

GREENSBURG GREEN:

Design Strategies for a Progressive Community

WHY THIS BOOK?

Choosing to build a new home can be a daunting task. As you start out on this long but rewarding process, it is important to know the options and opportunities you have for creating the home of your dreams. But where to begin? Hopefully this manual will help answer that question. This booklet describes a conventional design approach involving a client (you), an architect, and a builder. However, there are different possible solutions. Exciting progress has been made in the area of prefabricated homes that can be purchased and installed at much lower prices than conventional housing, and often with better results. By choosing not to design your own home you can skip several of the steps outlined in this booklet.

CREATED BY:

Sally Maddock, 5th year, Architecture Student
Kelsey Kern, 4th year, Landscape Architecture Student

College of Architecture, Planning and Design
Kansas State University
December 2007

MANY THANKS TO:

Todd Gabbard, Assistant Professor, Architecture
Melanie Klein, Assistant Professor, Landscape Architecture/
Regional & Community Planning
Kansas State University

On the Cover
Map: Source 1
Historic Photo: Source 14



SOURCE 19

THE DESIGN PROCESS

- 1 Research your options
- 2 Selection of the Design Team
- 3 Program Planning
- 4 Site Analysis
- 5 Site Selection
- 6 Site Design
- 7 Building Passive Systems Design
- 8 Building Active Systems Design
- 9 Interior Finishes and Appliances
- 10 Plan Permitting and Approval
- 11 Construction
- 12 Occupation and Maintenance



1 RESEARCH YOUR OPTIONS

1 RESEARCH YOUR OPTIONS

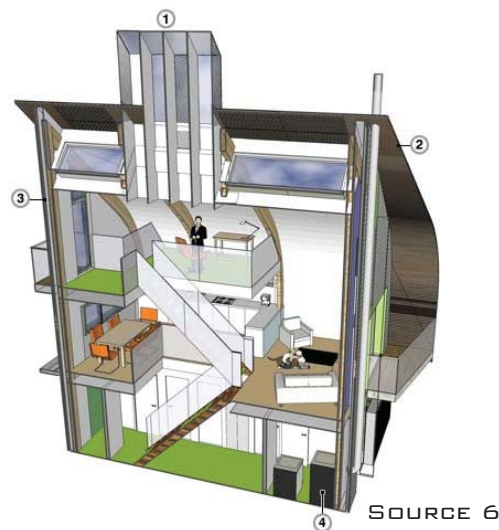
Prefabricated Housing

Modular Housing

Mobile Housing

Purchasing a Floorplan

Custom Design Process



- (1) Wind Catcher for Summer Ventilation
- (2) Solar Array
- (3) High Level of Insulation
- (4) Biomass Boiler

PREFABRICATED, MODULAR, AND MOBILE... WHAT'S THE DIFFERENCE?



SOURCE 33

PREFABRICATED OR "PREFAB"



SOURCE 36

MODULAR



SOURCE 37

MANUFACTURED OR MOBILE

The differences between prefabricated, modular, and mobile housing are often unclear. In this book we will use the following rule of thumb:

- If the home is a "kit of parts" that some labor has been completed on it is **prefabricated**.
- If the home comes in a few large sections that were assembled in a factory it is **modular**.
- Finally, if the home is built on a steel frame and considered movable³⁶ it is probably a **mobile** home [think single, double, or triple wide].¹⁰

PREFABRICATED HOMES

Prefabricated homes are a recent development in making architecture commercially accessible. There are many different systems that can compose a prefabricated house including:

- Stick built
- Structurally Insulated Panels [SIPs]
 - High insulation value [R-25]
 - Very strong
 - Extremely lightweight
- Pre-cast concrete
 - High strength in compression
 - Low maintenance
 - Easily available
 - Fire resistant¹¹
- Shipping containers
- Structural Steel members



For information on specific model homes, please see the Resources section at the end of the book.

Advantages:

1. Quick assembly
2. Cheaper to transport than modular housing because it is broken down into smaller pieces
3. Not limited in size like a modular or mobile home
4. More customizable because units can be reconfigured more easily
5. 10-20% cheaper to build than 'site built' homes¹³
6. Come in a wide range of architectural styles (see images at left)

Disadvantages:

1. More "on-site" labor than modular or mobile homes
2. Careful handling of prefabricated components such as concrete panels or steel and glass panels is required.
3. Purchase and transportation of assembled materials can cost more than purchasing materials locally.



PREFABRICATED HOMES



MODULAR HOMES

Advantages:

1. Reduced need for formwork, shuttering and scaffolding.
2. Reduced construction time.
3. On-site construction and congestion is minimized.
4. Better quality control due to assembly line production.
5. Construction can be located where skilled labor is more readily available and costs of labor, power, materials, space and overheads are lower.
6. Time spent in bad weather or hazardous environments at the construction site is minimized.
7. Less waste may be generated and in a factory setting it may be easier to recycle it back into the manufacturing process, for instance it is less costly to recycle scrap metal generated in a metal fabrication shop than on the construction site.



Disadvantages:

1. Attention has to be paid to the strength and corrosion-resistance of the joining of modules to avoid failure of the joints. If not, leaks can form at joints in modules.
2. Transportation costs may be higher for modules than for the materials of which they are made.
3. Large modules require heavy-duty cranes and precision measurement and handling to place in position.⁷

MANUFACTURED OR MOBILE HOMES

Advantages:

1. \$20,000+ for a basic single wide mobile home (600-800 sq. ft) and \$90,000 + for double or triple wide (2000-2200 sq. ft). Mobile homes have the cheapest construction.
2. Fast and easy to install.
3. Minimum sitework.
4. Have the potential for future relocation.

Disadvantages:

1. Rapid depreciation. A home of with an initial coat of \$70,000 will be worth \$40,000-\$50,000 in 10 years.
2. They are inherently narrow and long and the outer shells are generally made of thin materials.
3. More costly to heat and cool due to lower insulation values.
4. Little flexibility in floorplan.
5. Not built to the same strict building codes and standards as modular and site-built homes.³⁶
5. Usually do not have a basement and do not stand up well to severe weather conditions.¹⁰ Unlike other housing options, mobile homes are not assembled in place, and essential structural members are not anchored to foundations.



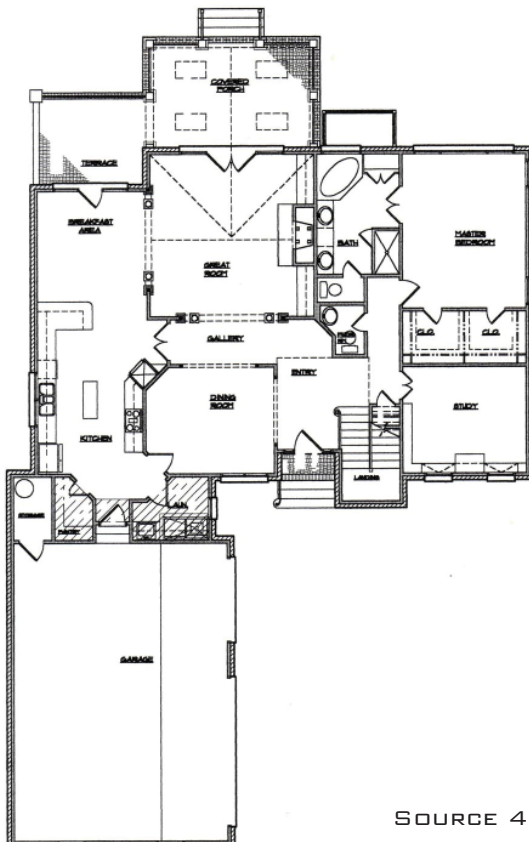
PURCHASE A FLOORPLAN

Advantages:

1. Choose your own builder
2. Select your own finishes, colors, etc.
3. Cheaper than having an architect design for you.
4. Small changes to plans may be possible.
5. May be able to see a built example before you buy.

Disadvantages:

1. Less control over appearance, spatial configuration, etc
2. Difficult to tailor to climatic needs for optimum sustainability
3. May require the use of specific systems or materials that are difficult to locate in your region.



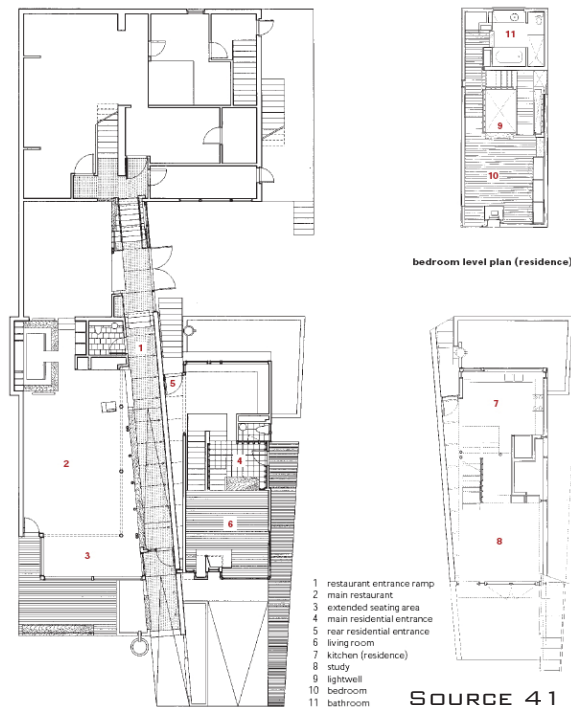
SOURCE 42

CUSTOM DESIGN PROCESS

This is the process the remainder of this booklet will walk you through. As architects, of course we feel this is the most beneficial method to creating the best home possible for your individual needs, for the regional climate, and your particular site.

Advantages:

1. Because the house is designed specifically for your needs it can be customized in any way you want.
2. Heat and cool less square footage because house is not bigger than you want it to be.
3. Your home is one of a kind, made especially for you.
4. The house can also be tailored to meet your budget needs.
5. Assurance that all your local building codes will be met.
6. The home can be designed to take advantage of site-specific views, the micro-climate, and the lot size.
7. Highest potential for energy efficiency, passive thermal and lighting systems, and environmentally friendly construction.



Disadvantages:

1. You will have to pay an architect's design fees.
2. The process will require more of your time through the design and construction process.

2 SELECTION OF THE DESIGN TEAM

2 SELECTION OF THE DESIGN TEAM

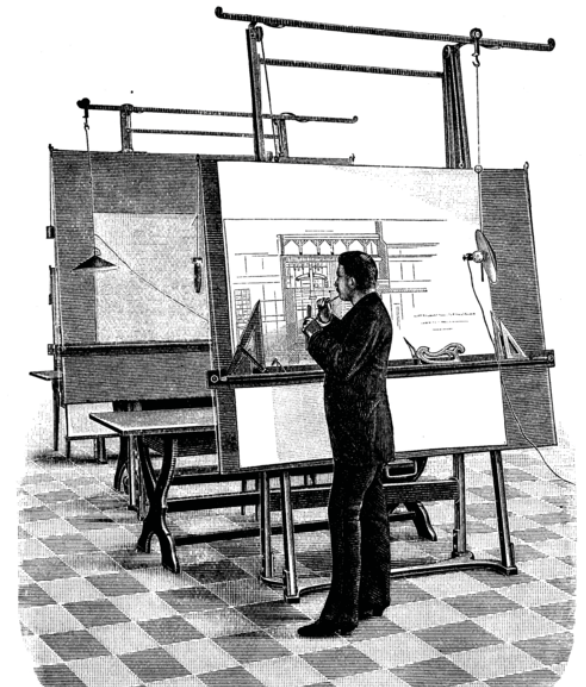
SELECT AN ARCHITECT OR ARCHITECTURE FIRM

When choosing an architect it is important to do research in advance. Ask to view their portfolio to see if you have similar taste. Ask them what kind of knowledge, experience, and skills they have in green design. A firm that employs at least one United States Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) accredited professional is a good place to start. It is also important to ask for references. Previous clients can give you insight into how reliable and successful a design firm is.

Similarly, if there is a building in town that you like, do not be afraid to inquire who the architect is. Referred business is the number one compliment any design firm can receive.

SELECT APPROPRIATE PROFESSIONALS FOR THE EXPANDED DESIGN TEAM

In many cases the architect you select can help you select a good builder, landscape architect, engineer, etc. Depending on your contract, the architect may hire some of those services for you. Once again, references are important, as is selecting professionals who have experience working toward your goals. It is especially important to look for individuals who are skilled at value/cost analysis, energy simulation, green expertise, and facilitation of integrated design tactics (or how well they can work with other design professionals on the team).



SOURCE 39



WHY HAVE AN INTEGRATED DESIGN TEAM?

15

An integrated design team can help you set realistic environmental performance targets. As the owner, you will be an integral part of this team. The performance targets you set should be appropriate to the site of your building and your particular needs. Take special care when addressing the following issues:

- Energy (Energy Use, Energy Source, Clean Energy Transport)
- Water (Water Use, Water Filtration, Human Waste, Ground Water Recharge)
- Landscape (Integrated Pest Management, Green Space, Native Plantings and Wildlife Habitat)
- Materials (Recycled Materials, Efficient Materials, Salvaged Materials, Local Materials, Durable and Low Maintenance)
- Waste (Recycling and Composting Facilities)
- Construction Practices (Construction Waste, Reuse Topsoil, Vegetation and Watercourse Protection)
- Indoor Environmental Quality (Air Pollutant Emissions, Ventilation Effectiveness and Air Filtration, System Commissioning and Cleaning, Daylighting)
- Economic Performance (Life-Cycle Assessment, Capital Cost Accounting)¹²

3 PROGRAM PLANNING

3 PROGRAM PLANNING

Drafting your project program is one of the most difficult but rewarding steps of building a new house. A program is like a recipe for your new building. It lists what spaces should be designed into the new house and how many square feet they are. Design professionals will follow this 'recipe' to design the home of your dreams.

HOW TO MAKE A PROGRAM:

Outline your needs.

Consider spaces you had in your last residence. Which were essential, which were not used, and which did you wish you had? Try to estimate how many square feet each space should be and what spaces they should be adjacent to. Should your house be one story or two? The more information you give your architect, the more successful the project will be overall.

Identify potential shared and adjacent spaces.

Can the formal dining room double as a guest bedroom? Get creative and save money! For more information about grouping spaces see Section 7: Building Passive Systems Design.

Prioritize the spaces in terms of importance.

Consider which spaces are the most beneficial and which spaces are the most costly.

Determine your budget.

Be realistic. How much money do you want to invest in your house? Do you prefer more space and fewer details, or a high quality finish with a lower square-footage? You may want to discuss this with your banker if you are planning to take out loans. It is important to keep at least 10 percent of your budget back for incidentals, as many projects go over budget.

Do the math.

Add up the total amount of square feet you require and divide it by the amount of money you are willing to spend. You will then know the number of dollars per square foot of house you will be able to spend. In 2006, the average price per square foot of home in the Midwest was \$86.96.²

Reduce, Reduce, Reduce

You will probably have to go through these steps several times to arrive at reasonable expectations. Each time try to eliminate the things that are not absolutely necessary while combining spaces that are. Remember, the smaller your home, the less money and resources it will require each month you live in it.

4 SITE ANALYSIS

4 SITE ANALYSIS



Climate

Sun

Wind

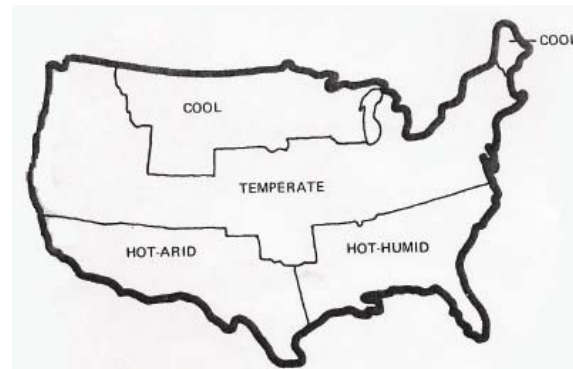
Water

SOURCE 34

CLIMATE

Greensburg is located in a temperate climate, categorized by "an equal distribution of overheated and under-heated periods... seasonal winds from the northwest and south along with periods of high humidity and large amounts of precipitation, [and] intermittent periods of clear sunny days are followed by extended periods of cloudy overcast days."⁶⁴

Based on this information, there are several objectives to accomplish in a temperate climate. The objectives for a temperate climate are to "maximize warming effects of sun in winter, maximize shade in summer, reduce impact of winter wind but allow air circulation in summer."⁶⁴



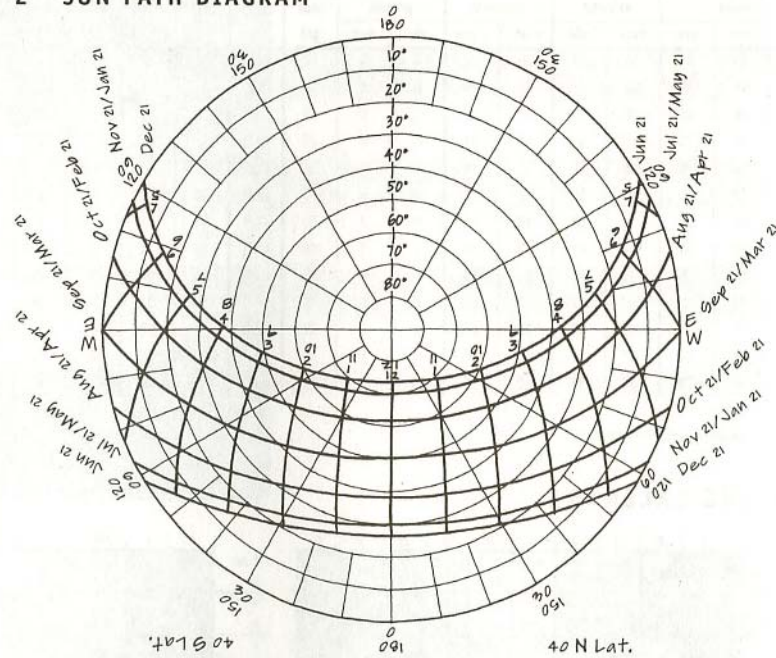
SOURCE 64



SOURCE 68

SUN

2 SUN PATH DIAGRAM



Sun Path Diagram, 40° Latitude

SOURCE 3

Greensburg is located at 37.602N latitude and -99.292W longitude. Its elevation is 2,234 feet.¹⁴ What this means is that on the winter solstice at noon the sun will strike the ground at approximately 25 degrees. On the summer solstice at noon the sun will strike the ground at approximately 85 degrees.³

This information can be applied to the design of your home and landscape in many ways to save you money on heating, cooling, and lighting, as well as contributing to the overall aesthetic of your home.

