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Guide for Green Residential Construction In Florida

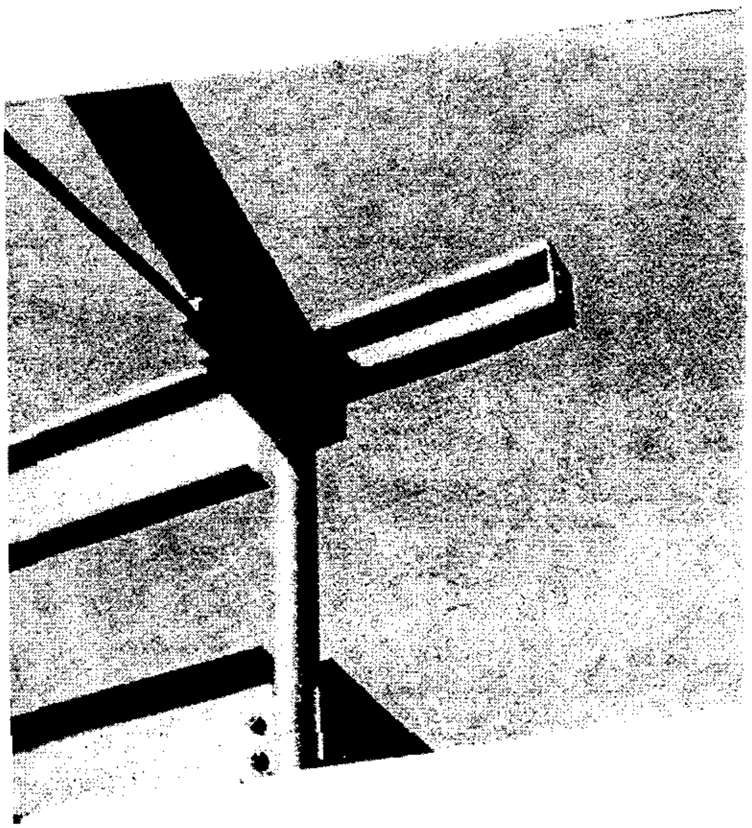

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TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 8

LIST OF TABLES

CHAPTER 8

CHAPTER 9

CHAPTER 1 INTRODUCTION

DEFINITION OF GREEN CONSTRUCTION

Green Construction is developing and building in an environmentally responsible manner. The goal of Green Construction is to produce buildings that are energy and resource efficient, healthy, environmentally sensitive, and economical. Green building principles take into consideration the life cycle of the structure, which involves selecting construction techniques and building materials that will ultimately provide the best performance over the entire life of the building. The objectives and potential benefits of Green Construction are generalized in Tables 1.1 and 1.2.

Table 1.1 Objectives of Green Construction

OBJECTIVES	CHAPTER
Minimize materials and energy consumption	
☞ Select materials for resource and energy efficiency	7
☞ Design for efficient use of materials	7
☞ Reduce energy consumption	4
Minimize pollution and environmental releases	
☞ Material Selection	7
☞ Construction Process	7,8
Protect the ecological (natural) environment	
☞ Site layout	2
☞ Protection of site during the construction process	8
Create a healthy, comfortable, non-hazardous space	
☞ Indoor Environmental Quality	6
Incorporate interior quality, function and performance consistent with the objective of the building	
☞ Passive Design	3
☞ Material Selection	7

HOW TO USE THIS MANUAL

Immediately following this page is a general Green Building Checklist titled Important Issues for Green Construction. This checklist is a brief overview of considerations for Green building.

Each of these issues are further discussed in the text of the corresponding chapters

Wherever possible, lists of important issues are provided. A summary of these lists follows the "Important Issues for Green Construction".

Boxed or bulleted information is used to identify important facts or issues

Shaded boxes indicate Case Studies.

<u>General Bullet Key:</u>

Bulleted information is currently in 3 forms.

✓ Indicates a checklist when in a table titled List
☞ Indicates an important point or issue
✋ Indicated a Caution

In CHAPTER 7, Construction Materials and Techniques
✓ Indicates a positive attribute
✋ Indicates a negative attribute

IMPORTANT ISSUES FOR GREEN CONSTRUCTION

Site Analysis and Building Placement (CHAPTER 2)

1. Consider environmental impacts of site location if you have control over selecting your site
2. Perform a detailed site analysis to identify prominent features such as existing vegetation for preservation and protection.
3. Existing natural features should determine building placement and orientation
4. Use Green landscaping strategies such as Xeriscaping and natural landscaping to conserve water while protecting and enhancing the site.
5. Develop a stormwater management plan consisting of design strategies to reduce runoff

Passive Building Design (CHAPTER 3)

1. Look at local vernacular architecture styles to illustrate passive design strategies that are effective in your area
2. To save energy and increase comfort in the home consider the homes shape / size, interior layout and window positioning.
3. Proper building layout and design can improve ventilation through a home reducing cooling costs and improving indoor comfort.
4. Use natural lighting strategies to improve lighting quality and conserve energy

Energy (CHAPTER 4)

1. Energy efficient building design
2. Energy efficient building techniques
3. Properly sized and maintained HVAC systems
4. Energy efficient and lighting
5. Energy efficient appliances
6. Use solar energy

Water (CHAPTER 5)

1. Use water efficient fixtures and appliances
2. Insulate water pipes
3. Use alternative water and discharge techniques

Indoor Environmental Quality (CHAPTER 6)

1. Design to reduce the level of contaminants in materials.
2. Design for optimal human comfort levels

Construction Material & Techniques (CHAPTER 7)

1. Minimize natural resource depletion
2. Protect ecological systems
3. Minimize pollution and toxins
4. Consider the environmental impact from material manufacturing, shipping and packaging, installation, waste, life cycle, and disposal.
5. Build for energy efficiency
6. Consider material and energy efficient alternatives to traditional construction techniques

Preconstruction Process (CHAPTER 8)
1. Set achievable environmental goals 2. Include environmental goals in specifications 3. Use preconstuction meetings to determine site layout and preservation of site 4. Protect existing vegetation during construction project 5. Use construction waste management techniques to reduce job site waste
House Operation and Maintenance (CHAPTER 9)
1. Assist building owner in developing a maintenance program 2. Educate building owner about environmental goals 3. Demonstrate operation of all mechanical and electrical systems 4. Consider life cycle cost of building and building systems 5. Consider future occupancy or use of building, renovations, reuse, deconstruction

CHAPTER SUMMARY

Chapter 1 — **INTRODUCTION**

This chapter provides a definition of Green construction and introduces some simple but important design strategies. Florida specific information is also provided regarding climactic information and population growth is also provided.

Chapter 2 — **SITE SELECTION AND BUILDING PLACEMENT**

Provides information on site selection and building placement. It is understood that the selection of the site, and / or the building placement on that site may not be within the builders control. Therefore, this chapter also offers suggestions regarding other site issues such as landscaping and stormwater management.

Chapter 3 — **PASSIVE BUILDING DESIGN**

Primarily focuses on passive building design and ventilation. Passive design attempts to balance all non-mechanical aspects of energy use in the building such as natural lighting, cooling, heating, and ventilation.

Chapter 4 — **ENERGY**

Discusses energy concerns specific to Florida and offers design and mechanical equipment suggestions to combat the State's massive energy requirement in buildings.

Chapter 5 — **WATER**

Provides general water consumption information and provides recommendations regarding fixtures and appliances for use in the home. Concepts regarding alternative sources and discharge such as waste water management, rainwater harvesting and collecting systems are discussed.

Chapter 6 — **INDOOR ENVIRONMENTAL QUALITY**

Concentrates specifically on Indoor Environmental Quality (IEQ). The chapter overviews the causes of poor IEQ and identifies the main contributing materials to avoid.

Chapter 7 — **CONSTRUCTION MATERIAL & TECHNIQUES**

Discusses specific building materials to avoid and offers suggested alternatives. Major components of the home are introduced and material suggestions are made. Discussion also includes alternative construction techniques for energy efficiency and material conservation

Chapter 8 — **PRECONSTRUCTION PROCESS**

Introduces the planning and stages associated with the construction process. This chapter offers suggestions regarding contract language, preconstruction conferences and protection of the construction site. Waste management options are also introduced and explained.

Chapter 9 — **HOUSE OPERATION AND MAINTENANCE**

Discusses operation and maintenance, renovation and adaptability, longevity, and deconstruction.

CHAPTER 1 INTRODUCTION

DEFINITION OF GREEN CONSTRUCTION

Green Construction is developing and building in an environmentally responsible manner. The goal of Green Construction is to produce buildings that are energy and resource efficient, healthy, environmentally sensitive, and economical. Green building principles take into consideration the life cycle of the structure, which involves selecting construction techniques and building materials that will ultimately provide the best performance over the entire life of the building. The objectives and potential benefits of Green Construction are generalized in Tables 1.1 and 1.2.

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☞ Passive Design	3
☞ Material Selection	7

Table 1.2 Benefits of Green Construction	
BENEFITS	**CHAPTER**
Reduced life cycle costs	
☞ Operating cost (energy, maintenance, repairs)	4, 9
☞ Renovation, demolition, disposal cost	8
Provide a better building, including	
☞ Energy Efficiency	4
☞ Improved lighting	4
☞ Healthier indoor environment	6
☞ Reduce Water Consumption	5
Potential identification of opportunities for new products, designs and approaches	
☞ Green building materials ☞ Innovative construction techniques	7 7

GREEN DESIGN STRATEGIES

The concept of "green" architectural design takes into account the structure's response to the environment. Ideally, structures will impose a minimal impact on their surroundings (the people, communities, and social character as well as the natural and built environment). The concept of "green" design incorporates passive and active systems to achieve a harmonious building design that will result in the least amount of impact on the natural environment. Passive strategies include, but are not limited to: building orientation, solar reflection, natural ventilation, and rainwater harvesting. Passive Design is further discussed in Chapter 3. Active systems may include efficient pumps, fans, and efficient light fixtures. The components of active systems are discussed in Chapter 5. Green design works best when several passive building strategies are coupled with active systems (i.e. natural ventilation techniques assisted by active fans).

JUSTIFICATION: WHY GREEN CONSTRUCTION?

With Florida's rapidly growing population and rapidly diminishing resources environmental conservation is becoming both popular and necessary. New products and techniques, decreasing water supplies and increasing electricity costs are making environmentally friendly construction and building methods more economical. There are several environmental problems associated with the construction industry including waste, non-point source pollution, habitat disturbance, hazardous materials, and soil erosion. Green design and construction will minimize these effects and provide a home that is comfortable, efficient, emissions-free, and attractive.

There are many simple passive design techniques that can save significant amounts of energy and create a more comfortable living space without changing the builder's selection of materials. For example, substituting different types of landscaping (i.e. the use of native and adapted species) can conserve water with the added benefit of being easier to maintain.

There is a common belief that green products have higher costs than conventional products. Many green products do carry a slightly higher initial price tag. It is important to consider that most of these products will pay for themselves, by increasing energy efficiency, over a short period of building operation. In addition, higher quality construction and materials will increase the long-term value of the residence.

There are many new green construction products available. However, there are a number of reasons these products and techniques are not currently being used. Builders may be comfortable with certain products and designs and therefore reluctant to venture in new directions, or they may simply be unaware of the alternatives. Also the benefits of some of the products and strategies are not widely recognized.

OVERVIEW OF FLORIDA CONDITIONS

Understanding Florida's unique climate and environment plays an important part in designing green residential construction. Florida has many natural resources, which are beneficial to green building. A summary of climactic conditions in five of Florida's major cities is provided in Table 1.3.

Table 1.3 Climatic Conditions in Florida Cities

	Miami	Orlando	Tallahassee	Jacksonville	Pensacola
Temperature (F)					
Annual Average	76	72	67	69	68
January High (3pm)	75	72	63	64	60
January Low (7am)	59	49	40	42	41
July High (3pm)	89	92	91	92	90
July Low (7am)	76	73	72	73	74
Humidity % - average	73	74	75	76	74
Wind					
Ave. Direction	ESE	S	N	N/A	N/A
Ave. Speed (MPH)	9.3	8.5	6.3	7.9	9.7
Rainfall (in.)	57.55	47.82	64.59	51.31	61.81
Heating Degree Days	199	656	1,652	1,434	1,617
Cooling Degree Days	4,095	3,401	2,492	2,551	2,636
Comfortable Days (%)	21.2	12.6	10.1	N/A	N/A

CLIMATE

Florida is a large state and has significant climactic differences. Changes in climate can affect the availability of materials and products, as well as design strategies. In general, Florida has a subtropical climate. Its summers are long, warm, and humid, and its winters tend to be mild with occasional intrusion of cool to cold weather from the north. Rain is abundant and, with the exception of the northwestern portion, the State has two seasons, a short (four-month) "wet" season and a long, relatively dry season. The State is subject to tropical storms and hurricanes with the southern part of the state more susceptible to severe storms.

TEMPERATURE

During the summer months, the change in Florida's temperature from daily high to nighttime low is relatively small (approximately 15 to 20 degrees.) These small temperature changes result in high energy consumption by cooling systems, which must work both day and night to maintain a good level of comfort. Cooling systems in Florida are active a great part of the year due to the high heat and humidity. Freezes are possible in the northern portions of the state during the winter months.

SUNLIGHT:

Florida's abundant sunlight allows for the use of several environmentally sensitive strategies such as passive cooling and heating, and natural lighting. Building structures collect heat during the day as a result of direct sunlight. Due to the small temperature variation at night, building structures continue to conduct heat throughout the building well past midnight. Harvesting the sun by using photovoltaics or by other means can provide essential energy for cooling, lighting, and hot water.

WATER:

Florida is a peninsula and nearly 90% of its perimeter adjoins bodies of water. The heating and cooling of the ocean waters create breezes and often drastic temperature swings in Florida's coastal areas. Florida also has approximately 4,440 square miles of shallow lakes and other standing water systems that may provide cool winds within the interior of the state.

Although Florida is surrounded by water and has an abundance of inland water systems, Florida often experiences water shortages. Water shortages result from high evaporation rates, excessive runoff and saltwater intrusion. Florida summers are well known for their afternoon showers, which dump several inches of rain daily. Because of the temperature and soil conditions, much of this water is never retained. Run-off occurs in areas where land has been covered by buildings and paving materials. Reducing daily water usage can help counter the water shortage problem. The St. Johns River Water Management district has estimated that 50% of residential water consumption in Florida is due to either lawn or garden irrigation. Appropriate landscaping (Xeriscaping) can greatly reduce the amount of water that is required for these tasks.

Geography

Florida is generally flat with the high ground supporting semiarid scrubs, and the low ground being covered with swamps and marshes. Generally, Florida has sandy soil, which is relatively infertile and porous, but the plant life traps nutrients and taps subsurface water that supports Florida's abundant wildlife. Under the sand is a substrate of limestone, which contains the "Floridan Aquifer", the main source of water for much of Florida.

Habitat

Due to its unique geographical, geological and climatic situation, Florida has one of the highest diversities of plant and animal life in the country. Almost 9% of Florida's 3,500 native plant species are unique to Florida. Since the mid-1880s, at least 34 species of native plants and animals are believed to have become extinct. Currently, 118 animal species and 482 plant species are listed as an endangered, threatened or a Species of Special Concern, making Florida second only to Hawaii in the number of species affected.

POPULATION GROWTH

Florida has seen phenomenal growth in the past few years. Population growth has a positive effect on the economy and construction industry, but has negative effects on the ecosystem. Between 1970 and 1998, the population of Florida grew from 6.8 million to 14 million, an increase of 106%. Florida's population is projected to grow by an additional 7.2 million by 2015, a 211% increase since 1970. Most of Florida's population and projected population is expected in an "H" shaped area. This area runs up the west coast of the State from Naples to Citrus County, spans the State from Tampa Bay through Orlando to Volusia County, and stretches the entire length of the east coast from Jacksonville to Miami and the Florida Keys. Florida's population growth has had a major impact on the State's natural resources. Mitigating the impact of future growth on these resources is a major challenge, and one that developers and builders can significantly affect.

CHAPTER 2 SITE ANALYSIS & BUILDING PLACEMENT

INTRODUCTION AND STRATEGY

A site survey should precede any design, preconstruction or sitework for a project. The natural features of the site should dictate building placement, landscape design, stormwater management, and driveway or other impermeable surface locations. The design process should not only include an analysis of the building site, but also infrastructure and transportation issues within the community. Although development will always cause some ecological disruption, this disruption can be reduced. Through careful planning and design, all members of the project team can work together sharing ideas and critiquing the project on a periodic basis.

SITE SELECTION

In many projects the site has already been selected and the placement of the building has already been determined. However, if control over site selection is possible, there are several factors that can reduce the environmental impact of building or developing. Table 2.1 provides guidelines for selecting a green building site.

Table 2.1 Guidelines for selecting a green building site	
✓	Select sites in developed areas
✓	Select sites that do not contain or encroach upon sensitive environmental features such as wetlands
✓	Consider factors such as thoroughfares, infrastructure, existing structures, zoning of adjacent parcels and the characteristics of the surrounding communities
✓	Select sites close to public transportation, amenities, and places of employment to minimize the impact of vehicles.
✓	Ideal site would provide clean air, water, soil, solar access, have public transportation, be close to amenities, utilize existing roads and utilities.
✓	Select a site that allows use of passive design, such as building orientation (allow the longer sides of the house to north or south) and good shading

SITE ANALYSIS

Any site analysis should begin with the identification of the prominent features such as existing vegetation and topography. Preservation of the site's natural features can result in cost savings associated with:

- Reduced landscaping cost
- Energy conservation from shading
- Reduced water use (Xeriscaping)
- Woods, woodlands, lakes, trails, and streams are important amenities that should be preserved. Protecting these features when building can result in higher property values.

Table 2.2 provides a checklist and guidelines for analyzing a potential site.

Table 2.2 Site Analysis Checklist	
✓	What natural features exist on site?
✓	How might a development be oriented to best preserve natural features?
✓	Can existing ecosystems possibly be restored?
✓	What are the characteristics of trees located on site--location, age, and species?
✓	One effective way to do a site survey is to take a topographic map or survey of the site into the field and make notes directly on it.

BUILDING PLACEMENT AND ORIENTATION

It is important to look at all aspects of the site when considering building placement. A large number of factors should be considered when deciding how to place and orient a building. Environmental factors such as the sun, wind and temperature effects on the building should be considered. Other environmental factors include visual aspects, such as levels of light or illumination, noise levels, and the possible presence of air pollution, such as unwanted odors, dust or smoke. The buildings potential views and privacy issues must also be considered. It is also important to consider the relationship of the building to the established town or development, and the part the building will play within the organizational framework of the community as a whole.

Where the building is placed can have a great influence on the effectiveness of passive design strategies, particularly as they relate to solar radiation and wind. **In southern climates such as Florida, buildings should be oriented to minimize the sun's radiation on the structure and to maximize the potential for cooling breezes.** Effective passive design is possible; however, compromises are often required regarding sun and wind orientation strategies. In low structures such as homes, wind orientation is not as important as avoiding solar radiation. **Airflow through a building is more dependent upon the use of windbreaks and the proper location of window and door openings than upon the orientation of the building.** (See Chapter 3 on Passive Design.)

All buildings, no matter what climate, perform better if the longest wall faces the south. The optimum shape of a Florida home is rectangular, elongated on its east-west axis at a ratio of 1:1.7 in order to maximize its north and south surface area, therefore minimizing east-west exposure to solar heat gain (Figure 2.1).

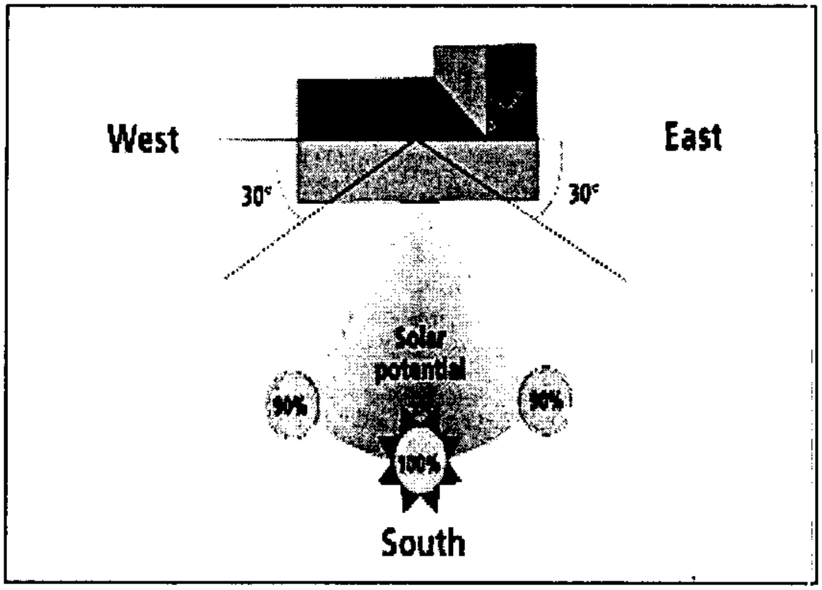


Figure 2.1 Building Orientation

The rule for ventilation with regards to building orientation is that air flow is often better captured when the house is placed off the cardinal (north-south) directions by approximately 30 degrees as shown in Figure 2.1. This strategy takes full advantage of prevailing breezes and wind patterns during summer months, while blocking any potential winter winds. Again, compromise is often needed between solar and ventilation design strategies. Table 2.3 provides a summary of important natural features to consider when determining building placement.

Table 2.3 Important Natural Features Determining Building Placement		
✓ Topography	✓ Water	✓ Sun
✓ Wind	✓ Habitat	

TOPOGRAPHY

Florida is a relatively flat state so many of the techniques regarding large hills and other landmasses are not applicable here. In general in Florida, the higher a home is raised, the better the natural ventilation will be, therefore a raised area of the site should be considered when selecting a location for a home. If this is not possible, consider a raised foundation.

- ☞ If you have a significant hill on your site, locate the building near the crest of the hill on the windward side slightly offset from prevailing wind direction to receive the most air movement.
- ☞ Southern and northern slopes rather than eastern or western are preferable because of reduced solar radiation.

Wind

Seasonal winds can have a significant effect on comfort, therefore orientation is an important factor to consider when attempting to capture prevailing breezes. The introduction of landscaping elements such as hedges, fences, or decorative walls can significantly increase the ventilation of a home (See Landscaping section in this Chapter).

Sun

A green building should always be sited to maximize the energy saving features of the site. In Florida, the dominant design consideration is the minimization of solar heat gain in living spaces in the summer months. All buildings, no matter what climate, perform better if the longest wall faces the south. This is because, during the mid-winter the intensity of the solar radiation is highest, while in the summer the intensity and irradiation is lowest.

Caution:

- If using solar energy or photovoltaics make sure the building is oriented to allow for maximum sun exposure on the panels. (See Chapter 4 on Energy).

Water

A body of water will modify its immediate surroundings, and it can make summer temperatures cooler in some parts of the state. It is therefore important to preserve any existing streams or lakes on a site. Additional water can be introduced in the form of a pool, fountain or waterfall. Water can have both physical and psychological effects. For example, the sound of falling or running water creates a feeling of calm in many people.

Caution:

- West facing windows and outdoor spaces may be subject to glare if water is located immediately adjacent to the building.

- The presence of nearby bodies of water can also affect the interior temperature of a home that is naturally cooled. Warm air passing over a body of water gains moisture, increasing its relative humidity and creating an air temperature that is uncomfortable in the summer.

Habitat

It is important to identify protected or endangered vegetation or animals on the site. Protected species can have a major influence on the placement and design of the building on the site. It is important to check with local agencies to determine a course of action to be taken if protected species are present.

MULTI-UNIT DEVELOPMENTS

Site design strategies for multi-unit developments include:

- ☞ Clustering buildings to preserve open space and wildlife habitats
- ☞ Avoiding especially sensitive areas including wetlands
- ☞ Keeping roads and service lines short.
- ☞ Laying out roads in a general east-west alignment so that homes can be oriented to a north-south direction, reducing solar gain.
- ☞ Leaving the most pristine areas untouched
- ☞ Using areas that have been previously damaged or need rehabilitation to build on.

LANDSCAPING

Landscaping is one way that builders and developers can save water while protecting and enhancing the site. *Xeriscaping* refers to landscaping that reduces water needs. *Natural landscaping* uses plants (native or other) that are appropriate for the site's microclimate and topography.

EXISTING NATURAL ENVIRONMENT AND VEGETATION

Buildings should be located to avoid damaging significant vegetation and to take advantage of the shade of mature trees.

Properly designed landscaping can:

- ☞ Prevent water runoff
- ☞ Reduce solar gain
- ☞ Reduce energy consumption by 30 percent
- ☞ Reduce air-conditioning consumption by 75 percent
- ☞ Reduce water consumption by 80 percent.
- ☞ Control pests without chemicals and invite wildlife.

Although landscaping strategies in Florida will vary drastically between the northern and southern parts of the state, some general strategies will be discussed in this section.

XERISCAPING AND NATURAL LANDSCAPING

The appendix of this guide contains charts that provide information to assist in the selection of the appropriate plant types and species for a particular application. Consult a landscaping nursery or local landscape architect to learn what these plants look like or to help identify these plants on the site. Always use a reputable nursery or contractor to supply and install plants.

Table 2.4 provides guidelines for Green Landscaping.

Table 2.4 Practices for Green Landscaping
✓ Preserve existing vegetation and native plants.
✓ Protect existing plants during construction.
✓ Use primarily native plants for new landscaping, as they require less water and maintenance than exotic plants, and reserving exotic plants for accenting.
✓ Use plants that will attract wildlife.
✓ Use organic mulch around plants to conserve water and maintain favorable soil temperature
✓ Avoid use of exotic species that will overrun native plant communities
✓ Plant communities of diverse plant species, using plants of varying ages.
✓ Avoid the use of conventional grass lawns and typical ornamental shrubs due to their high water use, pesticide use, and the pollution generated from mowing.

TREES:

Healthy trees and shrubs create many benefits for both the environment and the homeowner. **It has been found that the air on a shaded lot can be as much as seven degrees cooler than air on a lot that is not shaded**. It is important to try to locate buildings avoiding mature trees. Target any trees over 24" in diameter to be saved. Also consider water runoff that will result from the building and how vegetation on the site will be effected. (See the Stormwater Management section in this Chapter).

Benefits of trees include:

- Partially shielding the house from noise.
- Reducing the energy consumption of the house by shading the house from sunshine during hot summer months.
- Cooling, humidifying and filtering the air.
- Proving an attractive and relaxing backyard area.
- Minimizing the need for lawns.
- Boosting the value of a home or lot. National polls have indicated that trees can increase the value of a home by up to 15%.
- Saving money on landscaping after the home is built.

TREE TYPE AND VEGETATION PLACEMENT:

Palm trees are good choices for landscaping next to building, because their canopy provides shade but they do not block the natural airflow near the ground.

Trees can also be planted to either create windbreaks or to channel the wind into a building. Windbreak plantings diminish wind within a distance three times their height. Vegetation can be a valuable tool used to direct and accelerate natural breezes into a building's interior.

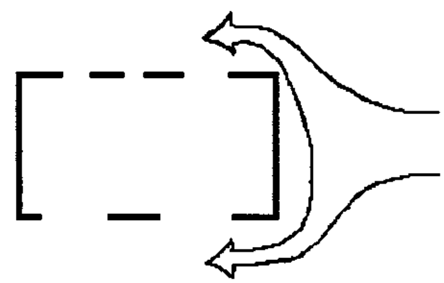


Figure 2.2 Vegetationless Landscape

Figure 2.2 shows the effects of a vegetationless landscape on the natural ventilation of a residence. Figure 2.3 shows the effects of medium to high hedges in aiding to channel breezes through a home. Figure 2.4 shows the effects of medium to high hedges and trees in aiding to direct air movement through north – south windows.

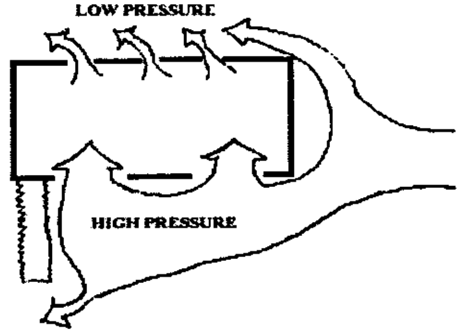


Figure 2.3 Medium to high hedges

Caution:

- Brush should be cleared around window locations in order to allow the maximum possible ventilation through the building.
- If using solar energy or photovoltaics, make sure that trees are not shading the part of the roof the panels will be installed on.
- No landscaping is totally maintenance free; regular maintenance is essential to keep landscaping healthy and able to fulfill its design objectives.

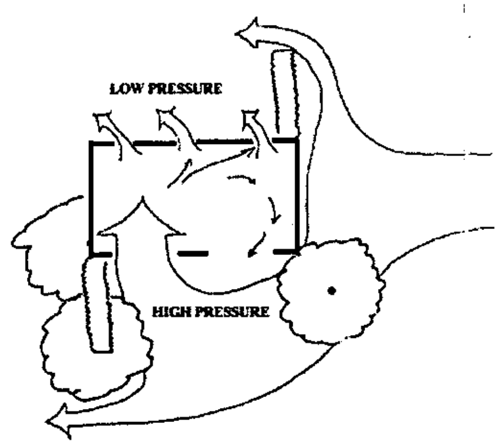


Figure 2.4 Hedges and Trees

OTHER SITE FEATURES.

Large landforms or manmade site features such as a high fence may also be used to partially shade a building or to channel a breeze. While not effective when the sun is high, a fence located to the west or northwest of a space can shade that space in the late afternoon when the sun is low. Fencing can also be used in the same way as vegetation to channel a breeze, but it must be carefully designed so as not to block the breeze it is trying to capture.

STORMWATER MANAGEMENT

Stormwater management is another way to protect and enhance the site. Stormwater is uncontrolled water from roof tops, roads, parking areas, and other impervious surfaces that does not soak into the ground or evaporate, but flows along the surface of the ground as runoff. Stormwater runoff can lead to erosion, threatening fertile topsoil, and can carry pollutants from roads, and fertilizers and pesticides from fields into streams and lakes. Excess runoff also reduces groundwater recharge leading to the depletion of underground aquifers.

