Chapter 16:

Design with Nature (Sustainable Designs)

Most people think of sustainable designs as something new. They aren't. Whether it is called *ecologically sustainable design* (ESD) or *ecological architecture*, sustainability is a new variation for designing with nature. Generally, designing with nature makes good sense because it is efficient and it saves money. The sustainability model suggests that sustainable designs need to be environmentally sound, economically feasible, and socially equitable (Figure 16.1). SITES defines sustainbility as the "*design, construction, operations and maintenance practices that meet the needs of the present without compromising the ability of future generations to meet their own needs*" (SITES 2009) This chapter serves as a primer regarding some of the principles and concepts behind designing with nature and sustainable designs.

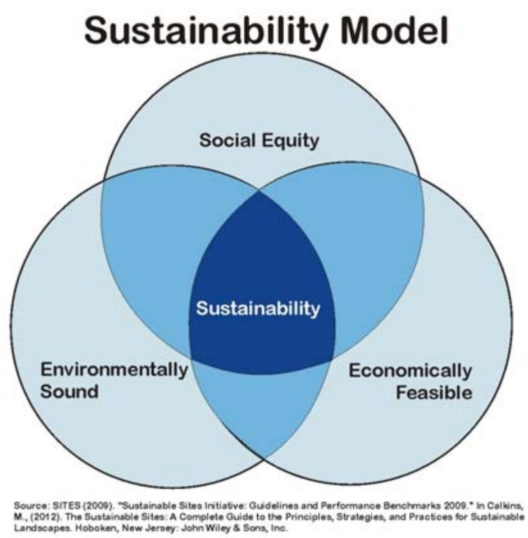


Figure 16.1 – Sustainability Model – Caption: Typically, sustainability is a balancing act between being environmental sound, economically feasible, and socially equitable. – Source: SITES (2009) – [file:\SustainbilityModel.jpg]

In terms of park and recreation, there are three levels of consideration. The first level is a regional analysis. Regional planning and the regional planner are usually the province of this analysis. The seashore analysis by McHarg (1971) is one of his classic examples of where to locate and where not to locate development. Stated another way it is to design with nature. His classic work was titled *Design with Nature* and the title of this chapter reflects his contribution to the planning process. The second level is designing with nature at the site level. Often, this is the province of parks and park planners. The third level focuses on designing buildings with nature. All three levels are addressed in this chapter. These levels set the foundation for master planning, site design, and facility design.

Design with Nature

Before sustainability, there was the concept of designing with nature. To a degree it was an outgrowth of or received considerable emphasis with the environmental movement of the 1960s and 1970s. McHarg (1971) wrote his classic book with the same title as this section. As an "ecological planner," his suggestions are consistent with the sustainability model prior to the development of the model. He suggests that the health and welfare of people are affected by the design of their environment. He further suggests that traditional economic interests have overshadowed the environmentally sound practices associated with designing with nature. His analysis includes an examination of the state of western civilization in terms of its history and philosophy. The primary focus of his work is from the perspective of a land planner regarding the development of different land areas in terms of their ability to handle development. For him, this was the focus of designing with nature.

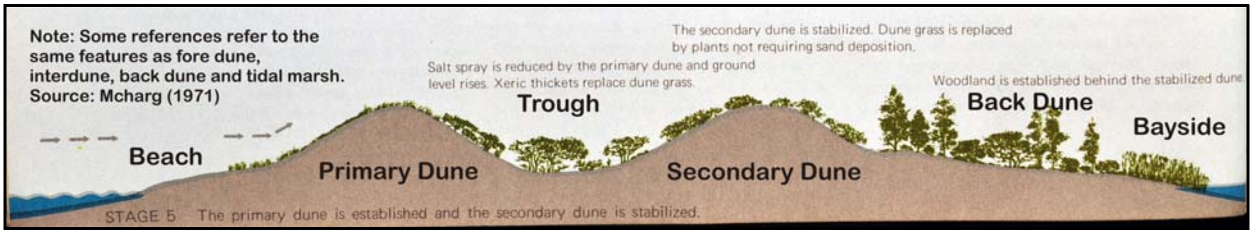


Figure 16.2 – Stage 5 of Dune Growth: As the dune grows and evolves, eventually the primary dune becomes established and the secondary dune becomes stabilized. The woodland on the backdune will tolerate development (see Figure 16.4).