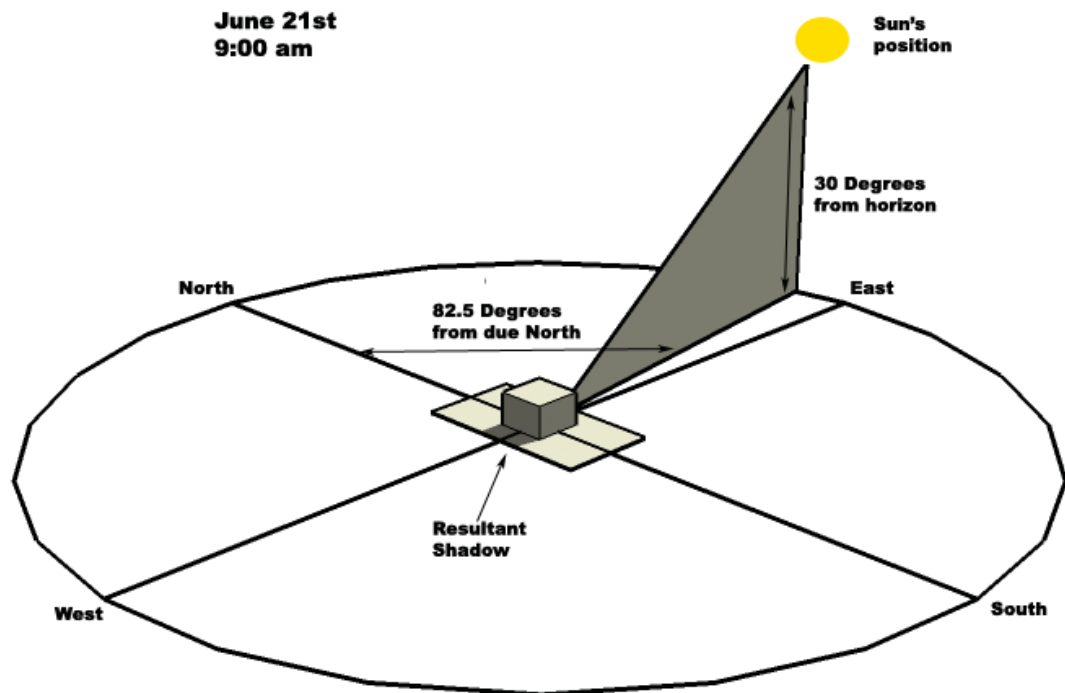
The above sun path diagram is read as if the sun were being cast on a flat surface, with the horizon as the outer circle and the observer in the middle. The

concentric circles represent the angle of the sun above the horizon, or its height in the sky. The radial lines represent the sun's angle relative to due north. The top line represents the sun's path on the summer solstice, June 21st. The bottom represents the sun's path on the winter solstice, December 21st or 22nd. The lines in between are the 21st day of each month, March and September being one in the same.⁶⁵

SUN

Based on the information from the chart, one can visualize the sun's effect on a site. One example can be modeled in 3D as shown in the image below.

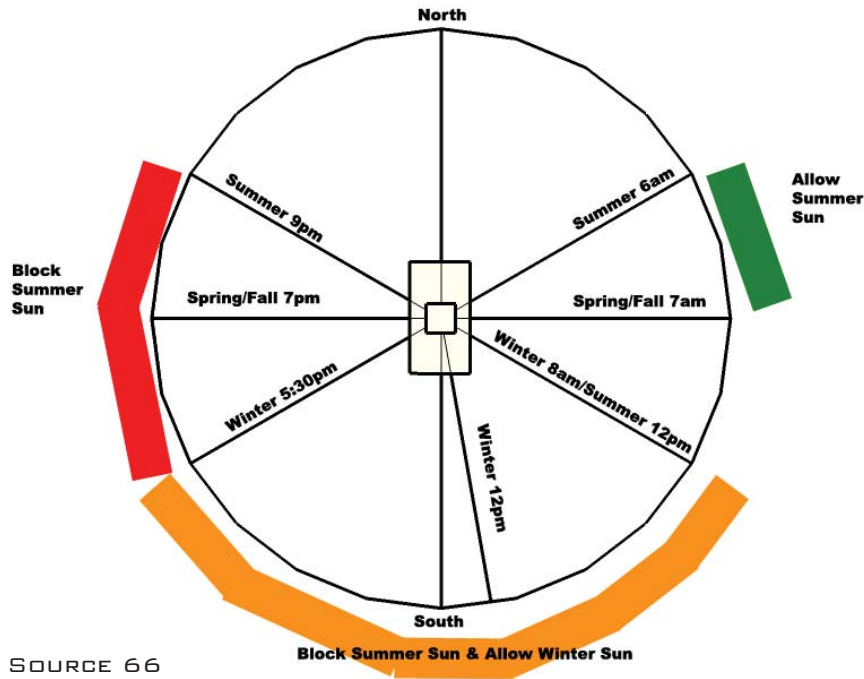
From this inventory of sun's angles we can analyze their effects on the site year round, as shown on the following page.



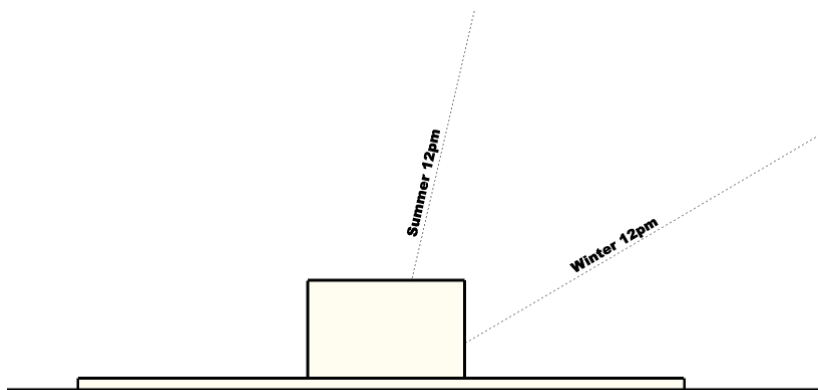
SOURCE 66

4 SITE ANALYSIS

SUN



SOURCE 66



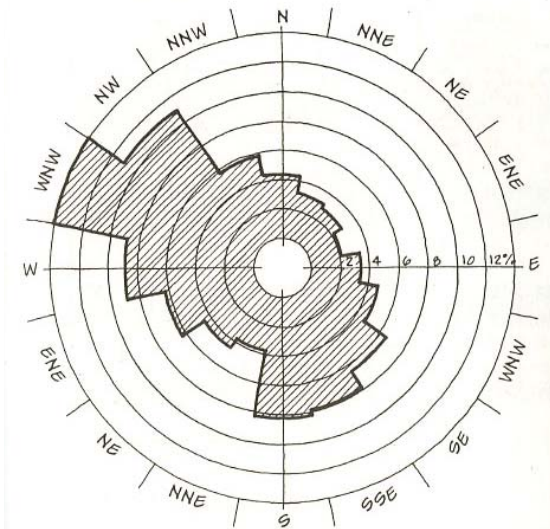
SOURCE 66

From an inventory of sun's angles we can analyze their effects on the site year round, as shown in the image above.

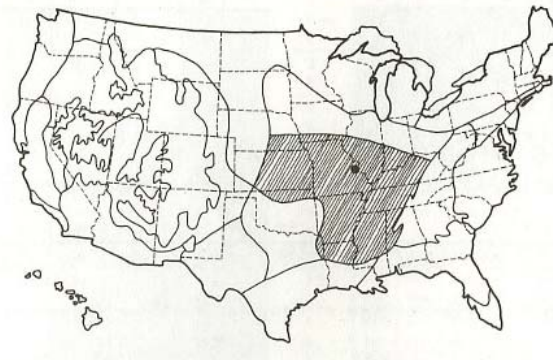
Sun angles can also be analyzed in section, as shown in the image to the left, for noon in summer and winter. Knowing these angles in section, one can start to determine heights of objects that may be used to block or allow sun.

WIND

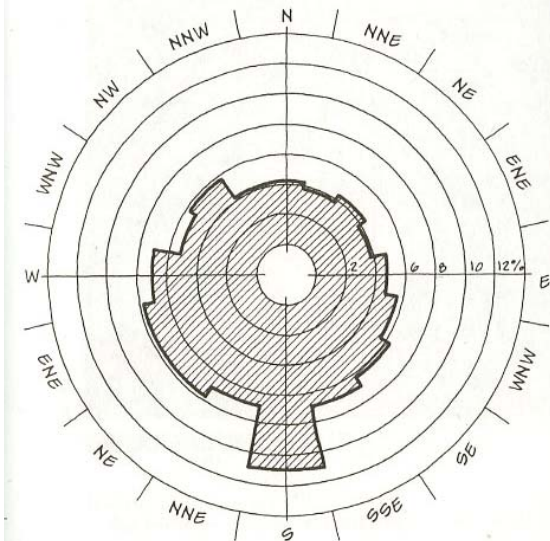
To determine the wind patterns for Greensburg, refer to the climatic zone that it is in. Similar to that of St. Louis, Missouri, it is known as "temperate continental." The wind rose (at right) for St. Louis can be used loosely to predict the seasonal winds for Greensburg.³ The wind rose tells us that in the winter the winds are predominantly from West North West and in the summer they are predominantly from due South.



January Wind Rose, St. Louis



SOURCE 3



July Wind Rose, St. Louis

SOURCE 3

WATER

Annual Precipitation

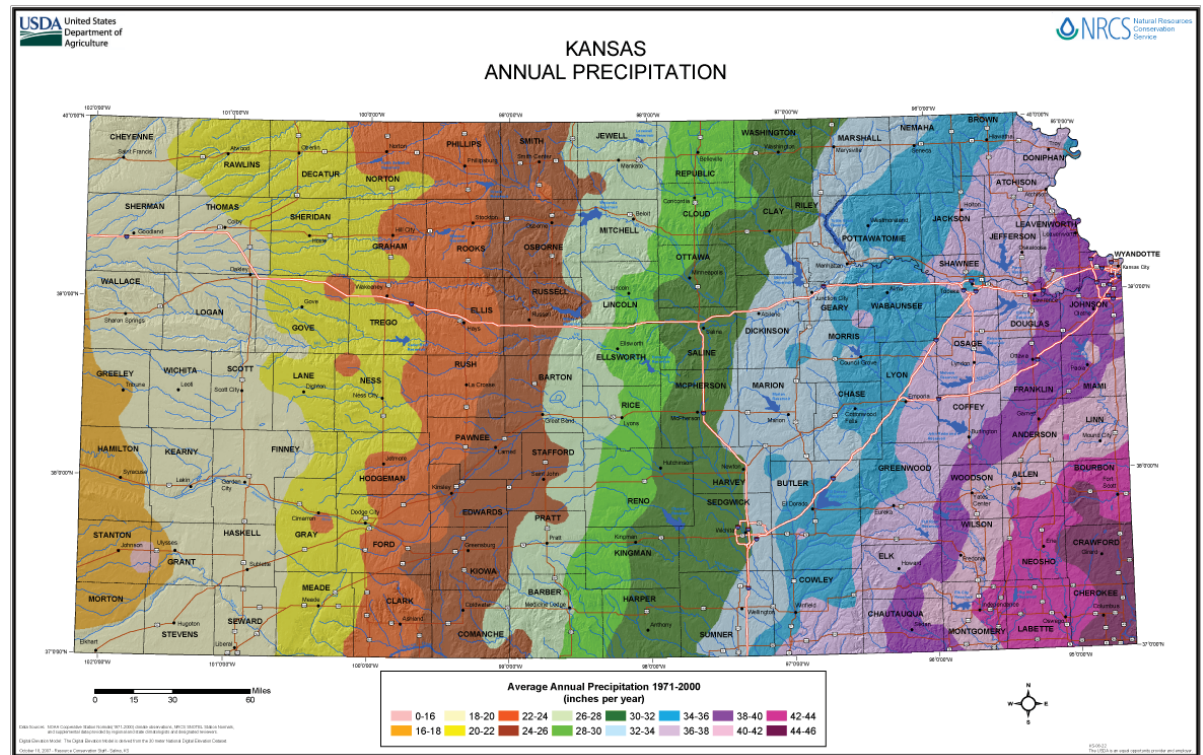
Greensburg, Kansas receives an average of 24-26 inches a year.¹⁰⁵ This average rainfall data can assist the homeowner in making decisions about building material and plant materials.

Drought

Drought is a possibility in Kansas and the chance of drought should be considered when designing a private lot. For information on Kansas Drought Watch from the USGS, see the Resources section.

Flood

Along with periods of drought, Kansas is susceptible to flooding. For more information on the Kansas Flood Watch, see the Resources Section.

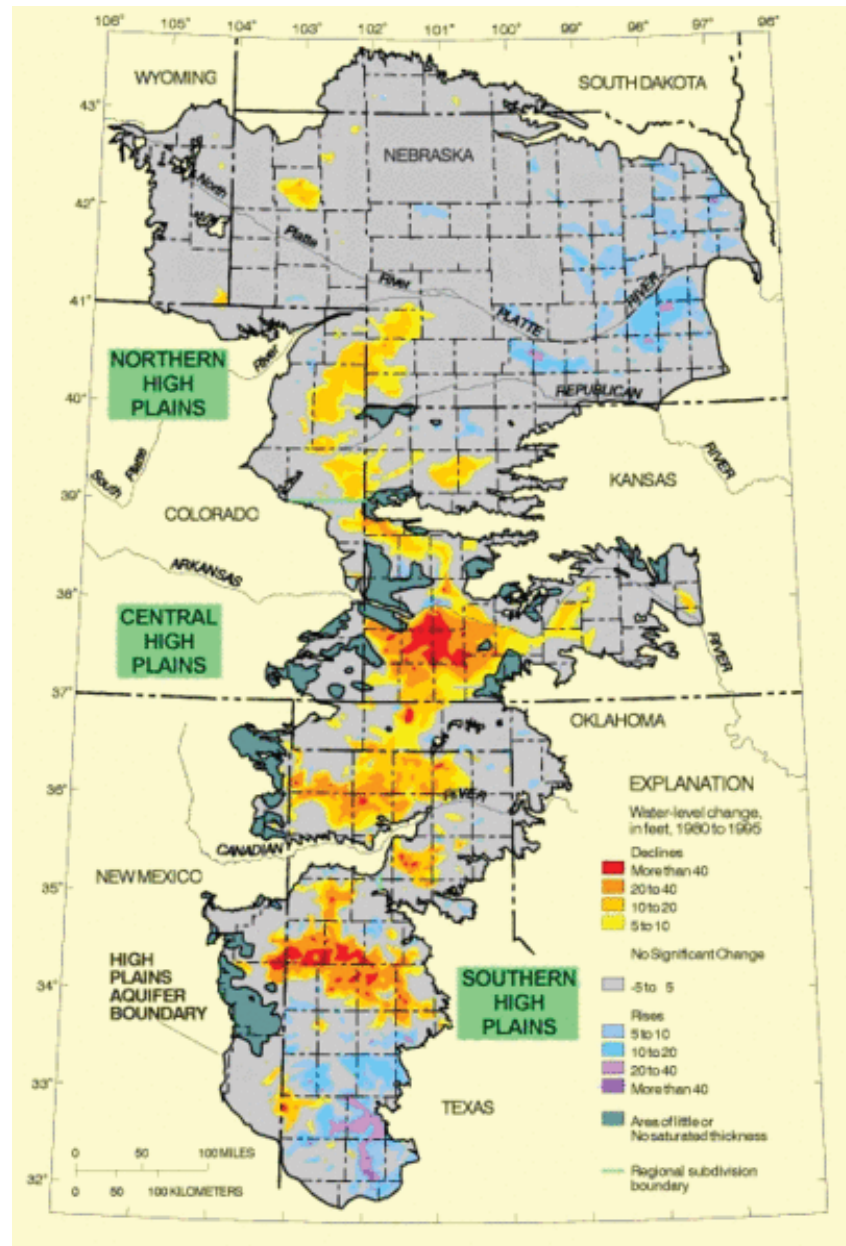


SOURCE 105

WATER

Aquifer Recharge

Greensburg, Kansas is above the Ogallala Aquifer, or High Plains Aquifer. This underground water table is one of the world's largest and is a source of fresh water and water for irrigation for much of the eight states in its area. Currently, more water is being taken out than being put back into the aquifer. Through sustainable practices and conservation of this natural resource, more water can be put back in the ground instead of on the surface and the aquifer can be recharged.¹⁰⁴ For more information on the Ogallala Aquifer, see the Resources section.



SOURCE 104

5 SITE SELECTION



SOURCE 63

When choosing to develop a site, the developer or contractor should analyze it to ensure the development would be safe for the environment. Development of "green" homes should not contribute to the degradation or loss of agriculture and natural resource lands. It is best to evaluate potential building sites for the following criteria prior to purchasing the land, or make sure the criteria are addressed by the designer during the conceptual design phase. In order to evaluate potential building sites, it may be necessary to utilize landscape architects, ecologists, environmental engineers, civil engineers, and similar professionals.⁶²

When selecting land for development, avoid environmentally sensitive land or precious resource land. According to LEED certification standards, this may include:

- Land whose elevation is lower than the 100-year flood as defined by FEMA.
- Land which is specifically identified as habitat for any species on Federal or State threatened or endangered lists.
- Land within 100 feet of any water including wetlands... and isolated wetlands or areas of special concern identified by state or local rule, or within distances given in applicable state or local regulations.
- Land which prior to acquisition for the project was public parkland, unless land of equal or greater value as parkland is accepted in trade by the public landowner.
- Land defined as prime farmland by the United States Department of Agriculture.⁶²

SITE SELECTION

Homes should be developed near or within existing communities. Preferably the site should be an infill or previously developed site, meaning building a new home where another home once was. This is best because utilities and infrastructure already exist, such as sewers and water supply. Within ½ mile of existing water service lines and sewer service lines is recommended by LEED standards. The reason for this is to "encourage the efficient use and reuse of land, and to minimize fragmentation of undeveloped land by channeling development to locations immediately adjacent to existing development."⁶²

Development of homes should be encouraged in patterns that allow for walking or biking as alternative means of transportation to necessary services. This means homes should be built within ¼ to ½ mile from at least seven basic community resources. Community resources can include schools, banks, supermarkets, etc. This objective reduces energy consumption from vehicular transportation and also encourages a more active, healthy lifestyle.⁶²

Land that is suitable for development is defined as land that:

- is a short walk from public transit, pedestrian and bicycle routes
- exists in an already-urbanized area
- is walking distance from amenities, such as a grocery store
- is already serviced by urban infrastructure such as roads and utilities.¹²



SOURCE 61

6 SITE DESIGN

6 SITE DESIGN



SOURCE 63

Soil

- Minimize Effects of Construction
- Healthy Soil

Landscaping

- Pest Control
- Irrigation
- Plant Material

Surface Water Management

- Design a Permeable Site
- Rain Collection
- Utilize Rain Gardens

Influence of Solar Angles

- Landscape Applications for Solar Energy

Influence of Wind

- Plant Material to Control Wind

SOIL

Soil on a site must be healthy enough to grow plant material, stable enough to build on, and controlled to prevent erosion. This section outlines ways the soil on a private lot can be "green."