Responsible management of storm water is not expensive. Some of the following recommendations, taken from Environmental Building News, are actually less expensive than conventional modern stormwater management practices, especially in large-scale projects. Conventional methods include the use of culverts, rip-rap-lined channels, stormwater sewers, and retention ponds. Table 2.5 lists guidelines based on designing projects to minimize the quantity of runoff generated and to provide natural infiltration.

Table 2.5 Strategies to Reduce Run-off
✓ Minimize the impact of development by preserving existing landforms, topography and vegetation and minimize the creation of impervious surfaces when possible.
✓ Don't let impervious areas connect to one another, so that one surface drains onto another, compounding the problem. For example, don't let a sidewalk drain onto a paved street, separate them with areas of turf or vegetation.
✓ Do not install gutters unless collecting rainwater for use. Install gravel filled "Dutch drains" at the base of the wall instead. If using gutters, then install as many downspout as possible in order to disperse the flow over a wider area. Special gutters that disperse water outward away from the building are also available.
✓ In multi unit developments, reduce paved areas by clustering units, building narrower streets and providing off street parking on pervious surfaces.
✓ Consider using porous materials such as sand, shells, rocks or wood chips for walks and driveways to allow stormwater infiltration. Other pervious paving surfaces include porous asphalt and concrete systems, and module concrete or plastic grid pavers or block lattices that can be planted with grass.
✓ Construct porous paving systems over properly sized gravel reservoirs in order to combine parking and a retention basin within a single area.
✓ Eliminate curbs along driveways and streets if possible, so that water can run directly into grass or landscaped areas and does not become concentrated.
✓ Plant trees, shrubs and groundcovers to encourage infiltration.
✓ Incorporate native or low maintenance landscaping that does not require frequent fertilizer, pesticide and herbicide applications, in order to keep pollutants out of stormwater

INTRODUCTION & STRATEGY

GENERAL

Responsibility for the environment begins in the earliest stages of design and carries through the life cycle of the building. Green design incorporates the use of passive and active systems to achieve a harmonious existence with the natural environment. Passive design concepts can improve the standard of living within a home by providing a structure that is more energy efficient, comfortable, and healthy than a traditional building.

A passive design is one that uses non-energized design features to make the building climate responsive. It uses nature to its best advantage to provide the most comfortable indoor environment possible. It is important to note that optimum results can not usually be achieved by using just one strategy; the strategies work best when an integrated approach is used. When beginning the process of passive design be aware of area-specific information such as climate conditions and the sun's position (azimuth & altitude) at different times of the day and in different seasons. Other important facts include location-specific information about prevailing wind direction and speed, seasonal humidity, and average combined temperature.

In short, passive solar design balances all aspects of the energy use in a building: lighting, cooling, heating, and ventilation. It achieves this by combining, in a single concept, the use of renewable resources and conventional, energy-efficient strategies.

VERNACULAR ARCHITECTURE

Although 90% of today's heating and cooling needs are accomplished by the use of mechanical systems it is important to consider historic architecture specific to this region.

- Past architectural styles can give us an indication of effective passive design strategies for our area.
- There are several styles of vernacular architecture that are specific to particular regions in Florida.
- Included among the various Florida types are the Cracker style, the St. Augustine style, and the Key West Conch styles.

The classic Florida Cracker style architecture (Figures 3.1 & 3.2) incorporates several passive design strategies. Though there are several styles of cracker homes, they all keep a familiar concept in mind - keep it simple. Some of the classic cracker details include its signature dog trot, its highly reflective metal roof, and large porches that covered the front and rear of the structure. Cracker homesteaders configured their homes so that the kitchen was a separate structure from the main house. This was done so the heat generated from cooking would not heat the rest of the house in the summer months when it was already too warm.

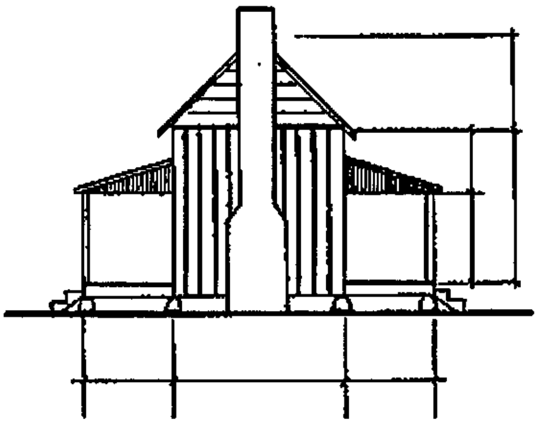


Figure 3.1 Cracker style architecture

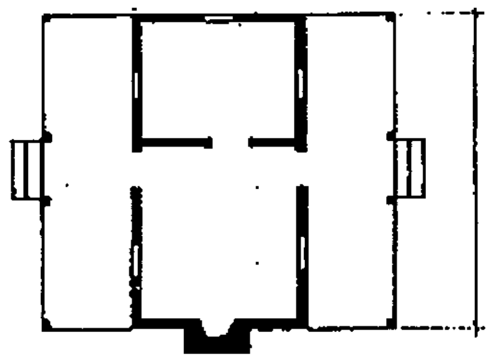
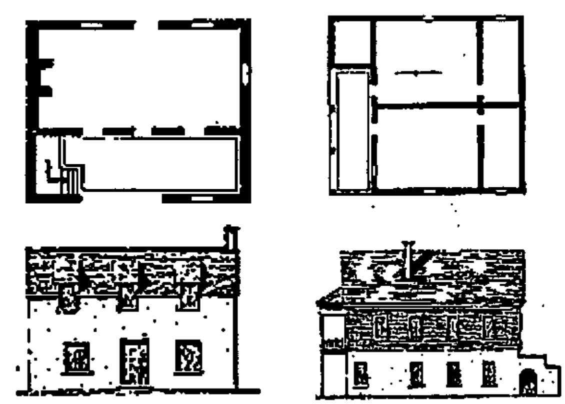


Figure 3.2 Cracker style plan view

The primary materials used in classic cracker homes were wood and metal. The wood used to construct these homes was often left in log form, reducing the amount of material waste. These logs were often harvested directly off the site on which the home was being constructed. Ron Hasse states in his book, *Classic Cracker*, that the cracker homesteaders often oriented their structures in the opposite direction as called for in current design guidelines. They would orient their homes on a north-south axis, in order to gain as much solar absorption on all three sunny sides, east, west, and south. This was done to reduce the moisture content of the logs that were used to construct the walls. This moisture often led to premature decaying of the wood, making the home uninhabitable.

A different style of vernacular architecture is the St. Augustine house (Figures 3.3 & 3.4). Located near the ocean, it was oriented to the south or east so that the prevailing southeast breezes present in the summer would ventilate the rooms and make the porches pleasant. Its thick tabby walls also insulated against the summer heat. In the winter, when the sun was low, light and heat flooded the loggias and porches, with the tabby walls acting this time as an insulator against the cold.



Figures 3.3 & 3.4 St. Augustine style Architecture

The Key West Conch style (Figures 3.5 & 3.6) was ideally suited to the hot, sub-tropical climate of the islands. The houses were built of wood, using the skills of the local builders, who were mostly ship carpenters. Nails were scarce so the builders used mortise-and-tenon joints and wooden pegs. The wooden pegs, which would swell in the humid air, provided strong, flexible joints that were ideally suited to the high winds that came with Key West's frequent tropical storms.

The Key West homes had large windows and doors located to allow for maximum ventilation. Small hatches in the roof would allow hot air to escape from the house through convection. Large porches provided shade and a cool place to sit or sleep. Raised foundations protected the house from flooding and allowed increased air circulation.

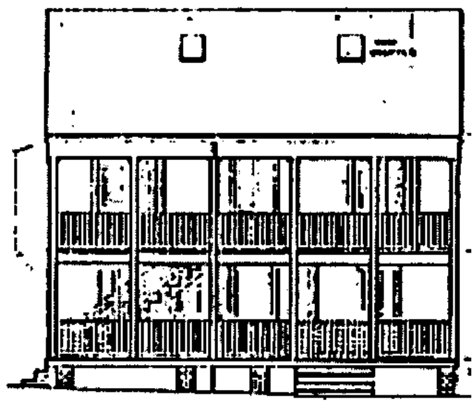


Figure 3.5 Bahama style architecture

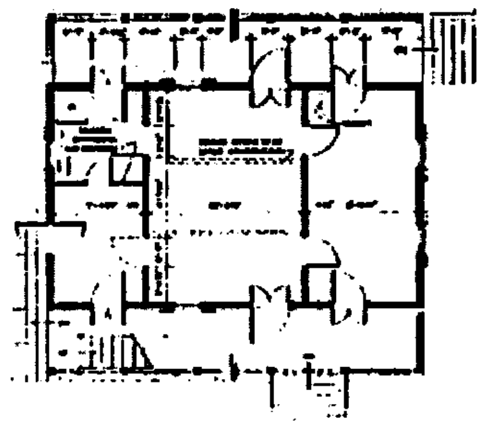


Figure 3.6 Bahama style plan

Many of these classic design strategies can be incorporated into the contemporary home. With simple attention to orientation, selection of materials, and size and shape of a Florida home, builders, architects, and homeowners can take advantage of some of the techniques used in the traditional structures in their areas.

BUILDING CONFIGURATION

As illustrated in the Florida Vernacular styles, a home's shape/size, interior layout, and window positioning will all affect the home's energy use. To maximize energy savings, multiple strategies should be implemented, providing an integrated design approach. If properly implemented, energy use can be reduced by 30% by using the suggestions provided in Table 3.1.

Table 3.1 Energy Saving Design Strategies
✓ Design a rectangular shaped building elongated on the east-west axis
✓ Use a simple house design that will minimize the area of perimeter walls.
✓ Orient living spaces, and areas that are the most frequently occupied during daylight hours, to the south
✓ Place laundry areas outside of interior living space if possible
✓ Take advantage of natural lighting strategies
✓ Use the proper amount of glass and window locations
✓ Use properly sized overhangs
✓ Plan windows for cross ventilation

SHAPE & SIZE

Generally, buildings should be elongated on the east-west axis. See Chapter 2 for more information about the orientation of the building on the site. A simple, compact design, which minimizes the total area of perimeter walls, will use less energy because there will be less area through which heat can enter or leave a home. Note when reducing the perimeter wall area to reduce interior heat gain, it is not necessary to take garages into consideration.

The design of a house will influence both its cost and its energy efficiency. A 1600 square-foot house with a length-to-width ratio of 1:1 (square) will have 25% less material in its exterior walls than a comparable house having a 4:1 ratio (long rectangle). Reducing wall area usually translates into reduced energy loss.

Living spaces should be raised to take advantage of natural ventilation. Windows should be properly located and plentiful and should be shaded from full sun exposure. As seen in the previous section, many of the vernacular architecture styles were elevated and contained open interiors, high ceilings, and shaded porches.

Caution:

- Although many of the vernacular styles had 10-foot high living spaces which worked well when air flow was present, when the breezes died the warm air would build up in the attic or ceiling space, making it too hot for comfort. Using roofing insulation and/or a ventilated double roof or ventilated attic design, as seen in Figure 3.7, may solve this problem. See Chapter 9 for more attic ventilation techniques.

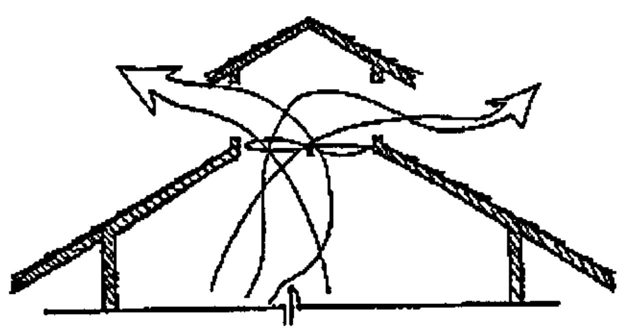


Figure 3.7 Vented outlet

INTERIOR LAYOUT

The interior spaces of the home should be arranged to take advantages of natural ventilation and natural lighting. A slender home with the living spaces along an axis provides increased privacy and increased levels of natural lighting and cross ventilation.

Living spaces should be placed to the southeast, south, and southwest according to their sunlight requirements. Rooms should also be laid out according to the time of day they will be used. Rooms used primarily in the morning, such as breakfast areas, should be located away from the east side of the house to avoid the heat of the morning sun. Rooms used in the afternoon or evening should be located away from the west side of the house to avoid the heat of the afternoon sun. Patios, decks and porches which will be used in the afternoon or evening should be located to the east side of the house so that they will be shaded by the shadow of the house, keeping them cooler. As shown in Figure 3.8, floor plans often only need to be mirrored to properly reorient the rooms according to the time of day they will be used.

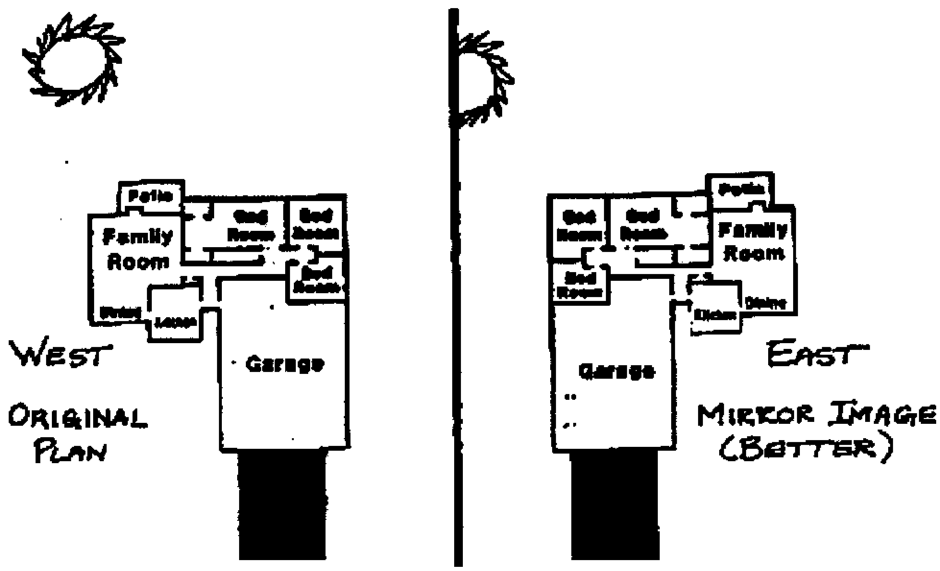


Figure 3.8 Use of Mirror Image Plan – The original plan places the patio, living room, dining room and kitchen on the west side of the house, exposed to the afternoon sun. An improvement is the mirror image, which places these afternoon-evening activity areas on the east side of the house, away from the heat of the afternoon sun.

Service spaces requiring diminished levels of light and heat, such as corridors, laundry rooms, closets, and garages can serve as a buffer oriented to the north. Garages can also serve as buffers to shield the house from sunlight and reduce the use of windows on east or west exposures. The best location for a garage from an energy efficiency standpoint is on the west side of the house; the southwest, northwest, and east, are also efficient garage locations.

Laundry rooms should be located outside of the main interior space if possible due to the dryer venting operations. A typical dryer pulls enough air from its surroundings, through its venting process, to remove nearly all of the conditioned air from a 1,500 square foot home once every hour, replacing it with unconditioned outside air.

Windows

Windows are an important aesthetic feature in homes, however, they are also the major cause of energy loss. Windows, skylights, and glass doors can account for up to 60% of the energy used for heating and cooling. Window size, location and orientation effects solar gain, natural lighting and ventilation. This Chapter contains separate sections on ventilation and natural lighting. **In general, use one square foot of glass area for every 100 square foot of living space for adequate natural lighting.** The amount of south-facing glass should be equal to five percent of the floor area of the home. It is best to avoid glass on the side of the house that faces east and west.

CASE STUDY *COST IMPACTS OF WINDOW ORIENTATION*

A study by the Jacksonville Electric Authority concluded that energy bills for an average 1,700 square foot house are about $35 per year higher when the majority of its windows face east and west, as compared to a house which had most of its windows facing north or south.

If using east and west facing windows, or if increased glass area is desired, design strategies such as proper eave width and window placement (See Figure 3.9) can be used to control the amount of solar heat gain entering a home.

Tinted glass or solar screens can also be used to reduce heat gain. Solar screens, which fit over the windows the same as standard window screens do, have thicker filaments that help block the sun. Tinted glass, which can appear almost exactly the same as clear glass, can reduce the amount of heat entering windows by almost 20 percent. Table 3.2 shows the energy savings from solar screen, window avoidance and overhangs on the various exterior wall orientations of the house.

Table 3.2 Annual Energy Savings From Solar Screens, Window Avoidance, and Overhangs

Direction Wall Faces	Solar half-Screens in 100 SF Of Window Area	R-11 Wall in Place of 100 SF Of Window Area	16-Inch Overhang Covering 100 SF Of Window Area
North	$5.45	$75.50	$6.13
Northeast	$7.75	$80.54	$10.56
East	$8.45	$90.15	$15.26
Southeast	$7.29	$84.70	$17.92
South	$6.95	$77.82	$17.99
Southwest	$10.36	$93.42	$26.37
West	$12.47	$107.93	$22.55
Northwest	$9.61	$91.65	$18.19

OVERHANGS

Shading devices are important because of the intense solar radiation in the southeast. Overhangs are most effective over windows located on the west and east sides of the house. Glass areas can be shaded using porches, trees, awnings, sunscreens, shutters, and heat mirror film applied to the surface of windows. Particular attention should be given to properly sizing overhangs on the south elevation to allow shade in the summer, while still allowing winter sun exposure.

A general rule of thumb for south elevations is to add the height of the window to the height of the wall above the window and divide by four to get the best size for the overhang's projection on the south facing windows.

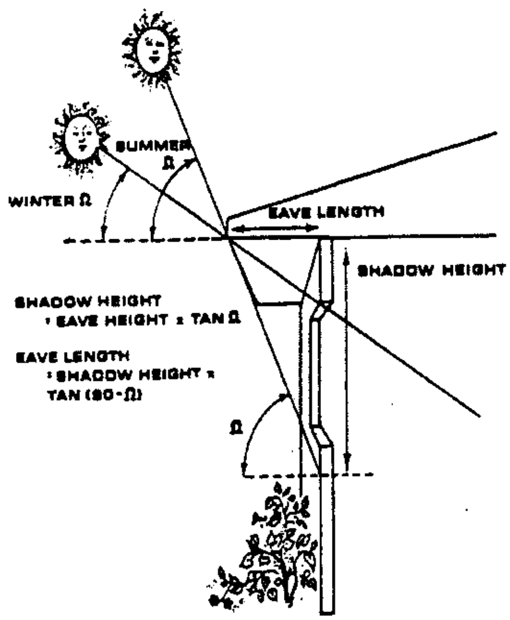


Figure 3.9 Illustration of proper solar profile calculation for eave length and window dimension for protection from solar gain.

Horizontal overhangs are effective when the sun is higher in the sky. In the afternoon, when the sun is low, vertical shading devices are more effective. The sun's position in the sky is always changing, therefore, when designing shading and shading devises the solar profile angles need to be known for the sites latitude; this information may available from local utilities and is included in most passive design books in the public library.

Caution:

- Although natural light is desirable, increasing window area also increases solar heat gain.
- External planes, such as some shading devises, can also effect the direction and amount of ventilation entering the house.

VENTILATION FOR PASSIVE COOLING

Air movement will evaporate perspiration, creating a cooling effect. For example, a well-shaded house with an indoor temperature of 85 degrees F and little or no air movement will be uncomfortable. If ventilation is introduced and that 85 degree air moves across the body at 200 feet per minute, or 2.3 mph, the human body will perceive it to be 5 degrees cooler .

Northeast Florida experiences from 90 to 100 days per year that are suitable for passive cooling by natural ventilation. The goal of passive cooling is to avoid overheating the structure by solar absorption. However, in order for passive cooling to be effective, consideration must be given to all climactic conditions. The most important factors to consider when planning passive cooling strategies are heat gain, humidity, and air movement (or ventilation). A truly passive home employs all of these factors satisfactorily, reducing the need for nonrenewable fuels used in mechanical systems. Table 3.3 provides suggestions to maximize benefits from ventilation.

Table 3.3 Design for Maximum Ventilation
✓ Install operable windows
✓ Place house slightly off the north-south axis
✓ Use landscaping elements to channel breezes (See Chapter 2)
✓ Properly locate and size windows for cross ventilation
✓ Reduce internal barriers to ventilation (i.e. walls)
✓ Use wing walls if cross ventilation is not possible
✓ Use stack ventilation to create a chimney effect

ORIENTATION FOR VENTILATION

Seasonal winds can have a significant effect on comfort. As stated in Chapter 2, ventilation is often better captured when the house slightly off the cardinal (north-south) axis by approximately 30 degrees. The introduction of landscaping elements such as hedges, fences, or decorative walls can significantly increase the ventilation into a home. (See Chapter 2 for more information about building orientation and the effect of landscaping on ventilation.)

CROSS VENTILATION

The placement and sizing of windows significantly effects the cooling effects felt from cross ventilation. It is important to keep the inlet opening as low as aesthetically possible to provide airflow at occupant levels. Ventilation is most effective when the house is fairly shallow or only one room in depth. It is also essential that windows be located on opposite walls to encourage cross ventilation. See Figure 3.10.

Room A, in Figure 3.11, represents a cross-ventilated space with strong airflow in the center of the room. Room B is also well ventilated producing substantial airflow. If the outlet window is moved closer to the windward building corner the air mixing in the room would be heightened, resulting in better ventilation. Room C has the least ventilation, due to the outlet location of the window. Finally, Room D has both openings located in the negative relative pressure zones and is poorly ventilated. Only minor recirculating airflows exist in the room because of the pressure difference between inlet and outlet openings.

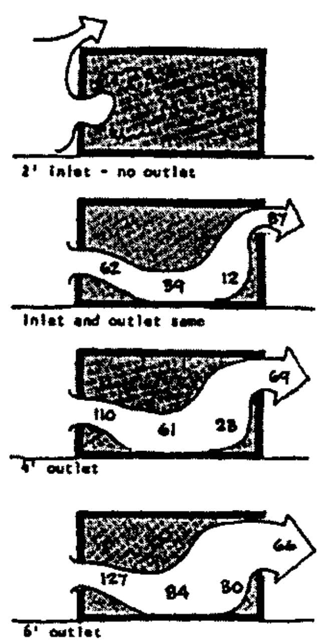


Figure 3.10 Effectiveness of wall openings on prevailing breezes. As the leeward wall opening is enlarged the velocity of the breeze entering the building increases, subsequently the exiting velocity decreases

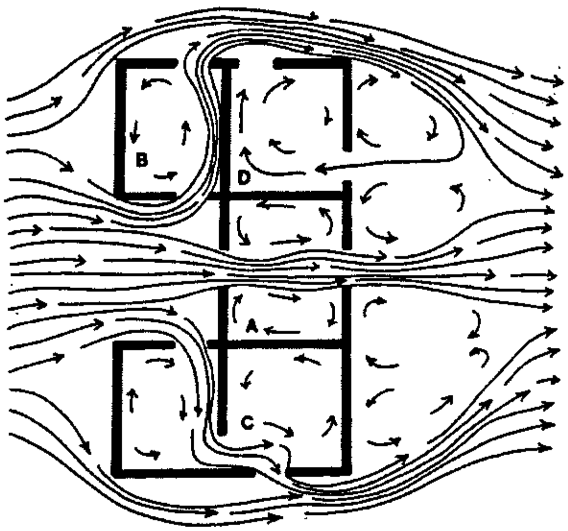


Figure 3.11 Strategies to increase airflow patterns in a ventilated designed five – room home.

Caution:

- When choosing between cross ventilation and stack ventilation a conflict is often created due to room layout. In cross ventilation, rooms are laid out in a long narrow configuration to present a larger skin area, increasing the capture of prevailing winds. In stack ventilation, rooms are bunched together to allow them to share the same ventilating stack. One recommendation is combine the two concepts as seen in the Case Study on the following page.

WING WALL

If direct cross ventilation proves to be impossible or impractical, wing walls can be employed. Wing walls are introduced when there is a wall that is long enough to have two windows that open to a common space. The wing walls are placed on the inside (windward) edge of the windows. The pressure differences created by the wing walls will accelerate the natural ventilation through the house as shown in the following Figure 3.12.

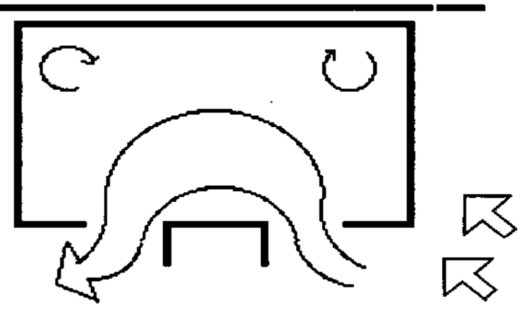


Figure 3.12 Illustration of Wing Wall strategy.

STACK VENTILATION

Stack ventilation (Figure 3.13) is slow moving air current of negative and positive air pressures throughout the home created by cross ventilation and the chimney effect. The chimney effect is created when an operable opening is provided at a higher elevation than the living space. Secondly, window openings need to face both the windward and leeward walls of the home; as fresh air enters the home from the windward wall a positive pressure is created. Fresh air will also enter the leeward side of the home if the negative pressure created from the chimney window is strong enough.

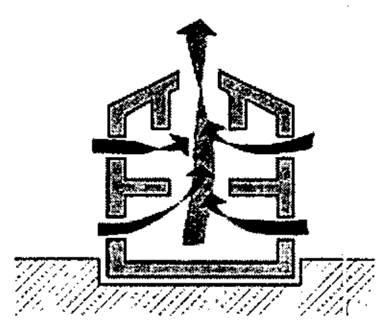
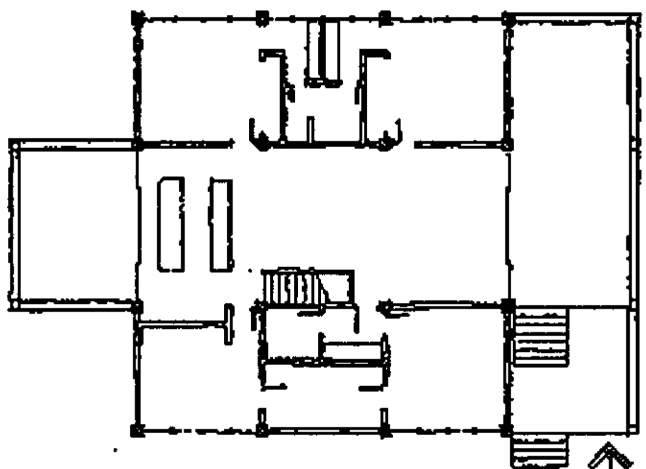


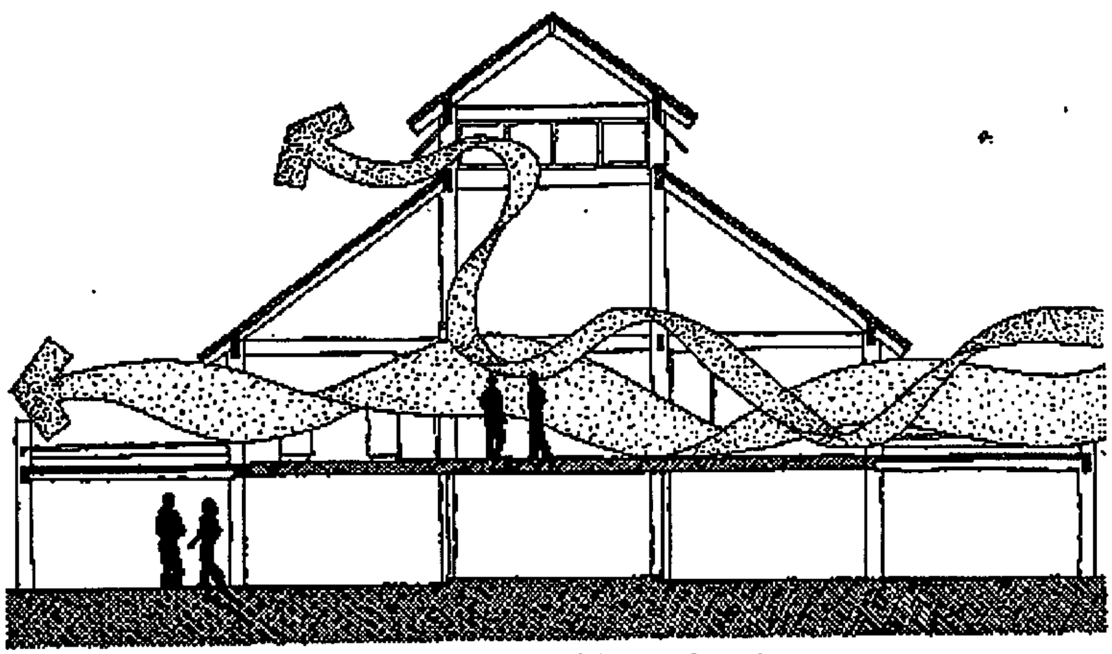
Figure 3.13 Stack Ventilation.

CASE STUDY: ***STACK AND CROSS VENTILATION***

Logan House, Tampa, FL – Designed by Rowe Holmes Associates
Rowe Holmes Associates solved the conflict between room layout for cross ventilation versus stack ventilation by bunching the rooms to use a central stack while opening the three center spaces to each other and to the outside to form a cross-ventilated breezeway through the entire house.



Logan House Tampa, Florida Rowe Holmes Assoc.



Logan House Tampa, Florida Rowe Holmes Assoc.

NATURAL LIGHTING

The ability to light an entire house with natural light through the day is extremely challenging, especially when the house has a complicated design. The goal of natural lighting is to provide as much indirect light (light that is reflected and not in a direct line to the sun) as possible to the interior of the building, and to prevent unwanted direct light from entering the building. Natural light does have its limits. Therefore, efficient artificial lighting needs to be incorporated into the building design as well (see Chapter 5). Table 3.4 provides a list of common natural lighting strategies.