In terms of development, one of the areas McHarg (1971) examined was the New Jersey seashore and the barrier islands. It is presented here because it graphically illustrates where one can build on a barrier island and where not to build. He documents how the development of seashores illustrates the overshadowing of environmentally sound policies by those of economic development. He begins his analysis with a discussion of the ecological development of a barrier island (Figure 16.2). Sand is continually being transported up the coastline by currents. Barrier islands grow, stabilize and transform their size and shape. In terms of development, certain parts of the barrier island become stable and will tolerate development while other portions remain intolerant to development. Since it determines with some degree of success where development can and can't occur, it is important to understand the ecology of the barrier island. Otherwise, the development runs the risk of being washed into the sea.

Figure 16.3– Primary Dune: Caption: This is the backside of the primary dune. The wind moves the sand until it is caught by the plants, snow fence and other objects. This area is very fragile. The ocean is on the other side of this dune. This area is so fragile that a boardwalk is often used to reduce human impact to the grasses. Assateague Island, Maryland – Source: author

The following is a brief overview of the seashore ecology and its carrying capacity. The ocean and sand beach are very tolerant to recreational use. They have a very high carrying capacity. In contrast, the dune-grass covering the primary dune is extremely insensitive to recreational use, let alone building and development (Figure 16.3). Boardwalk type bridges are often recommended to bridge the fragile primary dune and to connect the beach with the trough area located behind the primary dune that is relatively tolerant to structures and recreation. McHarg (1971) notes that the secondary dune is intolerant, but that the backdune between the secondary dune and the

Figure 16.4 – Backdune and Bayshore: Caption: In the foreground, a group of high school students examine the fragile ecosystem of the bayshore. The forest on the backdune is visible in the background of this scene. In contrast to the bayshore, it tolerates development. Assateague Island, Maryland – Source: author

bayshore is extremely tolerant to and suitable for development (Figure 16.4). And, he notes that the bayshore located between the backdune and the bay is also intolerant in terms of human use and development.

The problem is that society has built everywhere on the dunes and not just where it is environmentally sound to do so. With the next major northeastern storm, the seashore often goes through a major transformation and the developments on the sensitive areas of the dune perishes into the ocean. The coastal dunes are ephemeral and development attempts to be permanent in an ephemeral environment. McHarg (1971) isn't against development. Designing with nature is knowing where development can best occur and building there. Conversely, it is knowing which areas are intolerant to building and avoiding them. The seashore illustrates the principle of "management by avoidance" mentioned in Chapter 17. It is an example of designing with nature.

Sun

When designing with nature, the sun plays an important role in the site location and the design of any facility on the site. The climate and weather on the earth are determined by the position of the earth in relationship to the sun (Figure 16.5). In the temperate zones during summer, the sun is almost directly overhead, and during winter, the sun is much lower in the sky. Even in summer, when the sun is overhead in the northern hemisphere, it is still not directly overhead. It is still in the southern portion of the sky.

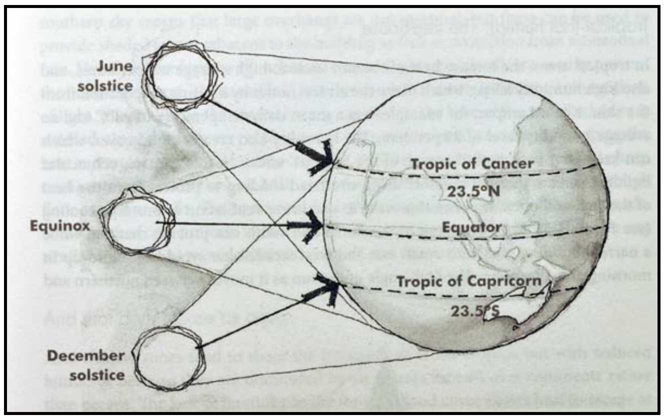


Figure 16.5 – Sun's position during year – Caption: In the northern hemisphere the angle of the sun hitting the earth provides maximum solar heating. – Source: Drake, (2007, p.7) – [Drake:\DrakeSun.jpg]

The effects of the sun can be viewed as an effort to either reduce or enhance the impacts of solar radiation. The late afternoon sun beating down on an outside deck has a tremendous heating effect. A properly placed tree or even an overhanging awning can block the rays of the sun and provide a relatively cool spot in the shade. In contrast, the energy from the sun can be used to provide supplemental heating and augment ambient light within a building.

<b>**<u>Energy Transfer</u>** – Energy is transferred by one of three methods: conduction, convection and radiation (Figure 16.6). Energy is either gained or lost through one of these methods. Some people consider evaporation an energy transfer also although it is really the absorption of energy to transform from a liquid to a gas. The energy transfer may result from differential heating from the sun or it may result from a differential in heating from other sources such as from internal heating systems in buildings. Whenever there is a differential between temperatures, there is an attempt to equalize the temperature differences.