Minimize Effects of Construction

The process and operations of constructing a home on a site can have several damaging effects on a site. These include disturbing existing vegetation and drainage ways, compacting soil, which prevents the proper amounts of air and water to access the soil, as well as creating a situation for soil to erode. These negative affects on the site can be minimized with a few extra measures.

Minimize Disturbed Areas

A guaranteed way of preventing damage to a site is to ensure parts of the site are not disturbed during construction. On a smaller site, such as a private residential lot, this can be difficult. In some cases, there may be large trees or plant material that can be preserved which should be clearly marked on construction documents and protected from construction vehicles. The U.S. Green Building Council recommends leaving at least 40% of the site undisturbed. Designing a building that has a small footprint with more floors reduces the area on the site needed for construction operations. Using clearly marked "do not disturb" zones and even creating punishments for contractors that disturb these zones is also an option. Using areas that will be paved as areas for storing equipment can also reduce the impact on the site as well as prevent unnecessary compaction.⁷⁷



SOURCE 78

SOIL

Compaction

Preventing or reducing compaction of soils should be a goal during the construction of a home, as compressed soil can reduce a plant's ability to grow roots as well as prevent water to penetrate the soil. For the private lot owner, this can simply mean making sure heavy construction equipment is used minimally.⁷³ In yards or gardens, foot traffic is usually to blame for soil compaction. Tips on tilling or aerating compacted soil can be found in the References section of this document.

Erosion Control

Erosion of soil happens when wind or water breaks up and moves soil from its original location, often too much soil erosion can pollute water or disturb natural processes. There are many ways to prevent erosion, most of which are done at a large scale. However, some things can be done on a private lot during the process of construction when soil is disturbed the most. These include protecting stripped and stockpiled soil from erosion using products such as erosion control blankets, especially on steeper slopes. It is recommended these controls must function until landscaping is in place.⁷⁷ Consider seeking a professional opinion when implementing erosion control measures. More information on these products can be found in the Resources section of this document.



SOURCE 79

SOIL



SOURCE 73

Healthy Soil

"Healthy soils allow rainwater to penetrate, preventing excess runoff, sedimentation, erosion and flooding."⁷³ Simple practices can be implemented to ensure healthy soil on a private lot.

Use Compost

Compost is used to bring nutrients and necessary organisms to the soil. "Compost helps sandy soils hold nutrients and water, loosens clay soils and feeds the beneficial soil life so it can feed and protect your plants."⁷⁴ Performing a soil test will help determine if your soil could benefit from compost. The Environmental Protection Agency (EPA) has several tips on making compost.

Whether compost is made or bought in bags or in bulk, it is beneficial to soil. One to three inches of compost should be mixed with the top 6-12 inches of topsoil when making new planting beds or planting a lawn. Compost can also be applied to existing lawns using a quarter to a half inch every spring or fall.⁷⁴ The easiest way to make compost is to reuse waste from food products or yard waste. Things like leaves, flowers, and grass clippings can be used in a compost pile. Along with yard waste, food scraps such as vegetable scraps and coffee grounds can be used as well. Be careful not to use food containing meat, dairy or oils as they can attract pests.⁷⁴ Tips on creating a compost pile can be found in the Resources section. Compost piles are usually very low maintenance, however when starting from scratch, there are a few things to be aware of. The pile should be turned and mixed every few weeks to circulate moisture and air. Watering the compost pile in dry weather is also recommended.⁷⁴



SOURCE 80

Compost can be collected easily in a bin or tumbler, often made from wood or plastic. Information about the variety of compost bins can be found in the Resources section.

SOIL

Use Mulch

Mulch is used to stabilize soil temperature, prevent the growth of weeds, bring valuable nutrients to plants, as well as conserve water. Mulch can be used in flower beds and vegetable gardens and usually comes in the form of shredded wood. Shredded leaves, compost, or grass clippings can also be used as mulch. The EPA suggests using no more than three inches of mulch in landscaping beds. It is also important to keep mulch about an inch away from stems and tree trunks to prevent rotting. Mulch can even be used on lawns. After cutting the lawn, the grass clippings will quickly decompose and release nutrients into the soil, which can reduce the need for fertilizer.⁷⁴ Tips on mulching can be found on the NRCS website in the Resources section.

Minimize fertilizer

When using fertilizer on annual plants like vegetable gardens, try to use a "natural", "organic", or "slow-release" fertilizer. These feed plants slowly and evenly, reducing the nutrient run-off into ground and surface waters. Using excess chemicals can be very harmful to drinking water and wildlife. Reading product labels and being aware of what you're purchasing is very important.⁷⁴ See the Resources section for organic fertilizers for specific soil needs.



SOURCE 103



SOURCE 81



SOURCE 82

LANDSCAPING



SOURCE 83

The placement and care of plant material should be addressed when greening a private lot. This section outlines principles to follow to make a lot's landscaping environmentally friendly.

Pest Control

When choosing and maintaining plant material, it is important to consider the impact of insects or disease on the chosen plants. If not dealt with properly, pests can cause harm to the environment through improper use of pesticides or simply create an unhealthy lawn or garden.

Prevention

Preventing pests from becoming a problem should be the first step in dealing with pests in your landscape. Be sure to select pest and disease-resistant cultivars or varieties of plant material. Using a variety of plants also reduces the spread of pests and diseases. Removing dead plants before insects have a place to hide is another prevention method.⁷⁴



SOURCE 84



SOURCE 85

LANDSCAPING



SOURCE 86

Replace Problem Plants

Plants that have become infested with pests or have developed a disease should be removed from the site to prevent the spread of the pest. Even a tree or large shrub should be removed and replaced with a more tolerant or resistant variety of plant material.⁷⁴

Identify Real Pests

Not all insects are pests, in fact, less than one percent of insect species are considered pests. Natural enemies of pests should be given time to establish and control the pest.⁶⁹

Use "Natural" Pesticides should be used as a last resort and when the pest threatens to cause serious damage to the host. Always choose a pesticide that is least harmful to natural enemies.⁶² More information about organic pesticides is listed in the Resource section.

Use the Right Product

Read the label of the chosen pesticide carefully, to protect yourself, children, pets, and the environment. The EPA has initiated a "Read the Label First" Campaign. For more information, see the Resources section.

LANDSCAPING

Irrigation

When creating a landscape plan for a private lot, it is important to consider how watering the plants will impact the environment. Utilizing an efficient system and choosing plants that require less water are great ways to save water, and money.

Minimize Need

Selecting plant material such as trees or shrubs that only need rainfall is one way to minimize the need for irrigation. Using compost and mulch to hold water and reduce evaporation also reduces the need to water certain plants or beds.

Less is More

Be aware of how much water your plant material needs. Watering too much or too little is often the cause of many plant problems. Be sure to only water what the plant requires and no more. It is also recommended to "water deeply, but infrequently"⁷⁴ meaning the soil should be allowed to partially dry out between waterings.

A loss of shine or footprints remaining after you walk across the lawn indicates the need to water. Vegetables and other annuals should be watered at the first sign of wilting and tougher perennials need water "only if they stay droopy after it cools off in the evening,"⁷⁴ Trees and shrubs do not require watering after 2-5 years except in very dry years.⁷⁴

Efficient System

Installing an irrigation system instead of using a traditional sprinkler can save money, and water, over time because it uses water efficiently. When watering flower beds or gardens, use soaker hoses or drip irrigation to prevent over-watering. Using an outdoor water timer, to water the right amount, at the right time of day will also increase efficiency. Be sure to water a lawn separately from other plants and do not water pavement or compacted soil. Also water early in the morning to reduce evaporation and, during a dry season, allow an established lawn to go dormant, watering only once a month.⁷⁴ Tips on efficient irrigation systems can be found in the Resources section.



SOURCE 87



SOURCE 88

LANDSCAPING

Plant Material

The majority of the land area on a private lot is filled with plant material. Due to the size of the area, plant material can have a major impact on the environment and, therefore, should be a major consideration for the lot owner.

Design Your Space

Knowing how you want to use outdoor space is the first step to finding the right plant material. Consult a professional landscape designer or do some research on plant material. Make a list of uses for the lawn or yard and how much space those uses will need. Keep these things in mind when deciding how you want to use your yard.⁷⁴ Ideas on landscape design are in the Resources section.

Use Native Plants

Native plants are those that originated in a certain geographic area. These benefit the environment because they do not require much maintenance such as fertilizer, excess water, and resist damage from freezing, drought, and diseases.⁷² Using plants from local growers saves energy use and other environmental impacts, these plants are also adapted to local environmental conditions and may require less care and maintenance than those that are not.⁷³ The U.S. Green Building Council recommends to "work with local cooperative extension services or native plant societies to select indigenous and well-adapted plant species for site restoration and landscaping."⁷⁷ The Kansas Native Plant Society has a website that has several resources regarding native plants.



SOURCE 89



SOURCE 90



SOURCE 91

LANDSCAPING

Use Turf Wisely

A traditional green lawn can be necessary for recreational uses in a landscape plan, however turf grass can have negative impacts on the environment. Over-watering, over-fertilizing, and improper maintenance can be avoided. Reducing the amount of turf grass used in the lawn can significantly reduce the maintenance, watering and fertilizing costs. Design your lawn to be only large enough for recreational use.

If possible, use a variety of turf such as buffalo grass that uses little water and requires little to no mowing. Where turf grass is used, be sure to maintain it in a proper way. Mowing more frequently when grass is actively growing, but only cutting one-third of the height of the grass minimizes the amount of grass clippings. Leaving the clippings on the lawn makes lawns healthier, acting as a fertilizer.⁷⁴

“Natural-organic” or “slow-release” fertilizers will reduce the amount of pollutants in streams and lakes. Using an environmentally friendly fertilizer correctly can help the environment and you. Less fertilizer means less growth which means the less you have to mow.⁷⁴

When watering the lawn, water for a longer period of time, less frequently. This will moisten the whole root zone and create less water runoff. In the summer, water about one inch every week. For some areas not used as much, let the grass go brown and dormant, watering about once a month; these areas will come back in the fall.⁷⁴



SOURCE 92

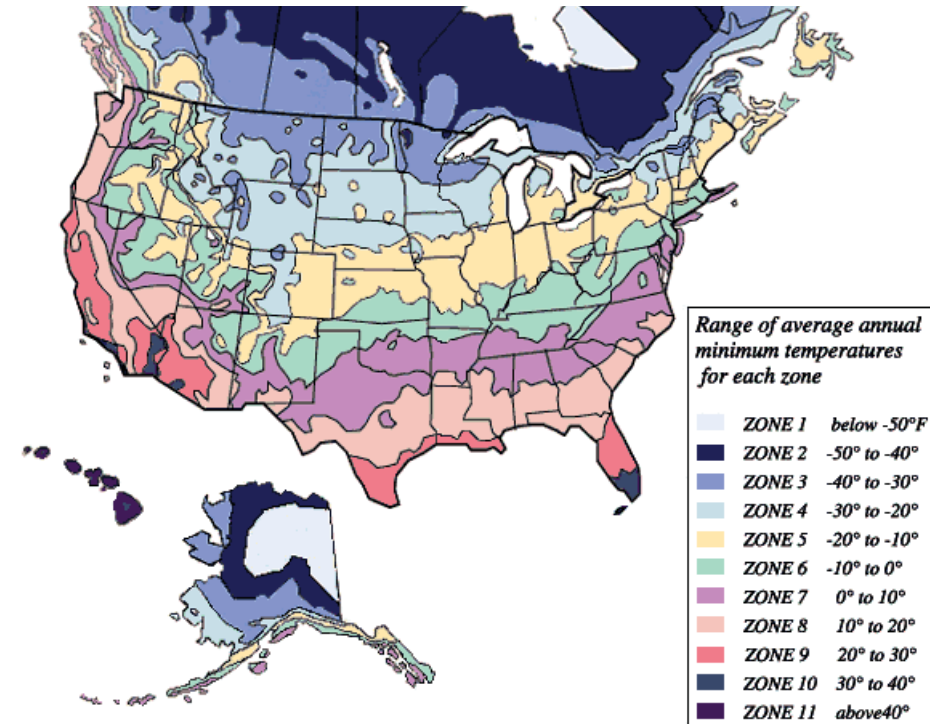


SOURCE 93

LANDSCAPING

Choosing The Right Plants

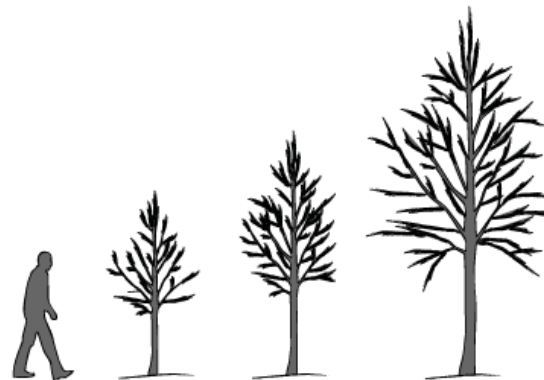
The USDA has identified hardiness zones of the United States. These zones are based on conditions in winter which can affect a plant's ability to survive. **Greensburg, Kansas, is in Zone 6.** When selecting plant material, the plant will have a range of hardiness. Be sure the plant is hardy in Zone 6.⁷⁰ For more information on hardiness zones, see the Resources section. Also be aware of the mature size of plants, especially trees and shrubs. Make sure the plant you select will grow to be as large or as small as you picture. Along with size, be sure to pay attention to the plant's sun, soil, and water needs. Choosing plant material that requires a minimal amount of water will save energy and money.⁷⁴



SOURCE 94

Invasive Plants

These plants should be avoided because they can jeopardize the survival of native plant material.⁷³ These weeds should be prevented and removed if present. Refer to the Resources section for a list of Kansas invasive plants.



SOURCE 95



SOURCE 96

SURFACE WATER MANAGEMENT



SOURCE 73

Water is a precious natural resource, therefore rain that falls on the site should be absorbed or collected.

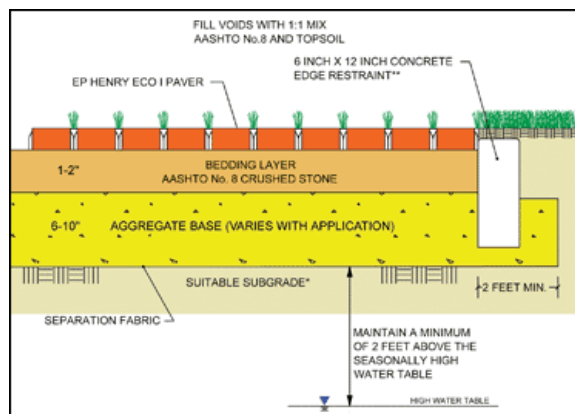
A private lot owner can utilize several principles to handle water in an environmentally friendly way.

Design a Permeable Site

When rain or snow falls on a site, it has to go somewhere. The main ideas are to get water back in the ground to recharge groundwater systems and prevent pollution of surface water. Several components can be assessed when dealing with precipitation in an environmentally friendly way at the private lot scale.

Reduce Hard Surfaces

When it rains, water hits hard surfaces and washes off, ending up in a storm water sewer or surface water such as a lake or stream. This “washing” of hard surfaces can be damaging to the environment because it can bring pollutants into the water or cause natural drainage patterns to become unstable.⁷⁵ Especially at the community scale, hard surfaces can have very severe effects on the drainage systems around it. For the home owner, this can mean simply reducing the size of driveway, patio or walkways. Implementing a green roof instead of traditional asphalt shingles is another option to reduce hard surfaces. More information on green roofs can be found in under “Building Envelope” in section 7: Building Passive Systems Design, of this document.



SOURCE 98

Use Permeable Paving

Instead of installing a traditional hard surface patio, consider using permeable pavers. These have the same aesthetic as traditional brick pavers but are able to absorb rain water and put it back in the ground instead of allowing it to runoff. This reduces pollution of surface water and recharges ground water. It also alleviates flooding by slowing the rate of stormwater runoff. For more information on permeable paving, see the Resources section.

SURFACE WATER MANAGEMENT



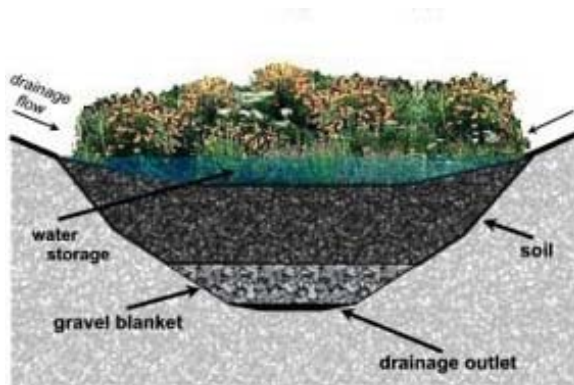
SOURCE 99

Rain Collection

Collecting and using rain water is an excellent way to save money on irrigation water. There are many products that allow a homeowner to collect water that runs off a roof to be stored and used, most easily, for watering lawns and gardens. Because rain is naturally soft, plants will respond very well to rain water.⁷⁶ These rain barrels are relatively inexpensive and most rely on gravity and do not require mechanical pumps to use. Most have the basic parts of a downspout, a plastic barrel, cover of some kind, and a spigot. For more information on these products and their application, refer to the Resources section.

Utilize Rain Gardens

Rain gardens are gardens that contain plants that will live in wet conditions. These plants are usually native to an area. The garden will hold water for a short period of time after it rains and soak up the water, putting it back into the ground. For more information, see the EPA's website in the Resource section. Designing your own rain garden can seem like a large task, however there are several resources to guide you. These are listed in the Resource section.