Table 3.4 Natural Lighting Strategies
✓ Sidelighting
✓ Skylights
✓ Cupolas
✓ Light shelves
✓ Overhangs
✓ Clerestories.
✓ Curved Ceiling Planes

SIDELIGHTING:

Sidelighting from windows located in the walls of the building is the most common source of daylighting. The amount of light decreases exponentially as you move toward the interior of the room. Light colored walls and ceilings that can reflect light in a diffuse manner will aid the effectiveness of the natural light. Horizontally oriented windows high on a wall will permit the best penetration of light into a room.

SKYLIGHTS:

Skylights can be a source of excessive heat gain. Use the following guidelines when designing skylights:

- Use a translucent glazing that reduces glare.
- If using clear glazing, use a ceiling diffuser at the bottom of the skylight shaft to improve light distribution.
- Use double-glazing or heat mirror™ glazing.
- Provide an exterior shading system over the skylight during the summer.

CLERESTORIES:

A clerestory is a windowed raised section or roof, typically consisting of operable windows, for light and ventilation. The most appropriate orientation is north or south. A southerly oriented clerestory would have an adequate roof overhang above it to prevent direct solar gain. Operable windows in the clerestory also allow heat to escape from the house during the cooling season. North-facing clerestories may require a vertical wall section on the exterior west side to prevent heat gain from the setting summer sun.

USE SLOPED OF CURVED CEILING PLANES:

Ceiling shape is the simplest mechanism for distributing light in a space. A ceiling that is sloped from a high point at the window or skylight essentially has the same impact as maintaining a high ceiling throughout the space. Curving the ceiling can produce dramatic effects. The light from the window or skylight can be focused or collimated in the case of a concave surface or further diffused and spread in the case of a convex surface.

OPTIMIZE OVERHANGS BASED ON WINDOW HEIGHT AND LATITUDE (SOLAR LATITUDE):

Although usually necessary to exclude light and solar gain at unwanted times, overhangs always reduce the overall amount of daylight in the space and should therefore be designed with care, including an analysis of their year-round effect. Figure 3.14 shows the effects of an overhang on the penetrating light. Note that hurricane requirements may result in special considerations for overhangs, especially those over 24".

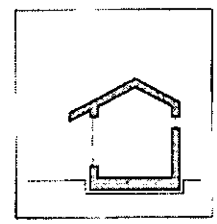


Figure 3.14 Overhang

INCORPORATE LIGHT SHELVES WITH WINDOWS WHERE APPROPRIATE:

The light shelf is an extremely useful tool when used in conjunction with sidelighting strategies. This mechanism, a horizontal surface at or above eye level, serves to reflect light falling above the vision window up onto the ceiling and therefore deeper into the room. At the same time, it reduces illumination immediately adjacent to the window, where illumination levels are typically too great to work comfortably. Figure 3.15 demonstrates the effects of light shelves.

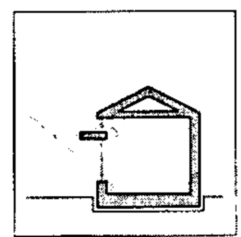


Figure 3.15 Light Shelf

INTEGRATE DAYLIGHTING WITH LUMINOUS CEILING SYSTEMS:

Locating clerestories and skylights above luminous ceiling systems provides a unique method of integrating natural and electrical light sources. However, increased maintenance may be a concern.

Caution:

- Baffles, louvers, and reflectors should be used as appropriate in conjunction with any of the above mentioned strategies to manipulate the infiltration of the suns rays into the homes interior.
- Using east or west facing areas for daylighting is not recommended unless they are shaded by trees or other means. An overhang will not adequately block direct light in east and west orientations.

INTRODUCTION AND STRATEGY

A principal goal of "Green" design is to minimize energy consumption. Florida's climate offers a great opportunity for builders to realize significant energy savings. The annual difference between indoor and outdoor temperatures in Florida is small compared to the large differences experienced in colder climates. For this reason, air-conditioning is a primary concern whereas energy for heating interior spaces in Florida is not as critical as in the northern U.S. Also, in addition to the energy saving strategies available through material selection, building techniques, and HVAC selection, Florida's almost continuous sunshine provides great potential for consistent, inexpensive use of solar energy.

It is important to take into account the energy consumption of a home early in the design process. Strategies such as the selection of alternative materials and orienting the home on the site can make a dramatic difference in heating and cooling requirements, reducing the total energy consumed.

Although design, function, and cost of homes vary based on owner specifications and individual builders, the key influences of energy efficiency remain the same. Energy use of a house is affected by:

- Floor Plans (Chapter 3)
- Building Orientation (Chapter 2)
- Window type and function (Chapter 2 and 7)
- Trees and shrubbery (Chapter 2)
- Insulation and construction materials (Chapter 7)
- Water heating method (later this Chapter and Chapter 5)
- HVAC units (later this Chapter)
- Door selection (Chapter 7)
- Fan use (Chapter 3)

BACKGROUND: THE PROBLEM

ENERGY DEMAND IN FLORIDA

The demand for electricity in Florida continues to grow with the population. If Florida's growth continues as it has over the last forty years, the State's energy generating capacity will be exceeded early in the twenty-first century. As a result, energy conservation on every level is becoming critical. It is hoped that conservation combined with the State's power companies searching for additional power generation sources will continue to meet the needs of our growing population.

The State of Florida consumes well over three trillion British Thermal Units (BTUs) of energy per year. Over three quarters of this supply comes from non renewable fossil fuels. Petroleum, used mostly in transportation, provides 50 percent of the total. Coal, burned almost exclusively to create electricity, provides an additional 20 percent; only twelve percent is contributed by natural gas. Electricity accounts for 93 percent of all residential energy use, 88 percent of the commercial use, and 47 percent of the energy used by the industrial sector.

With this rise in energy consumption, as well as the likely increase in fuel costs, it is inevitable that more homeowners will want the buildings they live in to be designed with energy efficiency in mind.

RESIDENTIAL ENERGY USE

It has been estimated that over 30% of all the energy and 60% of the electricity consumed in the United States is used in buildings (this includes all building types). On average the American family spends an estimated $1,500 per year on household energy. Figure 4.1 shows the cost breakdown of household energy consumption.

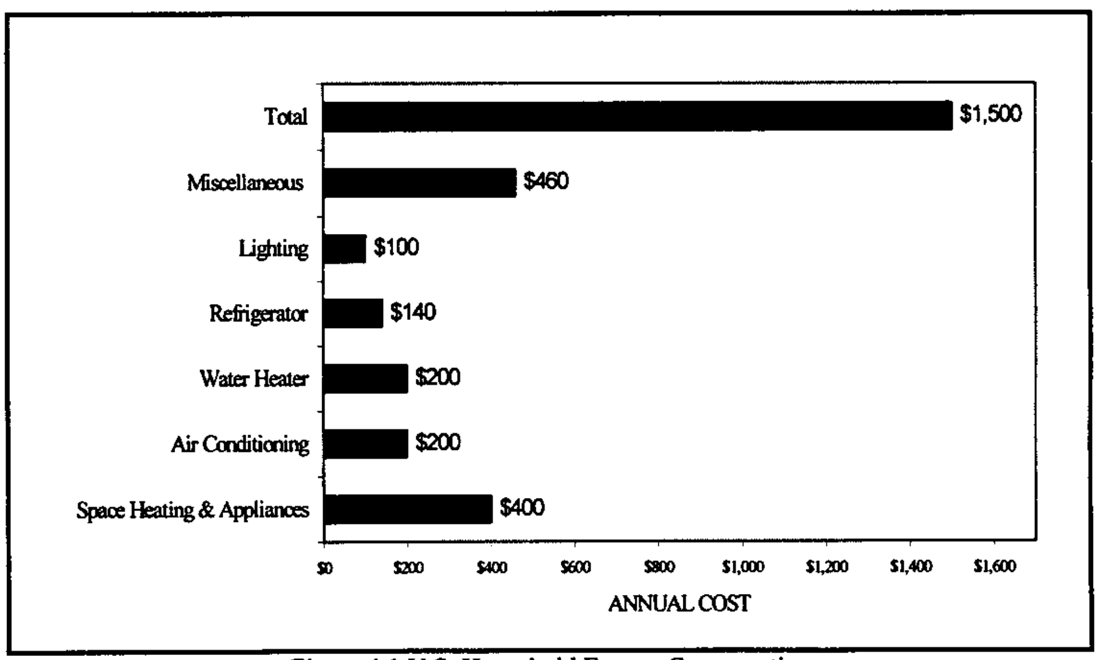


Figure 4.1 U.S. Household Energy Consumption

In general, about 55% of the total energy used in a Florida house is for heating and cooling. Approximately 20% of the energy used is for heating water, the remainder goes for operating equipment and appliances.

BENEFITS OF BUILDING FOR ENERGY EFFICIENCY

The Builder's Guide to Energy Efficient Homes in Georgia asks a simple question: "Why build efficiently?" The answer states that through this process everyone involved has a potential to benefit.

- Homeowners can receive a positive cash flow within 1 - 3 years.
- Homeowners benefit additionally from improved comfort, better indoor quality, reduced moisture problems, and fewer health problems.
- Builders have fewer callbacks and make additional profit from the extra construction cost.
- Heating and cooling contractors have fewer callbacks.
- Realtors receive additional fees from the value-added features and enhance their reputation by selling higher quality homes that consumers appreciate.
- Bankers receive higher mortgage payments for homes with lower annual costs of ownership due to the reduced energy bills.
- National lending agencies, such as the Federal Housing Authority (FHA) and the Veteran's Administration (VA), require some degree of efficiency by mandating that new homes comply with a residential energy code.
- The local economy benefits as more money stays within the community and local subcontractors and product suppliers make additional income by selling improved energy efficient features.

BUILDING FOR ENERGY EFFICIENCY

Since buildings are the largest energy consumers, they offer the greatest opportunity to conserve energy. Table 4.1 provides guidelines to create an energy efficient home.

Table 4.1 Energy Efficient Design
✓ Use passive building design and proper siting
✓ Properly maintain and size HVAC systems
✓ Choose efficient mechanical equipment
✓ Choose energy efficient appliances and lighting
✓ Increase insulation
✓ Use efficient windows and doors
✓ Pat attention to detail in sealing air leaks
✓ Seal duct leaks effectively
✓ Use quality construction techniques, particularly in framing, and installation of insulation and windows

Improvements in building energy efficiency, however, have been offset by the increase in the overall home size. These larger homes require significantly more energy to cool during the warm months.

GENERAL DESIGN CONCEPTS

The concept of energy efficiency must be incorporated in the initial design stage of any project. There are numerous factors that determine the energy efficiency of a building; these include insulation, window selection, thermal and moisture protection, appliance selection, and the incorporation of appropriate passive design strategies. A home's efficiency does not necessarily depend on special products or unique construction skills. With added attention to the quality of construction, efficiency can be quite simple. Use the pie chart in Figure 4.2 to help prioritize where to focus efforts of passive design. For example, humidity infiltration accounts for 25 % of air conditioning load in Florida, thus infiltration prevention measures such as extra sealant and caulking are cost effective options.

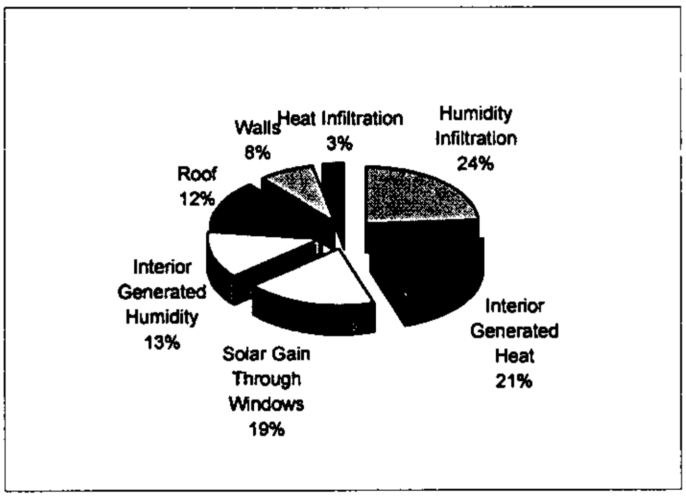


Figure 4.2 Average Air Conditioning Load Sources for the State of Florida

U.S. EPA Energy Star Program

Builders can get help in their efforts to improve energy efficiency from the U.S. EPA Energy Star Homes Program. This program promotes voluntary partnerships with homebuilders to construct residences that are 30 percent more energy-efficient than the current Model Energy Code (MEC). The program offers helpful tips and useful product information to interested homebuilders. Many of the benefits to being in the program are the same or similar to energy conservation in general. Contact them on the web at *http://www.epa.gov/energystar/*

Benefits to Builders	Benefits to Customers
Reduced HVAC system costs Faster selling homes Increased customer satisfaction Increased referrals Reduced call-backs Use as a marketing strategy	Improved comfort Improved indoor quality Improved construction quality Higher resale value Lower utility bills

Building Orientation and Passive Design

Building orientation and passive design was discussed in detail in Chapter 3. These simple design strategies can have a significant effect on the energy efficiency of the building and on the efficiency of solar design technologies such as photovoltaic panels and solar water heaters. Solar design technologies will be discussed in detail later in this Chapter.

Passive technologies require no mechanical energy input to improve thermal properties of the structure or its energy efficiency. Builders and contractors can play a leading role in reducing the energy required in their buildings by taking the time to consider building design and orientation on their selected sites. See Chapter 3.

Energy and Building Materials Another item to consider when designing, planning, and constructing a home is the negative effects associated with the acquisition, transportation, and processing of the raw materials used to produce energy, such as oil and coal. The associated environmental costs of these resources are not often observed by the average citizen, however, they are inevitably paid by all of us through increased energy bills, reduced air quality, and destroyed natural ecosystems. See Chapter 7.

BUILDING SHELL

Building materials were discussed in detail in Chapter 7, however, a brief discussion of techniques and materials that improve energy efficiency are also included in this Chapter. The following strategies are from "Energy-Smart Building" by Philip Russell. Heat can enter the building shell in three ways: conduction, convection and radiation.

Conduction

Conduction occurs when heat moves through the actual building materials. Heat always moves from warm areas to cool areas, and some materials are easier for heat to move through than others are. Introducing thermal breaks into the design of a building can also slow heat transfer. This is done by inserting a less conductive material in the path that the heat travels. Some examples of this are an air break between two panes of glass in a double-paned window or insulation in a metal door. Selecting materials that are difficult for heat to move through, for example, mineral fibers or plastic foams, can increase energy efficiency. Conductive heat transfer is less extensive in Florida than in northern states where temperature differences from winter to summer are more extreme.

Convection

Convection occurs when heat is carried by air currents. Convection can be slowed by eliminating leaks in the building shell, which allow warm air to infiltrate into the cooler indoor environment. Using quality construction practices, such as using caulks and sealants and weather stripping, can reduce energy loss from convection or infiltration. Table 4.2 lists common home components around which infiltration most commonly occurs. The Florida Energy Code requires most of these sources be sealed.

Table 4.2 Common sources of infiltration
Doors and windows
Poorly sealed duct runs
Fireplaces
Wiring and plumbing penetrations
Recessed lights
Vents
Hatches and stair openings to attics
Joints between interior and exterior walls and ceilings

RADIATION

Radiation is the process of heat traveling through waves in the air. An example of this is the sun shining on a roof in summer. The roof absorbs the heat and the heat is then radiated down into the cooler atmosphere of the house. Using reflective coatings on windows, shades, and radiant barriers may reduce heat gain from radiation into the conditioned space. These coatings will block almost all radiation and are relatively inexpensive.

HVAC SYSTEMS

Once a building has been designed and situated on its site to optimize its potential passive design strategies, the designer (either an architect, builder, or the homeowner) must introduce mechanical systems that will provide sufficient comfort in the home when passive strategies become impossible and/or impractical. Table 4.3 provides a summary of important issues regarding selecting the proper HVAC system.

The Florida Building Energy- Efficiency Rating Act of 1993 recognizes that air conditioning is the single largest energy use in the average Florida home. More than 30% of annual energy costs in Florida households are for air conditioning. The most effective ways to reduce air conditioning costs are to keep heat out of the building and to improve air conditioner efficiency.

The efficiency of an air conditioner has a strong impact on a home's energy consumption. Air conditioners should be selected based on their efficiency. Two indicators of the efficiency rating are the Energy Efficiency Ratio (EER) and the Seasonal Energy Efficiency Ratio (SEER). As a general rule, the higher the EER or SEER, the greater the efficiency. For example, a 3-ton air conditioner with a SEER of 8.0 would cost about $176 per month if operated 16 hours each day, whereas one with a SEER of 8.5 would cost about $117 per month. Consider that installing ceiling fans can reduce cooling costs by as much as 20%.

Caution:

- A major cause of energy waste in mechanical systems is poor design, improper installation, and inadequate insulation of the air distribution network or duct system.

Table 4.3 HVAC System Selection Considerations
System size
✓ Size of an air conditioning system is dependent upon the volume of space that needs to be cooled. Local HVAC contractors can calculate loads, and estimate appropriate system sizes. Individual components in the system should be compatible. Contact local professionals to determine which system is best suited. HVAC Systems are sized according to the number of Heating/Cooling degree days (as shown in Table 1.3). Note there is a tendency to select a larger unit than is necessary, but bigger is not better. Oversizing the system may result in increased humidity and mildew problems. In addition, larger systems may wear out faster and have higher associated maintenance costs.
Seasonal Energy Efficiency Ratio (SEER) of 12.0 or greater.
✓ The higher the SEER, the less energy will be used for cooling. In humid climates, such as we have in Florida, system efficiency should be balanced with dehumidification.
Zoned Systems
✓ Zoned systems allow individual rooms or zones to be conditioned separately, allowing for maximum system efficiency. This can be done by using one complex system, or several separate systems.
Air distribution networks or duct system design
✓ Duct systems should be designed based on the specific type of equipment that is to be used, taking into account the building layout for placement and duct sizing. ✓ Ducts should be run through conditioned areas when possible, avoiding attics, crawlspaces and basements. Even insulated ductwork running through unconditioned spaces can lose as much as 15% of the heating or cooling energy. ✓ Air conditioning duct systems should be tightly sealed and free of leaks, to ensure that valuable energy isn't wasted cooling the attic. ✓ Place ductwork in conditioned spaces or insulate with R-6 insulation with aluminum foil reflective backing.
Location of A/C equipment
✓ The air handler should be located inside an air-conditioned space, in a sealed plenum chamber.
✓ The compressor unit should be located in a shaded area outside the house. By shading the compressor, it is possible to reduce A/C costs by as much as 10 percent and to increase the capacity of the cooling system as well. **Heating Systems** ✓ Even in mild winters, heating may still account for 18% of the total energy used to condition a house. Many houses have electric heating systems that are not as efficient as natural gas or heat pump systems. Electric strip heat is not cost effective in northern and central Florida. ✓ If natural gas is available, it should be considered—generally this will cost two thirds less to operate than electric resistance heating.

Computerized Controls

Technology has progressed to the point where control systems for HVAC systems and lighting can be programmed to reduce energy use. If used properly, this technology has the potential to reduce home energy consumption dramatically. These systems allow the homeowner to program the thermostat to an adjusted temperature depending on the time of day and time of year. This can also be applied to the lighting system, allowing lights to automatically turn off when the occupants leave a room. Some other examples of lighting control features include clock timers, photocells, dimmers, and occupant sensors.

Heat Pumps

Heat pumps are a close second to natural gas in terms of utility cost savings. Heat pumps are systems that move heat from one location to another to keep the interior of a home cool in the summer and warm in the winter. In the summer the heat pump collects heat and humidity from inside the home and moves it outside. In the winter the heat pump collects heat from the outside and concentrates it for use inside the home. In most areas the initial cost of heat pumps is competitive with high efficiency fossil fuel HVAC systems.

A heat pump is an air conditioner that cools the house in summer, like any air conditioner, and heats the house in winter. In winter, the heat pump heats the house by "running backward" taking heat from the outdoor air and transferring it to the air within the house. In both cases and in the case of a refrigerator, heat is transported from a lower temperature space to a higher temperature space. Heat pumps may not be the best solution in South Florida where cooling is by far the dominant conditioning need because heat pumps do sacrifice some cooling efficiency to allow reversing between heating and cooling.

Benefits of Heat Pumps:

- Lower operating cost than other heating and cooling technologies - in Florida heat pumps can cut heating and cooling costs by 30 to 60 percent.
- Heat pumps supply constant, even temperature and humidity control for maximum indoor comfort.
- An optional hot water recovery package can supply free hot water during the summer months.
- Heat pumps are safe and easy to maintain because they have no pilot lights, flue vents, nasty odors or dangerous fumes.
- Utilities offer discounts since they have lower peak demand
- They are environmentally friendly because they reduce both outdoor noise and air pollution.

Most heat pumps are compact two-piece units with both indoor and outdoor components. There are three primary types of heat pumps:

Air-to-air (air source)

Air source heat pumps use air as a heat transfer medium.

Water-to-air (water source)

Water source heat pumps use water as the heat transfer medium. They take advantage of moderate groundwater temperatures in Florida to exchange heat and are generally more efficient than airsource models.

Ground-coupled (ground source)

Ground source heat pumps use the lengths buried in the ground to accomplish heat transfer using the earth instead of water or air to disperse heat. The system is very efficient but lacks the proven track record of the air to air and the water to air.

Heat pump efficiency depends on the outdoor temperature. The heating season performance factor (HSPF) is therefore higher in a mild climate than in a severely cold climate. In the cooling mode the heat pump operates as a central air conditioner. The seasonal energy efficiency rating (SEER) determines the seasonal cooling performance. Federal efficiency standards require that conventional heat pumps have an HSPF rating of at least 6.8 and a SEER rating of at least 10.0. The most efficient air source heat pumps have an HSPF rating between 7.7 and 10.0.

A heat pump is comprised of a closed circuit of pipes that circulate a refrigerant, often R-22. The refrigerant is never consumed or burned, but flows continuously within the closed piping circuit. While it circulates within the closed circuit it transfers heat from an evaporator coil to a condenser coil. Figure 4.3 illustrates this closed loop system.

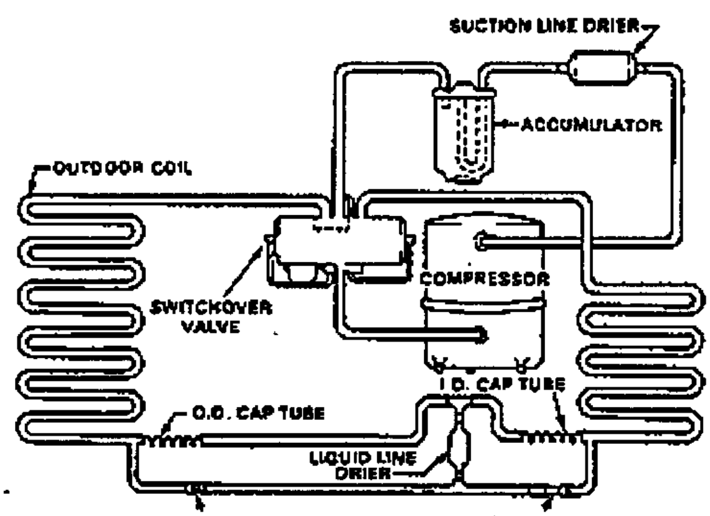


Figure 4.3 Heat Pump Operation

CASE STUDY ***HEAT PUMP***

To heat a typical 1500 sq. ft. home in north Florida in January may cost $160 (at $.08 per kwh) if an electric strip heater is used. If this heat were supplied by a water-source heat pump with an average Coefficient of Performance (COP) of 5.0, the electric heating bill would be about $32. This is a savings of $128 per month, neglecting the added capital cost of the heat pump.

Caution:

- Since water-source heat pumps require 1-2 gallons of water per ton per minute, price and availability of water should be considered.

LIGHTING

According to *Energy-Smart Building,* lighting accounts for approximately 5% of the average home's energy consumption. The basic concept behind lighting is to provide a comfortable visual environment when natural sunlight is not available. Proper lighting design provides visual comfort at low energy costs, and is very important to homeowners. Table 4.4 provides some simple energy saving lighting tips.

Table 4.4 Energy Efficient Lighting
✓ Offer dimmers or multilevel switches to control light levels.
✓ Specify timers and optical switches for exterior lighting.
✓ Try to install fluorescents in continuously lighted areas such as kitchens and in work areas such as laundry rooms.
✓ Design the home to take maximum advantage of sunlight as a daytime light source.
✓ Specify the new airtight cans for recessed lights.

LIGHTING TYPES

Incandescent Lighting

The traditional lighting for residential building is incandescent. Incandescent lamps only convert about 10 percent of the electricity they use to actual light.

Fluorescent Lighting

Fluorescent lamps only require about 25 percent of the energy that incandescent lamps use to produce the same amount of light, and have a longer life span. While this is a considerable energy saving, fluorescent lighting has long been considered undesirable for residential use due to the light spectrum (color) produced and the flickering and humming associated with fluorescent lights.

Compact Fluorescent Lighting

Compact fluorescents, a new type of fluorescent lighting, are overcoming some of these disadvantages, but are more generally more expensive than regular fluorescents.

Halogen Lighting

Halogen bulbs fall between incandecents and fluorescents in efficiency and have a clean, strong white light that is particularly useful in spot applications.

HOME APPLIANCES

Thirty-five to fifty percent of the total energy consumed in the average U.S. home is attributed to uses other than heating, cooling, and water heating. Appliances such as refrigerators, freezers, ranges, laundry equipment, lighting and small appliances are a large part of this usage. Refrigerators alone are estimated to make up 5 percent of the nation's total electric consumption, therefore it is important to carefully select appliances for energy efficiency.

APPLIANCES: HOW TO CHOOSE

Some appliances last up to 20 years. Because of appliance longevity, lifecycle or operating costs are a significant factor in appliance selection. A more efficient model may make economic sense even if the purchase price of the model is significantly higher. Table 4.7 provides suggestions regarding kitchen energy efficiency.

After the energy required for air conditioning and heating, the next largest user of energy in a home is the water heater. Water heating normally consumes 15-25% of all home energy. Natural gas water heaters are the most cost effective way to heat water. If natural gas is available, savings of 50-70% may be realized compared to electric water heaters. To make electric water heaters more efficient, they may be used in conjunction with solar energy or heat recovered from air conditioners or heat pumps.

Table 4.7 Energy Efficient Kitchen Layout
✓ All ovens, stoves, and clothes dryers should be vented to the outside.
✓ Timer switches on vent fans should be considered to ensure that vent fans are not left on, exhausting large amount of conditioned air to the outside.
✓ Placing refrigerators and freezers near an appliance that heats up, such as a stove, oven, or dishwasher, can reduce the energy efficiency of the refrigerator or freezer.

RENEWABLE ENERGY SOURCES

Florida is in a unique position because it is located in a part of the world where there is an opportunity to develop several alternative solutions to its energy needs. Florida's abundant sunshine and coastlines may hold the key to its ability to produce the electrical capacity needed for the twenty-first century.

There are several sources of renewable energy generation feasible in Florida: solar thermal energy, photovoltaics, wind power (along the coasts), and biomass power. These power sources may become a key to the future as Florida's energy requirements soar. The costs of generating energy from these renewable forms of energy will decline as the technologies to produce them become proven and they are massed produced. By the turn of the century, the cost per kilowatt-hour of some of these new technologies may be the same or less than power produced from the more traditional coal, gas, oil or nuclear sources.

SOLAR ENERGY

SUN / SOLAR

Florida's sub-tropical climate provides the numerous days of sunny weather that are necessary to take full advantage of solar technologies that convert the sun's energy to electricity. Solar power is becoming a more viable renewable energy source for Florida residents due to advances in the technology required to convert solar energy to electrical energy, and store it,.

SOLAR WATER HEATERS

Solar water heaters were introduced to Florida over sixty years ago. **Solar water heaters can provide nearly 100% of the required hot water in residential applications during summer months. In the winter the solar water heater can provide only 50 - 80% of the residential hot water needs and therefore must be supplemented by an electric or gas heating element.**

SOLAR ELECTRICITY - PHOTOVOLTAICS

The generation of electricity from the sun is not a new technology; it has been around for over thirty years in its current form. The primary obstacle to increased use of Photovoltaic (PV) systems is their high initial cost; however, photovoltaic panels, which produce solar electricity, have decreased in price by 50% during the last 10 years. The use of Photovoltaics results in much less pollution than other fuel choices. The primary strategy when using PV's as a power source is to reduce the need for electricity.

There are two approaches to using photovoltaics:

1. Stand Alone System
    - Does not use electric utility power
    - Requires batteries to store power when the sun is not shinning.
2. Grid Interface System
    - Uses power from the central utility when needed and supplies surplus home-generated power back to the utility when not needed.

Either approach (stand alone or grid interface) can be used partially with PV's being used in conjunction with a generator in a stand-alone system, or with the central grid power serving as a primary power source in a grid interface system.

Caution:

- Overall system costs are greatly influenced by installation and subsystem costs.
- Check local zoning regulations regarding the use of photovoltaics.

Design of a photovolatic system involves calculating the electrical load for a home and determining the proper system size needed to support the load. Photovoltaic systems consist of the main PV panels, inverters, controllers and wiring. Mounting the PV panels and back-up battery systems must also be considered.

CHAPTER 5 WATER CONSERVATION

INTRODUCTION AND STRATEGY

At first glance an individual might think the state of Florida would have an abundant supply of water. Nearly 90 percent of Florida's border consists of water, and the interior of the state contains numerous bodies of surface water. However, much of it is non-potable and not suitable for human consumption. The State's geographic character also increases the risk of saltwater intrusion into its aquifers and other fresh water supplies.

On average the State of Florida receives nearly 50 inches of rainwater annually, however, a majority of this valuable resource is never harvested for reuse. Rainwater takes one of three courses as it reaches the Earth's surface. It either percolates into the ground (infiltration), enters bodies of surface water such as streams, rivers, and lakes; (usually as runoff), or it reenters the atmosphere as water vapor (evapotransporation).

