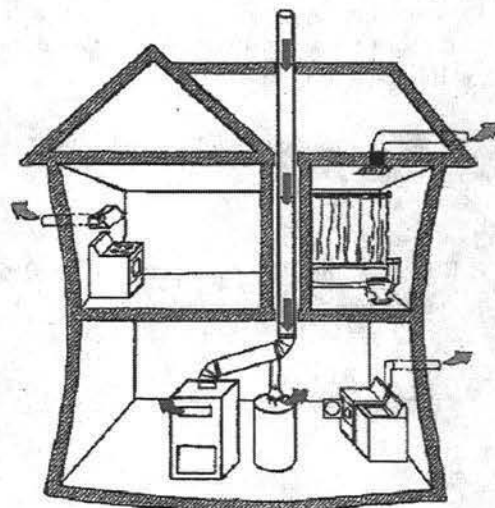
There are concerns that exhaust vents (bathroom, kitchen, etc.) can depressurize a tight home and cause the byproducts of combustion from appliances to be drawn into the home. If installing combustion space and water heating appliances, minimize the back-drafting potential by choosing direct-vent (sealed combustion) or mechanical/induced-draft (power-vented) equipment. All space and water heating appliances must meet these criteria to receive points.

Note: Points can be obtained for this guideline by mixing equipment types. For instance, direct-vent space heating equipment and an induced-draft water heater can be installed and receive credit.

Information / How to Implement:

Combustion appliance manufacturers offer equipment with various means of exhausting by-products:

- 1) Unvented equipment (aka, ventless, vent-free) where byproducts are exhausted into the home;
- 2) Natural draft equipment (aka, atmospherically vented) where environmental pressure and temperature differences cause by-products to be drawn up a chimney which is directly connected to the equipment;
- 3) Mechanical draft equipment (aka, induced draft, power vented) where by-products are exhausted through a vent due to pressure differences created by a fan, blower, or ejector located in the vent, or



- 4) Direct-vent equipment where all combustion takes place in a sealed chamber. Combustion air is drawn directly from the outdoors into the chamber. Products of combustion are then vented directly outdoors. Direct-vent space heating equipment also has an energy benefit as compared with natural draft or mechanical draft equipment. The Annual Fuel Utilization Efficiency (AFUE) of direct-vent equipment is typically above 85%.

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.

An alternative to direct vent equipment includes isolating combustion equipment from the conditioned space, such as constructing a combustion closet (see 5.1.2).

Resources:

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

5.1.2 Install space heating and water heating equipment in an isolated mechanical room or closet with an outdoor source of combustion and ventilation air.

Intent:

Installing combustion appliances in an isolated space, such as in a combustion closet, can minimize the concern that combustion byproducts could be drawn into the home.

Information / How to Implement:

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.

Alternatives include installing direct-vent or mechanical/induced-draft equipment (see 5.1.a-b) or installing electric equipment.

Resources:

- 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 sealed combustion gas fireplace, sealed wood fireplace, or sealed woodstove.

Or

No fireplace or woodstove installed.

Intent:

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

Information / How to Implement:

Fireplaces typically come in:

- Wood burning (uses room air for combustion, and exhausts up a chimney)
- Vented gas (uses room air for combustion, exhausts through vent or chimney),
- Directvent gas (aka, "sealed combustion," outdoor combustion air provided directly to sealed combustion chamber, exhausts through vent or chimney), or
- Vent-free gas (uses room air for combustion and exhausts to room).

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

Direct-vent fireplaces (aka, 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.

Resources:

- 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* 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 www.hpba.org/communications/FactSheets/Fact03-EPAWoodBurn3.pdf
- HPBA fact sheet *Wood Burning Fireplaces* www.hpba.org/communications/FactSheets/WoodBurningFireplace.pdf
- HPBA fact sheet, Gas Fireplaces www.hpba.org/communications/FactSheets/GasFireplace.pdf
- National Fireplace Institute. 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*: www.epa.gov/compliance/monitoring/programs/woodstoves
- For fireplace venting options, www.fireplacenow.com/_content/_VentingOptions.htm (Sept 2004)

5.1.4 Ensure a tightly-sealed door between the garage and living area and provide continuous air barrier between garage and living areas including air-sealing penetrations, walls, ceilings, and floors.

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 fumes to be drawn into the living space through common walls and ceilings. 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.

Automated mechanical ventilation is sometimes used to exhaust air from the garage to the outdoors. Because this type of system creates negative pressure in the garage, pollutants are less likely to be drawn into the home. However, mechanical ventilation is not a substitute for air sealing because wind speed and direction affect its performance. An alternative to providing a continuous air barrier is to construct a detached garage. However, this option requires more construction materials and therefore has a somewhat negative impact on resource efficiency.

Information/ How to Implement:

A continuous air barrier, which decouples garage air from living space air, 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 heavy insulation, and install an air barrier such as rigid foam or a sheet barrier (not a 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 also be used.

At a minimum, 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.

Resources:

- Super Good Cents Builders Field Guide—Chapter 9, Air Tightening Specialist
- Building Science Corporation: Figure 19. www.buildingscience.com/housesthatwork/hotdry/tucson.htm
- http://oils.com/library/airsealing/rim_joists.html
- 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

5.1.5 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.

Intent:

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

Information / How to Implement:

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

The Composite Panel Association's Environmentally Preferable Product Certification Program certifies that composite panels at least meet the appropriate ANSI product criteria. Particleboard should be in conformance with ANSI A208.1-1993. For particleboard flooring, look for ANSI grades "PBU," "D2," or "D3" stamped on the panel. MDF should be in conformance with ANSI A208.2-1994 and hardwood plywood with ANSI/HPVA HP-1-1994.

Resources:

- IARC Monographs on the Evaluation of Carcinogenic Risks to Humans—monographs.iarc.fr/htdocs/announcements/vol88.htm
- www.buildinggreen.com—GreenSpec Directory
- The Composite Panel Association (CPA) Environmentally Preferable Product (EPP) Certification Program, www.pbmdf.com/AboutCPA/EPP.asp
- 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. www.Greenguard.org
- For formaldehyde-free MDF, check www.advancedbuildings.org/main_t_finishes_formaldehyde.htm, Sept 2004.

5.1.6 Install carpet, carpet pad, and floor covering adhesives that hold the "Green Label" from Carpet and Rug Institute's indoor air quality testing program or meet equivalent thresholds verified by a third party.**Intent:**

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

**Information / How to Implement:**

The Carpet and Rug Institute administers a testing program to identify low-emitting carpets, carpet pads, and floor covering adhesives. Look for the "Green Label" when purchasing carpets. Natural fiber carpets are also good alternative floor coverings.

Resources:

- 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.
- Environmental Protection Agency. www.epa.gov/iaq/formalde.html (Sept 2004)

5.1.7 Mask HVAC outlets during construction and vacuum ducts, boots, and grilles before turning on central heating/cooling system.**Intent:**

When possible, do not operate ducted HVAC equipment during construction.

Remove dust and dirt from supply and return ducts before putting the equipment into operation to minimize airborne pollutants.

Information / How to Implement:

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

Resources:

- Information will be added in Version 2.

5.1.8 Use low-VOC-emitting wallpaper.**Intent:**

Use low-VOC-emitting wallpaper to reduce potentially harmful VOCs from being emitted into the indoor air.

Information / How to Implement:

Use materials certified by a third party as having low VOC emissions.