SOURCE 97



SOURCE 100



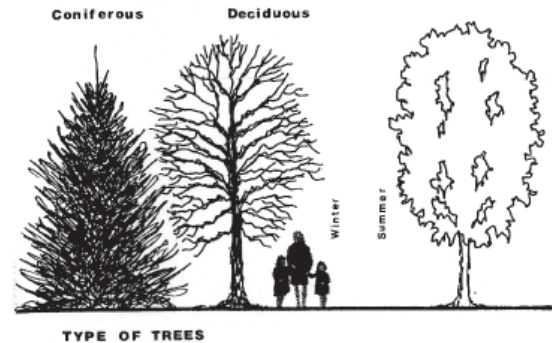
SOURCE 101

INFLUENCE OF SOLAR ANGLES

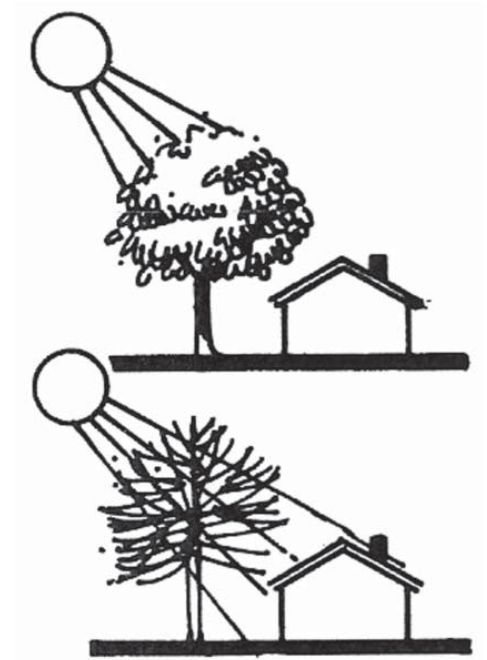
Landscape Application for Solar Energy

Besides the building's relationship to the sun, the landscape and spaces around the building can compliment and enhance the home's ability to take advantage of, or block, solar heat. The following are ways to block summer sun and utilize winter sun. Utilize deciduous trees, or those that lose their leaves in the fall for summer sun shading effects and for winter sun penetration as shown in the following images.⁶⁴

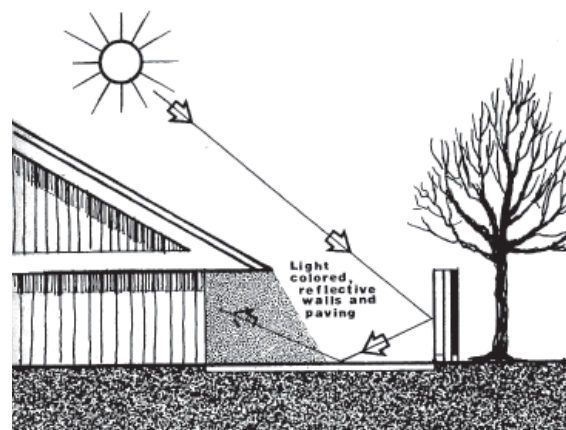
Install lighter colored paved areas to reflect the sun's rays. This is most effective for buildings up to two stories high. On the cool north side of a building a light colored fence or wall and a light colored, smooth paving may help reflect sunlight into the area and make it lighter and warmer.⁶⁴



SOURCE 64



SOURCE 64



SOURCE 64

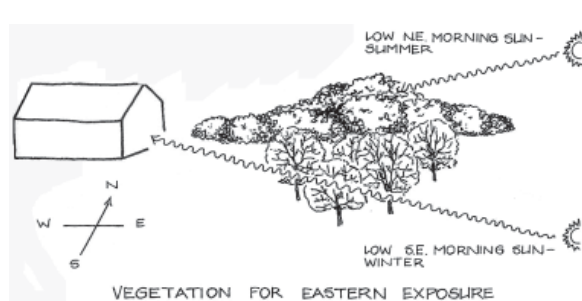
INFLUENCE OF SOLAR ANGLES

On the east side of a structure, the sun is low in the sky and transmits little radiant heat, the morning hours are usually under heated in the winter, and can be overheated in the summer. Plants such as low deciduous trees that block or filter sun only in the summer are desirable on the east and north east, though trees that filter sun rather than block it are best.⁷¹

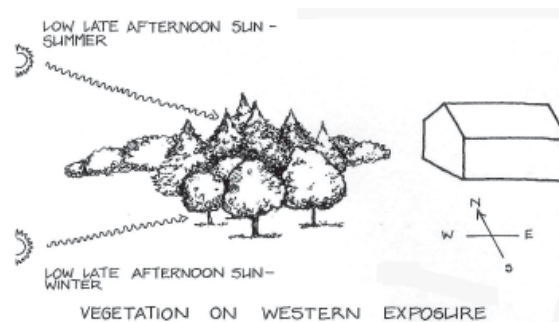
On the south side, the sun's angles vary greatly from winter to summer. The high summer sun can be blocked by planting tall, dense trees very close to the house. If this tree is deciduous, it will not block winter sun. An over-hanging roof, arbor, or pergola covered with a deciduous vine can also serve to block summer sun and allow winter sun.⁷¹

The western side of a site receives sun at a low angle. The late afternoon hours are usually too hot in the summer. The sun should be blocked in the summer and, depending on the climate, may need tempering in winter. A combination of short evergreens and deciduous plants planted close to the home on the west and northwest will filter late afternoon sun in winter and provide complete screening in summer.⁷¹

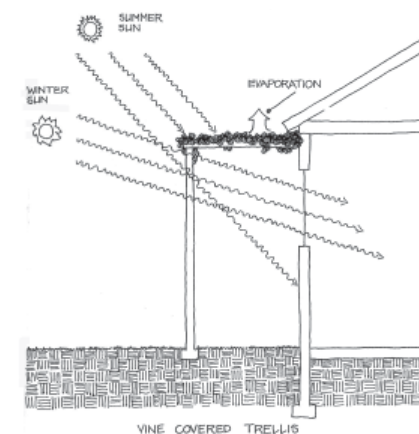
To the north, screening the sun is not necessary. The goal here is to provide a slight windbreak without blocking desired light. Ground covers and turf grass absorb radiation and should be planted close to a structure to keep a relatively even temperature throughout the day.⁶⁴



SOURCE 71



SOURCE 71



SOURCE 71

INFLUENCE OF WIND

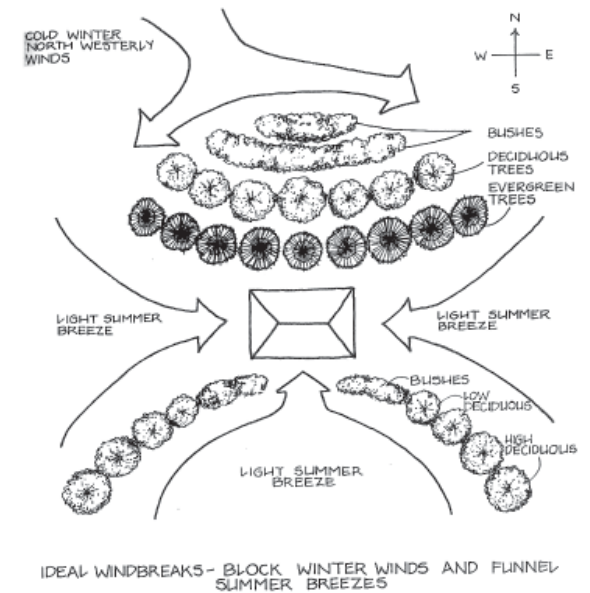
Plant Material to Control Wind

Using plant material to guide or block winds can benefit a site by directing cold winter winds away from the structure and cool summer breezes towards it. "It is more challenging to design a landscape to control wind than to control sun because strategies to control wind must contend with plantings already established to use or screen sun."⁷¹

In a case where summer and winter winds come from different directions, landscape plans can easily accommodate both needs. However, when both come from the same direction, it must be decided which takes priority. This is usually related to energy bill savings. If your heating bill in the winter is higher than your air conditioning use in the summer, plan the landscape to block winter winds.⁷¹

A general plan to block cold winds is to establish a barrier of tall dense plantings close to and upwind of the building. This windbreak diverts wind over the structure. The disadvantage of this is it blocks sunlight. To permit sunlight to reach the home and manage wind as well, create distant, sparse windbreaks planted upwind of the structure.⁷¹

Trees and shrubs planted in rows are better than those planted in clusters, and those planted singly are useless for wind control. Windscreens should be oriented perpendicular to the wind direction not to compass points, but because of a temperate climate where wind is secondary to sun control, wind control will follow the same format used to resolve sun management, by compass direction.⁷¹



SOURCE 102

INFLUENCE OF WIND

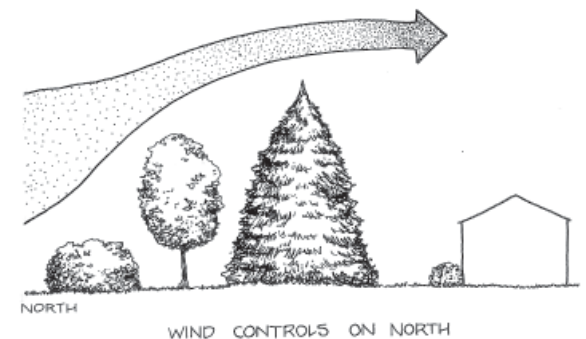
When winds blow from the east, they should be blocked without shutting out solar radiation. "This is done by placing tall trees with loose foliage... two to five tree lengths away from the house. Ideal plantings do not prevent the radiation of the low winter sun from reaching living areas, yet still temper wintery blasts."⁷¹ To reduce the impact of cold gusts further, well-maintained high-crowned trees, such as Norway maple, are placed close to the house on the east side. These trees further deflect wind which has already been calmed by the taller plants and they do not interfere with the radiation of the low morning sun.⁷¹

When controlling southern winds it is desirable to plant a row of trees with sparse foliage some distance from the structure to filter winds. Because low winter afternoon sun is needed to bring warmth, wind blocks must not be so high that they obstruct the sun. In general, most common deciduous trees should be placed two to six times their mature height from the building to be protected. A tree close to the house on the southern side is desirable for deflecting winds over the structure, as long as it is a well-maintained, tall specimen or it will block the winter sun.⁷¹

A strategy for the western side is much like that of the eastern side. Planting tall trees with loose foliage away from the house or dense species close to the house is ideal. Denser plantings can be used north of west and thinner, higher canopied plants are preferred south of west.⁷¹

To control wind on the north side is easier than others because there is no solar conflict. Dense coniferous, or evergreen trees close to the home are best because they provide maximum shelter immediately downwind of the planting.⁷¹

When summer breezes are needed, as in southern regions of the temperate zone, different strategies can be employed. The goal becomes to encourage breezes toward the building. As this funnel narrows, velocity increases, making the act more effective. It should be noted that elaborate wind tunnels are complicated to design.⁷¹



WIND CONTROLS ON NORTH

SOURCE 71

7 BUILDING PASSIVE SYSTEMS DESIGN

7 BUILDING PASSIVE SYSTEMS DESIGN



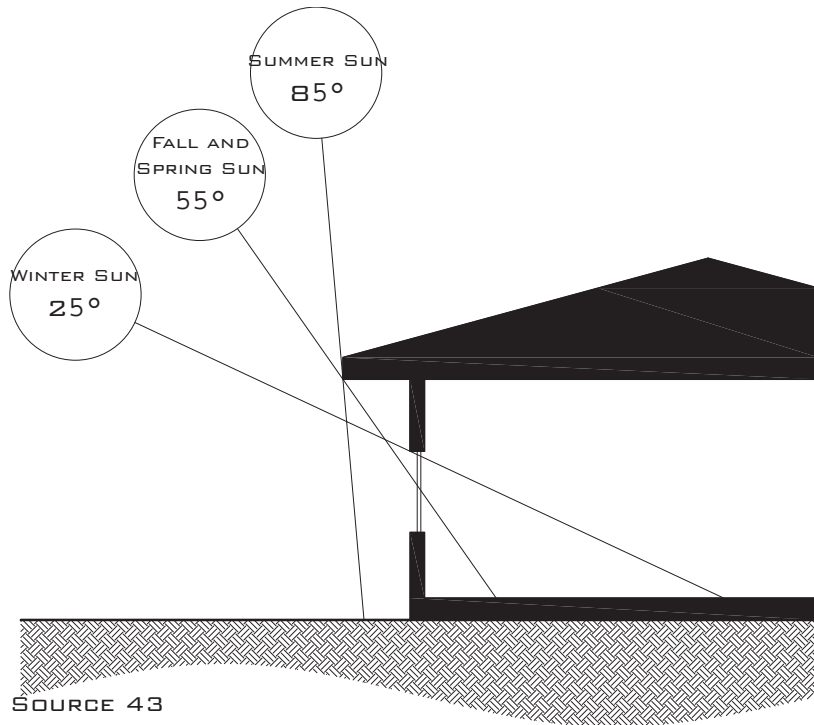
Solar Strategies

Wind channeling

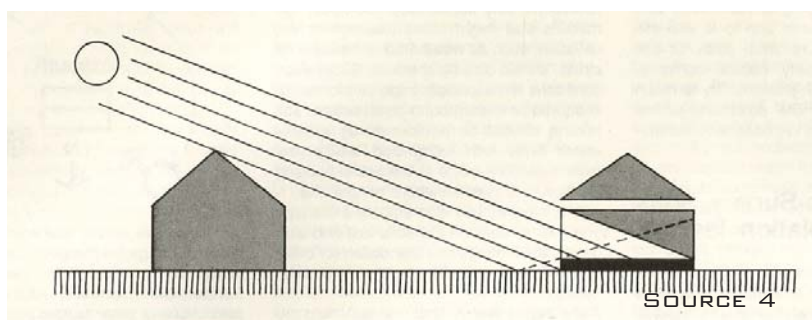
Building Envelope

Interior & Exterior Spatial Organization

SOLAR STRATEGIES



The sun is the most powerful of all passive design resources. If solar energy is harnessed effectively, a building can maintain a comfortable indoor temperature year round without electricity. In the winter, this means letting the sun in, and in the summer keeping sun out. In Greensburg, the sun will strike the earth at an 85 degree angle in the summer time and a 25 degree angle in the winter. Your architect can utilize this angle to determine appropriate placement of windows and shading structures (eaves, screens, decks, etc) for optimum solar gain (top). The placement of your home on the lot in relationship to surrounding buildings is also heavily influenced by solar angles. Check with your designer to ensure that in the winter when the sun is low your home will not lie in the shadow of surrounding structures (bottom).



SOLAR STRATEGIES

The following description explains the heating and cooling needs of Dodge City, Kansas. Dodge City is at approximately the same latitude as Greensburg, therefore the needs are similar. This description also displays the benefit of passive solar use on a private lot.

Dodge City, Kansas

Latitude: 37°46' N

Sun hours/year: 3,219

Degree Days/year: 5,046

Avg. wind speed: 13.2 mph

Heating need: Heating is required from September through June, with 57% of the total heating need occurring in December, January, and February. Normal low in January is 19°F, with extreme lows to -5°F.

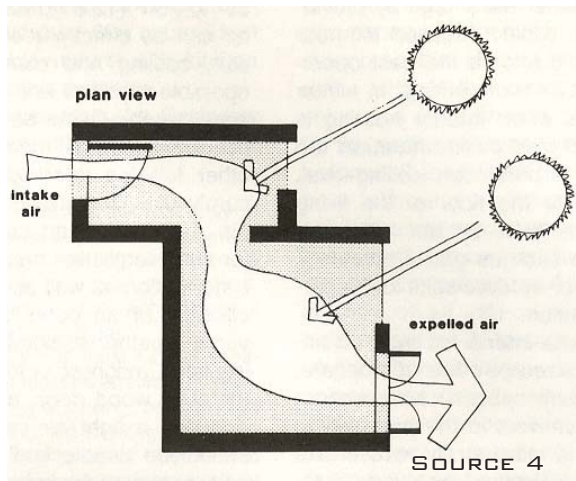
In a thermally efficient house, solar heating can provide 99% of the total heating requirement, with the solar contribution ranging from 98% in December to 100% February through November.

Cooling need: Relative humidity and temperature are above the comfort range about 50% of the time in June, July, and August, with humidity averaging 43% to 46% in July and August, and temperature averaging a high of 91°F. Extreme high temperatures to 109°F.

In a thermally efficient house, cooling needs can be satisfied naturally by a combination of shading from summer sun and winds admitted to the building at a speed of 6 miles per hour. However, winds at this speed may cause discomfort to residents simply because of the rapidity of air movement.

SOURCE 67

WIND CHANNELING

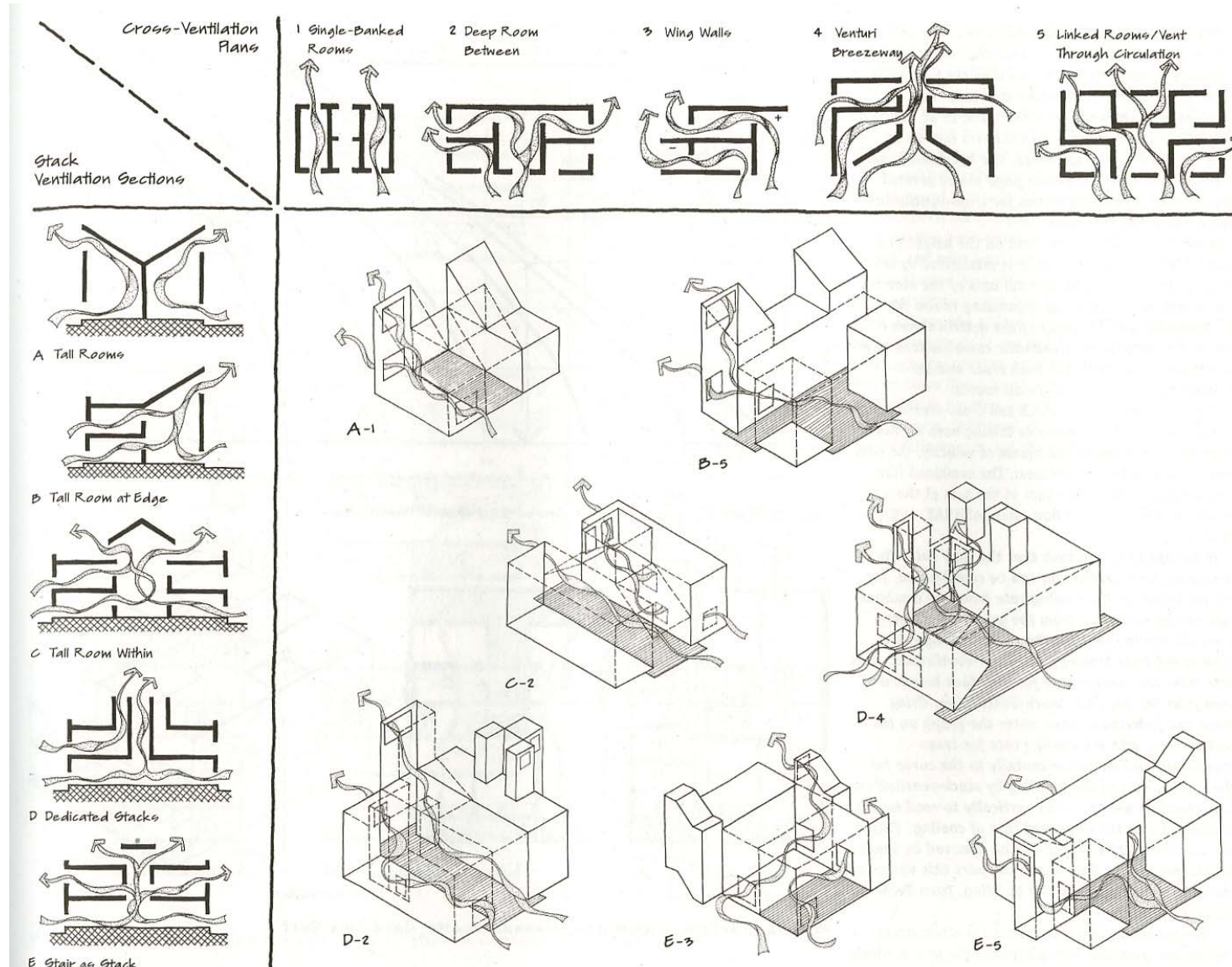


In today's world of high-tech heating and cooling systems, an increasing number of buildings include windows that do not open at all. However, there are many ways to harness the power of the wind for indoor cooling. Openings such as windows and doors that are placed to provide a clear entry and exit for wind are a good place to start. This strategy is called **cross ventilation**. **Stack ventilation** is another strategy, relying on hot air rising through openings high in the wall or roof, keeping spaces cool.