Surface water runoff generally enters one of the states' many rivers, steams, or lakes, and is then transported into either the Atlantic Ocean or the Gulf of Mexico becoming unusable for human consumption.

CONSUMPTION RATES

In spite of an average rainfall of 50 +/- inches per year and limited efforts to optimize scarce water resources, withdraw rates in Florida have increased dramatically. This increase in water consumption is mirrored by the steady growth in Florida's population as represented in Figures 5.1 and 5.2.

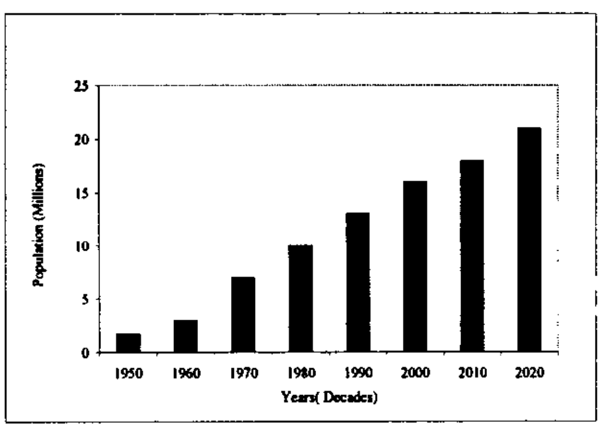


Figure 5.1 Population

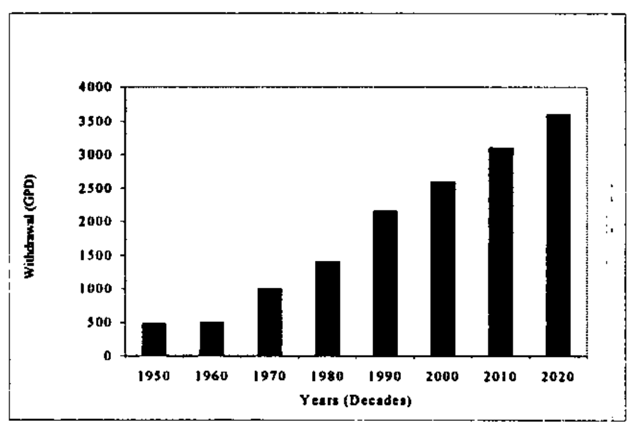


Figure 5.2 Water Consumption

WATER USES IN THE CONSTRUCTION PROCESS

Water use in the construction of a home or a development is minimal. Some of the basic water uses include the spraying of dusty construction areas with a tanker truck in order to reduce the impact on neighboring communities. The primary use of water in the construction process is as the key ingredient in cement. Water is also used for pressure testing of sewer and plumbing piping.

WATER CONSERVATION TECHNIQUES

Due to Florida's increasing water demands and decreasing potable water supply, it is necessary to implement water conservation wherever possible. Table 5.1 provides suggestions to reduce water consumption.

Table 5.1 Water Conservation Techniques
✓ Choose low-flow water fixtures
✓ Choose water conserving appliances
✓ Insulate water pipes
✓ Explore using non-potable water for irrigation and other appropriate uses
✓ Explore using graywater or blackwater systems
✓ Use rainwater harvesting to supply water for landscape irrigation
✓ Point source water heaters

Water conserving appliances are becoming increasingly available and are the easiest way to conserve water in a home. However, some of the most successful techniques to achieve large-scale water conservation depend on the use of non-potable water for landscape irrigation, and toilet flushing. Non-potable water is not intended for drinking, cooking, or personal hygiene. Non-potable water supplies include reclaimed wastewater effluent, graywater, and runoff from ground water surfaces. This water can be a viable alternative where potable water is often used, but not required. Figure 5.3 shows the percentage breakdown of wastewater created from a typical residence. A large percentage of this wastewater could be eliminated by the use of low flow appliances and fixtures.

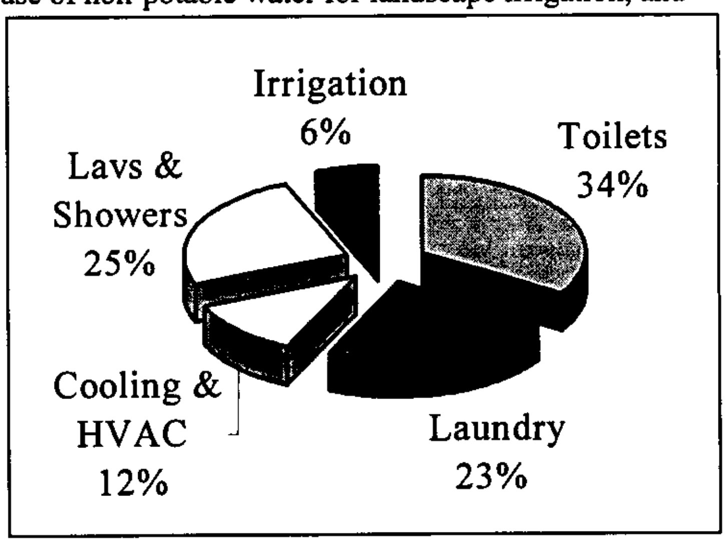


Figure 5.3 Wastewater flow characterization in typical residential structures

FIXTURES AND APPLIANCES

Installing low-volume appliances can reduce residential water use by as much as 30 percent to 40 percent. The 1994 U.S. Energy Policy Act (EPAct) created new federal standards for appliance efficiency. This policy requires all new plumbing fixtures to be water-efficient. Residential toilets are limited to a water use of 1.6 gallons per flush (gpf). Showerheads and faucets are limited to a water flow of no more than 2.5 gallons of water per minute.

FIXTURES

Toilets

Toilets consume the largest amount of indoor water, using more than one third of the water consumed in most homes. New low-flow toilets have a maximum allowable water use per flush of 1.6 gallons, older units use 5 gallons or more per flush. In homes with private wells, low-flush toilets also save energy by reducing the water pumping requirement to furnish the needed water supply. They also reduce the burden on septic systems and sewage treatment plants. Water conserving toilets are widely available, but must be carefully selected because of differences in performance quality. Recommendations from plumbing contractors are helpful in determining which models are most reliable.

Caution:

- Performance problems have been reported for some low flow toilets, particularly the inexpensive and imported models.

Alternative: Composting Toilets

Another option to consider is the composting toilet. Although not widely used, this toilet, depending on the model chosen, can completely eliminate or greatly reduce the need for water in the toilet. In the composting toilet, the human waste is transported to a large tank, where it is stored and allowed to decompose over time. Once a year a small amount of soil is removed from the bottom of the tank. Although not recommended for vegetable gardens, this soil is safe to use around trees or in flowerbeds.

Sink Faucets

Sink faucets represent approximately 10-12 percent of household water use. The new standards require a maximum flow rate of 2.5 gallon per minute (gpm) for faucets. While this may be useful in kitchens to fill up pots, in bathrooms a flow rate of just ½ gpm for facets is sufficient. Installing aerators on faucets can cut the flow rate in half.

Aerated Fixtures

Aerated fixtures incorporate air into the water stream in order to increase the pressure. An added benefit to installing an aerator is that the air bubbles help the flow feel heavier, so most people are not likely to notice the difference in pressure.

Shower Fixtures

In a normal household, lavatories and showers represent over 25% of total water use and over half of hot water use. **So reducing water use in showers will also result in energy savings due to water heating.** Low flow fixtures are available that provide sufficient results with only 1.5 and 2.0 gpm. A low flow fixture is classified as either aerated or non-aerated.

Caution:

- Shower fixtures should be rated for a maximum flow rate of 2.5 gpm at 80 psi, however many standard heads use up to 4.5 gpm.
- There are big differences in the quality of performance for the low-flow shower fixtures on the market so get recommendations.

APPLIANCES

Appliances such as dishwashers and washing machines can use more than 26 gallons of water per month. There are presently many manufacturers that provide units that yield significant water reduction. Washing machines designed on a horizontal axis (similar to those used in Europe) have recorded a 33% reduction in water use.

Features to look for when selecting a dishwasher

- ✓ Booster heater - This device is already on most models. It allows the temperature of a water heater to be kept lower (120 degrees) than the optimal dishwashing temperature by heating the dishwashing water up to the required 140-145 degrees within the unit.
- ✓ Energy-saving wash cycles - This feature offers a less energy intensive wash cycle if dishes are not very dirty. Some advanced units have a feature called "fuzzy logic" which can sense the level of cleaning needed for a particular load of dished and switch to energy saving modes automatically.
- ✓ No-heat dry cycle - This feature turns off the electric heating element in the dry cycle and uses the alternative of circulating room temperature air through the unit instead.

INSULATING WATER PIPES

Another simple way to save both water and energy is to insulate hot water pipes. Insulating of pipes helps prevent water being wasted while waiting for hot water. Water can stay warm up to two hours in a well-insulated pipe, as compared to about 20 minutes in a non-insulated pipe. Insulating pipes reduces the "warm up" time if the water is used more than once in a short period. Insulating cold-water pipes can reduce condensation or "sweating". The additional moisture from condensation can generate mold growth that may lead to allergies and other indoor air quality problems.

ALTERNATIVE SOURCES AND DISCHARGES

WASTE WATER MANAGEMENT

Wastewater is considered to be all water that has been used for human consumption and must now be treated for reuse. Human consumption includes all water that is reintroduced into the plumbing system via toilets, sinks, shower and bathtubs, and any other drain that captures excesses or polluted water. Wastewater can be classified either as graywater or black water.

CASE STUDY — ***WATER USE IN FLORIDA***

"Water reuse has been practiced in Florida since the early 1970s. In this relatively short time, reuse has become a central part of state water management policy. The State Comprehensive Plan endorses " the use and reuse of water of the lowest acceptable quality for the purposes intended." The Florida Statutes and Administrative Code encourages water reuse for many purposes, including landscaping. By law, new wastewater treatment facilities in critical water supply problem areas (most of Florida) must provide reclaimed water if determined to be economically and environmentally feasible. Also by law, developers must comply with local reuse programs. Already, one-fifth to one-third of all treated wastewater is reused in the St. Johns River, South Florida, and Southwest Florida water management districts. It is projected that over half will be reused by the year 2010."

GRAYWATER

Graywater is wastewater generated from uses such as laundries, shower, and sinks. Graywater can be reused for toilet-flushing and irrigation purposes through the use of a dual plumbing system to separate the graywater from black water. Check local health-code departments to determine requirements and restrictions regarding the use of graywater. Graywater irrigation systems are usually required to be subsurface. Other guidelines such as setbacks and backflow preventers may also apply.

BLACK WATER

Local health departments should be consulted about the treatment and definition of black water. In some areas black water is water that has been used in toilets, in others it also includes water from kitchen sinks or laundry facilities. Black water must be treated before reuse, but this treatment can occur on-site. The level of treatment is determined by the quality of wastewater to be treated and the water quality objectives of its intended use . Local health departments usually regulate type and acceptable levels of treatment required.

RAINWATER HARVESTING

Rainwater harvesting is collecting rainwater runoff and storing it for specific uses such as irrigation. Irrigation only requires screen or paper filtering, however, with additional treatment, rainwater can be potable. Roofs are often used as catchment areas, although other surfaces may be used. The water is then directed into a collection container, such as a cistern or storage tank. After the water is collected it must be pressurized to be used in an irrigation system.

Cisterns have been widely used in areas that have experienced severe water supply problems. Cisterns can be used for all potable (drinking, cooking personal hygiene) water needs, provided they are properly constructed and maintained. They can also be used for any non-potable application including irrigation, toilet flushing, and vegetative landscapes. Rainwater has superior cleaning abilities and can extend the life of appliances such as water heaters and coffeemakers in areas with hard water.

CASE STUDY ***RAINWATER HARVESTING IN FLORIDA***

With an average yearly rainfall of over 50 inches, Floridians could potentially eliminate their need for municipal water. An average home with a roof area of 2000 square feet could produce 1,400 gallons of water for every inch of rain. Therefore, this roof could potentially collect 70,000 gallons of rainwater in a year's time. This equates to 190 gallons of water per day. This, combined with other water conserving strategies, could provide a sufficient supply of indoor water for a two-person household.

COLLECTION SYSTEM

A rainwater harvesting system has several basic components. They include a catchment area (the roof), the conveyance system (guttering, downspout, piping) the filtration system, the storage system, and the distribution system. Some tips on these are shown in Table 5.2.

Table 5.2 Tips on Rainwater Collection
✓ Use appropriate roofing materials. Metal, clay and concrete are the best. Asbestos and lead-containing materials are not recommended.
✓ Appropriately size gutters and downspouts for the roof area and rainfall intensity.
✓ Install screening so leaves and debris do not enter the storage area.
✓ Install a roof-washer, which is a device that will prevent the initial runoff from a rainfall from entering the storage area. This first flush of water is usually contaminated with residue from the roof.
✓ Construct cistern storage. Cisterns can be purchased in prefabricated form or constructed on site from concrete, ferro-cement, stone or compressed earth. Interior surfaces must be watertight and they must be covered with an opaque material to prevent contamination, mosquito breeding, and algae growth, which can occur from exposure to sunlight.

WATER QUALITY

If the local air quality is poor, the rainfall may be contaminated and highly acidic. Such water is usually not a good candidate for reuse. If there are a lot of overhanging tree branches around the catchment area, the water may be discolored and contain debris which will have to be filtered out. Check local health-code departments to determine what the regulations require regarding the use of rainwater.

CASE STUDY — ***RAINWATER HARVESTING: CISTERNS***

W. Terry Osborne and June Engman built a pair of model houses side-by-side for the Sarasota County Cooperative Extension Service to demonstrate building houses that are environmentally appropriate. The first house, in the traditional cracker style (1600 ft^2 with 800 ft^2 of porches), is now complete. This home features pocket doors that open up to 16' for maximum cross ventilation, a cupola over the kitchen, natural pest control instead of toxic soil treatments and an engineered wood product called Timberstrand™ instead of solid wood studs.

The rooftop is detailed for rainwater collection. Rainwater is collected off the metal roof via gutters into two 5,000-gallon cisterns that stand above ground at each end of the house. The zinc in the galvanized metal roof prevents microorganism growth, and the cisterns are shaded to keep the water cool. The cisterns contain an ionizing system that keeps the water clean by releasing individual metallic ions into the water. The water collected is used for irrigation, laundry, and toilets in the house.

A settling tank that collects debris off the roof protects each cistern. After the settling tank has filled, water flows through a pipe into the cistern (see Figures 5.4 and 5.5). A pressure tank draws water from the cisterns and keeps it ready for use.

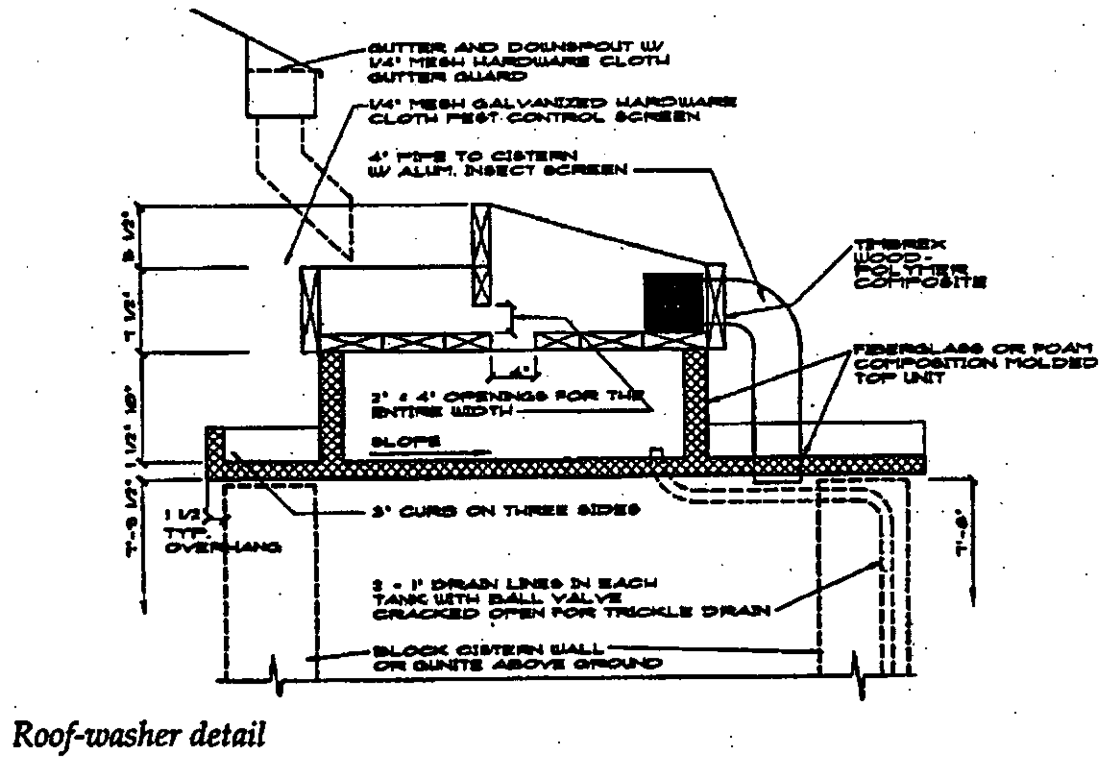


Figure 5.4: Roof-washer detail

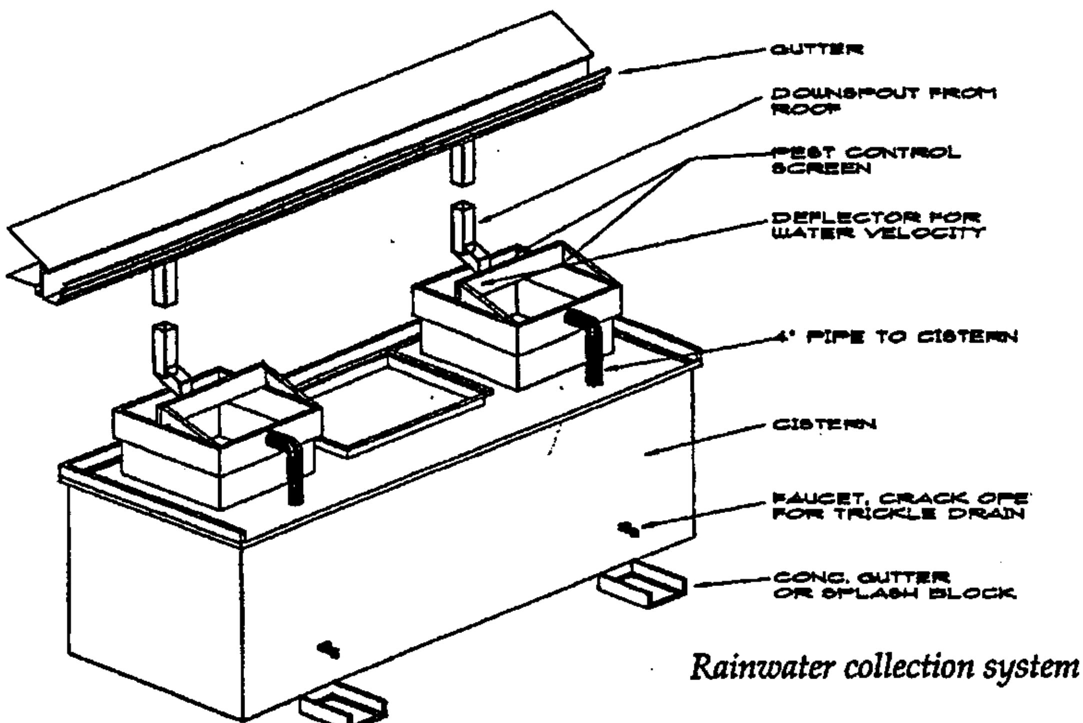


Figure 5.5: Rainwater Collection System

CHAPTER 6 INDOOR ENVIRONMENTAL QUALITY

THE IMPORTANCE OF INDOOR ENVIRONMENTAL QUALITY

What is Indoor Environmental Quality?

The indoor environmental quality of a home not only refers to its air quality, but must also considers the noise or sound, quality of light, temperature, and humidity.

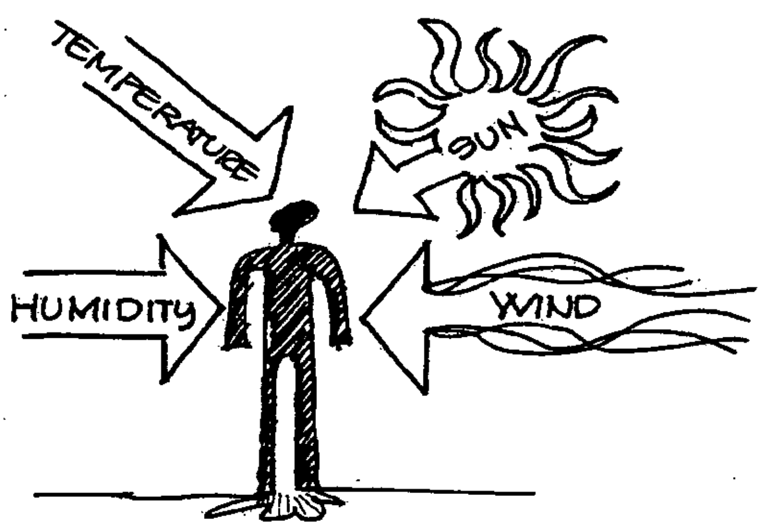


Figure 6.1 Elements effecting human comfort.

One of the lesser-known benefits of green construction is the health benefit it provides to the occupants of the finished buildings. The indoor environment of a home is a critical issue for many people who are highly allergic or have respiratory problems. Careful consideration during design, material selection, and construction will improve indoor environmental quality. Table 6.1 illustrates several factors that effect indoor environmental quality that should be considered when designing and selecting materials based on indoor environmental quality.

Table 6.1 Factors Affecting Indoor Environmental Quality.		
Source Factors	**Environmental Factors**	**Occupant Factors**
Chemical properties	Temperature	Genetics
Physical properties	Humidity	Gender
Toxicity	Light levels	Personal habits
Concentration	Noise levels	Diet
Duration of exposure	Pressure differences	Age
Route of entry	Presence of other contaminants	Health

CAUSES OF POOR INDOOR ENVIRONMENTAL QUALTIY

In the last twenty years, homes in the State of Florida have become dependent upon mechanical equipment to make them more comfortable in a hot and humid climate. With this trend, homes are being built with a tighter envelope. This envelope allows the homeowner to retain a desired interior air temperature but limits natural ventilation and air circulation.

Problems associated with poor indoor environmental quality include physical illness and mental conditions and loss in productivity. Poor air quality, lighting, and other indoor conditions often cause these problems. Most if not all of these problems can be overcome with proper attention and care during the initial building design. Table 6.2 identifies some key factors that may result in poor IEQ.

Table 6.2 Factors causing poor indoor environmental quality
✓ lack of the home's ability to "breathe"
✓ some building materials
✓ artificial content produces off-gassing of harmful chemicals
✓ radon infiltration through cracks and passages between the slab and the ground below.

AIR QUALTIY

When a building has an undesirable indoor air quality it is often referred to as being "sick". Sick buildings often cause occupants to have symptoms such as headaches, watery eyes, nausea, skin disorders, and fatigue. These symptoms often occur in homes where occupants are exposed to a buildup of air pollutants from household products, building materials, formaldehyde, and/or respirable particles.

In Florida, sick homes are usually houses with a severe moisture problem. Moisture is a major influence in promoting the growth and spread of mold (mildew) within the home. When people are repeatedly exposed to mold they can develop allergic symptoms and fatigue.

VOCs

Volatile organic compound or VOCs are carbon based organic chemicals that evaporate rapidly and give up vapors that can be inhaled. VOCs are base components of many types of "wet" building materials such as paints, solvents, varnishes, and resins.

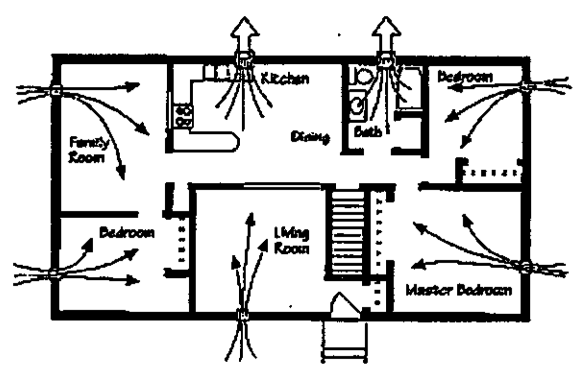
Types of VOCs

"Wet" products, as they dry, will emit VOCs. Emissions taper with time and continue at decreasing levels throughout the life of the product.
"Dry" products, off-gas in a brief burst when the product is unwrapped and exposed to the air. This is due to the manufacturing process of products.
"Re-emissions" from surfaces that had absorbed VOCs from other products. This is most often found in heavy fabrics and carpeting.
"Emission" of VOCs is most often caused by maintenance and cleaning products. To combat this type of VOC, materials with lower maintenance requirements should be selected during the design phase of the project. The less cleaning, polishing, and waxing needed the lower the VOC emission.

Some of the most common sources of VOCs are listed below. It may be noted that these are all found inside a typical residence. Table 6.3 provides suggestions to decrease the level of VOCs within a home.

Combating Poor Indoor Air Quality

Controlled mechanical ventilation is one key element in ensuring good indoor air quality. Mechanical ventilation systems all use fans to pull air out of the house exchanging the indoor air with clean outdoor air. It is common to install "exhaust only" systems which pull air out mechanically and the replacement air enters the home passively. Exhaust only systems can be as simple as beefing up the range hood and bathroom fans, and wiring them to allow for continuous, low speed operation. A more expensive, but generally more satisfactory option is a centralized exhaust fan with ducting to draw air from several locations in the house. Figure 6.2 below shows how well positioned supply and exhaust ports distribute fresh air throughout this single story house.



Well-positioned supply and exhaust ports distribute fresh air throughout this single-story house.

Figure 6.2 Positioning Exhaust Ports

Sources of VOCs

Adhesives	Pesticides	Floor and wall coverings
Carpet glue	Vinyl	Gasoline
Chlorine Bleach	Wallpaper glue	Liquid detergent
Dry cleaning agent	Carpet	Particleboard
Furniture wax	Caulking	Solvents
Joint compound	Cleaning fluids	Wallboard
Paint		

Table 6.3 VOC Design criteria
✓ Minimize wall-to-wall carpet
✓ Create air breaks between garage and living spaces
✓ Separate duct insulation and cabinetry particleboard from the interior air stream
✓ Eliminate use of vinyl wallpaper on interior walls
✓ Minimize use of "wet" applied materials (paint and adhesives)
✓ Use durable materials. Minimize use of manmade fibrous insulation; when used, ensure complete separation of fibers from interior air stream to eliminate the need for strong cleaning chemicals.
✓ Eliminate use of solvent based products of any kind
✓ Use water based adhesives with no or very low VOCs
✓ Use water based paints with no or very low VOCs
✓ Eliminate use of carpet adhesives
✓ Minimize use of vinyl plastics, and if used, only outside of the living space
✓ Keep solvents, pesticides, and other toxic material separate from living spaces

FORMALDEHYDE

Formaldehyde is one of the most harmful VOCs used in construction materials. Formaldehyde (HCHO) is a colorless VOC gas with a pungent odor from a family of gases called aldehydes (acrolein and acetaldehyde). Formaldehyde is highly soluble in water, and can be irritable to all body surfaces normally containing moisture, such as the eyes and upper respiratory tract.

Caution:

- It is important to note there are different types of formaldehyde, phenol and urea. Phenol formaldehyde offgasses less VOCs than Urea Formaldehyde (UF).

Formaldehyde Sources:

- Vinyl flooring
- Some glass products
- Packaging material.
- Fabrics and other building surfaces (absorb formaldehyde and release over time)
- Carpet glues

Caution:

- Adhesives used for interior grade plywood and particleboard. Particleboard is composed of small wood shavings glued together with UF resin and is used in buildings for subfloors, partition walls, paneling, cabinets, and furniture.
- Urea Formaldehyde foam insulation (UFFI) contains UF resins and has been used as insulation in walls. (Currently illegal)

FORMALDEHYDE FACTS

CASE STUDY — *EFFECTS OF TEMPERATURE AND HUMIDITY ON FORMALDEHYDE OFFGASSING*

A 70% reduction in formaldehyde can occur with a temperature reduction from 75 to 68 F, and a 40% reduction can occur by reducing the relative humidity from 70-40%. The use of an air conditioning system and/ or dehumidifier can be used to reduce the levels of formaldehyde.

Some important factors regarding formaldehyde potency follow:

1. **Time** - A product's urea formaldehyde potency decreases with time.
2. **Temperature**- For every 10°F rise, the potency doubles
3. **Relative Humidity**- Every one percent rise in relative humidity raises the formaldehyde level by one percent.
4. **Fresh Air**- The amount of fresh air in a house depends on the outside temperature. The greater the temperature differential, the more fresh air, and the lower the formaldehyde concentration.
5. **Coatings**- Paint, shellac, varnish and lacquer can seal in the formaldehyde fumes. Coatings, sealants and solid barriers can be used to cover pressed wood products.

SOUND / NOISE

The sound and noises within a home are also considered to be environmental criteria for determining its healthiness. Consideration should be given to locate the home on a site where it does not have direct exposure to high traffic roads. The design of the home can also place areas or rooms that require a quieter environment to the rear or away from problem areas. See Chapter 2. Proper insulation can also reduce noise infiltration into the interior environment.

LIGHTING QUALITY

Good lighting is an essential element in the ability to provide a high quality indoor environment. It is well accepted that natural sunlight is the best light source for vision and health, but typical artificial light lamps do not reproduce natural daylight. The ideal situation for a healthy indoor light environment is to provide natural light indoors with windows and skylights, or to replicate as nearly as possible natural light. Refer to Chapter 3.

Incandescent lights, particularly halogen, give the best color rendition of natural light. Fluorescent and mercury vapor lights give white light with a distinct preponderance of blue frequencies. Fluorescence can be made to offer more in the warm range. General Electric refers to this type as "warm whites". Refer to Chapter 4.