The reason this line item is in the IEQ guiding principle and the low VOC paints line item is in the “Global Impacts” guiding principle is because once the homeowner moves into a new home, the vast majority of VOCs in paints have already been released to the atmosphere and are thus do not have a significant impact on indoor environmental quality. However, wallpaper releases VOCs more slowly. Thus, there is still a relatively good amount of VOCs remaining in wallpaper after a homeowner moves into a new home.

Resources:

- www.greenguard.org
- *Green from Wall to Wall* by Environmental Design+Construction, 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, 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.****Intent:**

Remove moisture, odors, and combustion byproducts.

Information / 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 tightly seal around the penetration. Take caution not to over-ventilate. Large kitchen exhaust fans can increase the potential for back-drafting 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 of range top 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.

Resources:

- Home Ventilating Institute, 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. www.arb.ca.gov/research/indoor/rediap.htm (Sept 2004)
- Doiron, Jacques. Cleaner cooking. www.canadianhomeworkshop.com/quickfix/kitchen_vent.shtml (Sept 2004)
- Miltner, Karen. Keeping Kitchen Smells Fresh. www.democratandchronicle.com/homes/buyersguide/1010G221OKH_HOODS11_Homes.shtml (Sept 2004)

5.2.2 Provide mechanical ventilation at a rate of 7.5 cfm per bedroom +7.5 cfm and controlled automatically or continuous with manual override. The ventilation equipment may be:

- A. Exhaust or supply fan(s)
- B. Balanced exhaust and supply fans
- C. Heat recovery ventilator
- D. Energy recovery ventilator.

Intent:

Provide small amount of background ventilation to ensure that indoor air is exchanged at a consistent and adequate rate.

Information / How to Implement:

It is advantageous from an indoor environmental quality perspective and for energy-efficiency purposes and comfort to construct a tight building envelope. Air infiltration not only contributes to energy loss but can also cause 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 create the need for an intentional means of introducing fresh air into the living space. Introducing outdoor air into the home in a controlled manner has both an energy and IEQ advantage.

Exhaust or Supply Fan: Kitchen or bath exhaust fans can be part of a whole-house ventilation strategy in cold climates if fans are controlled with timers or humidistats. As air is exhausted from the home, the negative pressure created pulls in outdoor air from nooks and crannies in the building envelope. The practice is not recommended in warm, humid climates because humid, outdoor air traveling through a wall cavity can create moisture problems. In these climates, supply-only ventilation is preferable. For supply-only ventilation, locate the ducts carefully since cold or hot outdoor air can create comfort issues.

Balanced Exhaust and Supply Fan: Balanced ventilation does not contribute to pressure imbalances between indoors and out. As air is exhausted by one (or more) fans, fresh air is introduced by another. One option for balanced ventilation is to use bath fans for the exhaust and to install a small duct from outside to the return side of the air handler on a central heating or cooling system. Controls and timers are then used to operate the fans and air handler simultaneously or as desired. Outdoor air can also be supplied directly to the home with a separate fan, but take care in locating the ducts so that comfort is not compromised.

Heat or Energy Recovery Ventilators: These systems are also a form of balanced ventilation. In addition to supplying fresh air and exhausting stale air, they precondition the incoming air to some degree. Heat recovery ventilators exchange sensible heat while energy recovery ventilators transfer moisture to some extent as well. Thus, in a humid climate, some moisture from the incoming air is transferred to the exhaust stream. Energy recovery ventilators are not dehumidifiers; they transfer moisture from one air stream to another. For severely humid climates, one should consider a dehumidifying ventilator. Typically, heat recovery ventilators are recommended for cold climates and energy recovery ventilators for hot climates. However, if dry indoor air is a potential issue in a heating-dominated climate, an energy-recovery ventilator may be preferred.

See also Section 3.3.1B under the Energy Efficiency section.

Resources:

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

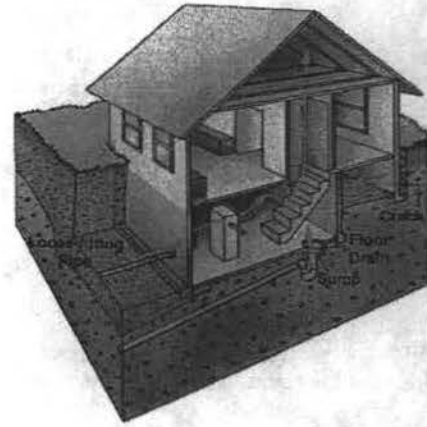
5.2.3 Install MERV 9 filters on central air or ventilation systems.

Intent:

Reduce the amount of airborne particulates.

Information/ How to Implement:

MERV 9 filters remove particles larger than 3 microns and are more effective than standard spun fiber filters. MERV 9 filters capture dust but not contaminants such as molds and bacteria that 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 airflow too much. More efficient filters such as MERV 9 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.



Resources:

- National Institute for Occupational Safety and Health. Guidance for Protecting Building Environments from Airborne Chemical, Biological, or Radiological Attacks. www.cdc.gov/niosh/docs/2003-136/2003-136c.html (Sept. 2004)
- CHMC "What a Furnace Filter Can Do For You" www.cmlr-schl.gc.ca/en/burema/gesein/abhose/abhose_ce22.cfm (Sept. 2004)

5.2.4 Install humidistat to control whole-house humidification system.

Intent:

Control excessive humidification, which can result in moisture damage.

Information/ How to Implement:

Indoor humidity should be between 30 and 60 percent. Indoor humidity below 30 percent causes dry eyes, nose, and throat, which are not only uncomfortable but also an invitation for bacteria and viruses. At the other extreme, indoor humidity above about 60% 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 to 48 hours. Therefore, if a whole-house humidification system is installed, it should have an adjustable humidistat control to avoid excessive humidification.

Resources:

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

5.2.5 Install sub-slab depressurization system or infrastructure to facilitate future installation of radon mitigation system. When applicable, the more stringent requirement of local building code and this provision shall apply.

Intent:

Prevent radon gas from entering the home.

Information / How to Implement:

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

Text and graphic from www.epa.gov/radon/construc.html

A. Gas-Permeable Layer

This layer is placed beneath the slab or flooring system to allow the soil gas to move freely underneath the house. In many cases, the material used is a four-inch layer of clean gravel.

B. Plastic Sheetting

Plastic sheeting is placed on top of the gas-permeable layer and under the slab to help prevent the soil gas from entering the home. In crawl spaces, the sheeting is placed over the crawl space floor.

C. Sealing and Caulking

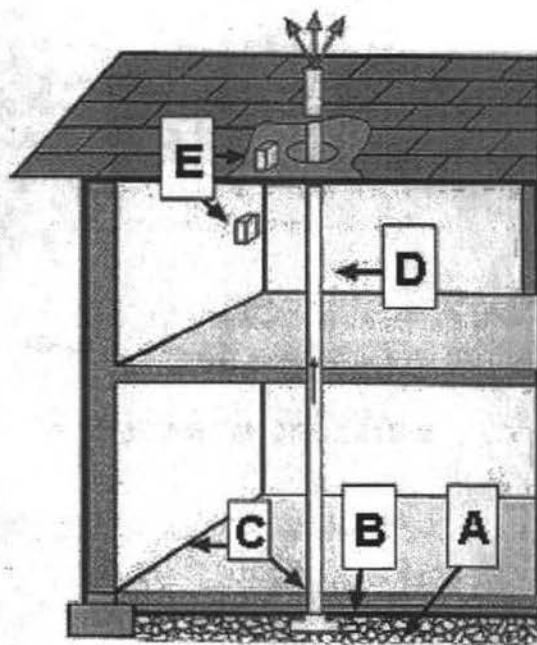
All openings in the concrete foundation floor are sealed to reduce soil gas entry into the home.