Conduction is the transfer of energy from molecule to molecule within a solid substance or from one object to another in contact with each other. On the radiator in Figure 16.6, it is represented by the finger touching the radiator. In homes, at approximately 55°F the basement floor is cool to the touch.

Convection refers to heat being carried by the moving particles of a fluid. In Figure 16.6, the radiator heats the air. The warm air rises. As it cools, the air sinks back to the floor where it is sucked into the radiator and reheated. The entire process sets up a convection current which attempts to equalize the heat throughout the room. Often, a ceiling fan is used to help force the warm air downward in homes with high ceilings.

Radiation is the transfer of heat through the air in the form of electro-magnetic waves. The hands can literally feel the long-wave radiation radiating from the hot radiator. In contrast, the backside of the hands cupped together in Figure 16.6 remain relatively cool. Anyone standing next to a cast-iron pot-belly stove can feel the heat radiating from the stove.

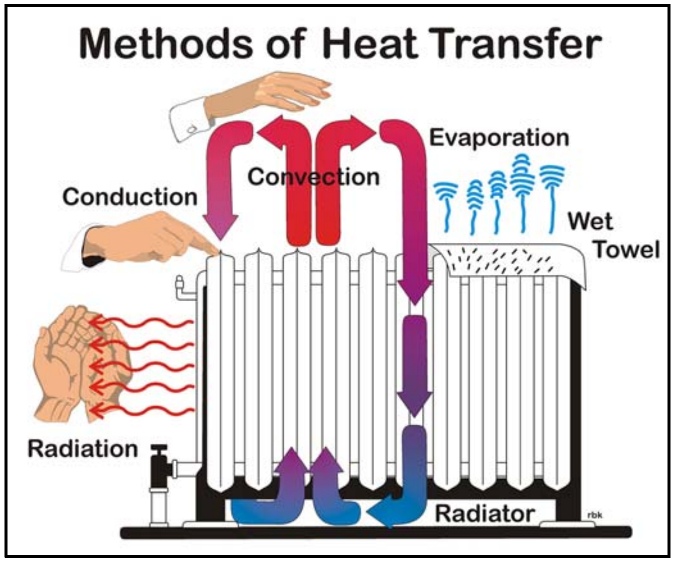


Figure 16.6 – Methods of Heat Transfer – Caption: There are three methods of heat transfer: conduction, radiation, and convection. Some people include evaporation also. – Source: author; adapted from Fear and Mitchell (1977, p.22) – [Drake:\Radiator.jpg]

Evaporation is the process of a liquid absorbing energy as it changes from a liquid to a gas. The transformation of water or other liquid to a gas requires the absorption of considerable energy. Figure 5.20 shows the typical Moorish influence in garden design where there is a pool in the center of a courtyard. As the water evaporates, it helps to create localized cooling of the surrounding area. In addition, it sets up a convection current which circulates the air.

<c>***Resistance and Insulation*** – Heat always flows from the higher temperature to the lower temperature. *Insulation* is a barrier to this transfer that reduces or retards the rate of flow. The best insulation strategies can differ for conduction, convection, and radiation energy transfers. A reflective surface works well to reflect radiating heat. In terms of conduction, materials like wood transfer energy more slowly than steel. Creating dead air spaces is effective insulation against convection losses. A dead air space is where the air space becomes so small that convection movements are essentially retarded.

To illustrate the differences in insulation, consider the following question. Conceptually, which insulates better, a cubic foot of goose down or a cubic foot of 000 steel wool? Against, convection losses both the steel wool and goose down would conceptually be about the same because each material effectively creates dead air spaces. However, against conduction losses, the goose down would be infinitely superior to the steel wool. Metal is a much better transmitter of energy than goose down and would conduct heat through it much faster.

Regarding insulation, most people are familiar with the R-value of materials. Different materials have different R-values or they have different conductive abilities of heat. R-values are a function of the depth of the material. Conceptually, the thicker the material the more resistance it has to transferring heat.

$$R = (1/k) \times d$$

where k is the conductivity of the building material,
and d is the thickness of the material

<c>***Application of Principles to Site Selection*** – These principles affect the site selection and location of buildings. One of the benefits of visiting the seashore in summer is that the temperature differential between the ocean and land creates a breeze (convection current) in the afternoon because of the differential heating to the ocean and land (radiation).