Caution:

- Typical residential lighting focuses more on lighting a room than lighting the area of activity.
- Uneven lighting and glare cause irritation and eye strain because of the difficulty the eye has in adjusting to different light levels simultaneously.

Table 6.4 provides general lighting quality guidelines.

Table 6.4 Lighting Quality Guidelines
✓ Low illumination is more restful than high illumination
✓ Flexible arrangement and control systems can be more energy efficient than an emphasis on general lighting
✓ Artificial light level of 6 foot-candles measured at a height of 30 inches above the floor in considered adequate area lighting in residences
✓ Task lighting is best for focusing increased levels of illumination on specific areas in the most energy conserving way.
✓ For reading and other concentrated visual tasks use higher levels of illumination (20-50 foot-candles)
✓ Indirect up-lighting has been shown to be preferable over down-lighting in reducing eyestrain

TEMPERATURE

Air temperature is a comfort factor that can be relatively subjective and can be influenced by additional factors such as radiant heat and air movement. ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) has established ranges for comfort levels in summer and winter for 80% of the general population.

> The temperature comfort range, with light clothing in the summer and long sleeves and slightly heavier clothing in the winter is 68° to 76° F at 30% relative humidity.

The temperature in homes can be affected by many factors (both passive and active) including, but not limited to radiant heat gain, ventilation, and humidity. The optimum approach is to provide a comfortable indoor environment without the need for mechanical assistance. Refer to Chapter 3.

HUMIDITY

Humidity is usually measured by relative humidity, which is the percentage of the amount of moisture in the air relative to the amount of moisture needed to totally saturate the air at the given temperature and pressure. Warm air can hold more moisture, and given the water surrounding Florida, high relative humidity is typical, particularly in the summer. High humidity inhibits evaporation of perspiration, which in turn prevents the body from further perspiring, possibly leading to overheating of the body. Air movement can actually increase a feeling of cooling at the same temperature by facilitating the removal of perspiration by evaporation.

For more information on how to increase air movement to provide personal comfort refer to Chapter 3.

CHAPTER 7 CONSTRUCTION MATERIALS & TECHNIQUES

INTRODUCTION AND STRATEGY

Climatic conditions influence the ability to maintain interior thermal comfort. The functional relationship between the building design (Chapter 3), construction techniques and material selection will define how successfully the building envelope responds to the climatic influences, thereby resulting in an energy efficient and environmentally sound building.

THERMAL ENVELOPE

The thermal envelope consists of the structure that isolates the home's interior from the effects of the surrounding climate. Everything between the inside and outside – walls, doors, windows, roof, floor, and foundation are a part of the thermal envelope. As Figure 7.1 shows, the function of the envelope is to control the conditioned inside space from the outside temperature, humidity and precipitation.

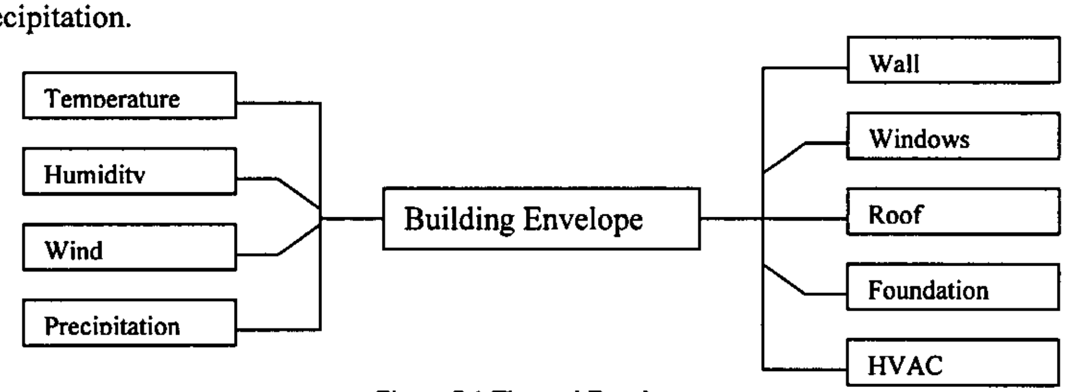


Figure 7.1 Thermal Envelope

MATERIALS

Use of green building materials can offer both financial and environmental benefits. The first step in ensuring the use of green materials is to specify green materials into your design. However, if you do not have control over the design, green materials may easily replace traditional materials throughout the construction of a residence.

To a contractor or builder, the driving force is often cost. However, the use of green materials does not necessarily mean an increase in cost. It may also be noted that the consumer may agree to additional initial costs when the financial payback for these materials is proven. It is also understood that new materials are often avoided due to their limited track record and the lack of information available to those purchasing the materials.

Green Materials consider the following three general concepts:

1) Minimize natural resource depletion
2) Protect ecological systems
3) Minimize pollution and toxins

This Chapter will:

1) Further elaborate on selection criteria
2) Identify materials to be avoided and
3) Offer suggestions and alternatives to traditional materials.

TECHNIQUES

Traditional construction techniques, although tried and true, may not be the most environmentally beneficial method to construct a residence. Many of these traditional techniques may be slightly altered, resulting in the use of fewer materials while providing a higher quality and more energy efficient structure. This Chapter will introduce the variety of green construction alternatives that result in greater energy efficiency and conserve materials. Alternatives to traditional construction techniques will also be introduced.

MATERIAL SELECTION CRITERIA

There is no simple way to evaluate building materials. Most materials have both positive and negative environmental impacts. This Chapter is not an attempt to select materials for the consumer, however, it is written to provide the consumer with the knowledge needed to make an informed decision when selecting materials. Each project will have its own set of environmental goals and preferences. Material selection itself is based on many factors, among the most common are cost, aesthetics, and properties specific to that material. It is recommended that the following environmental impacts of each material also be considered:

1. **Raw Material Acquisition:** The impacts of the raw material extraction vary greatly depending on extraction techniques, geographical location, and the extraction company's commitment to the environment. One aspect of green construction is trying to limit the overall impacts on the environment, including impacts from the extraction of raw materials.

2. **Manufacturing:** The manufacturing process of many materials can have vast environmental impacts. Due to stricter environmental regulations and many companies realizing that there is money to be made in recycling their own manufacturing waste, many processes are becoming more environmentally responsible.

3. **Shipment and Packaging:** Shipping and packaging must also be considered when assessing the overall environmental impact of materials. For example, marble may be the perfect material based on aesthetics and durability, however, if the marble must be shipped from Italy the environmental repercussions from the fuel and energy required to transport the material are significant. Additionally, the making of packaging materials could potentially have greater detrimental environmental impacts than the material itself. To the consumer, shipment and packaging ultimately increases the material cost. To the builder, packaging results in an increase in disposal, and therefore, project costs.

4. **Installation:** The installation and construction technique itself may be wasteful—this Chapter offers material conserving construction techniques.

5. **Waste:** The waste created from construction accounts for upwards of 24% of Florida's solid waste management burden. Therefore, being conscious of the waste produced and using techniques to limit and reduce the waste produced are equally as important as selecting environmentally friendly building materials in the green building concept. Waste reducing construction techniques are further discussed in this Chapter. Suggestions regarding waste management are discussed on Chapter 8.

6. **Life Cycle:** Life cycle and life cycle cost accounting are key issues in selecting environmentally sound materials. Life cycle takes into account the initial cost of the material, operating and maintenance costs, and any potential salvage value of the material. As one may expect, the life cycle cost takes into account the "durability" of the material over the life of that material.

7. **Disposal:** Here are two distinct meanings regarding disposal. During construction, consideration should be paid to the resulting disposal costs of the waste created throughout the construction process. The second disposal consideration is after the residence has passed its service life. Eventual demolition, deconstruction, or renovation of the structure may result in large disposal burdens. The key to reducing this burden is selecting durable materials and constructing a versatile, adaptable structure.

8. **Energy Efficiency:** Energy efficiency is the ultimate environmental goal. When we consider energy efficiency, not only are we looking at the energy efficiency of that material during its "operation" but also the energy efficiency associated with the previously stated items. Items such as the extraction of materials, manufacturing, and life cycle considerations all relate ultimate energy efficiency. When defining energy efficiency it is important to consider the minimum required building codes and their minimum required **R-values** relative to the insulating factor inherent in or built into certain materials. For example, windows have an R-value of 1 whereas the R-value of insulation depends on the type and thickness of the

insulating material. **The R-value may be simply defined as insulating capability**, for example, R-10 insulation is twice as effective as R-5.

9. **Water Efficiency**: Water efficiency is important in green construction and is further discussed in Chapter 5.

10. **Construction Cost**: Construction costs may be reduced by the use of Green building techniques. Green building techniques value engineer the construction process and provide non traditional material saving techniques. Construction cost may be lowered through the use of fewer materials and by reducing the waste generated on the construction site. Less waste will result in a decrease in disposal cost for the project.

11. **Building Maintenance**: Building operation and maintenance is often a result of the quality of construction and the selection of durable materials. Using Green building techniques results in a more sound building, reduces potential problems at the source such as reducing infiltration and passive solar heat gain. Infiltration and heat gain through windows significantly increase the need for air conditioning resulting in greater wear and tear on the homes mechanical systems. This results in additional operating costs to the owner as well as additional replacement costs.

Selection criteria for building materials can and will vary depending upon the environmental goals of the project. Environmental goals for each project will vary depending on the owner's desires and project specifications. It is important to first maximize the energy efficiency and then set goals such as using recycled content materials. These choices will ultimately determine the best materials and construction procedures for each specific project. Consideration should be given to the following when selecting building materials:

1. Saving Energy – Design and build energy efficient buildings
2. Low-Impact Materials – Specify low environmental impact, resource-efficient materials, recycled content materials.
3. Maximizing Longevity – Design for durability and adaptability
4. Healthy Building – Provide a safe and comfortable indoor environment.

These goals are provided as an example of important material selection criteria that will result on a Green residence. With the primary goal of saving energy, the consumer will benefit over the life cycle of the home. It will be easier to justify some additional initial cost to the homeowner if the ultimate payoff regarding energy efficiency is clear.

GENERAL SELECTION GUIDELINES

Table 7.1 outlines some general guidelines regarding material selection. The "use" column identifies characteristics of "Green" materials. The "avoid" column identifies characteristics that may ultimately contribute to negative environmental repercussions. For example, adhesives, depending on their origin, release VOCs as discussed in the indoor environmental quality Chapter. For this reason, when selecting materials it is necessary to consider all components of that material. Composite materials may be durable, however present a disposal problem after their service life. The table identifies more of these innate material characteristics.

Table 7.1 General materials to use and avoid	
USE	**AVOID**
✓ Low toxicity products ✓ Low emission products ✓ Materials with recycled content, for example, concrete containing fly ash and recycled aggregate. ✓ Products and materials with reduced packaging ✓ Durable materials ✓ Locally produced materials ✓ Salvaged building materials ✓ Materials in their natural state ✓ Organic solvent-based floor finishes, paints stains ✓ Durable reusable concrete forms ✓ Wood treated with less toxic wood treatment such as Alkaline Copper Quat (ACQ) or recycled plastic lumber ✓ Expanded polystyrene which does not use HCFCs are better than materials containing HCFCs such as extruded polystyrene rigid foam insulation	**Adhesives** (release VOCs) ☞ Materials made from products that off-gas VOCs (VOCs are discussed in Chapter 6) **Composites Materials** ☞ Materials combining many types of products are difficult to recycle or reuse. **Hazardous Materials** ☞ Limit use of hazardous materials. Hazardous materials are difficult to dispose of after their service life and are hazardous to construction personal and the occupants. ☞ Materials such as pressure treated wood treated with Chromated Copper Arsenate (CCA) are hazardous to the environment and create potential disposal problems.

CONSTRUCTION TECHNIQUES TO REDUCE WASTE

1. **Increased Spacing of Joists and Studs** – This can potentially reduce the amount of framing material required by 30%.

2. **In Line Framing** – Aligning framing members such as trusses, studs, and joints to bear directly over each other. This is the most efficient way to transfer loads from the roof to the foundation. Using this technique regardless of the spacing of framing members, allows the use of a single top plate.

3. **House Configuration and Roof Design** – A house plan with overall dimensions on a two-foot module permits the optimum use of floor and wall materials. Modest changes to the pitch of the roof or the width of the overhang can reduce the amount of material required and the amount of waste generated.

4. **Excessive Waste Factors and Take-Off Tools** – In many cases, the combination of waste factors and take-off tools results in estimates with excessive overages. Usually all material delivered to the site is used up regardless of the waste factor assumed. Therefore, it is important to estimate and order accurately.

5. **Construction Drawings** – A detailed set of working drawings provides the basis for accurate material estimates. These drawings include:

    - Standard floor plans and elevations
    - Detailed framing plans (including joist layout and stud plans)
    - Floor and roof sheathing plans
    - Miscellaneous framing details

6. **Separation of Reusable Lumber** – Cutoff wood waste can be used for bridging, stakes, bracing, shims, drywall nailers, and blocking where interior walls run parallel to joists or trusses. Similarly, cutoff sheathing waste can be used for drywall stops and furring.

7. **Header Size** – Use header tables in local codes – headers in non-load-bearing walls can be eliminated

8. **Relocating Doors, Windows and Stairs** – Moving the horizontal position of such openings as doors, windows, and stairwells to coincide with modular studs reduces the number of framing members required to frame a wall or floor. Although a desired aesthetic, furniture layout, or mechanical requirements often limit moving some openings, others can be shifted slightly without adversely affecting the home's form or function.

9. **Corner details** – The stud/block/stud detail is commonly used for framing many corners. The two stud/1x backer detail and ladder framing detail reduces the number of studs required to frame outside corners and intersecting walls. **SEE the section on WALL SYSTEMS later in this Chapter.**

FOUNDATIONS

Provide a solid area for constructing the building envelope. The floor placed on the foundation is designed to maintain interior temperature.

CONCRETE SLAB

The concrete slab foundation is one of the most popular systems in use today. Concrete is inexpensive and relatively easy to install. The most common problems associated with a concrete slab are moisture and heat / cold intrusion. Concrete slabs may also pose other problems such as cracking from settling. Retrofitting and major renovation to repair utilities under concrete slabs are difficult, time consuming and expensive. Lack of a proper vapor barrier, both in placement and thickness, can result in excess moisture intrusion into the residence.

CRAWL SPACE

In comparison to the slab-on-grade, the crawl space provides many advantages. The space can be incorporated into a passive cooling system by allowing improved air circulation in the raised living space. Another advantage is the crawl space provides easier access to mechanical, electrical and plumbing (MEP) systems allowing for renovations, repairs and retrofitting. Of other interest is the potential for deconstructability: the materials used in the construction of the crawl space can be removed and reused.

Insulating crawl spaces reduces the quantity of materials needed for insulation. This is based on insulating the walls of the space versus insulating the entire floor space. However, it requires more attention to sealing and caulking than non-insulated crawl spaces. Note that crawl spaces are substantially more expensive than slab on grade construction.

ALTERNATIVES

There are alternative foundation systems available that can reduce concrete use and increase energy efficiency. These products consist of stay–in–place concrete forms made of polystyrene foam or a cementitous matrix of recycled foam or recycled wood fibers. Precast concrete foundation walls use less concrete than site-cast foundations, and are designed to accommodate interior insulation.

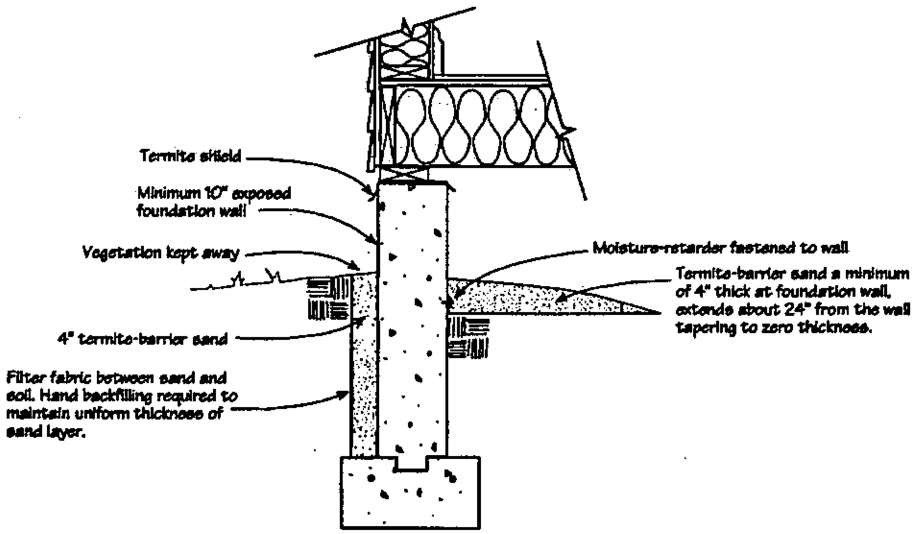
Caution:

- Non asphalt based dampproofing reduces the risk of leaching chemicals into local aquifers.

☞ Recycled aggregate or crushed glass can be specified for use in the concrete or as backfill for foundation drains.

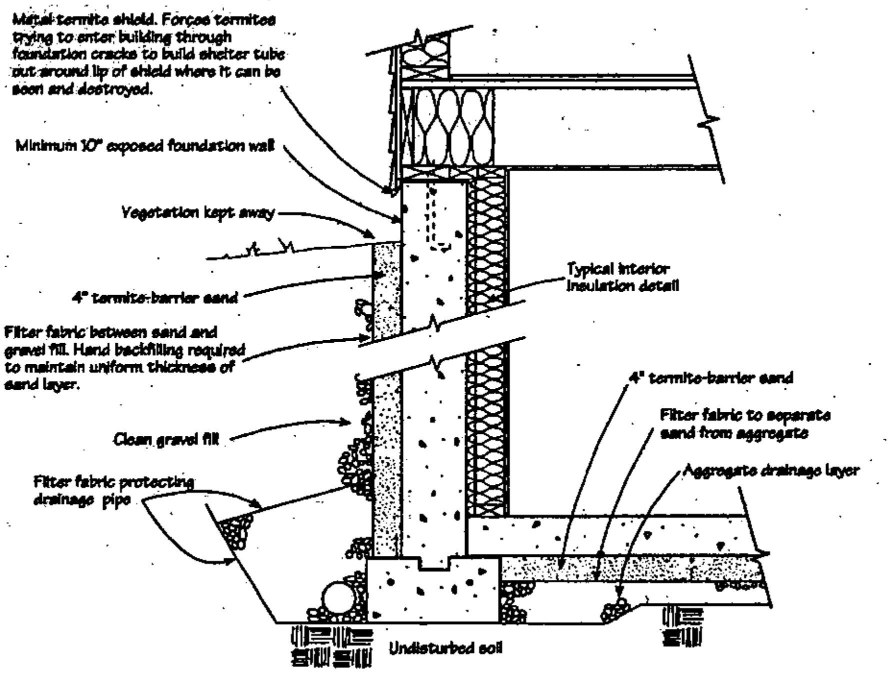
TERMITE CONTROL

The most common termite proofing treatment today is chlorpyrifos (Dursban®). This is applied to the ground around buildings and directly to building elements. Concern for human health and the environment has resulted in the move toward nontoxic termite control. Foundations can be designed with a termite shield or backfilled with special termite proof sand to reduce the use of toxic soil treatments. The theory behind termite-proof sand is that termites cannot tunnel through the sand, and therefore cannot infiltrate the home. Figures 7.2 and 7.3 show sand termite barriers for both crawl space and full height foundation walls.



Sand barrier with crawl-space foundations

Figure 7.2 Sand barrier with crawl space foundation



Termite-barrier sand with full-height foundation walls

Figure 7.3 Sand barrier with full height foundation wall

WALL SYSTEMS

As part of the envelope, the function of a wall is to provide an enclosure from the exterior elements. Because most of the year the outdoor temperature or humidity is not within the standard guidelines of thermal comfort, walls are constructed to provide a thermal division between the conditioned interior space and the outside. The two types of wall construction most frequently used are light framing with either wood or steel and concrete block.

Next to glass, walls generally account for the largest amount of energy loss from a house, about 15 to 20% . There are several factors that effect the energy performance of walls. These include insulating characteristics, surface area, infiltration and thermal mass.

Wood Framed Walls

One advantage of wood is the familiarity of timber construction. Wooden members are more easily manipulated, cut and shaped on site than steel members. However, often there is more waste material generated from wood framing than from steel construction. The most energy consumptive process for making dimensional lumber from logs is the kiln drying. Often scraps and bark from the debarking, sawing and planing stages are used to heat the kiln (which is a recycling process within itself).

Wood is biodegradable, and can be recycled or reused, however it is slightly more labor intensive to recover. Ultimately the environmental impact of wood use depends on the extraction and harvesting methods and the geographical area.

Wood can be one of the greenest building products if purchased from a certified sustainable forest. Collinswood® Certified Plywood is an example.

- ✓ Renewable resource
- ✓ Possibly reusable or recyclable
- ✓ Established codes and track record
- ✋ Treated wood, although durable, releases toxins and requires special consideration for disposal
- ✋ Inconsistent quality (can warp on site)
- ✋ Price fluctuations

Insulating Properties

Wood may also be the material of choice regarding insulating properties. The use of 2x6s in construction vs. using 2x4s can offer some advantages. First, you will use fewer 2x6s, since you can increase the stud spacing. It should be noted that there is no real net savings in material; although fewer 2x6s are used, their size is larger, resulting in approximately the same net material usage. By using 2x6s you increase the wall cavity (thickness) which will allow for a thicker insulation resulting in more energy savings. This added thickness also adds to the aesthetics of doorways and windowsills.

For builders desiring to super insulate their walls, using 2x4 inch stud system with R-11 batts and R-5.4 or 7.2 foil back rigid insulation as sheathing provides an excellent system complete with infiltration and moisture control if the seams are caulked or sealed properly. This system is superior to a 2x6 inch stud system with R-19 batt insulation because the studs and gaps in the batts are insulated by the insulated sheathing and will provide better infiltration control.

Waste Issues

Framing lumber is one of the largest material purchases and the largest component of the waste stream. Designing and framing a house efficiently can reduce the required amount of material and decrease disposal costs.

To reduce waste, it is important to once again consider design, engineering, estimating and framing. Be prepared to implement changes with the architect, estimator, and framing crew(s). The following Case Study shows savings from some techniques listed in the general strategy section at the beginning of this Chapter. Some techniques are further discussed following the case study.

CASE STUDY ***MATERIAL SAVINGS***

Builder: Caruso homes
House Type: 2,300 ft^2 single family detached

Technique	Savings
Accurate take-off tools	$ 595
Increased spacing for floor joists from 12" to 19.2"	$ 412
Modular Roof Design	$ 194
House configuration (modular overall dimensions)	$ 124
Reduced header sizes	$ 39
TOTAL	**$1364**

Construction Techniques

<u>Wood Stud Walls</u>

Wood is the most common framing material. In a typical light frame commercial or residential building with exterior wood frame studs, there is a significant opportunity for increasing the energy efficiency and reducing the quantity of material used. With many building codes requiring studs placed 16 inches on center, a substantial percentage of the wall volume is wood. The R-value of a standard 2x4 is 4.375. Conversely, the R-value of a typical insulation batt placed within an exterior stud wall is approximately 11. Many times in construction, installing more studs than necessary further reduces the overall thermal properties. Without sacrificing the code requirements, if construction techniques use only the studs that are absolutely necessary, material and energy savings are possible.

Corners

One opportunity for improving the energy efficiency for wood frame walls occurs at the exterior corners. Typical construction practices include installing three 2x4-stud corners and blocking (Figure 7.4). Although these three-stud corners are frequently used, an exterior void is created. In standard construction scheduling, this void is covered by the sheathing contractor long before the insulation is placed in the walls. This will result in a loss in energy efficiency of the wall corner.

There are two ways of correcting this problem: 1) coordinate the placement of insulation in the void area, or 2) construct an alternative wall corner using two studs and a dry wall clip.

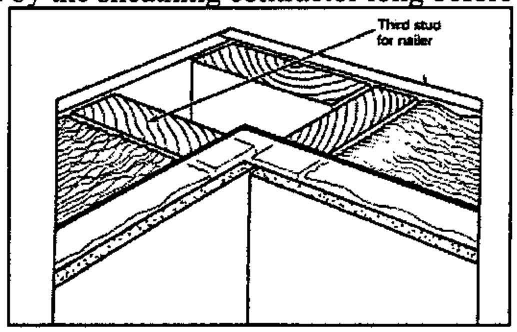


Figure 7.4 Three stud corner

Two Stud Corner

The two-stud corner is demonstrated in Figure 7.5. With a two-stud corner, heat loss through wood framing is reduced and there is no risk that pockets will be left uninsulated after exterior sheathing is installed. This also aids electricians because they will not have any built-up corners to snake wires through. This alternative is also preferred due to the material savings and the avoidance of coordinating with the subcontractors.

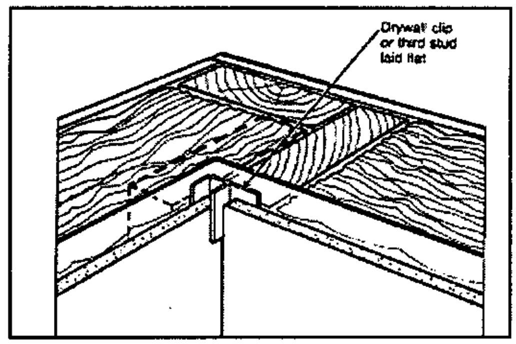


Figure 7.5 Two stud corner with drywall clip

Headers.

The careful design of headers will often result in saving framing lumber and increasing the efficiency of the building. See local codes for proper sizing of headers. A common example of unnecessary structure is headers over doors and windows in non-load-bearing walls. In the case of a gable roof structure, where the truss system carries the load of the structure to the side walls, the end walls are non-load bearing. Consequently, any window or door in the end wall is not required to have a full header installed. In the case where headers are required, for the purposes of energy efficiency foam board insulation should be placed between the two parts of the header during construction (Figure 7.6). The R-value of this material is typically from 3.75 to 6.25.

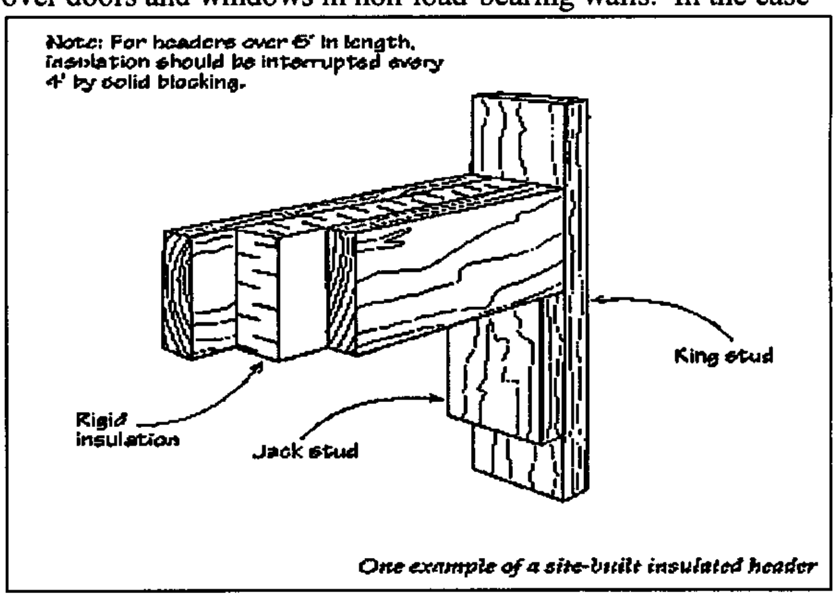


Figure 7.6 Insulated Header

Steel Framed Walls

Steel construction is relatively new to the residential sector—depending on the experience of the contractors in your area the duration of construction may be slightly longer. This is due to the construction sequence difference. For example, in timber construction an entire wall may be assembled and erected, while in steel framing each piece must be screwed into place one piece at a time.

- ✓ Most recycled material
- ✓ Demand for scrap
- ✓ Consistent quality
- ✓ Inherently insect and rot resistant
- ✗ Non renewable resource
- ✗ Energy intensive to produce
- ✗ Manufacturing produces air and water pollution

Although steel is noncombustible, thinner gauge members may lose strength and stiffness with the increasing temperature causing failures during fires.

Insulating Properties

Since steel is a good conductor its thermal performance is non-desirable in non-temperate climates. High conductivity results in thermal bridging where steel spans from outer to inner walls. This thermal bridging results in a significant increase in the expected life cycle cost associated with the heating and cooling of the structure. To combat this thermal bridging, additional insulation is needed on the exterior face of exterior walls. (It may be noted here that the additional insulation is typically extruded polystyrene, is derived from non-renewable fossil fuels, its production requires additional energy, and its production releases hydrochloro-fluorocarbons (HCFCs).)

Historically, steel studs for exterior framing use has been limited. The primary weakness of using this alternative has been the severely compromised thermal performance. If steel is used, it is common practice to model a 2x6 wood stud wall system by installing 2x4 steel studs and "wrapping" the building in 2" insulating foam sheathing. This alternative, when compared to the wood stud system, can be significantly more expensive.

Masonry (CMU) Walls

Concrete Masonry Units (CMUs) due to the nature of the material can be a cost effective alternative for exterior walls.

- ✓ Available in brick and hollow units
- ✓ Variety of shapes, sizes, and finishes
- ✓ Durable
- ✓ High Strength
- ✓ Economical
- ✗ Manufacturing requires substantial energy
- ✗ Thermal mass leads to heat retention

Insulating Properties

The main concern with masonry structures is the heat transfer conducted through the web. Think of a CMU as two squares, the web runs perpendicular to the wall front interior to exterior. The cross sectional area in the three perpendicular members determines how much heat is lost. Therefore, any effort to increase the overall R-value by filling the cores with insulating materials such as perlite, vermiculite and expanded polystyrene is only effective to a certain degree. To make a noticeable difference in thermal transfer the webs must be addressed.

In the recent past, several modifications of the traditional concrete blocks have appeared on the market. Some of these modified blocks reduce the total cross-sectional area of the webs. Additionally, these more efficient blocks have added shell insulation in the form of core inserts.