D. Vent Pipe

A three- or four-inch gas-tight or PVC pipe (commonly used for plumbing) runs from the gas-permeable layer through the house to the roof to safely vent radon and other soil gases above the house.

E. Junction Box

An electrical junction box is installed in case an electric venting fan is needed later.



Note that in high radon areas, special consideration should be taken to treat well water. Simple water treatments are available. For more information, call EPA's Drinking Water Hotline at (800) 426-4791, visit www.epa.gov/safewater/radon.html, or contact the state radon office.

Resources:

- 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 www.epa.gov/radon/zonemap.html
- HBA: EPA also recommends contacting your state radon representative. EPA has a list of contacts on its website at www.epa.gov/iaq/whereyoulive.html
- www.epa.gov/radon
- *Radon Resistant New Construction*—www.epa.gov/radon/construc.html
- 2000 IRC, Page 564, *Radon-resistant construction details for four foundation types*
- For Radon remediation, check www.toolbase.org/secondaryT.asp?TrackID=&CategoryID=1174



5.2.6 Verify all exhaust flows meet design specifications.

Intent:

Ensure all exhaust flows are operating as designed.

Information / How to Implement:

If ductwork is not properly sized and installed, fan flow may be restricted and not exhaust air at its rated capacity. For example, a fan rated at 50 CFM may exhaust only 35 CFM if duct runs are extremely long or if ductwork is kinked during installation. Without adequate fan capacity, moisture may not be properly removed. Size ducts according to the manufacturer's recommendation for diameter and maximum length. Fans should perform within 10% of their rated capacity. After installation, visually inspect the duct length, look for crimped or damaged ducts, check for missing parts, and ensure that connections are secure. A more accurate method of checking fan airflow is to use a flow hood or pitot tube and manometer. Ask the installer about methods of checking airflow.

Resources:

- ACCA Manual D www.cmhc-schl.gc.ca/en/burema/gesein/abhose/abhose_ce17.cfm
- Flow hood equipment—www.energyconservatory.com/products/products1.htm

5.3 MOISTURE MANAGEMENT (VAPOR, RAINWATER, PLUMBING, HVAC)

Intent:

Reduce risk of moisture accumulation, which can lead to deterioration of building products and potential mold problems.

Information / How to Implement:

See Resources section.

Resources:

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

5.3.1 Control bathroom exhaust fan with a timer or humidistat.

Intent:

Ensure that fans are operated in a manner that removes moisture without relying on input from the homeowner, and remove residual moisture from bathrooms after use.

Information / 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, especially timers or humidistats that remove residual humidity after a person leaves the bathroom, is an effective method for removing interior generated moisture at its source. Timers can also prevent unnecessary fan energy use that occurs when a fan is inadvertently left on.

Timers and humidistats are basically upgraded switches. They are wired in and mounted like a typical switch. Timers can typically be set to run from 10 to 60 minutes. Homeowners should be instructed to run 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% relative humidity. Timers and humidistats cost about \$25 and up. Bath fans are also available with integral humidistats and timers.

See Section 3.3.2 for information about energy-efficient exhaust fans.

Resources:

- <http://energyoutlet.com/res/fan/>
- 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*. www.toolbase.org/docs/MainNav/Energy/3947_spotventilation1.pdf (Sept 2004)

5.3.2 Install moisture resistant backerboard, not paper-faced sheathing, under tiled surfaces in wet areas.**Intent:**

Reduce the risk of problems if water penetrates tile surfaces in kitchens and baths.

Information / How to Implement:

A cement-based backerboard does not contain organic paper that can deteriorate, swell (potentially causing cracking in the grout), and be a substrate for mold growth when wet. Cement backerboard is resistant to the deleterious effects of moisture.

Resources:

Backerboard manufacturer Web sites for installation information (e.g., WonderBoard, Durock)
Tile Council of America, 2003-2004 Handbook for the Installation of Ceramic Tile, www.tileusa.com

5.3.3 Install vapor retarder directly under slab (6 mil) or on crawl-space floor (8 mil). In crawl spaces, extend poly up wall and affix with glue and furring strips, or damp-proof wall below grade. Joints should be lapped 12 inches.**Intent:**

Prevent moisture migration from the ground through wicking action (through slab) or by vapor movement (in crawl space).

Information / How to Implement:

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

Resources:

- Carter, Tim. *Vapor Retarders Will Stop Odors and Moisture*.
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.
www.holtonhomes.com/webcast_04_crawlspaces.pdf (Sept 2004)
- *Crawlspace Moisture Control*, fact sheet by Dominion Power,
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 Web site at www.eeba.org/mall/builder_guides.asp

5.3.4 Protect unused moisture-sensitive materials from water damage through just-in-time delivery, storing unused materials in a dry area, or tenting materials and storing them on a raised platform.**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.

Information / 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 will also allow water vapor to escape, such as by covering it with house-wrap (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 the weather, waste from warping, shrinking, and swelling can be avoided.

Resources:

- *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. www.toolbase.org/docs/ToolBaseTop/Research/3464_HelpingHomebuyersUnderstandMold.pdf (Sept 2004)
- *Proper Lumber Storage*, Southern Pine Council, www.southernpine.com/lumberstorage.shtml
- *Proper Storage and Handling of Glulam Beams*, APA—The Engineered Wood Association, www.apawood.org/pdfs/managed/R540.pdf
- *Storage and Handling of APA Trademarked Panels*, APA—The Engineered Wood Association, www.apawood.org/pdfs/managed/U450.pdf
- *Storage, Handling, and Safety Recommendations for APA Performance Rated I-Joists*, 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 Keep plumbing supply lines out of the exterior walls.

Intent:

Reduce the potential for condensation by keeping supply pipes in conditioned space, where pipes are not exposed to large temperature and humidity differentials. Also reduce the consequences of a potential plumbing leak, which could lead to wetting of structural members, insulation, and interior finishes.

Information / How to Implement:

Try to cluster bathrooms and other hot water uses, e.g., “stacked” bathrooms, to minimize the need for running supply lines on exterior walls. Water supply lines can be run through duct chases (designed for keeping ducts in conditioned space). 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).

Resources:

- *Builder's Guide to Placement of Ducts and HVAC Equipment in Conditioned Space*, 2000, NAHB Research Center. Available at 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 pipes in unconditioned spaces with insulation or other coating that comparably prevents condensation.

Intent:

Reduce the potential for condensation on cold water supply pipes located in unconditioned space by insulating the pipes. This guideline has more relevance in hot, humid climates where piping is more likely to be located in an unconditioned area. Cold water piping installed in crawl spaces can pose a condensation problem in colder regions during the summer months.

Information / How to Implement:

Foam insulation for insulating pipes is readily available and easy to install.