These principles can be illustrated in campsite selection. In the Canoe Camping wallchart developed by this author, there is a section on the wallchart illustrating the principles of heat gain and heat loss as applied to campsite selection (Figure 16.7). As with the seashore, locating the tent next to a water body can increase convection currents or breezes. Trees can be used to block late afternoon solar radiation and the prevailing harsh winds and weather of the weather moving out of the west. A foam pad in the tent (not shown) helps to reduce conduction energy losses to the ground while sleeping.

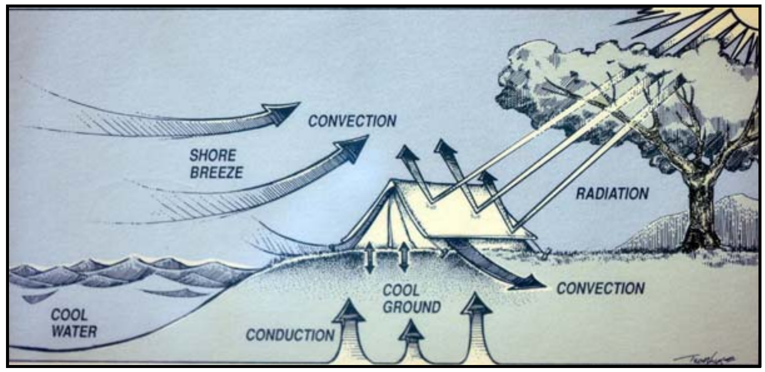


Figure 16.7 – Campsite – Caption: These principles are generic and can be applied clothing or campsite selection. – Source: Author; (Kauffman and Walke, 1990) – [file:\Campsite.jpg]

Terrain can have localized effects on temperature differentials. Building on the ridge exposes a building to the wind. In the summer, these breezes maybe comforting. However, in winter these breezes can become harsh winds. By early morning, cool air can sink and pool in the valley causing the valley to be several degrees cooler than the surrounding area. Even a small depression can pool the air creating a localized cool spot.

<b>**<u>Greenhouse Effect</u>** – Although most readers immediately associate the greenhouse effect with global warming, a greenhouse demonstrates important principles regarding how the sun heats the earth. The greenhouse effect affects the site location as well as the construction of facilities (Figure 16.8). Radiation from the sun penetrates the glass roof of the greenhouse. Some of the long-wave radiation in the infrared spectrum is deflected backward decreasing the total amount of solar radiation penetrating the greenhouse. The solar radiation heats the floor of the greenhouse. The floor stores the energy and releases it during the night as long-wave radiation. The glass roof deflects a large portion of the radiation back into the greenhouse maintaining some of the warmth inside the building. In addition, during the evening there are also convection currents established within the greenhouse to equalize the temperature within the greenhouse.

In terms of the atmosphere, clouds act as the roof of the greenhouse. Nights with cloud cover tend to be warmer than those where the sky is cloudless. Large windows on the southern exposure of a building can collect sunlight and store it in the floors or walls. In summer, deciduous trees planted in front of the windows can help to block the potentially intensive sunlight. During winter when the leaves are no longer on the trees, the sunlight can be collected and stored in the floor and walls of the building (see sun shielding in Figure 16.33).