A good general rule to follow when designing a home in Greensburg is to keep the openings in the building on the predominantly Southern side of the building and keep the Northwest side of the building generally closed. This technique will provide the maximum ventilation in the summer while providing higher insulation values to the side of the building that will be hit with the chilly winter winds.

You can use this knowledge of winter and summer wind patterns to your advantage with the placement of your home on the site as well. By partially digging the home into the site in areas of winter wind and providing maximum exposure to the South you can also see an energy savings.

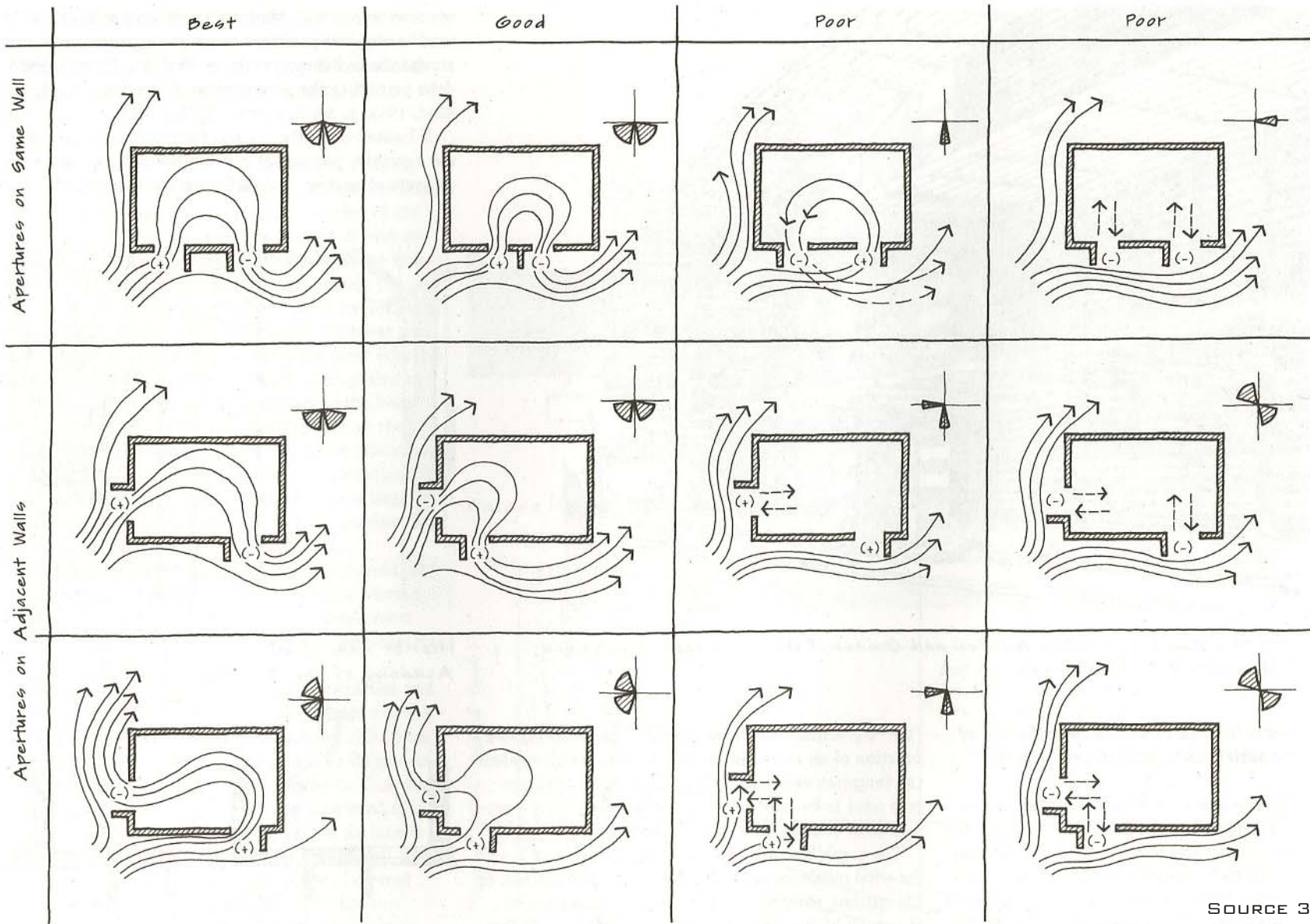
WIND CHANNELING



Room Organization Strategies That Facilitate Both Cross and Stack-Ventilation

SOURCE 3

WIND CHANNELING



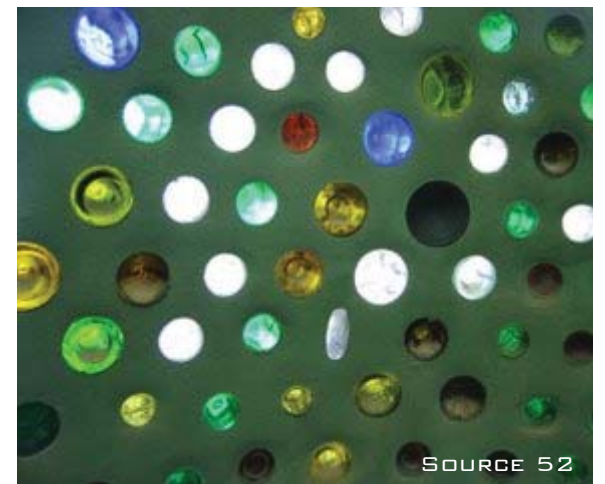
SOURCE 3

BUILDING ENVELOPE

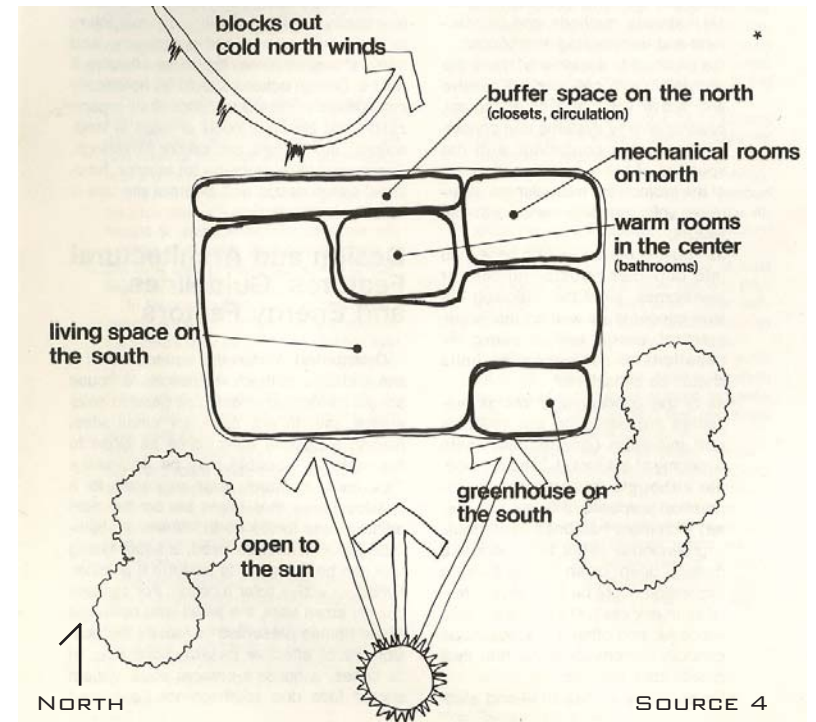
Another creative approach to the building envelope is the use of unconventional materials to save energy. A **white roof** (bottom center) has a high level of reflectivity which can keep a house much cooler in summer months. A **green roof** (bottom right), or planted roof can insulate your house while providing habitat for birds and insects. In the summer, the thick leaves will shade your home from the sun and the plants will transpire, further cooling the area through evapotranspiration. In the winter months, the foliage will die away allowing maximum sun into skylights and to strike and warm the roof. The same principles work for a **green wall** (right). To keep your green walls and roofs low maintenance, be sure they are planted with native grasses or other regionally adapted vegetation that will not require water beyond that which nature delivers. To shade windows and skylights beyond the use of overhangs, **louvers** and shutters can diffuse light and reduce heat gain in the summer (lower left).



BUILDING ENVELOPE

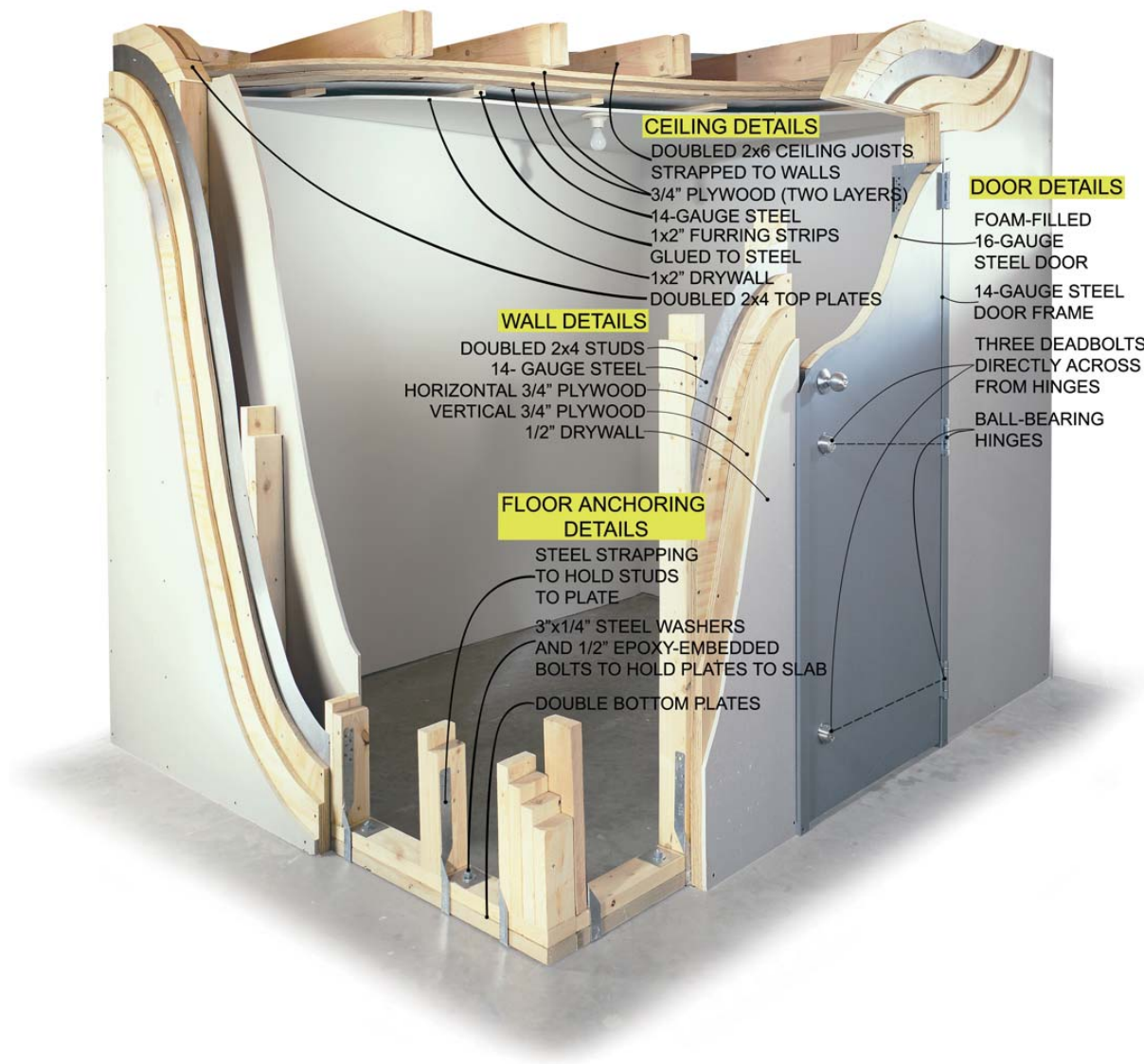


INTERIOR & EXTERIOR SPATIAL ORGANIZATION



Perhaps the number one strategy one can employ to reduce the cost of heating and cooling their home is compact design. Eliminating extra square footage will decrease heating and cooling bills, and make cleaning house go faster too. A small home can feel much larger than it really is if it feels 'open.' This open feeling can be achieved by limiting the use of full height walls and maintaining a visual connection to the outside. Outdoor rooms can also double the usable space of your home without increasing your budget. Grouping spaces according to use can help as well. Consider placing your garage to the Northwest side as a buffer against cold winter winds. Locate living spaces on the south side where they can be warmed by the sun during the day. The diagram to the right further explains these principles.⁵ Another technique to consider is using earth integration on the Northwest side of your home to block out winds and use thermal mass to maintain a constant temperature.

INTERIOR & EXTERIOR SPATIAL ORGANIZATION



"SAFE ROOMS"

You may choose to incorporate a space in your home to protect you from future severe weather events. This space will be most effective if built below ground, however an interior space on the first floor or a concrete slab can work as well. Below ground rooms should be protected from flooding, as severe storms also can bring flash floods. To function effectively the room should be anchored to resist overturning and uplift. The structure of the room and its connections must be strong enough to resist the wind and debris it may bring with it. The room's structure should also be separated from the house's structure so that in the event of serious damage to the home, the safe room will not be compromised.¹⁵ The room pictured at left can be built for around \$1000.00, however prefabricated options also exist for around \$4,000.00.²⁰

SOURCE 20

8 BUILDING ACTIVE SYSTEMS DESIGN

8 BUILDING ACTIVE SYSTEMS DESIGN

Design and Select all
Building Systems to Meet
Energy Targets

Choose Environmentally
Sensitive Structural
Materials

Design for Reuse

Design Wastewater Systems

Design Water Heating
Systems

Lighting Design

Mechanical Design

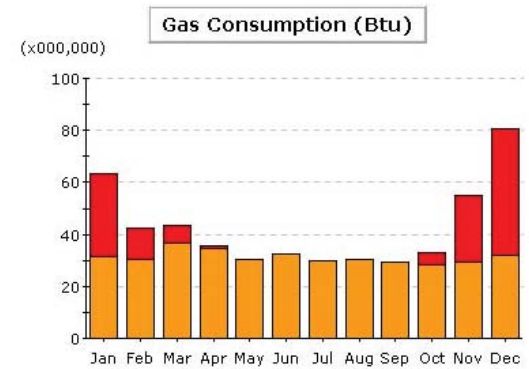
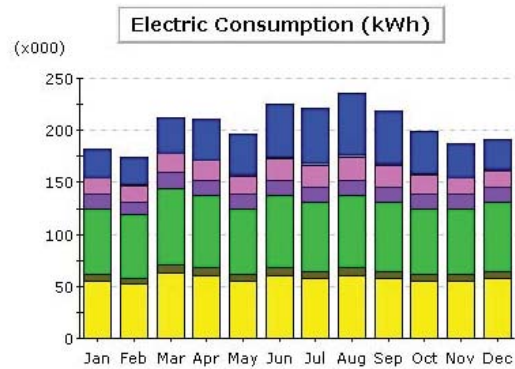
On-site Power Generation

Finalize Building Systems
Design



DESIGN AND SELECT ALL BUILDING SYSTEMS TO MEET ENERGY TARGETS

Hopefully when you made your building program you made some energy targets for your new home. Now is the time to make sure they come to fruition. Your engineers should be able to offer you a detailed simulation of your energy performance in almost every category imaginable, from lighting to refrigeration. As you go through this section of the booklet designing systems, be sure each one meets the criteria for energy you specified. This make take several rounds of revising levels of insulation, performance of systems, etc. This is one area where having an integrated design team really pays off, as the architects and engineers can collaborate to solve problems relating to energy use through the energy simulation.