An additional method of insulating masonry wall concrete is to place the insulation material directly in the wall cavities. Historically, this has been a problem because the low R-value of the masonry would transfer through the fairly large web surfaces Reducing the amount of cross sectional area reduces the amount of heat that can be transferred through the material. In summer, less heat can be transferred through the web from the outdoors to the home's interior. If this alternative is selected, coordination between the structural and thermal requirements of the block system are important.

Autoclaved aerated concrete (ACC) blocks manufactured by Hebel and Ytong provide significant insulation and simplification of wall systems. Although significant energy for their manufacture, their high R-Values result in substantial life cycle energy savings.

Construction Techniques

With respect to the masonry wall as a construction system, little can be done to improve the energy efficiency by changing installation techniques. A key to reducing masonry waste is to design on a 4-inch system that will result in fewer cut blocks. Unlike the framed system where areas could be improved by redesign, the monolithic nature of a masonry system restricts installation alterations. Masonry wall materials, rather than procedures, are the important factor in improving the efficiency of a masonry system.

SHEATHING

Sheathing generally serves as a secondary weather barrier (behind the exterior finish). It may also be the primary substrate for attaching the finishing layer and often provides diagonal bracing for the structure.

PLYWOOD

Plywood is formed by layering thin sheets of wood and glue. These thin sheets, or veneers, of wood are then pressed together to form 4x8 panels of various thicknesses. Plywood is often used in flooring applications or where the quality and texture of the surface is important.

- ✓ Provides smoother surface for subfloor
- ✓ Strong and efficient
- ✓ Withstands rain and water better tan OSB
- ☹ Require high quality logs
- ☹ Requires larger diameter trees than OSB
- ☹ Glues may contain formaldehydes and off-gas VOCs

Oriented-Strand Board (OSB)

OSB is formed from smaller "strands" or pieces of lumber instead of sheets of veneer as in plywood. The surface texture is slightly rougher than plywood and does not provide a good subfloor for linoleum application but will provide the needed lateral strength if used as wall or roof sheathing.

- ✓ May be manufactured from fast growing trees
- ✓ Uses a high percentage of the tree
- ☹ Glues may contain formaldehydes and off-gas VOCs

Fiberboard

Fiberboard is a lightweight panel made from wood and agricultural waste impregnated with emulsified asphalt. It is produced in a process similar to paper making, without the final pressing. It is commonly used as sheathing with plywood shear panels on the corners for racking strength.

Structurally Insulated Panels

Structurally insulated panels (SIPs) are produced from expanded polystyrene foam insulation laminated between oriented strand board sheathing to form framing system for basement walls, floors, above-grade walls and roofs. The following summary of sheathing options (Table 7.2) is taken from Environmental Building News.

Table 7.2 Summary of Sheathing options

Product	Application	Racking Strength	Primary Resource	Additional Components
Boards (1")	Walls, Roof	Excellent	Whole trees diameter > 10"	None
Plywood (1/2")	Walls, Roof	Excellent	Softwood logs diameter > 10"	Phenol formaldehyde
OSB (7/16")	Wall, Roof	Very good	Aspen or thinnings from commercial forests	Phenol formaldehyde or isocyanate
Comply (1/2")	Roof	Excellent	Softwood logs diameter > 10"	Phenol formaldehyde
Fiberboard (1/2")	Wall	Poor	Sawmill waste, agricultural by products	Asphalt, wax
Thermo-ply (1/8")	Wall	Fair	Recycled draft paper	Wax, polyvinyl alcohol, foil or polycoating

INTERIOR STRUCTURE--PARTITION WALLS

As in the three-stud vs. two-stud corners, a similar circumstance occurs when the interior partitions are framed into the exterior walls (Figure 7.7). The three-stud practice is corrected in a similar manner to the exterior corners. Either the insulation is placed in the void, or the connection is constructed using only one stud on the plane where the exterior wall crosses the interior (Figure 7.8). Attached to this partition lead stud is either a 1x6 or dry wall clips to provide a surface to attach the interior gypsum board. For stabilization, the lead stud is fastened to a horizontal brace that is then fastened to the exterior studs closest to the lead stud.

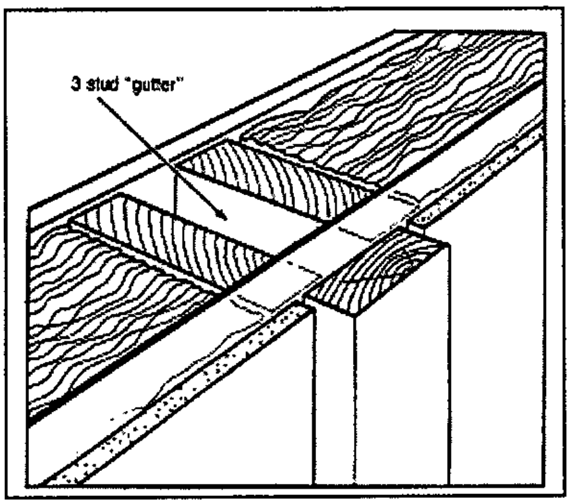


Figure 7.7 Three stud partition

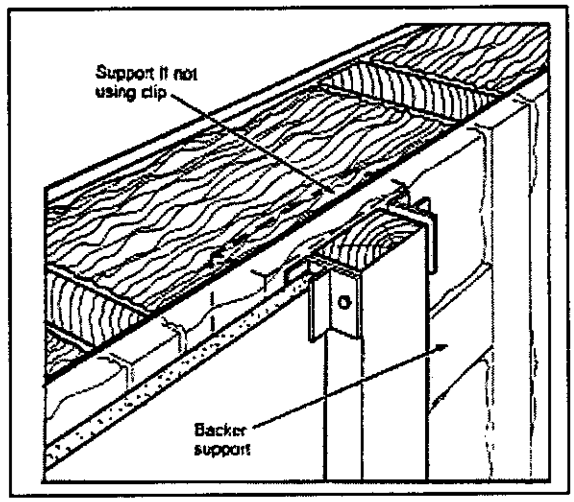


Figure 7.8 One stud partition

Strawboard panels may be used in place of both framing and drywall in partition walls.

Interior Surface--Drywall *The interior wall finish is used to cover the structural members of your home and provide a smooth straight surface for your finished wall covering.*

Gypsum Wallboard

By far the most common interior wall finish is drywall. A disadvantage of drywall is the large amount of waste generated during construction. Drywall generates about 15% of all construction waste and represents the highest percentage by weight of waste in residential construction. For a typical 2000 square feet home, 2000 pounds or five cubic yards of waste is generated. This equates to one pound of waste per square foot of building.

Drywall is an environmentally friendly product. Virtually all the paper backing is made of recycled paper. The natural gypsum is plentiful and has little impact to the environment during extraction. Gypsum is inert and does not contribute to indoor air quality problems. Some drywall is made of **synthetic gypsum**, which is created by the sulfur removal systems in the smokestacks of coal-burning power plants. Thus synthetic gypsum wallboard does not require extraction of raw material, helps reduce sulfur emissions and also eliminates the need to landfill the synthetic gypsum waste from power plants. Recycled gypsum drywall is available and is becoming more prevalent in the U.S. Specific types of drywall for fire rating and moisture resistance contain products which can not infect the recycling system.

- ✓ Proven track record
- ✓ Inexpensive
- ✋ No current recycling infrastructure. Some manufacturers recycle their waste, however, recycling of used drywall or construction site waste is not common.

☞ Look for local manufactures with a "take back" program for clean construction waste
☞ Specify Recycled Content Gypsum Board or By Product Gypsum

Reducing Drywall Waste

Current construction practices encourage waste because installers are paid by the number of sheets that are used. One way to curb the waste is to pay installers by the size of the project and not on the number of sheets used. This will make builders more responsible financially for any excess material. Drywall waste should be recycled if a nearby manufacturer will accept it. Table 7.3 provides recommendations for reducing drywall waste.

Table 7.3 Recommendations for reducing drywall needed and waste produced
✓ Provide incentives to drywall subcontractors to reduce waste
✓ Take advantage of the fact that drywall sheets come in different sizes, changing from only ordering one size to ordering various sizes to fit the drywall plan
✓ Use Drywall stops

☞ Detailed installation plans will take additional time and money during the planning phase but will reduce material costs and waste removal expenses.

Drywall Clips and Stops

__Drywall Clips:__ Most builders are familiar with drywall clips. They are fitted onto the edge of the drywall as it is being installed. May crews resist using the clips that complicate their work.

__Drywall Stops:__ Drywall stops, however, are installed beforehand just like wood blocking so the drywall hangers do not have to change their routine.

CASE STUDY ***DRYWALL STOPS***

Environmental Building News has estimated savings of one board foot of framing lumber for each drywall stop used. With drywall stops, two stud corners (as discussed above) can be made instead of the more common three-stud corner.

Procedure:
1. Build two stud corner
2. Install drywall stops 16" o.c.
3. Hang first sheet of drywall so that edge rests against stops.
4. Install second sheet against first.

Alternative Interior Finishes

Recycled Cellulose Waste Core Wallboard

This wallboard has cellulose fiber uniformly distributed in a matrix of gypsum and perlite. Due to its composite nature jobsite scraps are not readily recyclable. Some builders find this form of wallboard heavier, and harder to score and break.

- ✓ Made from perlite, recycled paper and gypsum
- ✓ Resists surface abrasion and impact damage
- ✓ No taping is required
- ✓ Good sound and thermal insulation
- ✓ Heavier, denser, more resistant to racking and impact than conventional wallboard

Strawboard

An alternative to drywall is strawboard. There are several manufacturers of this product. The panels are compressed straw covered with drywall paper which can be finished with standard joint compounds. Some of the core textures shows through on the panel surface, so the finished wall is not as smooth as drywall.

- ✓ Requires no studs, comes in 2-1/4" thick by 4x8 panels.
- ✓ Inner core of compressed straw and covered with recycled 69# linerboard paper.
- ✓ Taped, finished and painted like gypsum board.
- ✓ Internal electrical chases for wiring.
- ✓ 20% lighter, more moisture resistant and has excellent machinability.
- ✓ Can replace drywall and framing members in non structural applications
- ✓ Reduces approximately 60% of the lumber needed for framing.
- ✓ Environmentally friendly by providing an alternative to the burning of wasted straw fiber.

Figure 7.9 shows construction details and information for straw panels.

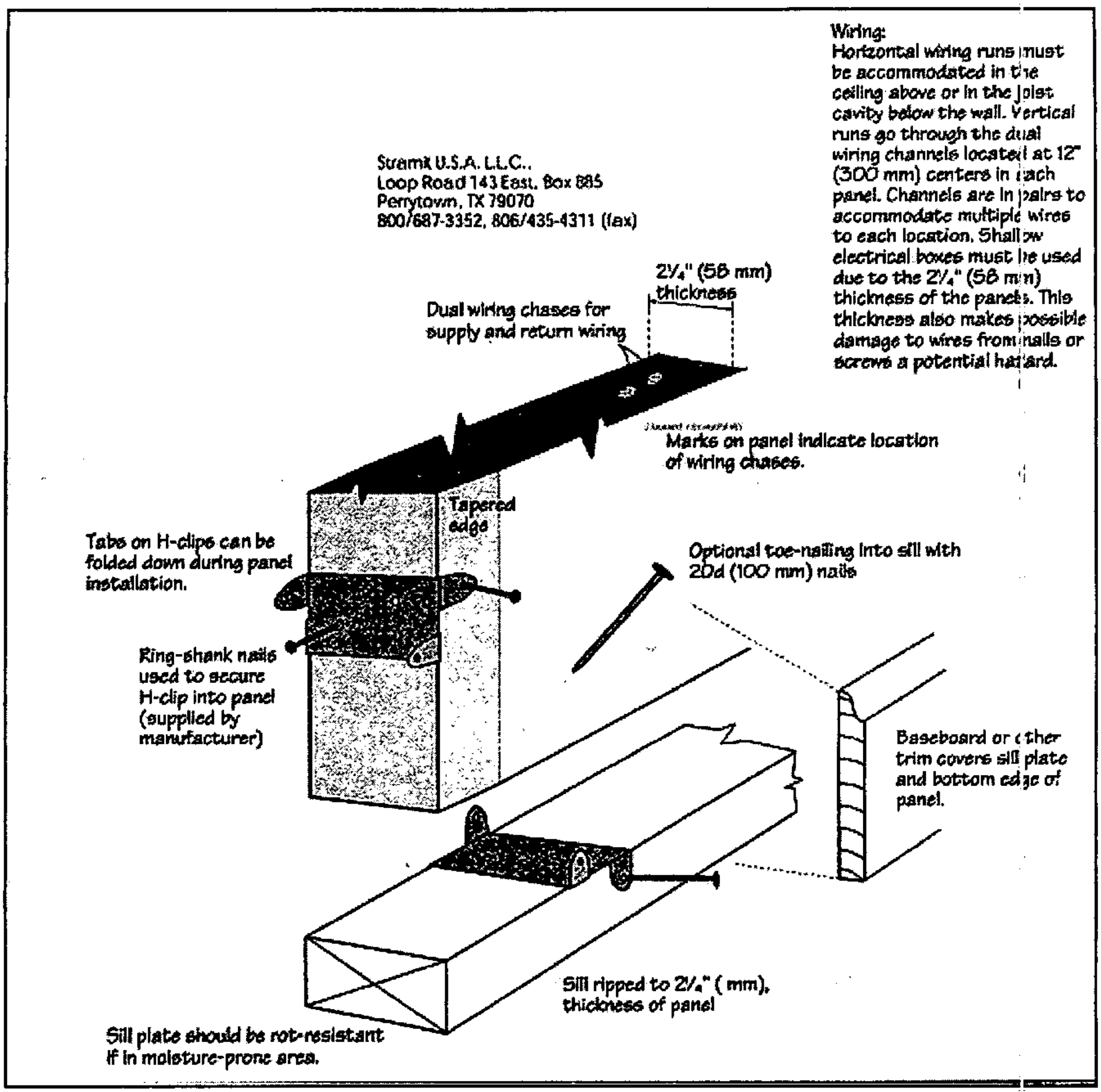


Figure 7.9: Straw panels

Gridcore® Panels

Gridcore® is an engineered honeycomb panel. This material is a potential replacement for plywood, "low density" particleboard, and medium density fiberboard (MDF) for interior applications such as furniture and cabinetry, exhibits, displays, and other interior design functions. These panels come in 3/4 " thick, 4'x10' sheets that are:

- ✓ made from 100% recycled fiber resources
- ✓ Free from toxic resins and binders.
- ✓ The manufacturing process generates little or no air pollution and water pollution.
- ✓ High strength-to-weight properties

Hardiboard™

This product is made from Portland cement, sand and small amounts of wood fiber and is potentially 100% recyclable. Recyclability will be limited to reuse in the manufacturing process.

- ✓ More durable, resistant to moisture and abuse than drywall.
- ✓ Historically used commercially in playrooms, poolside
- ✓ Fire rated higher than drywall and has a longer service life.

INSULATION

Insulation is one of the most important components of any environmentally responsible house because it reduces energy consumption and increases energy efficiency. Within virtually all climates, wall insulation plays a major role in the thermal properties of a building. In both light frame and heavy masonry wall systems, insulation is installed to maintain comfort within the building envelope.

Choice of insulation material should not be made without considering how it works with the rest of the wall, roof, or floor systems and what additional functions, such as air sealing the material, might serve. The different types of insulation have varying impacts in terms of their raw materials and manufacturing that should be considered in addition to the R-value, capacity for air sealing, and cost. Insulation types are discussed at the end of this section.

Table 7.4 provides a summary of important insulation considerations. These considerations include energy loss through infiltration, selecting green insulating materials, conductivity of framing systems, and the releasing of volatile organic compounds.

Table 7.5 provides a summary of environmental and health impacts of fiber and foam insulations. Fiber insulation includes celulose, fiberglass, mineral wood, cotton, and pearlite. Foam insulations include expanded and extruded polystyrene, polyisocyanurate, and polyurethane.

Table 7.4 Important Insulation Considerations
✓ Provide adequate insulation levels. Reducing the energy used is the single most important issue. Energy lost through infiltration can account for up to 55 % of all energy lost in a home. Energy Loss Summary Ceilings 10-25% Walls 15-20% Doors up to 10% Windows, skylights, and glass doors can account for up to 60% of the energy used for heating and cooling. **Caution**: Do not substitute a green insulation material for a non-green insulation material if you sacrifice energy performance.
✓ With lower R-value materials, increase insulation thickness. **Caution**: If substituting a green insulation materials for a higher R-value, but more environmentally damaging insulation material, design the building to permit greater insulation thickness as to not sacrifice energy performance.
✓ Avoid HCFC foamed insulation materials.
✓ In highly conductive framing systems, such as steel, avoid thermal bridging by installing a layer of insulating sheathing.
✓ Choose high recycled content insulation materials ☞ Cavity fill insulation with the highest recycled content are cellulose and mineral wood ☞ Look for fiberglass products with recycled content
✓ Chemically sensitive individuals should specify non off-gassing insulation (Miraflex fiberglass from Owens Corning or Air Krete)
✓ Choose an insulation contractor that recycles scrap

Table 7.5 Summary of Environmental and Health impacts of specific insulation types				
Insulation Type	**Installation Method**	**R-value per inch**	**Raw Material**	**Comments**
Fiber Insulation				
Cellulose	Loose fill, wet spray, dense pack, stabilized	3.0 – 3.7	Newspaper, borates, ammonium sulfate	• Fiber & chemicals can be irritants • High recycled content • Good infiltration barrier
Fiberglass	Batts, loose fill, stabilized, rigid board	2.2 – 4.0	Silica, sand, limestone, boron, PF resin, cullet	• Fibers & chemicals can be irritants • Industry standard; contains recycled material • Manufactured with phenol formaldehyde • New Miraflex fiber has no binder
Mineral wood	Loose fill, batts	2.8 – 3.7	Steel slag, PF, natural rock	• Fibers & chemicals can be irritants
Cotton	Batts, loose fill	3.0 – 3.7	Cotton & polyester mill scraps	• Considered very safe • Questionable fire retardant
Perlite	Loose fill	2.5 – 3.3	Volcanic rock	• Some nuisance dust
Foam Insulation				
Expanded polystyrene	Rigid boards	3.6 – 4.4	Fossil fuels, pentane	• Concern only for those with chemical sensitivities • The only non HCFC foam board
Extruded polystyrene	Rigid boards	5.0	Fossil fuels, HCFC-142b	• Concern only for those with chemical sensitivities • Only Amofoam-RCY has recycled content
Polyisocyanu rate	Foil faced rigid boards	5.6 – 7.7	Fossil fuels, HCFC-141b	• Concern only for those with chemical sensitivities
Polyurethane	Sprayed in	5.8 – 6.8	Fossil fuels, HCFC-141b	• Concern only for those with chemical sensitivities

FLOOR INSULATION

In the south, where the winters are mild and infiltration is not as much an issue, concrete floor systems benefit much less from insulation than in the north. Many times in these mild regions, the cost of installing installation is more than the long-term energy savings.

Off-Grade Wood Floor Insulation

Typically, batt insulation is placed underneath the floor system, between the rafters. If one face of the insulation has paper it is placed on the outside. Rather than act as a vapor or moisture barrier, the outside of the paper is used to minimize air intrusion. Another important practice when installing batt insulation is to minimize compression. Depending on the amount of compression, the R-value of the batt can be reduced as much as 40 percent. The batts are fastened by either stapling or by wire supports. Although the staples may be faster and less expensive, the wire supports will last longer and protect the insulation from damage.

> In the North Florida climate area, R-11 insulation is justified for off-grade floors; R-19 is probably not justified.

An alternative to the floor insulation is installing the same batts vertically on the foundation wall. Specifically, the batt is installed on the interior face of the foundation wall directly below the flooring system. The batt extends down the wall two to three feet past the bottom of the foundation and onto the floor of the crawl space. In a typical economic study, this method is more cost effective than insulating the entire floor.

WALL INSULATION

Frame Wall

Typical light frame wall insulation includes fiberglass batts installed between either the metal or wood structure system. From a performance position, the paper faced batt insulation presents a concern. During installation, the paper is used as a flange to staple the batt to the stud. This compresses the batt, lowering the thermal properties by creating a depression in the wall cavity. This depression becomes an area where the R-value is reduced even further due to the circulating convection currents. Furthermore, in humid climates, the paper backing should be placed toward the outside to prevent moisture from entering the wall cavity. To prevent this from occurring, paper-less friction type batts can be installed. When comparing friction batt to standard batt insulation, there is both a labor and cost savings when using the easy to install friction batts.

Alternatives

Two new developments in insulation have been used in place of the standard batt construction method. Stress-skin panels and dense wall batts have been successfully installed in many recently constructed buildings and are available to the consumer.

Stress skin panels are constructed using standard 2x4 wood framing 24 inches on center. Between the studs, a composite of waferboard panels and expanded polystyrene are fused together at the factory. The benefit to this alternative is the R-value is considerably higher than a normal stud wall, while the width remains at only 4.5 inches.

Similar to the skin panels, dense wall batts have been designed to provide an increased amount of insulation in the same space as a standard wall. To replace the R-11 batt insulation used in most exterior 2x4 walls, the dense batts are available in either R-13 or R-15. The potential cost savings is approximately $1.00 per single R-value per year for each 1,000 square feet of wall surface.

Wire Raceway

An alternative to fitting insulation around wires is to run the wires along the bottom plate of the wall. When it is installed, the insulation rests on top of the wires. This technique, called a wire raceway, can be used in 2x6 walls and in non-loadbearing 2x4 walls. See Figure 7.10 for details. Note that the electrical wiring is located at the bottom of the wall in a wire raceway. To allow drilling at the centers of the studs, all nails used to fasten studs to bottom plates should be at least one half inch away from the center of the stud.

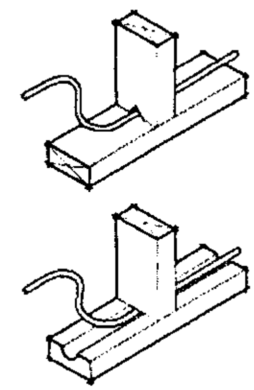


Figure 7.10: Wire Raceway

Masonry Walls

There are three basic methods of incorporating insulation into a masonry wall system. One method includes installing batt insulation in an interior cavity. The other two methods are based on fastening a rigid insulation sheet to either the inside or outside face of the masonry wall. The three methods yield similar R-values; but, because of the thermal properties of the mass wall remaining inside the envelope, the optimum solution is to install the insulation on the outside face of the masonry. Radiant barriers can be used in the fur space of masonary walls, for example, A1-Foil.™

Ceiling Insulation

Between 10-25% of the energy lost from a house is lost through the ceiling/roof system. A two-story house has 50% less of its ceiling and floor areas exposed to the outside, which means reduced energy losses. Although a two-story house may have slightly more exterior wall area, there will be a net gain in energy efficiency.

The two most common forms of ceiling insulation are batt and blown insulation. The material used in the blown insulation is fiberglass, cellulose, or rock wool.

In comparing the blown insulation to the batt roll insulation, there are advantages to both. The blown insulation is both cheaper and more efficient than batt insulation. The R-value of the blown-in material, because of the coverage over the framing members, is better than batt rolls. The actual R-value of the batt system must take the uninsulated framing members into consideration. For example, a ceiling with 16" on center joists with insulation having a rating of R-19 is actually an R-15.7 ceiling due to the joist reduction factor .

The advantage to the batt insulation system when compared to the blown insulation is durability. The blown insulation, because of its loose nature, is more easily distributed and compressed. The R-value, in the areas where the insulation is moved or compressed is lowered making the overall thermal resistance lower. The batt insulation tends to maintain its placement and thickness better. For ceiling insulation the ideal solution would be to place batt insulation first and then the blown in insulation on top.

Alternative

The most widely used alternative to fiberglass insulation is cellulose. Made from recycled wood fibers, this material has become the new form of insulating method. Advantages such as higher R-values, reduced moisture transmission and fire retardant properties, are found within blown cellulose insulation material.

WINDOWS

Window openings account for a substantial portion of a building's heat loss or gain. As a general rule, windows and glass doors are responsible for up to 60 percent of the energy used for heating and cooling. Thus, design of the most advantageous window locations (see Chapter 3) and the selection of the most appropriate type of window system is critical to the overall performance of the energy saving effort.

The basic function of a window is to provide either ventilation or enclosure. When the windows are open they provide ventilation and when they are closed they become similar to the wall and provide enclosure.

WINDOW SELECTION CRITERIA

Some window styles are more energy efficient than others. For example, a casement window will close more tightly than a double-hung or slider window. Check manufacturer's data for infiltration rating as well as R-value.

Shading coefficient

In climates where there is significant summer solar radiation and heat gain, a window system's shading coefficient is the most important measuring tool. The shading coefficient rates the energy saving ability of the window during the summertime, by indicating how effectively the glass resists the flow of radiant heat. The lower the shading coefficient the less radiant heat infiltration. When comparing shading coefficients, the guide is a single pane of untinted 1/8" glass with an arbitrarily assigned shading coefficient of 1.00. A glazing with any type of tint or reflective treatment will receive a smaller coefficient than the base 1/8" figure of 1.00. Typically, windows can range from a moderate gray tint with a coefficient of .85, to a super performance soft-coat tint with a coefficient of .37. In the case of the soft-coat tint, only about 1/3 of the radiant heat passes through the glazing. Less solar heat gain is preferable on east- and west-facing windows.

R-values

A second important factor in window performance is the glazing R-value. Typical single pane glazing has an R-value of 0.78 and double pane glazing has an R-value of 1.18.

Glazing

Glass by itself offers low insulating qualities. Air film trapped on either side of the glass gives the window the majority of its insulating value. When an additional layer of glass is installed with an air space, the conductive, convective and radiative heat transfer is reduced (see Chapter 4). Although this extra film reduces the amount of solar radiation used for thermal heat gain, the reduction in the amount of heat loss compensates for this reduction. Window glazing systems can be selected according to their placement and orientation of the house. For example, a west-facing window that would experience heat gain in the summer could use a heat rejecting glazing such as southern low-emissivity (Low-E.)

There are many different types of high performance glazing systems available. The most common for controlling thermal transmission are multi-layered heat absorbing glazing systems. Although triple glazing is still available, it is being replaced by the Low-E glazing. Low-E glazing allows light transmission, but blocks heat radiation.

Low-E window glazing is constructed of either soft film placed in the air space or hard, pyrolytic coatings that are incorporated into the glazing unit. The soft-coat film is a thin layer of silver and anti-reflective coating applied to the glass surface through a vacuum deposition process. The hard-coat, or pyrolytic, low-E films have a thin layer of tin oxide incorporated into the surface of the manufactured glass. These hard-coating films have the advantage of being durable and can be used as a single pane. Typically, the hard-coat low-E glazing has a lower emissivity and a higher transmissivity than the soft-coat. Thus, the hard coat would be more applicable in an environment where solar radiation was more important than heat reflection.

Air Space

With respect to heat loss, the air space distance and contents between glazing is an important factor in window units. In principle, the wider the gap the less heat is lost. When the air space is increased from .25" to .50" the insulating value increases from 1.75 to 2.04. If the air space becomes too thick, a convection loop is created and the convective heat loss is increased.

> ☞ The optimal thickness in a window system using air within the glazing space is between 1/2" and 1".

The contents of the space between the layers of glazing have also been improved. Because of the potential for conduction heat loss across the air space, the standard "air space" is being sealed and filled with matter to inhibit this heat transfer. Substances such as argon, sulfur hexaflouride and krypton are gases placed in the sealed air space. If properly sealed, these gas-filled spaces are up to 30 percent more insulated than the basic air-filled units are. Seals are prone to failure on insulated windows in Florida and the guarantee and warranty should include coverage of this failure.

Window Framing Materials

Aluminum Frame

- Should be constructed with a thermal break between inner and outer surfaces to improve energy performance.

Vinyl Frame

- ✓ Better thermal performance than Aluminum
- ✓ Better suited for sliders and double hung styles than casements
- Possible disposal concerns with PVC
- Sealing problem due to expansion and contraction over the life of the window

Wood Frame

- ✓ Standard for energy efficiency
- High initial cost
- Relatively short life

Consider

- Fiberglass, with or without foam insulation
- New composites made from recycled vinyl and wood fibers

The following Table 7.6 provides an economic analysis indicating the cost and benefit of window selection when compared to single pane aluminum frame.

Table 7.6: Economic analysis of selected windows compared to single pane aluminum frame

Window Type	Extra Cost of 200SF of "Better Window"	Energy Savings per year	Years to payback (assuming no interest)
Single Pane			
Clear + ½ Solar Screen	$40.86	$16.66	2.45
Tint	$296.48	$17.38	17.1
Double Pane			
Clear, Aluminum Frame	$362.62	$35.82	10.1
Clear + ½ Solar Screen	$403.48	$50.60	8.0
Clear Vinyl Frame	$990.20	$79.79	12.4
Clear, Wood Frame	$2482.04	$93.59	26.5
Low-E Tint			
Hard Coat	$1274.10	$66.92	19.0
Medium Coat	$2901.04	$111.86	25.9
Soft Coat	$3468.26	$134.17	25.8

Further economic analysis is needed based on the home's location, orientation and square footage of glass area relative to wall area to determine the most economical window choices for a specific project.

ROOFING

Design the home with an accessible attic. This allows the homeowner to check the condition of the ductwork and to add additional insulation when it becomes feasible to do so in the future. When a cathedral ceiling is desired, trusses should be used, since they can create an attic space (to allow for insulation). When a single assembly ceiling is used to produce a cathedral ceiling, there is no attic. This system provides little protection against heat radiation into the interior spaces. This problem may be solved by installing insulation in the roof to retard heat radiation into the attic space, and installing it in the ceiling to retard any residual heat from radiating into the living space of the home. The roof skin must be aided with the help of both insulation and ventilation to protect the interior living space from excessive heat radiation. This can be done through the construction of an insulated, ventilated roof envelope as shown in Figure 7.11.