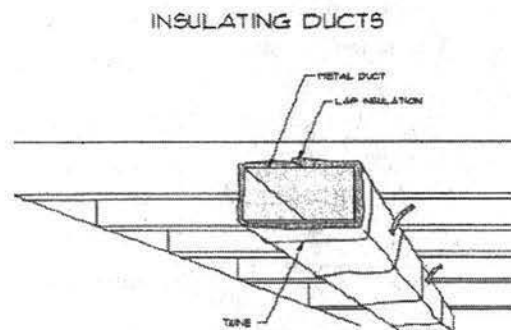
Resources:

- *Preventing and Thawing Frozen Pipes*. www.prepare.org/basic/frozen.htm (Sept 2004)
- Do It Yourself. www.diy.net.com/diy/diy_kits/article/0.2019.DIY_13787_2275412.00.html (Sept 2004)

5.3.7 Insulate HVAC ducts, plenums, and trunks in unconditioned basements and crawl spaces to avoid condensation.

Intent:

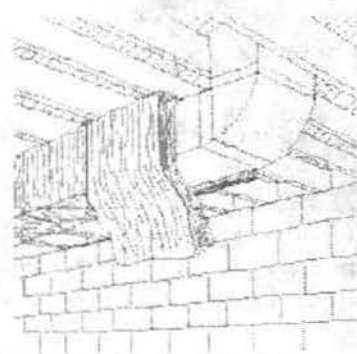
Prevent condensation on the outside of cold HVAC ducts located in unconditioned basements and crawl spaces that can lead to moisture problems in those areas.



Information / How to Implement:

www.mme.state.va.us/de/energybook/hbchap5.html

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



(Source: Reflectix)

Resources:

- Energy Outlet information on duct sealing, available at 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*. www.bobvila.com/ArticleLibrary/Subject/HVAC/Insulation/InsulatingDucts.html (Sept 2004)

5.3.8 Check moisture content of wood before enclosing on both sides. Ensure moisture content of subfloor/substrate meets the appropriate industry standard for the finish flooring material to be installed.

Intent:

Because wood's ability to dry is compromised when it is not 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.

Information / How to Implement:

Use a moisture meter (preferably a probe-type meter, which is more accurate than the scanning type) to measure the moisture content in the wood and wood subfloor. A sample of wood materials can be checked relatively quickly before installing finish materials.

For hardwood flooring over a truss or joist system, the average moisture content of framing members and subflooring should be below 12% to 14% before delivery of the flooring.

When installing flooring over a concrete slab, testing a concrete slab requires use of a calcium chloride test; the test should show a moisture content of three pounds or less (if no moisture retarder is installed) and four to seven pounds (if a moisture retarder is installed). Per the National Wood Flooring Association's guidelines, wood flooring should not be installed over concrete with readings exceeding seven pounds calcium chloride. Use a surface moisture meter, and perform a calcium chloride test to measure moisture in a concrete slab/subfloor.

Resources:

- National Wood Flooring Association, Hardwood Flooring Installation Guidelines, www.nwfa.org.
- The Wood Flooring Manufacturer's Association, Installing Hardwood Flooring, www.nofma.org/installation1.htm
- Electric Moisture Meters, ToolBase Services fact sheet, available at www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2120&CategoryID=1013 Golden, J.A., 1998, Moisture Testing Guide for Wood Frame Construction Clad with Exterior Insulation and Finish Systems, p. 7-8. Available at www.toolbase.org/docs/MainNav/MoistureandLeaks/876_protocol5A.pdf
- Computing Moisture Content of Wood. www.woodbin.com/ref/wood/emc.htm (Sept 2004)
- EPA Moisture Content Calculation. www.epa.gov/athens/learn2model/part-two/onsite/mc.htm (Sept 2004)

5.4 INNOVATIVE OPTIONS

Information will be added in Version 2.

Ensure that homeowners are aware of the green features of their new home, know how to operate and maintain the home to achieve the highest level of environmental performance, and have a resource for warranty issues.

6.1 PROVIDE MANUAL TO OWNERS/OCCUPANTS ON THE USE AND CARE OF THE HOME THAT INCLUDES ALL OF THE ITEMS BELOW

- A. Narrative detailing the importance of maintenance and operation to keep a green-built home green.
- B. Local Green Building Program's certificate.
- C. Warranty, operation, and maintenance instructions for equipment and appliances.
- D. Household recycling opportunities.
- E. Information on how to enroll in a program for purchasing energy from a renewable energy provider.
- F. Explanation of the benefits of using compact fluorescent light bulbs in high usage areas.
- G. List of habits/actions to optimize water and energy use.
- H. Local transportation options.
- I. Clear labeling of safety valves and controls for major house systems.

Intent:

Help homeowners to "live green" in their green-built home.

Information / 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 whether the local Green Building Program offers a sample Green Homeowner's Manual.

Resources:

- Fannie Mae, *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 www.toolbase.org (click on "Green Building").
- Various manufacturers
- City, county, or township recycling information
- U.S. DOE's Green Power Network: www.eere.energy.gov/greenpower/
- Lighting energy savings calculator at www.goodmart.com/light_bulb_energy_saving_calculator.aspx
- Water-saving tips at www.h2ouse.org. Energy-Saving tips: www.eere.energy.gov/consumerinfo/energy_savers/ and www.aceee.org/consumerguide/chklst.htm
- Metropolitan-area, city, county, township, or private public transit information (usually listed in the front of the phone book)
- *Homeowner's Manual—At last, an owner's manual for your new home*. By CMHC. www.cmhc-schl.gc.ca/en/bureho/buho/buho_002.cfm (Sept 2004)
- National Environmental Services Center. www.nesc.wvu.edu/nsfc/NewReleases/nsfc_NR_11_14_03.htm (Sept 2004)

- Community Associations Institute, www.caionline.org/about/homeowner_education.cfm (Sept 2004)
- Massachusetts Housing Partnership, www.mhp.net/homeownership/education.php (Sept 2004)
- How-To Publications by Family Resource Management, College of Agriculture & Home Economics. 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: www.seismic.ca.gov/pub/CSSC_2002-04_HOG.pdf (Sept 2004)
- For fire prevention: www.ofm.gov.on.ca/english/FirePrevention/FireSmart%20Communities/pdf/User%20guide.pdf (Sept 2004)
- For soil-lead hazard: www.epa.gov/region01/leadsafe/pdf/chapter8.pdf (Sept 2004)
- For septic system by University of Minnesota Extension Service: 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:
www.healthgoods.com/Education/Healthy_Home_Information/Space_Heating_and_Cooling/sizing_heat_and_ac.htm (Sept 2004)

6.2 OPTIONAL ITEMS TO INCLUDE IN THE HOME MANUAL (CHOOSE AT LEAST FIVE)

- List of local service providers that focus on regularly scheduled maintenance and proper operation of equipment and the structure (sealants, caulks, gutter and downspout system; shower/tub surrounds, irrigation systems, etc.).
- Photo record of framing showing utilities installed. Photos should be taken prior to installing insulation, clearly marked, and provided in homeowner's manual.
- List of the Green Building Guideline items that are included in the home.
- User-friendly maintenance checklist.
- Instructions for proper handling and disposal of hazardous materials.
- Information on organic pest control, fertilizers, de-icers, and environmental cleaning products.
- Maintenance instructions for native or low-water landscape.
- Information on how to keep a home's relative humidity in the range of 30% to 60%.
- Information about checking crawl space for termite tubes periodically.
- Instructions for keeping gutters clean. Information should note that downspouts should divert water at least five feet away from foundation.