- Area Lighting
- Task Lighting
- Misc. Equipment
- Exterior Usage
- Pumps & Aux.
- Ventilation Fans
- Water Heating
- Ht Pump Supp.
- Space Heating
- Refrigeration
- Heat Rejection
- Space Cooling

Electric Consumption (kWh) x000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	27.5	27.3	34.1	38.5	39.1	50.1	53.0	58.4	50.9	41.0	32.3	28.9	481.0
Heat Reject.	0.2	0.2	0.4	0.7	0.9	1.8	2.2	2.8	2.0	1.2	0.5	0.2	13.0
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	15.9	15.8	19.0	18.8	17.5	20.4	21.3	21.8	20.8	18.2	16.0	16.2	221.7
Pumps & Aux.	13.7	13.0	15.7	15.0	13.7	15.0	14.3	15.0	14.3	13.7	13.7	14.3	171.3
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	63.4	60.3	72.9	69.8	63.4	69.8	66.6	69.8	66.6	63.4	63.4	66.6	796.1
Task Lights	6.5	6.2	7.5	7.1	6.5	7.1	6.8	7.1	6.8	6.5	6.5	6.8	81.3
Area Lights	54.8	52.1	63.0	60.3	54.8	60.3	57.6	60.3	57.6	54.8	54.8	57.6	688.0
Total	182.0	174.7	212.6	210.2	195.9	224.6	221.7	235.3	219.0	198.7	187.1	190.5	2,452.4

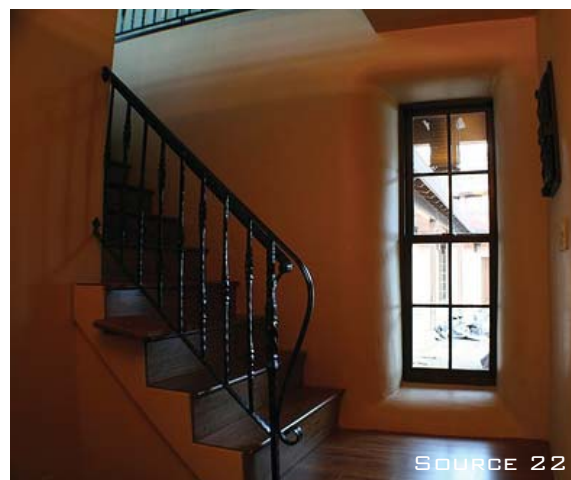
Gas Consumption (Btu) x000,000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	32.16	12.41	6.82	1.05	-	-	-	-	-	4.80	25.81	48.79	131.85
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	31.22	30.18	36.57	34.63	30.40	32.21	29.73	30.52	29.10	28.24	29.21	31.79	373.80
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	63.38	42.59	43.39	35.68	30.40	32.21	29.73	30.52	29.10	33.04	55.02	80.58	505.65

SOURCE 23

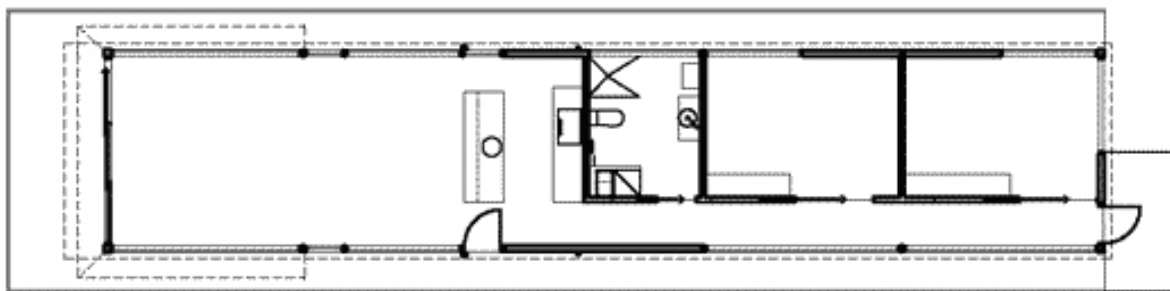
CHOOSE ENVIRONMENTALLY SENSITIVE STRUCTURAL MATERIALS

The construction of your house is among the most important features of your home. Most homes in the United States are made of steel, lumber, and/or aluminum framing. However there are many more structural options. Salvaged lumber is one way to save money and the environment. The use of local or renewable materials is another way to go green. Strawbale houses (below) are extremely strong, fire resistant structures that can easily be made in the Midwest. In some cases, glulam beams may be suggested as a potential sustainable structure for your home. However, before selecting processed wood materials, discuss the effects they may have on air quality in your home. Some heavily treated products can "off gas" making the air in your home toxic. Look for "low-VOC" products to avoid these problems.



DESIGN FOR RE-USE

A growing trend in design is to consider the future of your home in 50 years or more. Flexible design will ensure that your spaces will be usable for other people and purposes. Consider whether your design is suitable for a handicapped person or someone with small children. In addition, design for disassembly, such as bolting instead of welding steel, allows for materials to be recycled into other projects in the event of demolition. Features such as these could provide a higher resale value for your house down the road. In addition, design for re-use makes renovation and/or expansion projects will be much easier.



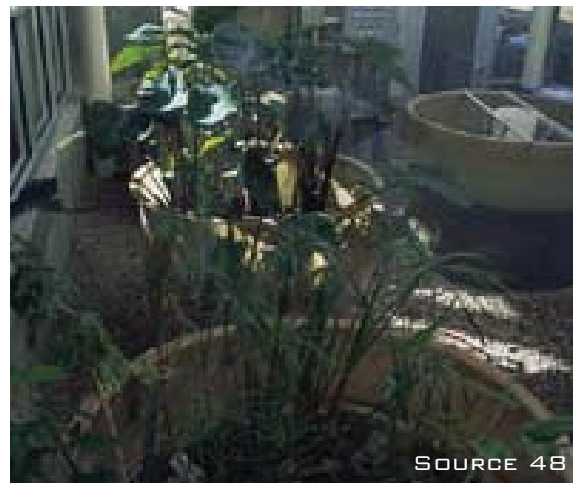
SOURCE 19



DESIGN WASTEWATER SYSTEMS

As residents of Southwestern Kansas, I am sure you are already aware that water conservation is very important. There are many ways to reduce your use of potable, or drinkable water, through 'recycling' water into other uses. A **living machine** purifies household wastewater using nothing but plants. The water can then be used for flushing toilets and irrigation. An easier strategy to provide irrigation is harvesting rainwater off of roofs and other surfaces into cisterns. For more information rainwater harvesting refer to Section 6: Site Design.

Another strategy to reduce water consumption is to install low-flow fixtures and appliances throughout your home. These days, if a fixture deals with water, it probably has a conservation option. Low-flow toilets, sink faucets, dishwashers, and clothes washers can be easily found at most home improvement stores today. Once again, small changes such as these will save you money on your water bill and help your local community combat drought conditions.

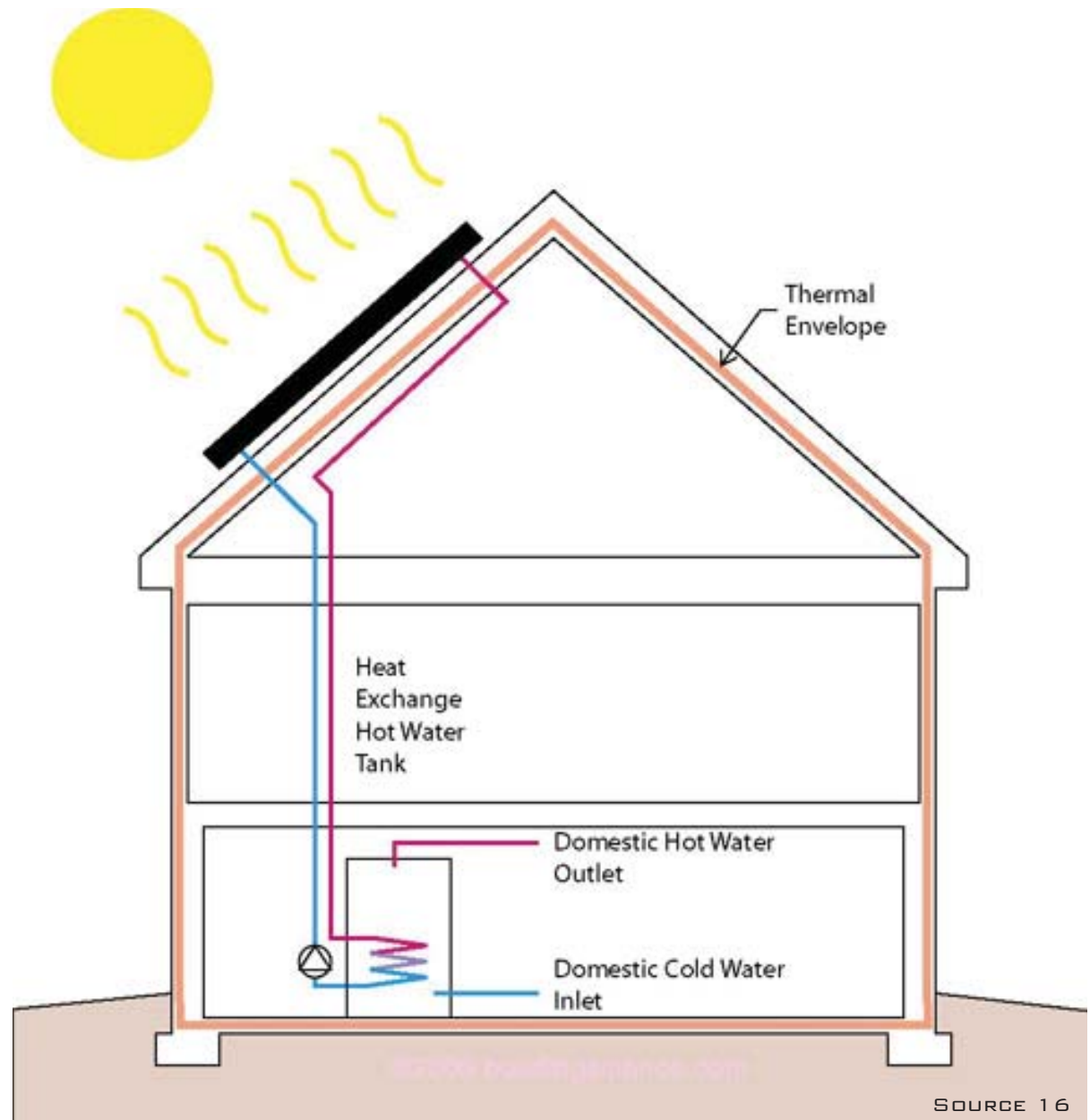


DESIGN WATER HEATING SYSTEMS

Solar hot water systems are a combination of passive and active systems. The sun is used to heat water in tubes placed on the roof or another south facing surface. This hot water is then pumped to the outside of a pre-heat hot water tank where it conductively heats the water inside the tank. A secondary electric hot water tank can then finish heating the water to 120 degrees if the sun is not hot enough each day. This system requires little maintenance and can greatly lower energy use.



SOURCE 47

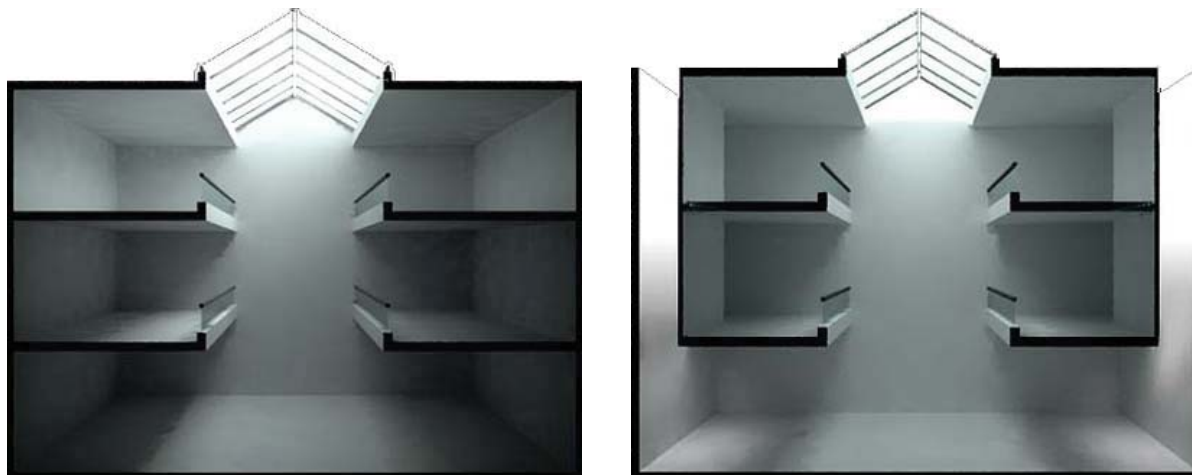


SOURCE 16

LIGHTING DESIGN

The design of interior lighting not only saves energy but significantly changes the quality of the spaces in a home. **Daylighting** or the use of natural sunlight in a home is the easiest way to save money on electric lighting. Providing views to the outside can also make your home a more psychologically comfortable place to live. However, to save money on electric lighting at night, you have to get a bit more creative. Try using energy saving fixtures, such as compact florescent light bulbs. Also, provide dimmers and other lighting control mechanisms that allow you to adjust light levels to save energy. Carefully consider your placement of area, task, and accent lighting.

You may also want to consider how much light you are shinning outside at night. **Dark Sky** is a nationwide program that strives to reduce light pollution to preserve views of the stars and protect the health of nocturnal animals. Shielding exterior lights from shining upwards and minimizing light escaping from your home at night through screens and directional lighting can accomplish dark sky's goals.

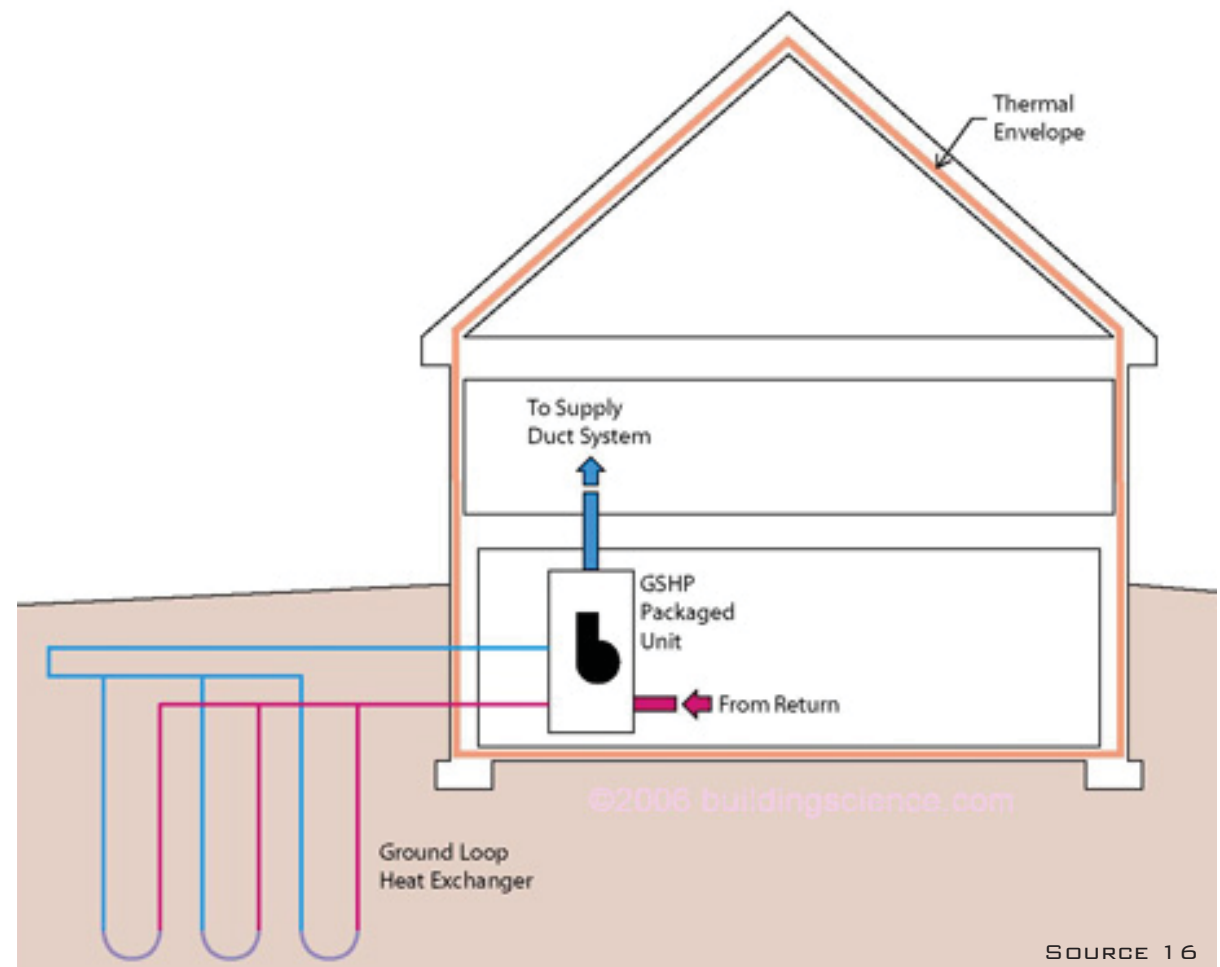


MECHANICAL DESIGN

Mechanical systems are usually those within your home that provide heating and cooling. By working closely with your mechanical engineer, determine the needs your home will have in terms of the size of your mechanical systems. It is important to size it correctly because an oversized mechanical system wastes energy and up front costs, but one that is too small will not adequately heat and cool your home, and will probably wear out much quicker. Discuss the option of high efficiency heating and cooling equipment with your engineer, as well as systems control technology that can keep your rooms more comfortable according to each user's preferences. Also, be sure your engineer has designed an adequate level of fresh air intake in the system, and that the intake is located away from pollutants such as car exhaust.

If you opted to use solar hot water systems, perhaps using a **radiant heating** system is a good option.¹² A radiant heat system will pump the hot water from the roof through pipes in your floor. Using

just the electricity to run the pump you can heat your entire home! Another option is **ground source heat pumps**. Playing on the same idea as earth integration, ground source heat pumps use the stable temperature of the ground to heat or cool air that is then circulated into the home.



SOURCE 16

ON-SITE POWER GENERATION

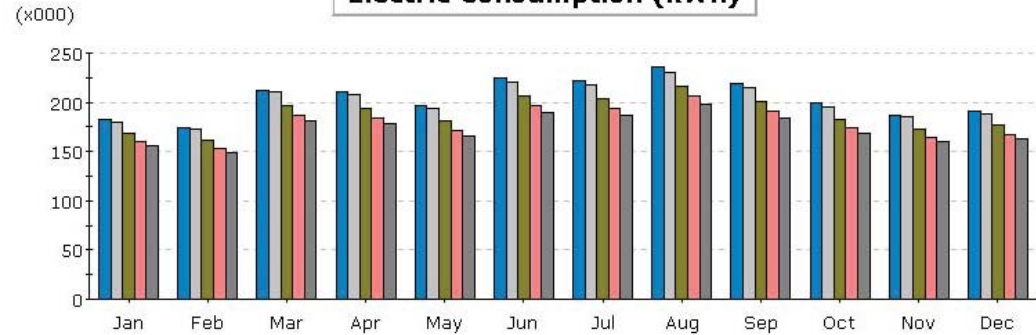
If you have ever dreamed of watching your electricity meter spin backwards, then this is the section for you. Through exciting advances in solar and wind technologies, you can begin to generate energy at your home quietly and sustainably. If you produce more energy than you use, the electric company will buy it back from you. Unfortunately, the wind doesn't blow nor does the sun shine all the time, so there will be times when you have to buy some of that energy back. While it is unlikely that you will actually make a profit from your power technology, you could reduce your energy bill to just a few dollars a month. Wind energy is especially viable in Kansas and there are many technologies that are making it quieter and safer all the time. Windterra's vertical turbine (bottom right) operates at slower speed to reduce associated noise and vibration.¹⁷ Solar power is a more expensive option but is easier to integrate into the design of your home. Today solar panels, or photovoltaics come in all shapes and sizes, from shingles to clear skylight sections.