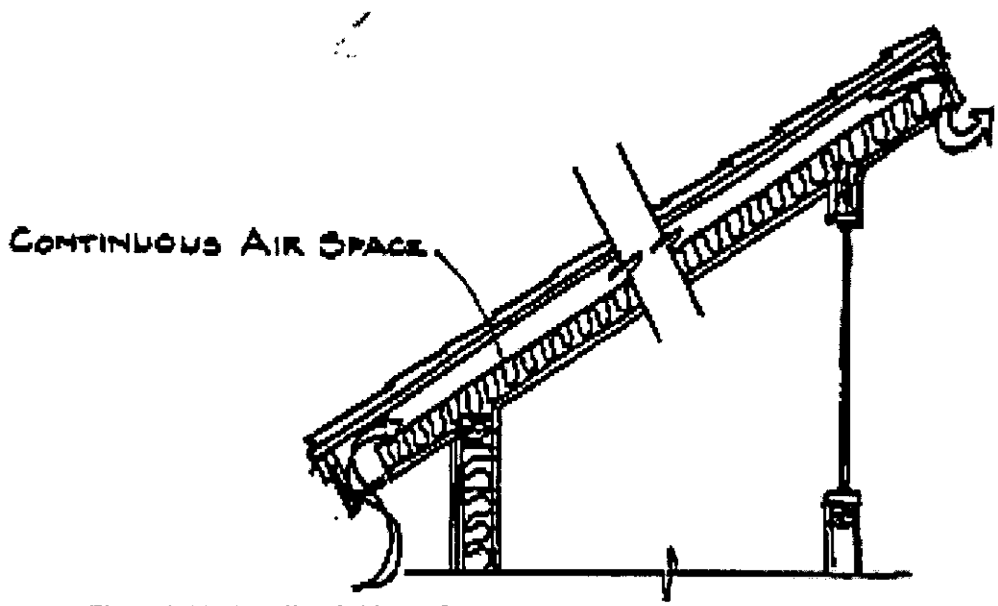


Figure 7.11 Ventilated skin roof

As a part of the building envelope, the roof also maintains thermal control. Secondary, but also very important, roof functions include shedding rainwater and protecting overhead HVAC ductwork. Selection of roofing materials is discussed in later in this chapter.

Residential Construction Waste Management, A Builder's Field Guide provides the following roof design suggestions for modular roof dimensions.

Value engineering principles can be applied to nearly all components of a house. For example, a value-engineered roof has a top chord/rafter dimensions on the two-foot module, i.e. 12,14,16 lengths to minimize sheathing waste. In addition, the range provided in Table 7.7 minimizes rafter cutoff. This table assures a square cut at the rafter end, an adjustment can be made for a plumb cut.

Using these eave widths with the corresponding design conditions results in sheathing cutoffs no greater than 12 inches in width. Although eave dimensions can differ from the front to the back of houses, use of a two-foot module (as opposed to a four-foot module) assures that a 24-inch wide strip of sheathing could be used on the other side of the roof.

Table 7.7 Optimum Range of Eave Widths for Value-engineered roof design

		ROOF PITCH					
		4:12	5:12	6:12	7:12	8:12	9:12
HOUSE WIDTH (in feet)	22	Less than 4" or 16"-24"	12"-20"	8"-16"	4"-12"	4'-6' or 20"-24"	12"-20"
	24	4"-12"	4"-8" or 24"	4'-6' or 20"-24"	12"-20"	6"-12"	4"-8" or 16"-20"
	26	16"-24"	12"-20"	8"-12"	4"-8"	16"-20"	8"-16"
	28	4"-12"	4"-8" or 24"	16"-24"	12"-16"	4"-8" or 24"	4" or 16"-20"
	30	16"-24"	12"-16"	4"-12"	4"-6" or 20"-24"	12"-16"	4"-12" or 24"
	32	4"-12"	4'-6' or 20"-24"	12"-20"	6"-12"	4'-6' or 20"-24"	12"-16"

Selection of the roofing materials will impact the overall performance of the building. The color and composition of the roofing material will determine the amount of heat the roof will retain. For example, if a dark shingle system is installed, the amount of heat absorbed will be significantly higher than a roofing system with light colored reflective shingles.

It is important to note, correct material selection is a small portion of a roof systems overall efficiency. Computer simulation research by Lawrence Berkley Laboratory suggests that lighter roof colors can decrease air conditioning costs by 5 to 19 percent. It was also determined that more savings resulted from roofing systems that are not well insulated. A study conducted by the Florida Solar Energy Center (FSEC) demonstrates that high reflectivity coatings can dramatically reduce air conditioning costs. Figure 7.12 illustrates the reflectivity of common roofing.

Caution:

- White asphalt shingles are not much more reflective than dark ones, (White 25%, Gray 20%, Black 5%) when compared to other roofing materials.
- Although light material selection has proven to be successful in reducing energy costs, it should be considered a secondary measure to the overall efficiency effort, (i.e. insulate well).

Examples of High Reflectivity Roof Surfaces

- ✓ High Reflectivity Roof Surfaces
- ✓ White anodized sheet-metal roofing
- ✓ White cement / composite shingles
- ✓ Aluminum shingles
- ✓ White EPDM roll roofing

Durability is critical in roofing. The selected roofing material will be exposed on a long-term basis to ultraviolet light, high winds, and extreme precipitation. Roofing failure can mean serious damage not just to the roofing itself, but to the entire roofing system, building and its contents. Such damage multiplies the economic and environmental cost of less reliable roofing materials.

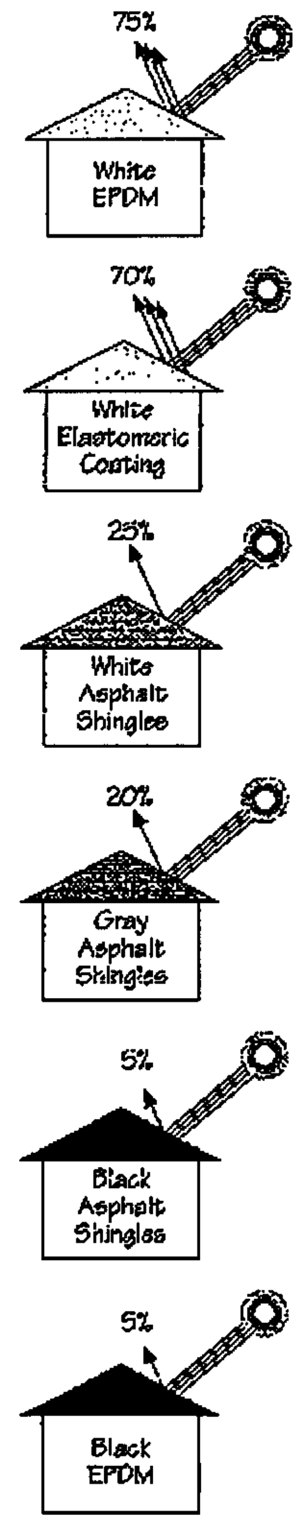


Figure 7.12 Reflectivity of common roofing materials

Asphalt

Asphalt roofing is the most affordable up front option for roofing, however its service life can range from 10-30 years depending upon the grade of tile purchased. As far as deconstruction is concerned, the tile may not be immediately reused nor is it readily recycled. Manufacturers publicize the recycling of asphalt roofing in road mix designs; however, the FDOT uses no asphalt roofing in their paving operations. Research is being conducted to incorporate asphalt roofing into mix designs, however the roofing the FDOT is using is waste from the manufacturing process, not waste from the roofs of homes.

- ✓ Low initial investment
- ☟ High overall life cycle costs
- ☟ 10 – 30 year life
- ☟ Generates high quantities of waste
- ☟ Not recyclable

> ☞ Specify recycled content asphalt shingles

The FDOT reports there is simply too much contamination and inconsistency in the "take-offs" to use this waste when trying to create a predictable mix design.

Metal

Options for metal roofing include galvanized steel, aluminum, galvalum and copper. Metal roofing is a great alternative to the common problems experienced with traditional roofing shingles. Metal roofing may cost more up front than a typical shingle or tile roof, but it is actually cheaper because of its longer service life, (approximately 3 times that of a shingle roof). In addition to the longer service life, metal roofs have fewer maintenance requirements, provide a better appearance, and greater value for homes. Because of the great variety in steel roofing, costs can range from slightly higher than premium asphalt roofing materials to more expensive decorative profiles resembling tile or slate. These more decorative profiles usually cost less than the products they are made to resemble.

- ✓ Durable (30 yr. minimum)
- ✓ Recycle content
- ✓ Recyclable
- ✓ Lightweight
- ✓ Best for rainwater collection
- ☟ High initial cost

Wood

Wood shingles, although they may not be immediately reused, may be readily recycled. The expected life of a wood shingle roof however, is only 15-20 years. Code requires that wood shingles carry a specific fire rating which effects their make up and recyclability.

Polymer

There are a variety of new products on the market made from recycled polymers. One product is made from asphalt and recycled baby diapers which has the appearance of slate and includes a 50 year warranty. Pictured in Figure 7.13 are Eco Shake's™ which are made of 100% recycled vinyl and reclaimed wood roofing products and also come with a 50 year warranty.

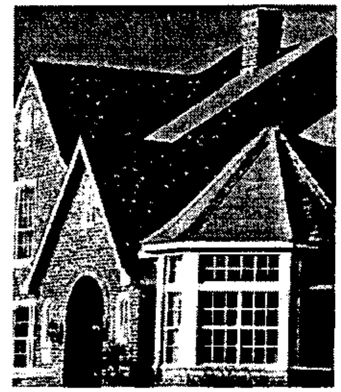


Figure 7.13 Polymer roofing

It may be noted here that the appearances of the shingles, regardless of the material they are made out of all resemble each other. Ultimately initial cost will be the driving factor in selecting a product, however, the life cycle and environmental effects of the product should be considered.

Clay Tile / Concrete

Clay and concrete tiles are also an option where hail is not a serious threat. Both of these roofing options offer excellent service lives.

- ✓ Extremely Durable (50-75 yrs.)
- ✓ High Fire Resistant Rating
- ✋ Must account for added weight in roof design
- ✋ Energy intensive manufacturing process

Fiber Cement Tiles

Fiber cement tiles are manufactured using special concrete mixes to form usable tiles. These tiles are then laid on the rooftop in the traditional manner. Color additives may be added to these products for aesthetics. Although these products contain recycled content, cement itself requires a very energy intensive manufacturing process.

- ✓ Durable (50 yr.)
- ✓ Lighter weight than clay and concrete
- ✓ High fire resistance
- ✓ Recyclable
- ✓ Efficient use of wood fiber (i.e. recycle content)

Slate

Slate is one of the most durable roofing options with an expected life span of over 100 years. This roofing material is also very expensive yet desirable. Slate is reusable if it is not cracked. The pre manufactured nail holes reduce the amount of waste created.

- ✓ Expected life > 100 yrs.
- ✋ Must account for added weight in roof design
- ✋ Not a local product

EXTERIOR FINISHES

The exterior finish protects your home from the environment. This is also one of the most visible features. Selecting the most durable exterior finish will reduce life cycle costs and reduce maintenance requirements.

VINYL SIDING

Vinyl siding is one of the most popular siding materials due to the low initial cost and favorable maintenance properties relative to other exterior finishing choices.

- ✓ 20+ year warranty
- ✓ Innate durability and flexibility.
- ✓ low maintenance
- ✓ does not need to be painted or stained
- ✋ Shows mold and mildew
- ✋ Recycling of vinyl results in downcycling, meaning that existing vinyl siding will not be recycled into vinyl siding again, but as a product lower on the product cycle chain.

METAL SIDING

Metal siding is slightly more expensive than vinyl siding but offers similar life cycle and maintenance advantages.

- ✓ High performance
- ✓ Recyclable
- ✓ Efficient use of material
- ✋ Subject to denting

WOOD

Wood is a traditional material, just like brick, but unlike brick, it will require more maintenance and has a shorter life. Life expectancy is shorter because of the possibility of termites and weathering. In addition, wood requires continuous upkeep, maintenance, and painting. Wood siding that is painted or stained will also contribute to air pollution more than any other siding material. A water repellant preservative (WRP) should be applied before painting. A WRP can add many years to the lifetime of wood siding.

- ✓ Aesthetically pleasing
- ✋ Requires heavy maintenance
- ✋ Needs frequent replacement
- ✋ Requires skilled installation

FIBER CEMENT PRODUCTS

These products are extremely durable composites made from portland cement, ground sand and cellulose wood fiber. These products offer a 50-year warranty and are resistant to humidity, rain, and termites. Although these products are not currently recycled they are potentially 100% recyclable.

- ✓ Extremely Durable
- ✓ Fire Resistant
- ✓ Holds paint well
- ✓ Little maintenance

BRICK

Brick has one of the longest expected lives of all exterior finishes, however, that long life is reflected in it's cost. Although brick has a higher initial cost, the low maintenance, long life, and potential for higher resale are worth considering.

- ✓ long lasting,
- ✓ low maintenance
- ✓ Recyclable
- ✓ Can contain recycled content
- ✋ Energy intensive to produce
- ✋ Manufacturing may release air pollutants
- ✋ High transportation cost

RECYCLED WOOD FIBER

Recycled wood fiber siding is gaining popularity due to its long, relatively maintenance free service life. It is durable, and has the appearance of a painted wood siding.

- ✓ Resource efficient
- ✓ More stable than natural wood
- ✓ Holds paint well reducing maintenance costs
- ✋ Requires skilled installation and precise nail placement

ATTIC VENTILATION

Attic ventilation is required in order to allow air movement in attic spaces

Historically, attics have been designed with various types of ventilation methods. Vents located in the gable ends, on the peak of the ridge and the underneath side of the soffits have been used to extract as much warm attic air as possible. In the summer, where heat gain is a concern, lowering the attic temperature reduces the cooling load requirement. In the case of the soffit and ridge vent roof system, the stored warm air is flushed through the attic by the air entering the soffit vent and forcing the warm air through the higher ridge vents. The Standard Building Code requires "Attics not used for habitational purposes shall have provisions for the emission of excess heat".

Recommended Ventilation System

Continuous Ridge Vent at the top of the roof plus Continuous Eave vents at the bottom of the roof under the overhangs.

For a gable end roof the continuous ridge vent should travel the entire length of the ridge, from gable end to gable end. Houses with hipped roofs often do not obtain enough attic ventilation by using continuous ridge vent alone. Off ridge vents which are located several inches below but parallel to the ridge often need to be used in addition to the continuos ridge vent. Generally a hipped roof will require a continuous ridge vent plus six feet of off ridge vent for each hip end of the roof.

Caution:

- Attic ventilation is directly dependent upon the local wind velocity and the net free vent area. It is necessary to determine the average summer wind velocity at the given site

Baffles

Baffles are needed above top plates to assure that insulation does not block the incoming flow of ventilation air. When used for attics, they should be approximately 48 inches long; when used for single-assembly roofs they should extend continuously under the entire roof deck from the eave to the ridge. Figure 7.14 is an illustration of baffles. Baffles are required by the Florida Energy Code when blown insulation is used, but they may be necessary even with batt insulation to prevent insulation from restricting the air passage above the top plate.

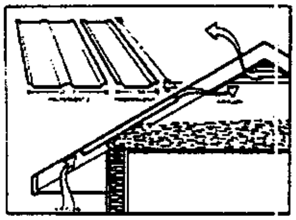


Figure 7.14 Baffles

RADIANT HEAT BARRIERS

A radiant barrier is basically a layer of foil facing an airspace, installed in either the attic spaces or the exterior wall surfaces of a building. These reflective sheets have proven to be very effective in impeding radiant heat transfer and consequent heat gain. They function simply by reflecting infrared radiation back outside the structure.

Wall Systems

In a wall system, similar to the attic space, the success of a barrier system depends on the environment in which the barrier is installed. The key to a good wall system is providing an air space adjacent to the face of the barrier. The design intent of the wall and the climatic conditions of the building will usually dictate the location of the radiant barrier on an exterior wall system.

In a humid climate, a framed wall system should have the barrier placed similar to the vapor or moisture barrier, between the exterior skin and the wall structure. The exterior system can be either vented or unvented. In the summer, venting will improve cooling performance by keeping the airspace temperature lower.

ATTIC SYSTEMS

With attic spaces typically experiencing very high daytime temperatures, efforts to vent and flush the attic space of accumulated heat have continued for many years. In addition to removing the heat by various forms of soffit, ridge and gable vents, there have been many attempts to reduce the amount of heat allowed to enter the attic space. By installing these radiant barriers on either the floor of the attic space, underneath face of the roof truss system, or directly underneath the roof sheathing a substantial portion of the radiant heat gain can be reflected away from the conditioned air space below.

According to many design publications, the optimum location to place the barrier is underneath the rafters. The separation from the sheathing will allow two faces for radiation and an area for ventilation between the barrier and the hot roof deck. Additionally, when compared to the barrier placed on the floor of the attic, where dust will invariably collect, the rafter-mounted barrier stays relatively clean. The following illustrations Figures 7.15 a,b,c,d,e show 5 locations for radiant heat barriers within the attic system. Radiant barriers are installed face down to minimize dust accumulation which interferes with the reflection of infrared energy.

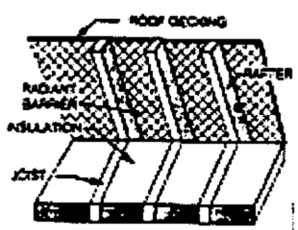


Figure 7.15a Radiant barrier (shown crosshatched) on underside of roof deck. Reflective side must face downward.

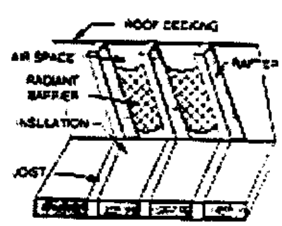


Figure 7.15b Radiant barrier draped over rafters. It is recommended that the reflective side face downward.

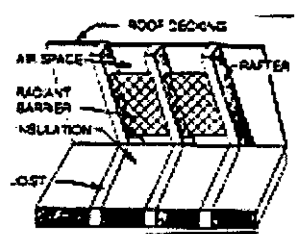


Figure 7.15c Radiant barrier attached between the rafters. It is recommended that the reflective side face downward.

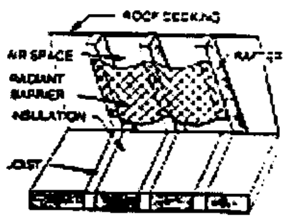


Figure 7.15d: Radiant barrier attached to bottom of rafters. It is recommended that the reflective side face downward.

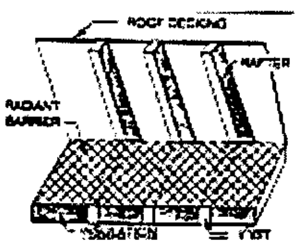


Figure 7.15e Radiant barrier on attic floor over conventional insulation. Reflective side must face upward.

The success of any of these locations is based on the environment in which the barriers are placed. The attic must have adequate ventilation. Continuous eve and ridge vents are recommended and are required by the Florida Energy Code in order to obtain credit for the installation of radiant barriers.

FLOORING

Selection of flooring should be based on durability. Since there are many flooring options, maintenance and life should be key considerations in their selection.

CARPET SYSTEMS

Including carpet pads and carpet adhesive

- ✓ Carpet padding has long been made of recycled materials and is extremely recyclable.
- ✋ Potential source of indoor air pollution.
- ✋ Retains dirt and pesticides creating an unhealthy environment.
- ✋ Short life span
- ✋ Life expectancy of carpet on slab is reduced due to the harsh backing concrete offers.

Consider
☞ Carpets made from natural fiber
☞ Recycled content carpets
☞ Manufacturers that recycle carpet or offer "take back" programs.

Table 7.8 provides a summary of common flooring options. Ultimately the owner's needs and desired resulting aesthetics will dictate the selection of flooring material. The trade off between cost, both initial and life cycle (maintenance and expected service life) and durability should be considered.

Table 7.8 Floor Covering Options		
Flooring Type	Advantages	Disadvantages
Linoleum	Can be manufactured with recycled content Low initial cost	Adhesives may release VOCs Short life span Requires smooth subfloor
Thin Wood Composite	Aesthetically pleasing Lower cost than solid wood	Glued down Not reusable May use toxic adhesive
Ceramic and Porcelain Tile	Durable and recyclable Environmentally sound Can incorporate recycled glass from automobile windshields	Must consider maintenance of grout and cracked tiles.
Cork	Made from recycled waste Sustainable, natural, durable Good acoustical properties	Color and aesthetics limited

DOORS

Conventional doors are responsible for a significant amount of heat transfer for the same reasons as windows: excessive amounts of infiltration and high conductivity of materials. There are many door styles and materials. The most common materials are wood, steel and fiberglass. Steel and fiberglass doors are made with insulating cores that perform better than wood doors. Steel and fiberglass doors can be exposed to the weather without experiencing any damage while wood doors should be protected with storm doors to prolong their lives and to provide added insulation. Steel and fiberglass doors are less likely to wrap compared to wood doors, a significant factor in conserving energy. A better quality door, which costs only slightly more than a lower quality variety, will provide significant cost savings.

Solid or hollow cores

☞ Solid Core doors are heavier, more fire resistant, and are better insulators thermally and acoustically

☞ Hollow core doors have light honeycomb like filler material that provides minimal surfaces to which door faces can be glues. Should only be used for interior applications.

Table 7.9 Door Checklist
✓ Specify Insulated doors
✓ Minimum insulation of R-7
✓ Specify prehung doors for better installation
✓ Seal under the sill and around the framing before the trim is installed
✓ If glass is used in the door, use double glazing to minimize heat loss
✓ Interior doors should have adequate undercut to maintain balance in the HVAC system. Be sure the airspace from the undercut is still sufficient after carpeting has been laid since the carpenter will have hung the doors earlier and may not know the thickness of the pad and carpet.

PAINTS / COATINGS / ADHESIVES

During the drying process, VOCs are evaporated. Air quality regulations and health concerns have driven a shift toward water based products for many applications. Paints, coatings and adhesives have their greatest effect on indoor environmental quality during and immediately after installation. The health hazard is particularly acute for installers. Most conventional products off-gas VOCs, formaldehyde, and other chemicals that are added to enhance the performance and shelf life of the products.

Caution:

- Even so-called zero VOC products may release small amounts of organic compounds. See Chapter 6 regarding IEQ for more information.

CHAPTER 8 PRECONSTRUCTION PROCESS

INTRODUCTION

When approaching construction from a green perspective, a builder should ensure that the construction contract and specifications address the design and construction teams' environmental requirements and goals for the construction process. Many of these issues and practices are typically under the direct control of the construction contractor.

There are many stages in the construction process in which the environmental impact of a home may be reduced. The construction process itself has a significant impact on the environment and our environmental resources. The construction process itself being the stage after which a design is established, materials are selected, but prior to the actual construction work. Establishing specific guidelines for the construction prior to the beginning of construction will prove to be most successful. Environmentally conscious construction practices can markedly reduce site disturbance. Processes such as clearing the site disturb the site's existing natural resources such as vegetation, wildlife, and natural drainage systems and often replaces them with artificial systems. Environmentally conscious construction practices can also reduce the quantity of waste sent to landfills, and can reduce the use of natural resources during construction. These practices include:

1. Selection of environmentally friendly materials.
2. Non-destructive preparation of the building site.
3. Altering the traditional construction techniques in an attempt to reduce the amount of material used and limit waste that must be landfilled.
4. Selecting materials that provide the home with the most value.

Taking action during the preconstruction process, for example during the design and planning stages, can result in significant financial and environmental savings. These benefits may be realized through lower landscaping costs, material savings, reduced construction waste, lower tipping fees, and cost savings on water treatment.

However, green building may require one of the most expensive and limited of resources: time. Proper research and supervision are required to ensure that the environmental goals, established either by the owner of builder, is a project-wide goal.

GREEN MARKETING

DEFINED

The majority of people believe that green marketing refers solely to the promotion or advertising of products with environmental characteristics. Terms like Phosphate Free, Recyclable, Refillable, Ozone Friendly, and Environmentally Friendly are some of the things consumers most often associate with green marketing. While these terms are green marketing claims, in general green marketing is much broader concept, one that can be applied to the construction industry. Green marketing incorporates a broad range of activities; design modification, selection of materials, changes to traditional construction methods, as well as modifying advertising.

IMPORTANCE

Answering the question of why Green Marketing is important is best defined by looking at the definition of Economics: *Economics is the study of how people use their limited resources to try to satisfy unlimited wants. (McTaggart, Findlay and Parkin 1992, 24)* Mankind has limited resources on the earth, with which she/he must attempt to provide for the worlds' unlimited wants.

OPPORTUNITIES

All types of consumers, both individual and industrial are becoming more concerned and aware about the natural environment. This concern for the environment can benefit progressive organizations actively practicing or implementing Green building strategies. Green Marketing addresses:

1. **Social Responsibility**: Many firms are beginning to realize that they are members of the wider community and therefore must behave in an environmentally responsible fashion. This translates into firms that believe they must achieve environmental objectives as well as profit related objectives. This results in environmental issues being integrated into the firm's corporate culture.

2. **Competitive Pressure**: Another major force in the environmental marketing area has been firms' desire to maintain their competitive position. In many cases firms observe competitors promoting their environmental behaviors and attempt to emulate this behavior. In some instances this competitive pressure has caused an entire industry to modify and thus reduce its detrimental environmental behavior.

3. **Cost & Profit Issues:** Firms may also use green marketing in an attempt to address cost or profit related issues. When attempting to minimize waste, firms are often forced to re-examine their production process. In these cases they often develop more effective production processes that not only reduce waste, but reduce the need for some raw materials. This serves as a double cost savings, since both waste and raw material are reduced. In other cases firms attempt to find end-of-pipe solutions, instead of minimizing waste. In these

situations firms try to find markets or uses for their waste materials, where one firm's waste becomes another firm's input of production.

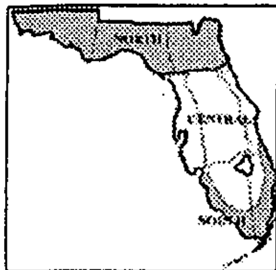
4. **Governmental Pressure:** Increasing governmental pressure regarding the environment and to "protect" consumers and society; have significant green marketing implications. Governmental regulations relating to environmental marketing are designed to protect consumers in several ways, 1) reduce production of harmful goods or by-products, 2) modify consumer and industry's use and/or consumption of harmful good,; or 3) ensure that all types of consumers have the ability to evaluate the environmental composition of goods.

Three main elements of encouraging environmental participation are:

1. **Concern**: appeal to the self-image of environmental awareness; studies show that people who make or show interest in making a small commitment toward the environment are likely to make larger commitments if shown a rational economic benefit model.
2. **Competence**: cite specific references of previous experiences and become environmentally registered in a certificate program
3. **Imagery:** capture your audience's attention through vivid information that is concrete and personalized, but not too complex or technical

Table 8.5 Important Marketing Points
Educate the home buyer to the immediate and larger issues of green construction:
✓ Protecting the natural environment of Florida and the local
✓ Protection for the elderly and children by providing good indoor
Demonstrate the benefits of good site design:
✓ Landscaping adds aesthetic value to the property
✓ Mitigates solar gain
✓ Absorbs pollutants
✓ Provides habitat for urban wildlife
✓ Mitigates noise levels
✓ Increases evaporative cooling
Use lifecycle analysis:
✓ Show the value of energy efficient equipment
✓ Show the value of passive design
✓ Show the value of renewable energy sources
✓ Compare the homebuyer's current energy bills to one of your

PLANT SELECTOR FOR THE STATE OF FLORIDA



	GEOGRAPHIC LOCATION			FOLIAGE		SIZE	SHADE DENSITY			TOLERANCE SOIL			SALT			GROWTH RATE			REMARKS
	NORTH	CENTRAL	SOUTH	EVERGREEN	DECIDUOUS	MATURE HEIGHT	OPEN	MEDIUM	DENSE	GOOD	FAIR	POOR	YES	NO	SOME	FAST	MODERATE	SLOW	
VINES																			
Creeping Fig Ficus Pumila	X	X	X	X		Variable		X		X					X	X			Good for masonry walls
Coral-Vine Antigonon Leptopus	X	X	X	X		"			X	X				X		X			Good for fences, arbors
Bougainvillea Bougainvillea Spectabilis		X	X	X		"		X		X					X	X			Rail fences and walls
Wisteria Wisteria Sinensis	X	X			X	"		X		X				X		X			Cover fences, arbors, good vigorous growth
Ivy Hedera Species	X	X	X	X		"		X		X					X		X		Good for walls, doubles as ground cover
Rangoon- Creeper Quisqualis Indica			X		X	"		X		X				X			X		Use on walls and fences
Janpanese Honeysuckle Lonicera Japonica	X	X		X		"		X		X				X					Good on Fences

Appendix: **PLANT SELECTOR FOR THE STATE OF FLORIDA (HOUSES AND CLIMATE 1979).**

Legal Issues

Firms using Green Marketing must ensure that their activities are not misleading to the consumers or industry. Green Marketing claims must:

- Clearly state environmental benefits
- Explain environmental characteristics
- Explain how benefits are achieved
- Ensure comparative differences are justified
- Ensure negative factors are taken into consideration
- Only use meaningful terms and pictures

CONTRACTS

General

The key ingredient for a successful green construction project is teamwork. It is necessary for the architect, designer, engineers, contractor and subcontractors to work together during pre-construction meetings to develop guidelines, plans, goals, and practices for the construction process. This teamwork approach will ensure that the contractor understands the projects' general and environmental goals and the accompanying specifications before the work begins.

Construction design documents typically define the responsibilities of the contractor during the construction process. They mainly focus on the design elements that comprise the finished product. Rarely do they set environmental guidelines to be followed during the construction process. These guidelines must be incorporated within the construction contract with specifications that spell out the requirements for their implementation.