Intent:

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

Information / How to Implement:

Provide above information in the homeowner's manual.

Resources:

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

- Local Green Building Checklist or other documents
- EPA document: www.epa.gov/epaoswer/non-hw/household/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. The county or state may have Cooperative Extension fact sheets geared toward your municipality (see, for example, 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, www.uky.edu/Agriculture/Entomology/entfacts/struct/ef604.htm.

6.3 PROVIDE EDUCATION TO OWNERS/OCCUPANTS IN THE USE AND CARE OF THEIR DWELLINGS

- A. 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.

Intent:

During the walk-through, demonstrate how to control all the mechanical systems in the home. Demonstrate how to use all controls such as thermostats, lighting controls, and fan controls.

Resources:

- National Association of Home Builders, *Your New Home and How to Take Care of It*. Washington, DC: BuilderBooks, 2001, 60 pages Provide homeowners 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.
- www.builderbooks.com, 800-223-2665
- Manuals from manufacturers for reference.

6.4 SOLID WASTE

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

Intent:

Make it convenient to recycle.

Information / How to Implement:

Include a recycling center in or near the kitchen under the sink, in an island near the sink, or in a pantry. Credit is also given in this line item for an in-counter compost bin.

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 other typical under-sink items.

Resources:

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

6.5 INNOVATIVE OPTIONS

Information will be added in Version 2.

7.1 PRODUCTS

7.1.1 Manufacturers' operations and business practices include environmental management system concepts (the product line, plant, or company must be ISO 14001 certified).

Intent:

Use products that come from organizations that have taken the time and resources to create an environmental management system (EMS) that conforms to the ISO 14001 standard.

Information / How to Implement:

See Resources section.

Resources:

- U.S. EPA Position Statement on Environmental Management Systems (EMS), www.mswg.org/USEPAPS/EMSposState.pdf

7.1.2 Choose low- or no-VOC indoor paints. VOC concentrations (grams/liter) of interior paints should be equal to or less than those specified by the EPA's Environmentally Preferable Purchasing Program as follows:

A. Interior latex coatings: Flat: 100 grams/liter

B. Non-flat: 150 grams/liter

C. Interior oil-based paints: 380 grams/liter

Intent:

Reduce the amount of volatile organic compounds (VOCs) released to the outdoors and to reduce the formation of ground-level ozone.

Information / How to Implement:

VOC content of paints is categorized under Global Impacts rather than Indoor Environmental Quality because, once a homeowner moves into a new home, the vast majority of VOCs in paints have been released to the atmosphere and are thus not a significant impact on indoor environmental quality.

Although emissions of VOCs from paints can negatively affect indoor air, the half-life of VOCs in paints is usually shorter than the time between painting and homeowner occupancy. For example, paints cure and finish off-gassing in approximately four days; a home buyer typically occupies a home two to four weeks after painting.

Although the builder's paint isn't a big indoor pollutant, homeowners can be informed about the use of low-VOC-emitting paints when repainting the home in the future. There are paints certified as low-VOC emitting that are certified through GREENGUARD—an independent air-quality certification organization.

Note that low-VOC-content paints are not the same as low-VOC-emitting paints. The U.S. EPA established low-VOC-content standards based on a set of ozone-forming chemicals; these standards do not take into account the many other potentially hazardous chemicals found in indoor paint.

Low-VOC-content paints are widely available; by choosing them you contribute to a healthier environment. Check the label on the paint can for the VOC content.

Resources:

- Green Seal certifies low-content paints: www.greenseal.org/certproducts.htm#paints
- The GREENGUARD Environmental Institute (GEI) provides a guide to third-party-certified low-VOC-emitting interior products and building materials, www.greenguard.org
- Master Painters Institute, www.paintinfo.com
- National Paints and Coatings Association (NPCA), www.paint.org
- EPA's Environmentally Preferable Purchasing Guide, www.epa.gov/oppt/epp/documents/pfs.htm (Sept 2004)



7.1.3 Use low-VOC sealants. VOC concentrations for construction adhesives and sealants should meet the limits specified in the California Air Resources Board Regulation for Reducing Volatile Organic Compound Emissions from Consumer Products as outlined below.

- A. Construction adhesives: the greater of 15% by weight or 200 grams/liter
- B. Sealants and caulks: the greater of 4% by weight or 60 grams/liter
- C. Contact adhesives: the greater of 80% by weight or 650 grams/liter

Intent:

Use low-VOC sealants to reduce potentially harmful VOCs from being emitted into the environment.

Information / How to Implement:

Note that, like low-VOC-content paints, low-VOC-content sealants are not the same as low-VOC-emissions. The California Air and Resources Board created low-VOC-content standards based on a set of ozone-causing chemicals. Also, VOC content does not directly equate to VOC emissions. In addition, VOC emission rates and times are greatly affected by temperature, humidity, age, and other factors.

Resources:

- www.arb.ca.gov/consprod/consprod.htm
- California Air Resources Board, www.arb.ca.gov/consprod/regs/Cpreg.doc (Sept 2004)

7.2 INNOVATIVE OPTIONS

7.2.1 Builder's operations and business practices include environmental management system concepts (the builder must be ISO 14001 certified)

Intent:

Institutionalize and consistently apply the concept of incorporating environmental considerations into all phases of the company's operations.

Information / How to Implement:

At the time this document was created, there was only one ISO 14001 certified builder in the United States: Skanska USA.

You may be familiar with the 9000 series of international standards regarding quality management systems (QMS). As a continuation of this standardization process, the ISO 14000 series of international standards have been developed for environmental management systems (EMS).

In September 1996, the International Organization for Standardization (ISO) finalized the ISO 14001 standard for environmental management systems.

Similar to the QMS implemented for ISO 9001, the ISO14001 requires implementation of an EMS in accordance with defined, internationally recognized standards as set forth in the ISO14001 specification. The standard specifies requirements for establishing an environmental policy, determining environmental aspects and impacts of products/activities/services, planning environmental objectives and measurable targets, implementation and operation of programs to meet objectives and targets, checking and corrective action, and management review.

ISO14001 standards require a company to document and make this policy available to the public. In addition, the company must review the environmental aspects and impacts of products and then create and implement procedures to reduce them. The process of creating an EMS can help a company better understand how it affects the environment through all of its business processes.

Resources:

- Skanska USA's EMS information can be found at its website under Management Systems, www.skanska.com/
- The ISO 14001 Information Center provides information on the EMS at <http://www.iso14000.com>.

1.0 IDENTIFY GOALS WITH YOUR TEAM

Establish a knowledgeable team, and communicate in writing.

Intent:

One of the earliest challenges for a builder in developing a green lot is assembling an effective team to help implement best green practices throughout the process. Those involved in the development phase must understand the mission of the site, what it means to be a green lot, and why green practices should be followed. Once this baseline is established, coordination and communication with and among the various team members are essential to successful development.

Information / How to Implement:

Before ground is broken, all parties involved in lot development (the team) should understand that the lot will be developed as a green site. Team members can include staff, site superintendents, utilities, excavators, landscape architects, wildlife biologists, ecologists, and arborists. 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 team members, as well as facilitate coordination between the members to achieve best green practices.

Resources:

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

Establish a green development mission statement.

Intent:

Communicate relevant, streamlined green goals into the field to ensure that they are put into practice

Information / How to Implement:

Post the mission statement for all project personnel to see.

Resources:

Information will be added in Version 2.