FINALIZE BUILDING SYSTEMS DESIGN

At this point in the design process the hard work is done. But before moving on to the fun of selecting materials and finishes, there is one last step to be completed. You must take all the data from your new systems designs and run them through the energy simulation model one last time. This documentation will help you evaluate how well you met your original energy performance targets. It can also give you an idea of how much energy your house should be using each month. This information can help you detect a problem with your building's systems early and save you money. In addition, if Greensburg adopts a Greensburg Green home rating system, this information could be helpful in attaining tax incentives which means even more money saved. If the energy simulation isn't what you hoped, don't fret, just speak with your design team about how things can be adjusted to meet your goals.

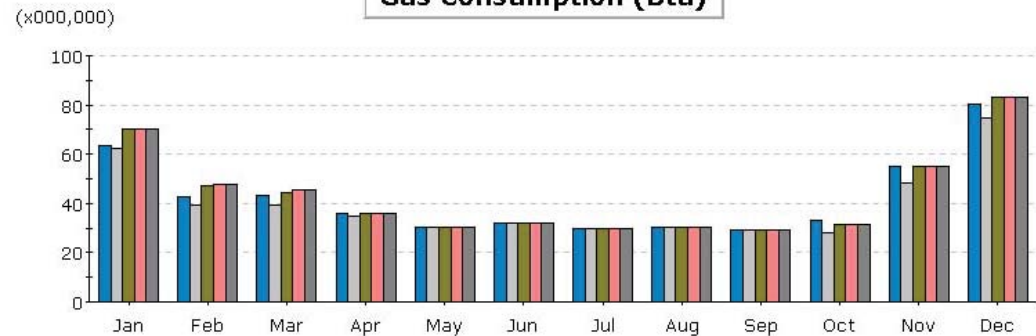
Electric Consumption (kWh)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Run 1.	182.0	174.7	212.5	210.2	195.9	224.6	221.7	235.3	219.0	198.7	187.1	190.5	2,452.4
Run 2.	179.9	172.6	210.0	207.5	193.3	221.0	217.3	230.8	214.7	195.6	185.0	188.8	2,416.6
Run 3.	168.4	161.4	196.4	194.1	180.9	206.9	203.6	216.4	201.2	183.0	173.1	176.7	2,262.0
Run 4.	159.8	153.1	186.3	184.3	171.8	196.7	193.9	206.1	191.5	173.9	164.3	167.8	2,149.4
Run 5.	155.7	149.1	181.3	178.6	166.0	189.4	186.2	197.6	184.1	168.0	159.6	163.4	2,078.9

- 1. eQUEST Example Office - Baseline Run (03/30/00 @ 13:24)
- 2. eQUEST Example Office - 15 ft overhang (03/30/00 @ 13:24)
- 3. eQUEST Example Office - LPD reduction (03/30/00 @ 13:25)
- 4. eQUEST Example Office - VSD on fan motors (03/30/00 @ 13:25)
- 5. eQUEST Example Office - Chiller COP improvement (03/30/00 @ 13:26)

Gas Consumption (Btu)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Run 1.	63.38	42.59	43.39	35.68	30.40	32.21	29.73	30.52	29.10	33.04	55.02	80.58	505.65
Run 2.	62.42	39.40	39.21	34.63	30.40	32.21	29.73	30.52	29.10	28.24	48.46	74.79	479.12
Run 3.	70.12	47.09	44.49	36.21	30.40	32.21	29.73	30.52	29.10	31.38	54.95	83.13	519.34
Run 4.	70.26	47.63	45.60	36.21	30.40	32.21	29.73	30.52	29.10	31.38	55.05	83.38	521.48
Run 5.	70.26	47.63	45.60	36.21	30.40	32.21	29.73	30.52	29.10	31.38	55.05	83.38	521.48

SOURCE 23

9 INTERIOR FINISHES AND APPLIANCES



Reduce Internal Building Loads

Use Sustainable Materials

Ensure Indoor Air is Free of Pollution

REDUCE INTERNAL BUILDING LOADS

Specify appliances and fixtures that are energy and water efficient and do not produce much waste heat as a consequence. Water and energy efficient dishwashers and clothes washers are becoming more and more common. To save space, try a stacking washer and dryer set. Clothes dryers also now come with centrifugal technology that can greatly increase efficiency. Identify the amount of refrigerator and freezer space you really need and purchase accordingly. Refrigerators can be huge energy hogs, so look for the Energy Star® rating before you buy. Microwaves, ovens, and ranges should all also come with Energy Star® certifications. That is the easiest way to ensure your purchase will be good for the environment, and good for your wallet. Also, look for light fixtures that do not give off much heat. LED lights are a great example of a 'cool' light source.



SOURCE 54



SOURCE 55

USE SUSTAINABLE MATERIALS

Use materials that are designed to be recycled, reused, or are recycled or reused. If using a freshly harvested resource, ensure that it is sustainable. Local materials are also considered sustainable because excess energy is not used to transport goods long distances. A good example of a recycled material is enviroglass tile. This beautiful material is made of 100% recycled glass and porcelain (right). It is also sustainable because it is highly durable and will not have to be replaced as often as its lesser counterparts.²⁴ Another surprising material to look into is paperstone. This new product can be used to create recycled, elegant countertops. Look for creative ways to incorporate recycled materials into your home. Perhaps you have always wanted a claw foot bathtub, or love old doors. Check out salvage yards in the area to see if you can locate some items that speak to you.

A few good examples of sustainable flooring are cork (lower left and center) and bamboo (lower right). They are considered sustainable because they grow fast enough to be harvested in ten years or less. And like their hardwood counterparts, cork and bamboo come in any color, texture, and dimension you can imagine.



ENSURE INDOOR AIR IS FREE OF POLLUTION

Ever wonder what gives a new car that "new car smell?" Well, the case of a car is probably much different than a home, but in a home that well loved smell is something to avoid. Some houses are made of materials that "off gas," or breakdown over time releasing unhealthy substances into the air. To combat this, look for materials and finishes that are low- or no-VOC (Volatile Organic Compound). Paints are a common source of VOC's, however low-VOC paints cost about the same amount as their polluting counterparts so they are an easy change to make.²⁵ Check the details on all the protective finishes, adhesives, and sealants you specify to make sure they are low-VOC, as well as exclude other materials from your home that could put you at risk.

Also consider your family's needs when specifying materials. If you have small children who will be crawling on the floor a softer material such as cork or carpet could be a good way to go. Or does someone in your family have severe allergies? In this scenario a hard flooring surface and smooth walls will



allow easier cleaning and less collection of particulate matter.

1 0 PLAN PERMITTING AND APPROVAL

10 PLAN PERMITTING AND APPROVAL

After the completion of your construction documents they may have to be approved by the city for code compliance and aesthetic considerations. Upon approval by the city, a building permit must be purchased. According to the Greensburg, KS website, "All building permits are \$35 and can be obtained at the Building Codes and Permits office at City Hall. Any questions can be directed to the Building Codes Department at 723-2751.⁶⁰"

For more information go to:
<http://greensburgks.org/resident/rebuilding>



1 1 CONSTRUCTION

1 1 CONSTRUCTION

The construction process can be very damaging to the environment of your site. To minimize the destruction of existing plants, wildlife, and soil, ensure your contractor has developed and instituted an erosion control plan. In some cases, the homeowner may elect to have the topsoil on the site removed and stored during the construction process. Furthermore, identify any trees or other plants you would like to preserve and have them marked to protect them from construction damage. For more information on landscape conservation, please refer to Section 6: Site Design.

Once construction on your home has been completed, ask to have the heating and cooling system flushed with air to remove contaminants such as dust and allergens from the interior. This process typically takes a day or two and requires air being circulated through the home at high pressure.

Construction sites produce large amounts of building waste. Discuss a recycling plan with your builder to reduce



the amount of waste going to landfills and save money on disposal fees. Depending on what types of materials you are using, you might even get a little money back from the recycling center. Copper and aluminum are in high demand from recycling centers nationwide.

1 2 OCCUPATION AND MAINTENANCE

12 OCCUPATION AND MAINTENANCE

Congratulations! At this point in the booklet you will be free to move in and begin enjoying your hard work on your new home. To ensure optimum performance and life of this valuable investment, proper and prompt maintenance will be required. Maintain accurate records of any and all work done on the property or its systems, as well as the manuals for all of the systems in place. This will help determine an appropriate course of action for future problems with the home. Tracking your electric, gas, water use is another way to diagnose a problem with systems in your home. A drastic decrease in energy efficiency from seasonally comparable months, such as average Januarys' in two different years, is a good sign your systems need a checkup.

In many cases, systems will have specific maintenance needs, such as replacing air filters in your heating and cooling system every 3 months. Other maintenance requirements will be self-evident, however attention to detail is important. For example, when a light bulb burns



SOURCE 59

PROPER MAINTENANCE CAN EXTEND THE LIFE OF YOUR HOME

out it may be tempting to use whatever bulbs you have handy to replace it. However, it is important to use the bulb that was specified to be used in the fixture, or fire-hazard, glare, or energy waste could occur.

Often times the appearance of the home alone is enough to signal the need for maintenance. For example, peeling paint can forewarn a rot problem. Similarly, cracks in walls are signs of settling and potential foundation problems. However, other pests, such as termites, are seemingly invisible. Have your home checked regularly by an exterminator and take corrective action in the event of a problem.

It may also be helpful to keep up to date with new technologies that could be of benefit to home. For example, solar power may not be an economical choice for you at this point in time, but in ten years the technology may have advanced enough to make it a good investment.



SOURCE 35

RESOURCES:

Greensburg Websites:

The Official Website of Greensburg, KS

[HTTP:// GREENSBURGKS.ORG/](http://GREENSBURGKS.ORG/)

Greensburg GreenTown

[HTTP://WWW.GREENSBURGGREENTOWN.ORG/](http://WWW.GREENSBURGGREENTOWN.ORG/)

Home Energy Efficiency Rating Systems:

United States Government Energy Star Rating System

[HTTP://WWW.ENERGYSTAR.GOV/INDEX.CFM?C=HOME.INDEX](http://WWW.ENERGYSTAR.GOV/INDEX.CFM?C=HOME.INDEX)

United States Green Building Council LEED Certification

[HTTP://WWW.USGBC.ORG/DISPLAYPAGE.ASPX?CMSPAGEID=147](http://WWW.USGBC.ORG/DISPLAYPAGE.ASPX?CMSPAGEID=147)

BC MFCR Green Buildings Checklist

GBBC Performance Targets for Pilot Projects

New York City High Performance Building Guidelines

Santa Monica's Green Building Guidelines

Green Building Information Council (GBIC)

NRCan's Office of Energy Efficiency

AIBC's Resources

Environmental Building News

Center of Excellence for Sustainable Development

Case Study Buildings:

WBDG - Whole Building Design Guide

[HTTP://WWW.WBDG.ORG/INDEX.PHP](http://WWW.WBDG.ORG/INDEX.PHP)

British Columbia Green Building Case Study Series

Green Building Challenge 2000

Advanced Buildings, Technologies and Practices

Visions, Tools and Targets

MEI Case Studies of Green Buildings

Committee on the Environment (COTE)'s Home Page

'Green' Prefabricated Housing:

Living Homes

[HTTP://WWW.LIVINGHOMES.NET/PRIMER.HTML](http://www.livinghomes.net/primer.html)

Michelle Kaufmann Designs

[HTTP://WWW.MKD-ARC.COM/](http://www.mkd-arc.com/)

miniHome

[HTTP://SUSTAIN.CA/](http://sustain.ca/)

JoT House

[HTTP://WWW.JOTHOUSE.COM/](http://www.jothouse.com/)

For an extensive list of other prefabricated housing, please visit:

[HTTP://WWW.FABPREFAB.COM/FABFILES/FABLISTHOME.HTM](http://www.fabprefab.com/fabfiles/fablisthome.htm)

and

[HTTP://WWW.SCRAPBOOKSCRAPBOOK.COM/DAG-ART/MODULAR-KIT-HOUSES.HTML](http://www.scrapbookscrapbook.com/dag-art/modular-kit-houses.html)

Sustainable Materials:

Heartland Green Sheets: Recycled-content building products in the American Heartland

[HTTP://HEARTLANDGREENSHEETS.ORG/INDEX.HTML](http://heartlandgreensheets.org/index.html)

GVRD's Construction/Demolition Recycling Program
Design Guide—Salvaged Building Materials in New Construction
EcoSmart Concrete Project

Site Analysis:

Kansas Drought Watch

[HTTP://KS.WATER.USGS.GOV/KANSAS/WATERWATCH/DROUGHT/](http://ks.water.usgs.gov/kansas/waterwatch/drought/)

Kansas Flood Watch

[HTTP://KS.WATER.USGS.GOV/KANSAS/WATERWATCH/FLOOD/](http://ks.water.usgs.gov/kansas/waterwatch/flood/)

Ogallala Aquifer

[HTTP://WWW.NPWR.ORG/NEW_PAGE_2.HTM](http://www.npwr.org/new_page_2.htm)

and

[HTTP://WWW.WATERENCYCLOPEDIA.COM/Oc-Po/OGALLALA-AQUIFER.HTML](http://www.waterencyclopedia.com/Oc-Po/Ogallala-Aquifer.html)

and

[HTTP://WWW.IITAP.IASTATE.EDU/GCCOURSE/ISSUES/SOCIETY/OGALLALA/OGALLALA.HTML](http://www.iitap.iastate.edu/gccourse/issues/society/ogallala/ogallala.html)

Soil:

Tilling or Aerating Compacted Soil

[HTTP://WWW.HGTVCLASSIFIEDS.COM/HGTV/GL_SOIL_WATER_OTHER/ARTICLE/0,1785,HGTV_3635_3305723,00.HTML](http://www.hgtvclassifieds.com/hgtv/gl_soil_water_other/article/0,1785,hgtv_3635_3305723,00.html)

Erosion Control Products

[HTTP://WWW.NAGREEN.COM/INSTALLATION/INDEX.HTML](http://www.nagreen.com/installation/index.html)

Compost Piles

[HTTP://WWW.EPA.GOV/EPAOSWER/NON-HW/COMPOSTING/BY_COMPOST.HTM](http://www.epa.gov/epaoswer/non-hw/composting/by_compost.htm)

Compost Bins

[HTTP://WWW.RECYCLING-REVOLUTION.COM/COMPOST-BINS.HTML](http://www.recycling-revolution.com/compost-bins.html)

NRCS Tips on Mulching

[HTTP://WWW.NRCS.USDA.GOV/FEATURE/BACKYARD/MULCHING.HTML](http://www.nrcs.usda.gov/feature/backyard/mulching.html)

Organic Fertilizers

[HTTP://WWW.EXTREMELYGREEN.COM/FERTILIZERGUIDE.CFM](http://www.extremelygreen.com/fertilizerguide.cfm)

Landscaping:

Organic Pesticides

[HTTP://WWW.ORGANICPESTICIDES.COM](http://www.organicpesticides.com)

[HTTP://WIWI.ESSORTMENT.COM/HOMEMADEORGANI_RENU.HTM](http://wiwi.essortment.com/homemadeorgani_renu.htm)

EPA "Read the Label First" Campaign

[HTTP://WWW.EPA.GOV/OPPTINTR/LABELING/PUBS/CAMPAIGN.HTM](http://www.epa.gov/opptintr/labeling/pubs/campaign.htm)

Efficient Irrigation Systems

[HTTP://WWW.IRRIGATION.ORG/SIM/DEFAULT.ASPX?PG=BASICS.HTM&ID=233](http://www.irrigation.org/sim/default.aspx?pg=basics.htm&id=233)

Ideas on Landscape Design

[HTTP://WWW.HGTV.COM/HGTV/GL_LANDSCAPING_DESIGN](http://www.hgtv.com/hgtv/gl_landscaping_design)

Kansas Native Plants

[HTTP://WWW.KANSASNATIVEPLANTSOCIETY.ORG](http://www.kansasnativeplantsociety.org)

Hardiness Zones

[HTTP://WWW.USNA.USDA.GOV/HARDZONE/HZM-SM1.HTML](http://www.usna.usda.gov/hardzone/hzm-sm1.html)

Kansas Invasive Plants

[HTTP://WWW.KANSASNATIVEPLANTSOCIETY.ORG/INVASIVE_PLANTS.HTM](http://www.kansasnativeplantsociety.org/invasive_plants.htm)

Surface Water Management:

Permeable Paving

[HTTP://WWW.FORESTER.NET/SW_0203_GREEN.HTML](http://www.forester.net/sw_0203_green.html)

[HTTP://WWW.GREENWORKS.TV/STORMWATER/POROUSPAVEMENT.HTM](http://www.greenworks.tv/stormwater/porouspavement.htm)

Permeable Paver Products

[HTTP://WWW.ADVANCEDPAVEMENT.COM/INDEX.HTM](http://www.advancedpavement.com/index.htm)

[HTTPS://WWW.EHENRY.COM/HOMEOWNER/PRODUCT.ASP?PRODUCT_ID=79](https://www.ehenry.com/homeowner/product.asp?product_id=79)

[HTTP://WWW.SCOTTSDALEAZ.GOV/ASSET7396.ASPX](http://www.scottsdaleaz.gov/asset7396.aspx)

Rain Collection Products

[HTTP://RAINBARRELGUIDE.COM/](http://rainbarrelguide.com/)

Rain Water Collection

[HTTP://WWW.NSF.ORG/CONSUMER/RAINWATER_COLLECTION/INDEXASP?PROGRAM=WATERTRE](http://www.nsf.org/consumer/rainwater_collection/index.asp?program=watertre)

Rain Gardens

[HTTP://CFPUB.EPA.GOV/NPDES/STORMWATER/MENUOFBMPS/INDEX.CFM?ACTION=BRO
WSE&RBUTTON=DETAIL&BMP=72](http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&rbutton=detail&bmp=72)

Designing Rain Gardens

[HTTP://WWW.LOWIMPACTDEVELOPMENT.ORG/RAINGARDEN_DESIGN/
HOW2DESIGNRAINGARDEN.HTM](http://www.lowimpactdevelopment.org/raingarden_design/how2designraingarden.htm)

and

[HTTP://WWW.RAINKC.COM/](http://www.rainkc.com/)

BIBLIOGRAPHY:

1. 1 km W of Greensburg, Kansas, United States 4/1/1996. TerraServer USA. U.S. Geological Survey. Accessed November 5, 2007. <http://terraserver-usa.com/image.aspx?T=1&S=10&Z=14&X=2370&Y=20809&W=1>
2. Median and Average Price per Square Foot of Floor Area in New One-Family Houses Sold by Location. Accessed November 11, 2006. http://www.nahb.org/fileUpload_details.aspx?contentID=560
3. Brown, G.Z. and Mark DeKay. *Sun, Wind & Light: Architectural Design Strategies*. New York: John Wiley & Sons, Inc, 2001.
4. Crowther, Richard. *Affordable Passive Solar Homes*. Denver: SciTech Publishing Company, 1984.
5. Hastings, Robert, and Maria Wall. *Sustainable Solar Housing: Strategies and Solutions*. London: Earthscan, 2007.
6. Metaefficient. *A Zero Emissions House*. Accessed November 7, 2007. http://www.metaefficient.com/archives/architecture-and-building/a_zero_emission_house.html
7. "Prefabrication." October 22, 2007. Accessed on November 7, 2007. www.wikipedia.com
8. Smith, J. *Its a Hotel Room Makeover, uwishunu-style*. April 26th, 2007. Accessed on November 7, 2006 www.uwishunu.com/.../2007/04/design_team.jpg
9. Suntech Power. *Suntech BIPV System Installed on Model Sustainable Home in United Kingdom*. June 15, 2007. Accessed November 7, 2007. <http://www.suntech-power.com/News/tabid/99/Default.aspx?id=290&Module=597>
10. Valubuild. Valubuild Panels Homes Corp. Accessed November 9, 2007. <http://www.valubuild.com>
11. "Why Precast?" The Association of the Manufactured Precast Concrete Industry. Accessed November 14, 2007. <http://www.precast.org/whyprecast/index.htm>
12. Woolliams, Jessica. *PLANNING, DESIGN AND CONSTRUCTION STRATEGIES FOR GREEN BUILDINGS*. Eco-City Planning Company, July 2001. Accessed November 5, 2007. http://www.greenbuildingsbc.com/Portals/0/docs/pdf_files/greenbuild_strategies_guide.pdf
13. "Prefab Houses Go Outside the Box." *Business Week*. Accessed November 14, 2007. <http://images.businessweek.com/ss/06/01/prefab/source/1.htm>

14. "Greensburg, Kansas." *ePodunk: The Power of Place*. Accessed November 14, 2007. <http://www.epodunk.com/cgi-bin/genInfo.php?locIndex=4680>
15. "Preparing a Safe Room." FEMA. Last Modified: April 6, 2006. Accessed November 17, 2007. http://www.fema.gov/hazard/tornado/to_saferoom.shtm
16. "BSP-034: Designs that Work: Cold Climate (Pontiac, MI)" *Building Science*. Accessed November 17, 2007. <http://www.buildingscience.com/documents/primers/plonearticlemultipage.2006-11-14.1183847686/section-3-advanced-technologies-for-a-cold-climate/>
17. "WindTerra." Accessed November 18, 2007. <http://www.windterra.com/index.php>
18. "Daylighting: Design Strategies." Squal.org. Accessed November 18, 2007. http://squal.org/wiki/Daylight_Strategies
19. "Pirates Bay House." *Arquitectura en Portugal*. Accessed November 18, 2007. <http://www.arkineta.com/Articulos/art358.aspx>
20. "Building a Storm Shelter." *Reader's Digest: The Family Handyman*. May 2000. Accessed November 18, 2007. <http://www.rd.com/content/openContent.do?contentId=19418>
21. NK. "Great (Bamboo) Wall." *Inhabitat*. February 26, 2006. Accessed November 18, 2007. <http://www.inhabitat.com/2006/02/26/great-bamboo-wall/>
22. "Straw Bale Home." *Strawbale.com*. July 27, 2007. Accessed November 18, 2007. <http://www.strawbale.com/straw-bale-photos/album/72157601046087576/photo/922200980/Straw-Bale-Residence-Straw-Bale-Home-bale-stairs.html>
23. "Software: eQuest." *Energy Design Resources*. Accessed November 18, 2007. <http://www.energydesignresources.com/resource/130/>
24. "What is EnviroPlank?" *Enviroglas*. Accessed November 18, 2007. <http://www.enviroglasproducts.com/plank.asp>
25. "Low- or No-VOC Paints and Finishes." *ToolBase Services*. Accessed November 18, 2007. <http://www.toolbase.org/Technology-Inventory/Interior-Partitions-Ceilings/low-voc-paints>

26. Mace, Charles E. Plainfield, Indiana. 8/27/43 Accessed November 7, 2007. <http://content.cdlib.org/ark:/13030/ft038n992r/>
27. Caoimh, Donncha O. JCB on the street. May 9th, 2007. Accessed November 7, 2007. <http://inphotos.org/page/25/>
28. Building Science Consulting. Guaranteed Watt Saver Systems, Inc. Accessed November 7, 2007. <http://www.gwssi.com/Services/buildingScience.htm>
29. Green Modular Habitat for Humanity Home wins AIA Award. Green Modulares. March 29th, 2007. Accessed November 7, 2007. <http://www.greenmodulars.com/>
30. Rebecca. Prefab - So Fab - at CA Boom Show & MOCA. Ecorazzi. March 28, 2007. Accessed November 7, 2007. <http://www.ecorazzi.com/2007/03/28/prefab-so-fab-at-ca-boom-show-moca/>
31. Landrum, Kellis. Living Homes. January 22, 2007. Accessed November 27, 2007. <http://www.neu-black.com/date/2007/01/>
32. jwilliams. Prefab Goes Live in Santa Monica. April 13, 2006. Accessed November 27, 2007. http://la.curbed.com/archives/2006/04/prefab_goes_liv.php
33. Living Homes. Accessed November 27, 2007. <http://www.livinghomes.net/galleryConstruction.html>
34. Maddock, Sally (Co-Author). Travel Photos.
35. Bobi. What Is A "Realtor?" October 9, 2007. Accessed November 27, 2007. www.alpinelakes.com/blog/
36. JBS Enterprises LLC. Accessed November 27, 2007. www.jbsmodular.com/ModularFAQ's.htm
37. J&L Mobile Home Services Inc. Accessed November 27, 2007. www.jandlmobilehome.com/
38. Q. "Dreaming of a Home." The Q Speaks. June 19, 2005. Accessed November 27, 2007. <http://theqspeaks.blogspot.com/2005/06/dreaming-of-home.html>

39. Wood Engraving. Teknisk Ukeblad. May 25, 1893. Accessed November 27, 2007. <http://commons.wikimedia.org/wiki/Image:Architect.png>
40. Dow, James. Photos. "Shim fit: Rundles restaurant and tower house in a riverside setting in Stratford, Ontario." The Architectural Review. October 2004.
41. Shim-Sutcliffe Architects. Drawings. "Shim fit: Rundles restaurant and tower house in a riverside setting in Stratford, Ontario." The Architectural Review. October 2004.
42. Floor Plans. Palmetto Custom Construction, Inc. 2005. Accessed November 27, 2007. http://www.palmettocustomconstruction.com/images/Upper_pond_1st.jpg
43. Maddock, Sally. Line Drawing. November 2007.
44. White, Fred. "Here Comes The Sun- and its Power." ThomasNet. July 10, 2007. Accessed November 28, 2007. <http://news.thomasnet.com/IMT/Photovoltaic%20solar%20panels%20on%20a%20house%20roof.jpg>
45. Brinkley, Mark. "On Green Roofs." Housebuilder's Update. June 4, 2006. Accessed November 28, 2007. http://www.housebuildersupdate.co.uk/uploaded_images/green%20roof-716849.jpg
46. Tetro, Jim. Photos of the Day October 20, 2007. DOE Solar Decathlon. Accessed November 28, 2007. http://www.solardecathlon.org/2007/daily_photos_1020.html
47. Evans-Lutterodt , Kaye. Photos of the Day October 18, 2007. DOE Solar Decathlon. Accessed November 28, 2007. http://www.solardecathlon.org/2007/daily_photos_1018.html
48. Discovery Center. Conservation Commission of Missouri. April 22, 2003. Accessed November 28, 2007. http://images.google.com/imgres?imgurl=http://mdc.mo.gov/areas/kcmetro/discovery/gallery/images/photo9.jpg&imgrefurl=http://mdc.mo.gov/areas/kcmetro/discovery/gallery/gallery3.htm&h=300&w=203&sz=24&hl=en&start=1&sig2=XlRA3vp1T8OF_Ilsa1_BxA&um=1&tbnid=Fe8gKQPZx3_wYM:&tbnh=116&tbnw=78&ei=msBNR5PbFIWCiQHmw5H2DA&prev=/images%3Fq%3DLiving%2BMachine%2BDiscovery%2BCenter,%2BMO%26svnum%3D10%26um%3D1%26hl%3Den%26client%3Dfirefox-a%26rls%3Dorg.mozilla:en-US:official%26sa%3DN
49. Jean. "My Solar Roof." Accessed November 28, 2007. <http://www.geology.wisc.edu/~jmbahr/roof.html>

50. "Small Wind Turbine Sizing." The Encyclopedia of Alternative Energy and Sustainable Living. Accessed November 28, 2007. http://www.daviddarling.info/encyclopedia/S/AE_small_wind_turbine_sizing.html
51. Tetro, Jim. "Photo Gallery of Homes." DOE Solar Decathlon. Accessed November 28, 2007. http://www.solardecathlon.org/homes_gallery.html#aandm
52. Kohn, Beth. "Moving in with Oscar the Grouch." Lonely Planet Travel Blog. June 7, 2007. Accessed November 28, 2007. http://www.lonelyplanet.com/blogs/travel_blog/uploaded_images/Earthship-house-729424.jpg&imgrefurl=http://www.lonelyplanet.com/blogs/travel_blog/2007/06/moving-in-with-oscar-grouch.html&h=540&w=720&sz=80&hl=en&start=5&sig2=4T1RdO19T_C3Pko6FZnrVg&um=1&tbnid=er3Nc0wg7NsWNM:&tbnh=105&tbnw=140&ei=IchNR7nrHZGGiQGm_ZH2DA&prev=/images%3Fq%3Ddesert%2Bships%2Bhouse%26svnum%3D10%26um%3D1%26hl%3Den%26client%3Dfirefox-a%26rls%3Dorg.mozilla:en-US:official%26sa%3DG
53. Alter, Lloyd. "Berkeley Mills Sereno Kitchen." Treehugger. September 18, 2006. Accessed November 28, 2007. http://www.treehugger.com/files/2006/09/berkeley_mills.php
54. "Frigidaire washer and dryer - Affinity line washers and dryers." Appliancist. May 19, 2006. Accessed November 28, 2007. <http://www.appliancist.com/frigidaire-affinity-washer-dryer.JPG>
55. Allison. "The Interactive Refrigerator from LG Electronics." Blavish. April 21, 2006. Accessed November 28, 2007. <http://www.blavish.com/the-interactive-refrigerator-from-lg-electronics/>
56. Formisano, Bob. "The Beauty and Durability of Cork Flooring." About.com: Home Repair. June 14, 2007. Accessed November 28, 2007. <http://homerepair.about.com/b/2007/06/14/the-beauty-and-durability-of-cork-flooring.htm>
57. "Floor for Life." Boxler. Accessed November 28, 2007. http://www.boxler.de/uploads/pics/pic_bodenbelaege_01.jpg
58. Rubin, Gary. "The Beauty of Bamboo Flooring." Accessed November 28, 2007. http://www.extremehowto.com/xh/printpage.asp?article_id=60347
59. "Now We're Cooking." Temple Interiors. Accessed November 28, 2007. http://www.templerinteriors.com/What_We've_Done/Kitchens/Kitchen%205.htm

60. "Rebuilding Greensburg." City of Greensburg, KS. 2007. Accessed November 29, 2007. <http://greensburgks.org/resident/rebuilding>
61. Grassland image. DeSoto National Wildlife Refuge. November 20, 2007. Accessed November 30, 2007. <http://www.fws.gov/midwest/desoto/images/grassland.jpg>
62. U.S. Green Building Council. 2007. LEED for homes program pilot rating system.
63. Rolfs, Brett. Aerial Photo. 2007.
64. Robinette, Gary O., ed. *Landscape Planning For Energy Conservation*. New York: Van Norstrand Reinhold Company, 1983.
65. Gaisma.com. Dodge City, Kansas Basic Information. Accessed November 18, 2007. <http://www.gaisma.com/en/location/dodge-city-kansas.html>.
66. Kern, Kelsey. Solar Angle Diagrams. November 2007. Based on information from source 65.
67. Wright, Rodney, Sydney Wright, Bob Selby, and Larry Diekmann. *The Hawkweed Passive Solar HouseBook*. Chicago: Rand McNally & Company, 1980.
68. Photographs of Kotzebue, Alaska XI. January 2007. Accessed November 18, 2007. http://personal.otz.net/kotzjail/kotzphotos/sun-wind_6228.jpg.
69. Blessing, Arlene, ed. "Pesticides and Pest Prevention Strategies for the Home, Lawn, and Garden." Purdue University Cooperative Extension Service. May 2001. Accessed November 18, 2007. <http://www.btny.purdue.edu/Pubs/PPP/PPP34.html#landscape>.
70. Jordan, Ramon, ed. USDA Plant Hardiness Zone Map: South-Midwest US. U.S. National Arboretum. 2001. Accessed November 18, 2007. <http://www.usna.usda.gov/Hardzone/hzm-sml.html>.
71. Moffat, Anne, and Mark Schiler. *Landscape Design That Saves Energy*. New York: David McKay Company, 1981.

72. National Park Service. An Introduction to Using Native Plants in Restoration Projects: Why Use Native Plants. Accessed November 18, 2007. <http://www.nps.gov/plants/restore/pubs/intronatplant/why-usenatives.htm>.
73. The Sustainable Sites Initiative. *How to Have a Sustainable Site*. 2007. Accessed November 18, 2007. <http://www.sustainableites.org/index.html>.
74. U.S. Environmental Protection Agency. GreenScaping: The Easy Way to a Greener, Healthier Yard. June 2006. Accessed November 18, 2007. <http://www.epa.gov/epaoswer/non-hw/green/owners.htm#water>.
75. U.S. Environmental Protection Agency. Stormwater Program. October 18, 2007. Accessed November 18, 2007. http://cfpub.epa.gov/npdes/home.cfm?program_id=6.
76. Waskom, Roger. "Graywater Reuse and Rainwater Harvesting." Colorado State University Extension - Natural Resources. 2003. Accessed November 19, 2007. <http://www.ext.colostate.edu/PUBS/natures/06702.html>.
77. U.S. Green Building Council. 2007. LEED for Homes Program Pilot Rating System.
78. Construction Equipment. Picasa. 2004. Accessed December 1, 2007. <http://picasaweb.google.com/myconstructionphotos/ConstructionExcavation1/photo#5118581539604283234>.
79. Erosion. Accessed December 1, 2007. <http://plantandsoil.unl.edu/croptechology2005/UserFiles/Image/siteImages/GullyErosionPasture-NRCS-LG.jpg>.
80. Compact Indoor Compost Bin. A Recycling Revolution. Accessed December 1, 2007. <http://www.recycling-revolution.com/image-files/indoor-compost-bin.jpg>.
81. Mulch Samples. Mulch Manufacturing, Inc. Accessed November 18, 2007. <http://www.eejohnson.com/pix/mulch-swatch.gif>.
82. McCoy, Aaron. Botanica (RM) Image. Accessed November 18, 2007. <http://images.jupiterimages.com/common/detail/33/82/23218233.jpg>.
83. Summer Hill Landscapes, Inc. Accessed November 18, 2007. http://www.summerhilllandscapes.com/images/landscaping/Landscaping_image_center.jpg.

84. Creative Landscape. All American Landscaping Management Services. Accessed November 18, 2007. <http://www.allamericanlandscape.net/sitebuildercontent/sitebuilderpictures/creative-landscaping.jpg>.
85. University of Missouri Extension. Accessed November 18, 2007. <http://extension.missouri.edu/explore/images/g01918art01.jpg>.
86. Eco World. Accessed November 18, 2007. http://ecoworld.com/articles/images/Pesticides_ladybug3.jpg.
87. Spartan Irrigation, Inc. Accessed November 18, 2007. <http://www.spartanirrigation.com/Spectrum/Files/Image/SPRAYCU.jpg>.
88. Irrigation Association. "Don't Send Money Down the Drain." 2007. Accessed November 18, 2007. <http://www.irrigation.org/SIM/default.aspx?pg=basics.htm&id=233>.
89. Plants. Northland Floral. Accessed November 18, 2007. <http://www.northlandfloral.ca/images/plants.jpg>.
90. Forest Roadside. USDA Forest Service. Accessed November 18, 2007. http://www.fs.fed.us/wildflowers/nativeplantmaterials/images/roadside_lg.jpg.
91. Carolina anemona. Kansas Native Plants. Accessed November 18, 2007. http://www.kansasnativeplants.com/images/site/large/ohio_spiderwort.jpg.
92. Monkeygrass.net. Accessed December 1, 2007. http://www.monkeygrass.net/images/grass/grass_250x251.jpg.
93. Nutri-Green Lawn Care. 2005. Accessed December 1, 2007. http://nutri-greenlawns.com/art/lawn_mower.jpg.
94. USDA Plant Hardiness Zone Map. Prairie Frontier. Accessed December 1, 2007. <http://www.prairiefrontier.com/pages/hardiness/lzone24usda.gif>.
95. Dawnay Estates: Wykeham Mature Plants. Accessed November 18, 2007. <http://www.wykehammatureplants.co.uk/Dawnay/WMP/accessorypages/Images/TreeSizes.gif>.

96. Amur Honeysuckle. Hilton Pond Center. November 14, 2006. Accessed November 18, 2007. <http://www.hiltonpond.org/ThisWeek061108.html>.
97. Mille Lacs Soil and Water Conservation District. January 24, 2007. Accessed December 1, 2007. <http://www.millelacsswcd.org/raingarden.JPG>.
98. EP Henry. Accessed November 18, 2007. https://www.ephenry.com/HomeOwner/Product.asp?Product_ID=79.
99. Rain barrel. Rainsaver. Accessed November 18, 2007. <http://www.rainsaverusa.com>.
100. Bioretention Area in a Residential Subdivision. Environmental Protection Agency. Accessed November 18, 2007. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=72>.
101. Rain Garden. Cuyahoga Soil and Water Conservation District. Accessed December 1, 2007. <http://www.cuyahogawcd.org/pictures/RainGardenExample.jpg>.
102. Thuja Green Giant. Fast Growing Tree Nursery. Accessed December 1, 2007. http://www.fastgrowing-tree.com/fgt/paulownia_graphics/ThujaGiant3.jpg.
103. Joyce Landscaping Inc. Accessed December 1, 2007. <http://www.joycelandscaping.com/images/services%20images/mulch.install.jpg>.
104. Wikipedia. Ogallala Aquifer. November 27, 2007. Accessed December 2, 2007. http://en.wikipedia.org/wiki/Ogallala_Aquifer.
105. National Resource Conservation Service. Kansas Annual Precipitation Map. Accessed December 2, 2007. ftp://ftp-fc.sc.egov.usda.gov/KS/Outgoing/Web_Files/Technical_Resources/Maps/ks_08_22.pdf