Approach

To establish and enforce environmental guidelines for construction, the guidelines must be incorporated into the construction drawings and specifications. It is also necessary to monitor compliance during construction and incorporate environmental responsibilities into the construction contract. This process must be entered into with an open mind, understanding that this is an educational process. Some subcontractors may be unaware of environmentally friendly practices and their economic benefit. Include specifics regarding each stage of construction and outline what will be done during the duration of the project. For example:

- Develop a staging plan for the project. Develop a plan that will balance the desire to build cost effectively, with the owners desire to preserve and protect the sites resources and amenities.
- Develop specific site protection requirements. These requirements should include how each area on the site may or may not be used for construction. Site utilization specifications should include the items listed in the Contract Content section.

Table 8.1 Contract Content	
✓	Specify what if any areas of the site are not to be disturbed.
✓	If job trailers are used by contractors and trades specify where they will be located.
✓	Identify storage and staging areas
✓	Specify waste handling and removal requirements.
✓	Specify fencing requirements around site
✓	Specify where the site will be accessed for deliveries and workers.
✓	Identify worker parking area
✓	Clearly identify vegetation that will be protected
✓	Specify how the site will be cleared and graded to minimize site disturbance
✓	Identify areas for potential storage of topsoil, wood chips etc which may be used later for landscaping
✓	Create a stormwater management plan

SITE LAYOUT

The first opportunity for change in traditional construction activities occurs during the first stage of construction - the site work. Steps taken at the beginning of the sitework can greatly reduce the cost of landscaping. As established in Chapter 2, it is important to conduct a careful survey of the building site prior to determining the placement of the building. Allow the natural lay of the land to determine the placement of building(s), driveway(s), leach fields, and buried utility lines on the property. This will allow the protection of natural features and reduce the general disturbance of the land. However, even if the building placement has already been determined, there are still opportunities to influence items such as solar access and minimizing site disturbance.

Table 8.2 Selecting a Excavation Subcontractor	
✓	When selecting an excavation contractor concern for the environment should be a major factor (Many excavators understand the value of protecting native vegetation and will work with owner or general contractor to ensure that damage is minimal)
✓	Locate the driveway as far away from existing trees as possible, allow it to wind around important trees, (far enough away to avoid compaction)
✓	Subcontractors will request more room to work. Explain why limiting their space will preserve the property an ultimately reduce the cost of landscaping.
✓	Point out the value of the trees and ask for advice for protecting them
✓	Consider incentive payments if tree damage is minimized

Table 8.3 Site Layout Recommendations	
✓	Carefully mark location of building, driveway and utility lines with stakes
✓	Erect a clearly visible fence around building areas, including driveways
✓	Keep fence at an absolute minimum distance from the actual excavations to minimize soil compaction and damage to vegetation (10 – 15 feet is a good goal)
✓	Ideally, equipment should be parked away from building site

VEGETATION PRESERVATION

The most important issue is to limit the destruction of natural resources as much as possible. Historically, large equipment is brought in, bulldozing the site clean. Although this allows for the work to progress quickly, it is no longer a viable option where there is concern for the environment. Regulations exist which protect older trees and require that the land be cleared more carefully. Protecting what is already on the site during excavation and grading will ultimately result in lower landscaping costs. It is also important to take note of native vegetation. Vegetation that is prospering on site should not be replaced with non-native plants. This will be possible if a landscape plan is developed during design, preconstruction conferences, or if the construction administrators carefully watch the clearing process.

Table 8.4 Vegetation Preservation
Remove all trees and shrubs where building and driveways will be located (depending on the specific site and the excavation equipment to be used in digging the foundation, trees within 15-20 feet of the building usually have to be removed.
Certain trees and shrubs only have a marginal chance of surviving the sitework; rather than spending too much time and money trying to save them, it may make sense to remove them and replant with the same species after the sitework is complete.
In addition to erecting tree fences, flag important trees and lower branches that might be damaged needlessly when dumping fill excavating or delivering construction materials
Maintaining grade preserves trees, therefore use terracing or retaining walls to preserve grade around trees. If grade needs to be raised or lowered near the house, valuable trees can be saved by building a retaining wall around the tree to maintain the grade around the tree. The retaining wall should be located at the edge of the tree canopy.
Have topsoil removed from areas that will be excavated, but limit topsoil removal to that area only.
Have excavator pile topsoil in a flat location away from trees.
Pile should be covered or seeded with grass to prevent erosion
If site is densely wooded, it is sensitive to stresses experienced by the remaining trees. Excessive sunlight exposure and drying are the most common problem.
Avoid additional clearing of land until after construction has been completed to avoid multiple stresses on the trees.
For good tree maintenance mulch, water regularly, and fertilize
If clearing large wooded area, leaving a few trees standing, consider that the biggest/tallest trees on site may not be the best candidates. Consider the stresses and loss of structural support on nearby trees.
In primarily wooded areas, leave tree stumps to avoid damaging other trees, disease, and vulnerability to wind damage.

STORMWATER

When considering a stormwater evaluation, the following items should be considered based on specifics to the construction site. Construction activities should:

- ☞ Reduce the amount of stormwater created
- ☞ Keep pollution out of the stormwater
- ☞ Manage stormwater runoff at the construction site

Refer to Chapter 2 for more details regarding stormwater management.

RESOURCE EFFICIENCY

Environmental performance improvements can reduce waste, increase efficiency and water conservation and reduce consumption of natural resources.

Include language in the construction documents that promote energy and water conservation. These specifications should hold the contractor financially responsible for resource consumption, this makes the contractor more likely to curb consumption and to reduce his associated costs. It is therefore the contractor's responsibility to monitor resource usage and implement steps to reduce consumption.

CASE STUDY ***MATERIAL SAVINGS***

Builder: Deluca Enterprises
House Type: 2,300 ft^2 single family detached

Technique	Savings
In line framing spaced at 24" o.c.	$960
Increased spacing of floor joists from 16" to 24"	$747
Reduced header sizes	$162
Relocating four windows and doors	$45
Ladder framing at intersecting walls	$45
Two stud and backer corner framing	$30
TOTAL	**$1989**

Specific Construction techniques are discussed in detail in Chapter 7: Construction Techniques

WASTE MANAGEMENT

One of the most important factors in preventing and reducing the waste created is knowing exactly what type of waste residential construction produces. Figure 8.1 shows the typical breakdown of waste generated from new residential construction by weight. Understanding what waste and in what quantities will be generated aides in finding solutions to eliminate or greatly reduce that waste. There are many waste disposal options. The most common is a large dumpster placed on site into which all construction related debris is discarded. The general contractor usually provides the dumpster for their and their subcontractors use.

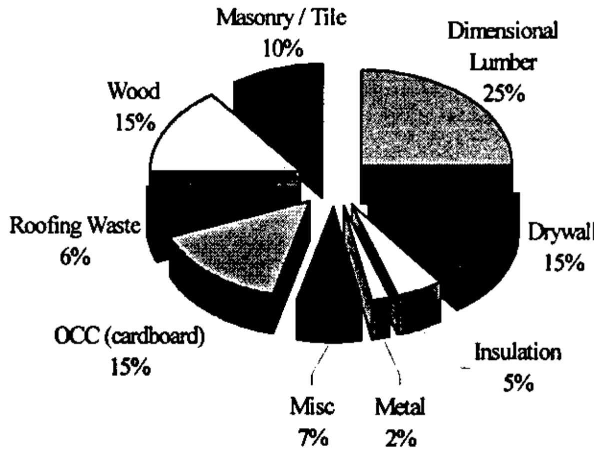


Figure 8.1 Waste generated from new construction

Goals

- ☞ Minimize job site waste, at the start of the project set up clearly marked bins or trash cans for different types of useable waste
- ☞ Minimize packaging waste
- ☞ Arrange for reverse distribution (return to manufacturer) of packaging materials

WASTE MANAGEMENT OPTIONS

Jobsite Clean-Up Service

A relatively new concept in construction waste management is a Jobsite Cleanup Service. The builder moves all waste to the front of the house or curb. The waste management firm establishes the service schedule and container type (if any) and separates, transports and tips the material. Fee structures are often based on the square footage of the house.

CASE STUDY	*SAVINGS FROM WASTE MANAGEMENT*

Builder Dan Kent of Kent Homes employed a Jobsite Clean-up Service called Site Clean for a 3,300 square foot single family detached home in Wilmington, NC. The clean up service included general site cleaning as well as the removal of waste materials. The six or seven site visits by Site Clean were timed to recover wood and brick, which are tipped at a lower fee than the area landfill. Materials were contained on site in a 8x8x4 fenced area (about 10 cubic yards) and loaded onto dumptrucks with a Bobcat.

Diversion Rate 60%
Savings: $600.00

Jobsite Commingled Recovery

Commingled processing facilities accept mixed waste and retrieve recoverable materials mechanically and/or manually. The builder puts all waste in a conventional container and schedules service. The waste management firm transports the materials and pays tipping fees. Fee structures are normally the same as for conventional disposal.

Jobsite Separation

The builder is responsible for separating materials and scheduling container service. Although the fee structures are often the same, savings can be achieved through the higher value of separated materials.

Self-Haul

The builder handles all phases of waste management including separation, containers, transport and tipping. Disposal/recycling costs are determined by vehicle cost, tipping fees, and required labor.

Require Subcontractors to Remove their own waste

- ☞ This approach can be more cost effective than conventional disposal techniques.
- ☞ Each subcontractor produces a specific type of waste which, when kept separate from the general waste stream, lends itself to recycling or recovery.
- ☞ Another advantage to this method of waste disposal is the removal of the large dumpster from the site. This frees up more space for other construction operations and protects the site.
- ☞ The subcontractor will be less likely to waste material if he is responsible for the disposal of his waste.
- ☞ It will be easier to identify if the materials are not being used efficiently.

Since the disposal of hazardous waste is both detrimental to the environment and expensive, use of hazardous materials should be limited. When designing or selecting materials that are considered hazardous, it is important to look into potentially selecting "green" products.

Treated Wood

In general avoid the use of Chromated Copper Arsenate (CCA) wood. Use wood treated with Alkaline Copper Quat (ACQ). ACQ is less harmful to the environment.

The chemicals used for treating wood are designed to kill or repel biological organisms. The waste created from treated wood therefore potentially poses an environmental hazard. The best option for treated wood is to salvage and reuse the pieces in other applications. Under no circumstances should woods treated with CCA be burned or incinerated. Currently there is research being conducted to transform CCA wood scraps into other usable products. Alternatives to pressure treated lumber should be used wherever possible. Options include using naturally resistant woods such as red cedar or redwood in place of treated wood, or using a non-wood product such as plastic lumber, brick or stone.

Paints

There are an increasing number of companies that are producing "green" paints. Wherever possible, they should be specified for projects. Many municipalities have set up donation programs that will accept partially empty cans of paint. Those paints, stains, finishes and solvents that can not be donated must be taken to a hazardous waste facility.

GREEN CONSTRUCTION

What is Greening? The word Green or Greening has come to mean energy efficiency, the environment and the green of dollar savings. This is achieved through the application of energy-efficient technologies and environmentally preferred or environmentally friendly products and practices in a multi-year, multidisciplinary project designed to improve energy efficiency, reduce wasted, improve worker productivity, and save money throughout a facility. The goal is continued movement toward sustainability.

Building operation and maintenance (O & M) impacts the owners life cycle costs and the internal and external building environment. If conducted on a routine basis, O & M can lead to benefits such as: reduced energy consumption, better indoor air quality, resource efficiency, and occupant satisfaction.

Without proper O & M, the Green practices you have implemented will be less effective. For example, proper maintenance of mechanical systems will result in better efficiency, longer system life, and better air quality. To ensure proper operation and maintenance of equipment after building turnover, make sure to pass on owner manuals for appliances and systems.

Table 9.1 O & M Considerations
✓ Examine crawlspaces for dust, debris, insects, standing water, and moisture damage or seepage.
✓ Termite inspections
✓ Examine flues, vents, back-draft dampers, fans and filters, and screens to note their general condition and obstructions and make repairs as required
✓ Regularly inspect, clean and replace filters for humidifiers and air delivery systems.
✓ To keep pollutants out of living spaces, keep garages and carports free of excess wastes such as dusts, oil and grease that may be tracked inside.
✓ Separate garage from living space to avoid fume transfer
✓ 85% of soil deposited in carpets is brought in by foot traffic, therefore concentrate cleaning efforts on entryways
✓ Store hazardous materials outside the home in well ventilated areas
✓ Check gaskets and seals around windows and doors frequently to ensure they are not cracking
✓ Check caulking everywhere it occurs (windows, doors, window sill, showers, sinks, countertops, etc.)

CLEANING PRODUCT SELECTION

Select cleaning products that minimize waste and harmful chemicals using the following guidelines:

- ✓ Reduce the toxicity of cleaning products by selecting chemically benign products that reduce health and safety risks
- ✓ Purchase concentrated products to minimize the quantity of product used and packaging needed
- ✓ Buy in bulk to minimize excess packaging
- ✓ Select products derived from renewable sources such as detergents and solvents made from corn starch, coconut oil and orange peels
- ✓ Avoid products that require disposal as hazardous waste (i.e. some, furniture strippers and paint thinners),

Table 9.2 Natural Cleaning Product Formulas

Window Cleaner 1 2 teaspoons white vinegar 1 quart warm water Mix well; use a natural linen towel or other soft cloth to clean	Window Cleaner 2 ½ cup cornstarch 2 quarts warm water Mix well, apply with a sponge, then wipe windows dry with absorbent cloth or towel.
General Cleaner & Disinfectant 1 ½ cup borax 1 gallon warm water Dissolve borax in water and apply with a sponge	General Cleaner & Disinfectant 2 ½ cup household ammonia ½ cup washing soda 1 gallon medium-warm water Mix in pail; after washing, rinse with clear water. Store in clean bottle
Drain Opener 1 ½ cup baking soda 1 cup vinegar boiling water Dissolve soda & vinegar in boiling water, pour in drain; flush with hot tap water.	Drain Opener 2 ½ cup table salt boiling water Pour salt in drain, followed by boiling water; flush with hot tap water.
Scouring Powder Sprinkle borax, baking soda, or dry table salt on damp sponge; scour and rinse	Basin, Tub, & Tile Cleaner Rub area with half a lemon dipped in borax. Rinse, then dry with a soft cloth.
Mildew Remover ½ cup vinegar ½ cup borax warm water Mix fresh for each use	Spot Remover ¼ cup borax 2 cups cold water Soak fabric in the solution before washing in soap and cold water
Furniture Polish 2 parts olive oil or vegetable oil 1 part lemon juice Mix; apply with soft cloth, then wipe dry.	Laundry Soaps For natural fibers like cotton, use borax, baking soda, washing soda, or natural soap. Grate pure bar soap, such as ivory, add water and liquefy in blender.
Oven Cleaner While spill is warm, sprinkle salt on it; let cool, then scrape spill away and wash. Use baking soda for scouring.	Appliance Cleaner Dry baking soda will shine small appliances and remove bread wrappers burned onto toasters.

DUST

House dust can be comprised of several components that can result in potential allergic reaction. Materials that make up house dust include, but are not limited to: fibers, feathers, bacteria, mold spores, human dander, plant and insect particles, pet hair and dander. The most allergenic component of house dust is often dust mites--microscopic, spider-like insects. The allergen may be either the hard outer shell of the mite or a substance the creature excretes or secretes.

HEALTH EFFECTS FROM DUST

The known effects associated with dust are similar to those of mold and mildew. The symptoms include sneezing, runny and stuffy nose, watery and itchy eyes. Studies have shown that dust mites can contribute to one-half of all asthma cases. Under extreme exposure, dust mites can trigger severe asthma attacks characterized by wheezing, coughing and shortness of breath.

Table 9.3 Controlling Dust
✓ Dust mites depend on humidity and grow fastest at about 80% relative humidity but the relative humidity must be below 50% to stop mite growth. Temperatures in a home are just right for dust mites.
✓ Avoid the use of material that can harbor dust mites, such as carpet and heavy draperies.
✓ Use simple metal or wood furniture, washable cotton or synthetic shades, cotton or fiberglass curtains.
✓ Throw rugs should be washed weekly.
✓ Air conditioners will help keep air dry and discourage the growth of dust mites, but an electrostatic filter can remove particulates from the air.

ADAPTABILITY / RENOVATION

The same guidelines developed for new construction can also be applied to building renovation. Green renovation practices include: use of natural design elements such as increased daylighting; installation of resource-conserving materials and systems; recycling and reuse of construction and demolition waste and maintenance of good indoor environmental quality during construction.

The cost of renovation is substantially percent higher than the cost of new construction. It is possible however, to design a more adaptable building which would require less reconfiguration. This would reduce the cost of renovating buildings and make it more appealing than simply demolishing a structure. Renovating is the ultimate reuse of a space, if done properly, few new materials are needed and the bulk of the structure remains intact.

ADAPTABILITY CHECKLIST

- ✓ When designing, provide open adaptable spaces
- ✓ Use non-intrusive structural elements (i.e. post and beam instead of interior bearing walls)

LONGEVITY

Longevity is central to environmentally responsible building design. Longevity can relate to a building as a whole by adaptive reuse rather than new construction, or its components through increased recycling and use of salvaged materials. The common aim of each is to keep materials within the materials cycle as long as possible without the need for further processing. Consideration of longevity points to the importance of distinguishing between strategies that result in immediate environmental benefits and those for which the benefits are deferred to the future.

Table 9.4 Longevity Checklist
✓ Quality construction techniques
✓ Durable long lasting materials
✓ Build using classic architectural design
✓ Built-in items such as recycling bins

DECONSTRUCTION

Deconstruction (or selective demolition) allows materials to be salvaged, recycled or otherwise diverted from landfills. When a building is demolished, a tremendous amount of material must be disposed of. Deconstruction technology offers a more environmentally responsible alternative to demolition.

BENEFITS

Deconstruction offers compensation historically, economically, and environmentally. Older buildings often contain craftsmanship which may be of significant historical value to collectors. Deconstruction is more time consuming and requires more skill than simply demolishing a structure. This provides a market for labor and sales of salvaged material. More importantly, deconstruction puts back into circulation items which may be directly used in other building applications, reducing the amount of waste sent to landfills. Currently there are few incentives to break the historical mold of landfilling debris. However, the higher cost of selected demolition can be offset by the increased income from salvaged materials, decreased disposal costs, and decreased costs from avoided time and expense needed to bring heavy equipment to a job site.

One example of the benefits of deconstruction is removing sound materials from the waste stream, eliminating the need to harvest and mill new lumber and manufacture new household basics. Even when building codes prevent the use of old non-graded boards directly in a new home, they can be used in concrete forms, walkways, and equipment sheds at the construction site. Deconstruction also provides low income and thrifty people with inexpensive building materials and potential tax incentives.

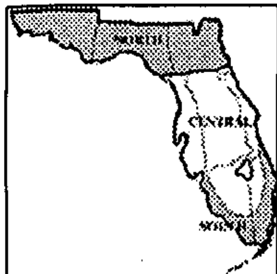
Table 9.5 Deconstruction Checklist
For Existing Buildings
✓ Deconstruct whenever possible
✓ Determine Destination of building elements, (landfill, salvage yard, immediate reuse)
✓ Determine Feasibility for reuse/recycling of building elements (2ii)
✓ Identify Market and Potential Use for building elements
For New Construction
✓ Examine Design process (design for deconstruction) while sustaining building integrity during useful life
✓ Design for recycling
✓ Acknowledge limit of structure life span
✓ Examine new building materials and systems that encourage recyclability of building elements

GREEN BUILDING MATERIALS

On an environmental level, there is a choice between using "green" materials in the construction of buildings and designing buildings as potential sources of future resources (raw materials) for new buildings. One must address the issue that green building materials are not always the best choice when designing a building for deconstruction. The ideal choices for deconstructable building materials are those with the greatest service life, and those materials which are desirable or hold historical value. In order for the concept of deconstruction to be effective, it is necessary to use materials that will be in great demand in the future. For example, linoleum floor such as Marmoleum®, is made from renewable raw materials. The flooring contains linseed oil, wood and cork flours, natural rosins, crushed limestone, and non-toxic pigment. This flooring is a much "greener" product than a traditional vinyl floor covering, however holds little future value. If a traditional solid wood tongue and groove floor was installed, not only will it last much longer, the floor will retain its value over time. The tongue and groove floor is worth salvaging, whereas the linoleum floor is disposable. It is important to note that the tongue and groove flooring may be a Green material if the wood was harvested from a certified sustainable forest.

APPENDIX

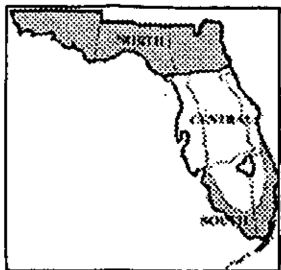
PLANT SELECTOR FOR THE STATE OF FLORIDA



	GEOGRAPHIC LOCATION			FOLIAGE		SIZE	SHADE DENSITY			TOLERANCE SOIL			TOLERANCE SALT			GROWTH RATE			REMARKS
	NORTH	CENTRAL	SOUTH	EVERGREEN	DECIDUOUS	MATURE HEIGHT	OPEN	MEDIUM	DENSE	GOOD	FAIR	POOR	YES	NO	SOME	FAST	MODERATE	SLOW	
CANOPY TREES																			
Shubard Oak Quercus Shumardii	X				X	40'-60'			X	X				X		X			Good shade tree
Magnolia Magnolia Grandiflora	X	X		X		100'			X		X				X		X		Good shade tree
Live Oak Quercus virginiana	X	X	X	X		60'			X	X			X					X	Broad spreading - long lived
Red Maple Acer Rubrum	X	X	X		X	50'-60'		X		X				X		X			Excellent native - short lived
Sycamore Platanus Occidentalis	X	X			X	75'-100'			X	X				X		X			Good shade - very fast growth
Gumbo Limbo Bursea Simarubra			X		X	60'			X	X			X			X			Excellent native- resistant to wind, drought, neglect
Mahogany Swietania Mahogani			X		X	40'-50'		X		X			X			X			Good street tree

Appendix: **PLANT SELECTOR FOR THE STATE OF FLORIDA (HOUSES AND CLIMATE 1979).**

PLANT SELECTOR FOR THE STATE OF FLORIDA



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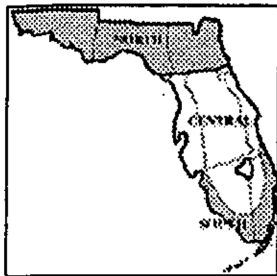
	NORTH	CENTRAL	SOUTH	EVERGREEN	DECIDUOUS	MATURE HEIGHT	OPEN	MEDIUM	DENSE	GOOD	FAIR	POOR	YES	NO	SOME	FAST	MODERATE	SLOW	
GROUND COVER																			
Shore Juniper Juniperus Conferta	X			X		24"					X		X				X		Good for full sun
Lily- Turf Liriope Muscari	X	X	X	X		12"				X					X			X	Does well in shade
Cat-Iron- Plant Aspidistra Elatior	X	X	X	X		24"					X				X		X		Tolerant of adverse conditions
Conferderate Jasmine Tracherlosperuum Jasminn	X	X	X	X		12"				X				X		X			
Peperomia Peperomia Species			X	X		12"						X		X			X		
Coromandel Asystasia Gangetica			X	X		12"					X			X			X		
Wedelia Wedelia Trilobata		X	X	X		18"					X		X			X			Good in sunny location
TURF GRASS																			
St. Aufustine Stenotaphrum Secundatum	X	X	X										X			X			Tolerant of Sun, shade and salt
Zoysia Zoysia Species	X	X	X										X					X	
Centipede Eremochloa Ophiuroides	X	X	X											X			X		Requires least amount of water and mowing
Bahia Paspalum Notatum	X	X	X											X			X		Thrives on sandy soil

Appendix: PLANT SELECTOR FOR THE STATE OF FLORIDA (HOUSES AND CLIMATE 1979).

PLANT SELECTOR FOR THE STATE OF FLORIDA



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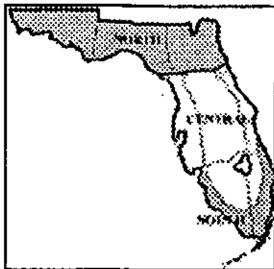
SHRUBS																			
Pittosporum Pittosporum Tobira	X	X	X	X		10'-20'			X		X		X			X			Excellent hedge material withstands heavy pruning
Sandankwa Viburnum Viburnum Suspensum	X	X	X	X		10'-12'			X		X			X				X	Good enclosure plant
Feijoa Feijoa Sellowiana	X	X	X	X		15'-18'			X	X			X				X		
Boxthorn Severinia Buxifolia		X	X	X		5'-6'			X	X				X				X	Good hedge material
Natal Plum Carissa Grandiflora		X	X	X		6'-8'			X		X		X				X		Good ocean front barrier plant
Surinam Cherry Eugenia Uniflora		X	X	X		20'			X	X				X			X		Good hedge plant
Snow Bush Breynia Nivosa		X	X	X		10'		X			X			X					Hedge plant

Appendix PLANT SELECTOR FOR THE STATE OF FLORIDA (HOUSES AND CLIMATE 1979).

PLANT SELECTOR FOR THE STATE OF FLORIDA



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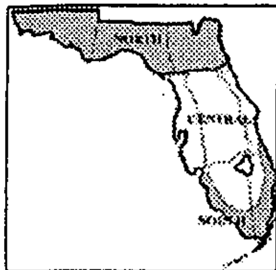
UNDERSTORY TREES																			
Dogwood Cornus Florida	X	X			X	30'		X				X		X				X	
Wax Myrtle Myrica Cerifera	X	X	X	X		25'			X	X			X			X			Fast grower- does well in variety of soils
Redbud Cercis Canadensis	X	X			X	30'-40'	X					X		X			X		
Anise Tree Illicium Anisatum	X	X		X		15'-20'			X	X				X		X			Good enclosure plant
Sea Grape Coccoloba Uvifera			X	X		15'-25'			X			X	X				X		Excellent seashore plant grows in beach sand
Benjamin Fig Ficus Benjamina			X	X		35'-40'			X	X					X	X			Good street tree
Black Olive Bucida Buceras			X	X		30'-40'				X			X					X	Good street tree- resistant to salt & wind

Appendix: PLANT SELECTOR FOR THE STATE OF FLORIDA (HOUSES AND CLIMATE 1979).

PLANT SELECTOR FOR THE STATE OF FLORIDA



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VINES																			
Creeping Fig Ficus Pumila	X	X	X	X		Variable		X		X					X	X			Good for masonry walls
Coral-Vine Antigonon Leptopus	X	X	X	X		"			X	X				X		X			Good for fences, arbors
Bougainvillea Bougainvillea Spectabilis		X	X	X		"		X		X					X	X			Rail fences and walls
Wisteria Wisteria Sinensis	X	X			X	"		X		X				X		X			Cover fences, arbors, good vigorous growth
Ivy Hedera Species	X	X	X	X		"		X		X					X		X		Good for walls, doubles as ground cover
Rangoon- Creeper Quisqualis Indica			X		X	"		X		X				X			X		Use on walls and fences
Janpanese Honeysuckle Lonicera Japonica	X	X		X		"		X		X				X					Good on Fences

Appendix: **PLANT SELECTOR FOR THE STATE OF FLORIDA (HOUSES AND CLIMATE 1979).**

BIBLIOGRAPHY

Baronet, Dianna, and William D. Browning. *A Primer on Sustainable Building*. Rocky Mountain Institute. 1993.

Carriker, Roy R. and Albert L. Starr. "Florida's Water Resources." Fact Sheet FRE-40. Florida Cooperative Extension Service, University of Florida, Gainesville, FL, 1991.

Cook, Gary, *A Guide to Selecting Window and Glazing Options for Florida Buildings*, Florida Cooperative Extension Service, University of Florida, Gainesville, FL, 1995.

Ewing, Reid. Best Development Practices: Doing *the Right Thing and Making Money at the Same Time*. Joint Center for Environmental and Urban Problems. May, 1995.

Florida Design Initiative. e-design. Online archives http://fcn.state.fl.us/fdi/e-design/ 1997.

Haase, Ronald W., *Classic Cracker: Florida's Wood-Frame Vernacular Architecture*, Pineapple Press, Sarasota, Fla., 1992.

Houses and Climate—An Energy Perspective for Florida Builders. Bureau of Research of Architecture, University of Florida, Gainesville, FL, 1979.

Houston, Michael M. *A Checklist for Building an Energy Efficient Home in Florida*. FSEC-EN-10-82. Florida Solar Energy Center, Cocoa, Fla., 1985.

Johnson, Timothy E. *Low-E Glazing Design Guide*, Butterworth-Heineman, Stoneham, 1991.

Lenchek, Thomas, C. Mattack, J. Raabe, *Superinsulated Design and Construction*, Van Nostrand Reinhold Company, Inc., New York, N.Y., 1987.

Myers, Ronald L., and John J. Ewel. *Ecosystems of Florida*. University of Central Florida Press, Orlando, Fla., 1990.

Olgyay, Victor. *Bioclimatic Approach to Architectural Regionalism*. Princeton University Press, Princeton, N.J., 1963.

Passive Solar Industries Council. *Passive Solar Design Strategies: Guidelines for Home Building*. National Renewable Energy Laboratory with support from US Department of Energy, Asheville, N. C.

Peart, Virginia. "Is Your House a Sick House?: The Mold/Air Conditioner Duct Connection." Florida Cooperative Extension Service. Fact Sheet H-2001. University of Florida, Gainesville, Fla., 1992.

Peart, Virginia. "Indoor Air Quality in Florida. Formaldehyde." The Institute of Food and Agricultural Sciences. IAQ-11 February, 1992.

Peart, Virginia. "Indoor Air Quality in Florida: House Dust/Dust Mites." The Institute of Food and Agricultural Sciences. IAQ-5, February, 1992.

Russell, Philip, and Joe Hammer. *Energy-Smart Building for Increased Quality, Comfort, and Sales.* Home Builders Press, Washington, D.C., 1993.

Schwolsky, R. and James I. Williams, *The Builders Guide to Solar Construction*, McGraw-Hill, Inc., New York, N. Y., 1982.

Sustainable Building Technical Manual—Green Building Design, Construction and Operations. Public Technology, Inc., 1996.

Wemhoff, Philip, *Southern Home Building: Energy, Comfort, and Value*, Gainesville Regional Utilities Trade Alliance Program, Gainesville, Fla., 1995.