Identify goals and objectives.

Intent:

Those involved in the development phase must understand the site's goals and objectives, what it means to be a green development, and why they should follow green practices.

Information / How to Implement:

Information will be added in Version 2.

Resources:

Information will be added in Version 2.

Identify team member roles and how they relate to various phases of development.

Intent:

Before ground is broken, all parties involved in lot development (the team) should understand that the lot will be developed as a green site.

Information / How to Implement:

Examples of possible team members include staff, site superintendents, utilities, excavators, landscape architects, wildlife biologists, ecologists, and arborists.

Resources:

Information will be added in Version 2.

Provide training to onsite supervisors and team members on the green development practices that will be instituted onsite.

Intent:

The noblest intentions pursued in designing a site are practically achieved through onsite supervision during the lot development phase. A qualified member(s) of the builder's team should be onsite as these activities progress to ensure that each objective is achieved according to targeted green lot specifications.

Information / How to Implement:

Information will be added in Version 2.

Resources:

Information will be added in Version 2.

Create a checklist to be completed onsite that contains only those targeted green development practices that will be implemented in the project.

Intent:

A qualified member(s) of the builder's team should be onsite as these activities progress to ensure that each objective is achieved according to targeted green lot specifications. A checklist will facilitate the process of tracking progress.

Information / How to Implement:

Information will be added in Version 2.

Resources:

Information will be added in Version 2.

2.0 SELECT THE SITE

Select the site to minimize environmental impact.

Avoid environmentally sensitive areas as identified through site footprinting process or third party.

Intent:

Thoughtful site selection can be the first step in 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. If a site is selected that at any time has been identified as an environmentally sensitive area, no credit will be given for this line item, regardless of the site's classification at the time of construction.

Information / 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 environmental 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.

Resources:

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

Choose an infill site.

Intent:

Remediation of a brownfield results in the environmental restoration of a polluted site, a transformation that makes an abandoned site habitable. Like greyfield and infill development, brownfield development provides an efficient use of land and infrastructure while allowing for the preservation of open space and wildlife habitat in the midst of growth.

Information / How to Implement:

The U.S. Environmental Protection Agency (EPA) 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." The EPA estimates that there are 450,000 brownfield sites around the country. Grants, loans, and training are available through the EPA's Brownfield Initiative to assist builders and developers in the remediation and development of Brownfield sites.

Resources:

- U.S. EPA, *Brownfields Cleanup and Redevelopment*: www.epa.gov/Brownfields/index.html
- U.S. EPA 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 and provide access to information about cleanup grants—www.epa.gov/Brownfields/bfwhere.htm

Choose a Greyfield site.

Intent:

Redevelopment of a greyfield site can provide an efficient use of land and infrastructure. Greyfield redevelopment allows for the preservation of open space and wildlife habitat in the midst of growth.

Information / How to Implement:

Within these guidelines, a greyfield is defined as "any site previously developed with at least 50% of the surface area covered with impervious material." The development of a greyfield site can be daunting, but local or national incentives

may exist to reward builders who go through the process. Incentives may include the elimination of development-related fees, contribution from the local government in the development of offsite improvements, and tax breaks. For more information, see Resources.

Resources:

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

Choose an infill site.

Intent:

Building on an infill site can effectively conserve resources (e.g., infrastructure) and preserve open space that could be lost from “green field” development.

Information/ 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.

Resources:

- Policy Link, Equitable Development Toolkit, Infill Incentives, www.policylink.org/EDTK/Infill
- Northeast-Midwest Institute and Congress for the New Urbanism, *Strategies for Successful Infill Development* (2001), www.nemw.org/infillbook.htm

3.0 DESIGN THE SITE

Minimize environmental impacts; protect, enhance, and restore the natural features and environmental quality of the site.

Conserve natural resources.

1. Complete a natural resources inventory that is used to drive/create the site plan.
2. Create a protection and maintenance plan for priority natural resources/areas during construction. (*See Section 4 for guidance in forming the plan.*)
3. Locate roads, buildings, and other built features to conserve high-priority vegetation.
4. Participate in a natural resources conservation program.

Intent:

Onsite natural resources concern features such 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. A builder can identify high-priority resources for conservation (e.g., trees, waterways, snags, micro-habitats) and plan for the conservation of those resources during each stage of site development.

Information / 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 invasive from regionally appropriate vegetation, understand how to site a house to take advantage of solar energy, be able to identify areas important to wildlife habitat, and understand how natural features can be used in managing storm water onsite.

A protection and maintenance plan should be drafted to detail how resources identified through the inventory will be protected throughout development. Section 4 of this module provides details on how to protect existing onsite vegetation and minimize soil disturbance and erosion through installation of fencing, identification of specified washout and material storage areas, laying of mulch to reduce soil compaction, and other means. In addition to protecting priority areas from invasive species 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 as needed before, during, and after development.

One way to verify that the plan is implemented as planned is to create construction documents that explain how to implement the plan during construction.

Resources:

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

Orient streets and configure lots to allow for the majority of homes to optimize solar potential (see the Energy Efficiency module for guidance on solar resource optimization).**Intent:**

Thoughtful orientation of a home can maximize solar heating potential in the heating season and minimize solar gains in the cooling season. By reducing non-renewable energy needs, orienting a home to optimize the solar resource reduces the life-cycle pollution caused by a home.

Information / How to Implement:

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

Resources:

See Section 3.4 of this User Guide for resources.

Minimize slope disturbance.

1. Limit development footprint on steep slopes (slopes greater than or equal to 25%).
2. Complete a hydrological/soil stability study for steep slopes, and use this study to guide the design of all structures onsite.
3. Align roads with natural topography to minimize grade to reduce cut and fill.
4. Reduce long-term erosion effects through the design and implementation of terracing, retaining walls, and re-stabilization techniques.

Intent:

Leaving a slope undisturbed when siting a home reduces the chances of disturbing natural hydrological drainage and causing long- and short-term erosion, thereby reducing the potential to pollute water sources and damage local ecology.

Information/ How to Implement:

Within these guidelines, steep slopes are defined as being greater than or equal to 25%. Note: Points should be awarded only 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 offsite.

Resources:

- Prince George's County, Maryland, Department of Environmental Resources, *Low-Impact Development Design Strategies: An Integrated Design Approach* (EPA 841-B-00-003) (Largo, MD: June 1999), www.epa.gov/owow/nps/lid/lidnatl.pdf

Minimize soil disturbance and erosion.

1. Phase development in order to minimize exposed soils.
2. Use alternative means to install utilities, such as tunneling instead of trenching. Use smaller equipment, shared trenches or easements, and place utilities under streets instead of yards.

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. Minimizing soil disturbance and erosion can both reduce stressors on downstream water bodies and save valuable topsoil for the site.

Information/ How to Implement:

NAHB's *Storm Water Permitting: A Guide for Builders and Developers* contains information about the federal Phase I and II stormwater permitting program and the equivalent requirements for state storm water permits (see Resources section). *Storm Water Permitting* also contains technical information, including recommendations for use and cost estimates, on over 50 of the most commonly used best management practices; sample storm water pollution prevention plans; and tips on compliance, including how to handle visits from inspectors.

Methods for preventing erosion include silt fences, sediment traps, vegetated buffer areas, and mulching. More permanent solutions include biomechanical devices such as swales and vegetated buffers. Another highly effective, environmentally responsible method to prevent erosion is to use compost filter berms, compost erosion socks, and/or surface application of compost erosion control. The compost should be from organic sources like bioshields, yard waste, and wood chips. Turf and plant material—which help to facilitate the reestablishment of a natural environment—are established more quickly when organic compost is used.

Resources:

- National Association of Home Builders (NAHB), *Storm Water Permitting: A Guide for Builders and Developers*, 2005, 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](http://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), www.arborday.org/shopping/merchandise/merchdetail.cfm?id=62

Manage storm water properly.

1. Direct storm water to a locally approved regional storm water management and treatment facility that has been designed to address water quality.
2. Preserve and utilize natural water and drainage features.
3. Develop and implement storm water management plans that minimize concentrated flows and seek to mimic natural hydrology.
4. Minimize impervious surfaces, and utilize permeable materials for
 - a. Parking areas
 - b. Walkways
5. Minimize street widths and rights-of-way as per recommendations in either local code or in Residential Streets, 3rd Edition:
 - a. No on-street parking: 18 feet
 - b. Parking on one side: 22 to 24 feet
 - c. Parking on both sides: 24 to 26 feet

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 offsite while safely and effectively managing much of their storm water load onsite.

Information / How to Implement:

Use open space and natural systems such as vegetative swales, french drains, wetlands, dry wells, and rain gardens that promote water quality and infiltration.

Resources:

- The Practice of Low Impact Development, U.S. Department of Housing and Urban Development (HUD); www.huduser.org/publications/destech/lowimpactdevl.html
- Tom Schueler, Center for Watershed Protection, *Site Planning for Urban Stream Protection*, Ellicott City, MD, 1995, 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, 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

Where municipal sewage is not available, use an advanced wastewater system as an alternative to the conventional septic system and drain field. Examples include sand/media filters and aerobic treatment units.

Intent:

Refer to the Water Efficiency section of the User Guide for details on this topic.

Information / How to Implement:

Information will be added in Version 2.

Resources:

Information will be added in Version 2.

Devise landscape plans to limit water demand while preserving or enhancing the natural environment.

1. Formulate a plan to restore or enhance natural vegetation that is cleared during construction or development. Within this plan, phase landscaping to ensure denuded areas are quickly vegetated.
2. Select turf grass and other vegetation that are native or regionally appropriate species.
3. Limit turf areas of landscaped area, selecting native and regionally appropriate trees and vegetation in a way that complements the natural setting.
4. Group plants with similar watering needs (hydrozoning).
5. Specify planting of trees to increase site shading and moderate temperatures (see also Energy Efficiency Guideline 3.3.5.1 specifying siting of trees to reduce the energy consumption of the home).
6. Require onsite tree trimmings of regionally appropriate species to be used as protective mulch during construction or as a base for walking trails.
7. Establish an integrated pest management plan to minimize chemical use in pesticides and fertilizers.

Intent:

Landscaping water use accounts for approximately 50% of a home's total water 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.

Information / 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. Other benefits of landscaping with native plants: minimizes maintenance (reduces emissions of equipment); fosters wildlife habitat. See EPA's Mid-Atlantic Region Green Landscaping <http://www.epa.gov/reg3esd1/garden/what.htm> for more information...

When planning for the revegetation of a site, consider the multiple services that natural areas can provide: natural habitat, storm water processing, shading, windbreak, etc. Trees that shade the streets can keep a neighborhood cool while also increasing the neighborhood's attractiveness. Properly selected plants can be grouped to serve as a bioretention zone. Deciduous trees allow the sun's rays through in winter and provide shade in the summer. Evergreens can provide an effective windbreak. Careful selection and integration of trees and vegetation can reduce a developer's initial costs while providing value to a development/neighborhood later. When planting trees, several factors should be taken into account such as the value of shading (trees shading asphalt will mitigate a site's temperature more than trees shading landscaped areas), maintaining a safe distance from the house (especially in areas prone to natural disasters), ultimate tree size, etc.

Developers may wish to consider enforcing guidelines for the protection of onsite vegetation. Some developers even fine builders for damage to areas designated for protection.

If grinding and scattering cleared plants, care should be taken to grind only regionally appropriate plants. Grinding of invasive species can increase their propagation and result in the ultimate destruction of native species.

One of the best ways to reduce energy consumption is through passive solar design of a home—using orientation, overhangs, fenestration, etc. Landscaping to reduce energy consumption is only part of the whole effort.

It is good practice to limit the ratio of turf area to total landscaped area due to maintenance requirements of turf versus native plants and regionally appropriate vegetation. In some areas, there may be restrictions on the percentage of turf that the front yard must contain. 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 there. For research on turf and landscape of front yards with native species, see Nassauer, Joan, 1995. Messy Ecosystems, Orderly Frames. *Landscape Journal*, 14 (2), 161-170.

In areas with low annual rainfall, one way to account for water usage is through the development and implementation of a water budget.

Resources:

- Center for Plant Conservation, www.mobot.org/CPC
- Lady Bird Johnson Wildflower Center, Native Plant Information Network National Suppliers Directory, www.wildflower2.org/NPIN/Suppliers/suppliers.html
- New England Wildflower Society, *Native Plant Societies of the United States and Canada*, www.newfs.org/nps.htm
- NAHB Research Center Inc., Onsite Grinding of Residential Construction Debris: The Indiana Grinder Pilot, February 1999

Maintain wildlife habitat.

1. Preserve open space as wildlife corridors where possible.
2. Submit evidence of wildlife habitat preservation and improvements to the green development guidelines' administrator for review.
3. Participate in a wildlife conservation program.

Intent:

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.

Information / How to Implement:

Examples of programs: USDA National Resources Conservation Service's Backyard Conservation Plan, the Audubon Cooperative Sanctuary System's Treasuring Home Initiative, 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's left for habitat). Birdhouses.

Resources:

- Audubon International, *Audubon Cooperative Sanctuary System*, 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>

Prepare operation and maintenance plan (manual) for transfer of common open spaces, utilities (storm water, wastewater), and environmental management.

Intent:

Green land use features often require ongoing maintenance so that they can continue to function as designed. Planning for such operations and maintenance prior to implementing the features is important and can help the long-term viability of such features.

Information/ How to Implement:

Many manufacturers and distributors of green land use features and technologies also sell annual and/or long-term maintenance plans. Ask the manufacturers and/or distributors of the particular technology you're planning on implementing for such a service plan.

Resources:

Information will be added in Version 2.

Disassemble existing buildings, and reuse or recycle the building materials (deconstruction) instead of demolishing.

Intent:

See the Resource Efficiency section for details on this topic.

Information/ How to Implement:

Information will be added in Version 2.

Resources:

Information will be added in Version 2.

4.0 DEVELOP THE SITE

Minimize environmental intrusion during onsite construction.

Provide onsite supervision and coordination during clearing, grading, trenching, paving, and installation of utilities to ensure that targeted green development practices are implemented.

Intent:

The noblest intentions when designing a green site are practically achieved through onsite supervision during the lot development phase. A qualified member(s) of the builder's team should be onsite as these activities progress to ensure that each objective is achieved according to targeted green lot specifications.

Information/ How to Implement:

The information for this line item should link to the plans and any documents produced in line item 1.3.5.

Resources:

Information will be added in Version 2.

Conserve existing onsite vegetation.

1. Provide basic training in tree and other natural resource protection to onsite supervisor.
2. 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.

3. Prepare designated existing trees and vegetation for the impacts of construction through pruning, root pruning, fertilizing, and watering.
4. Improve the soil with organic amendments and mulch.

Intent:

After a builder has identified (during the planning stage) the existing vegetation that will be conserved onsite, practical steps must be taken during the development stage to achieve the intended conservation. Such steps include pre-development preparation of the vegetation and protection of the foliage, soil, and root system of designated vegetation.

Information / How to Implement:

See Resources section.

Resources:

- National Arbor Foundation, *Building With Trees*, www.arborday.org/programs/Buildingwithtrees/index.cfm
- Phillip A. Pratt and Michael W. Schnelle, Oklahoma State University, Oklahoma Cooperative Extension Service, *Site Disturbance and Tree Decline* (OSU Extension Facts F-6429), September 2003, <http://osueextra.com/pdfs/F-6429web.pdf>

Minimize onsite soil disturbance and erosion.

1. Demarcate limits of clearing and grading.
2. Create construction “no disturbance” zones using fencing or flagging to protect vegetation and sensitive areas from construction vehicles, material storage, and washout.
3. Install and maintain sediment and erosion controls.
4. Stockpile and cover good soil for later use.
5. Reduce soil compaction from construction equipment by laying mulch, chipped wood, or plywood sheets.
6. Stabilize disturbed areas within the 14-day period recommended by EPA.

Intent:

This guideline seeks to ensure the field implementation of conservation plans. Each measure identifies a practical way to foster water quality and conserve onsite ecological habitat through reducing soil disturbance and erosion.

Information / How to Implement:

Soil stabilization may be temporary or permanent.

Keep in mind that while the use of stockpiled onsite soil is a preferred method, excavation, stockpiling, grinding, and screening destroy the ecological microsystem of the soil. Rejuvenation of the unimproved soil to its original form will take several years. To offset this phenomenon, the incorporation of compost and sand is an effective method for more rapidly rebuilding the structure and ecosystem of the topsoil and allowing turf and plants to establish more quickly. As indicated above, compost is recommended for this purpose.

When additional soil must be brought in, there are environmental advantages of using industrial by-products as ingredients in topsoil including foundry sand, biosolids compost, and other EPA-approved by-products. In addition to keeping these materials out of community landfills, processing techniques produce superior topsoil.

The use of organic mulch is an excellent way to conserve water in landscape beds and build soil quality. Ideally, use mulch that results from onsite recycling efforts such as yard waste, processed pallets, and other clean wood from construction waste.

Resources:

- 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>

5.0 INNOVATIVE OPTIONS

Seek to obtain waivers or variances from local development regulations to enhance green building.

Cluster development to preserve meaningful open space.

Intent:

Preserve meaningful open space, and reduce infrastructure and long-term maintenance costs.

Information / How to Implement:

During the past 50 years, a steady migration from urban to suburban areas and into the countryside has constituted a significant trend throughout much of the United States. In response to this phenomenon, planners, developers, and elected officials have created a number of tools designed to balance growth with the preservation of community environmental and financial assets. One tool that has received an increasing amount of attention lately is cluster development. This approach may be termed open-space development, conservation development, hamlet style, farm village, or other unique names coined by proponents and developers. Regardless of the title used to describe it, cluster development is an important tool community planners should consider as they look to the future. The purpose of this fact sheet is to describe cluster development, its history, potential, and limitations.

Resources:

- U.S. Environmental Protection Agency, Development, Community, and Environment Division, *Our Built and Natural Environments* (EPA 231-R-01-002) (Washington, DC: 2001), www.epa.gov/smartgrowth/pdf/built.pdf
- Urban Land Institute, www.uli.org/DK/index.cfm?CFID=526893&CFTOKEN=67483350

Reduce street widths.**Intent:**

Reduce the amount of impervious surface and storm water runoff in the development.

Information / How to Implement:

Street widths have the largest impact on runoff and on costs. Unfortunately, most communities have ordinances requiring excessively wide streets. Developers may be able to negotiate changes for a particular development but will likely have to seek changes to local land development standards to change street-width requirements more generally. The publication, *Proposed Model Land Development Standards and Accompanying Model State Enabling Legislation* (HUD and NAHB Research Center, 1993), includes recommendations for minimum street widths that recognize the cost and environmental benefits of narrower versus wider streets (see below) and other cost-effective development strategies. It also includes recommendations for turnarounds, another location where the pavement area can be reduced.

Recommendations for Minimum Street Widths

Widths of Traveled Way

Minimum Width of Traveled Way (ft.)

Street Type	Both On- and Off-Street Parking (1)	One-Way Street (2)
Major Collector	20 (3)	10
Collector	36 (4)	26
Subcollector	26–28 (4, 5)	26
Access	18–22 (5) ^p	18

Where no off-street parking is provided, the minimum width of traveled way for collector streets shall be 36 feet, and 34 feet for subcollector and access streets (two 9- or 10-foot travel lanes and two 8-foot parking lanes). Major collectors do not typically accommodate on-street parking. Access street width can be reduced to 26 feet if parking needs are met on one side of the street and restricted to that side only.

Where on-street parking is not permitted, the one-way street width may be reduced to 10 feet.

Parking is not allowed on major collector streets. Travel lanes may be added in accordance with traffic requirements.

Width can be reduced to 20 feet if on-street parking is not permitted.

Minimum street width shall be selected by taking into consideration the size of fire and emergency equipment that will serve the development.

Resources:

- Better Site Design Fact Sheet: Narrower Residential Streets, www.stormwatercenter.net/Assorted%20Fact%20Sheets/Tool4_Site_Design/narrow_streets.htm

Install an advanced wastewater treatment system.

Intent:

See the Water Efficiency section of the User Guide for more details on this topic.

Information / How to Implement:

Information will be added in Version 2.

Resources:

Information will be added in Version 2.

Install an advanced storm water treatment system.

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 offsite while safely and effectively managing much of their storm water load onsite.

Information / How to Implement:

This line item would be over and above what is done for line item 1.3.5. Use open space and natural systems such as vegetative swales, french drains, wetlands, dry wells, and rain gardens that promote water quality and infiltration.

Resources:

- *The Practice of Low Impact Development*, U.S. Department of Housing and Urban Development (HUD); www.huduser.org/publications/destech/lowimpactdevl.html
- Tom Schueler, Center for Watershed Protection, *Site Planning for Urban Stream Protection* (Ellicott City, MD: 1995), 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)

Institute wildlife habitat measures.

Intent:

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.

Information / How to Implement:

Examples of programs include the USDA National Resources Conservation Services Backyard Conservation Plan, the Audubon Cooperative Sanctuary System's Treasuring Home Initiative, and 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's left for habitat).

Resources:

- Audubon International, *Audubon Cooperative Sanctuary System*, 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>

Minimize grading.

Intent:

Excessive grading can disturb a site's natural drainage, vegetation, and ecological habitat. If topsoil removed during grading is not replaced, the health of the site's future ecological system may be compromised as well.

Information / How to Implement:

Information will be added in Version 2.

Resources:

Information will be added in Version 2.

Share driveways or parking**Intent:**

Sharing driveways or parking can reduce the amount of impervious material on a lot, thereby decreasing storm water and pollution runoff.

Information / How to Implement:

Information will be added in Version 2.

Resources:

Information will be added in Version 2.

Other (specify).

Information will be added in Version 2.