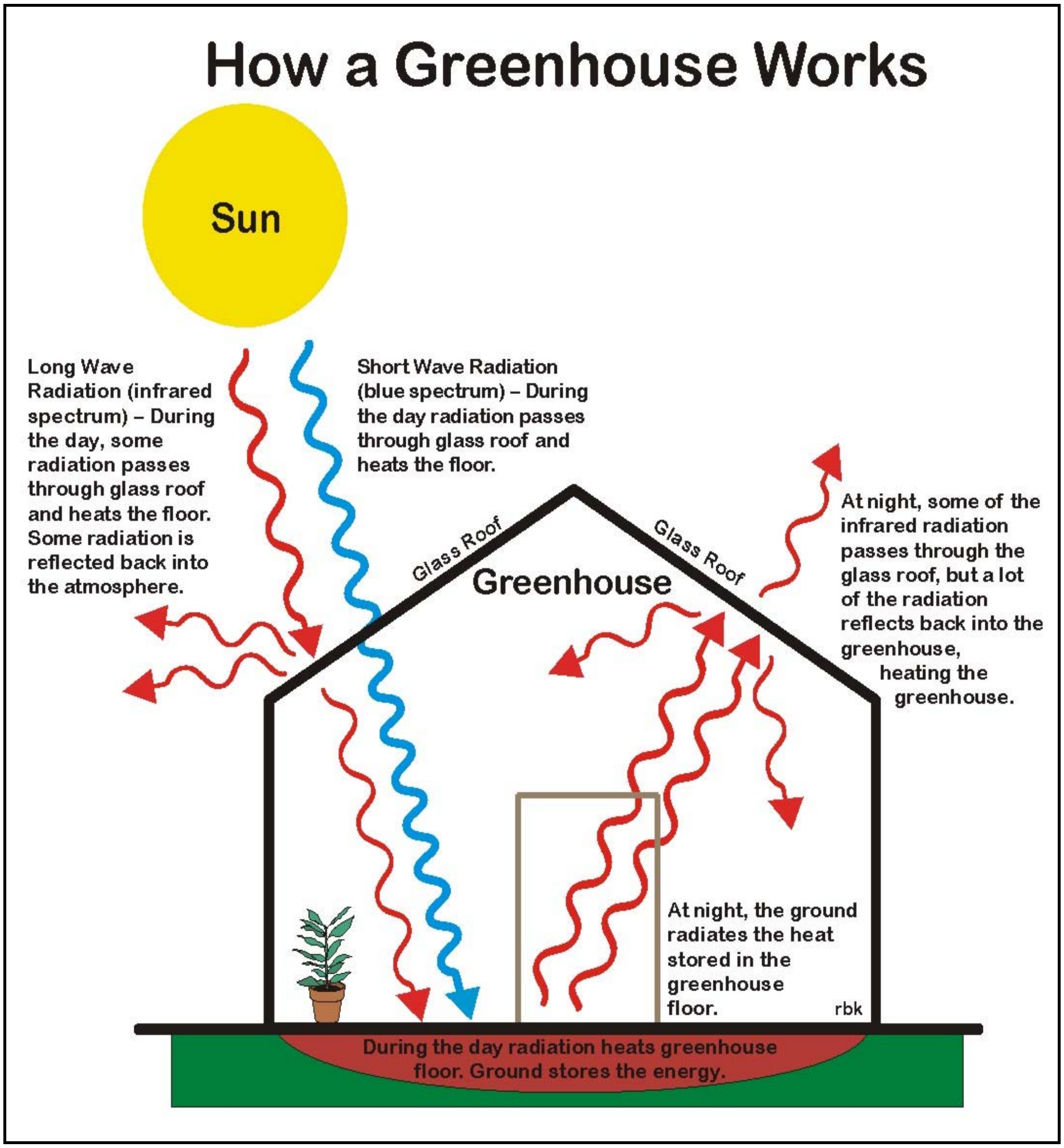
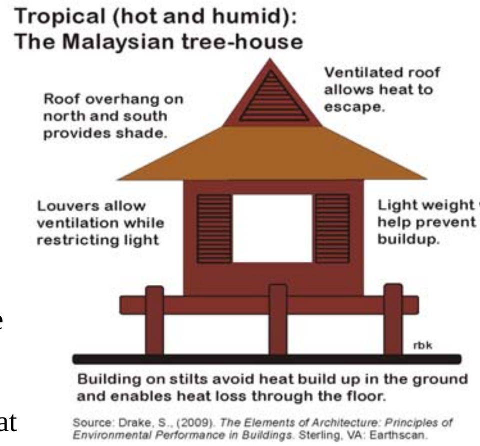


Figure 16.8 – Greenhouse Effect – Caption: Solar radiation passes through the glass roof of the greenhouse. Its energy is stored in the floor where during the evening the long-wave radiation emanates from the floor and reflects off the glass roof. – Source: author – [file: \fig1506-GreenhouseEffect.jpg]

<b>**<u>Construction Considerations</u>** – Illustrating the impact of the sun on buildings and architecture, Drake (2009) generalizes several building types for the different climate types found on earth. The significance of these building types is that they illustrate how to design with nature in each of these different climate zones. Each of the home types utilizes strategies of natural heating and cooling to make efficient and livable living spaces for people.

Figure 16.9 – Hot Humid: The Malaysian tree-house – Caption: The Malaysian house is designed to minimize the intense heat of the sun, create shade, facilitate air circulation, and offer protection during the rainy seasons. – Source: adapted from Drake, (2009, p.8) – [fig:\MalaysianHouse.jpg]



<c>***Hot Humid: The Malaysian tree-house*** (Figure 16.9) – Drake (2009, p.8) suggests that the Malaysian house typifies the approach to building a home in hot and humid regions. The house is built to minimize the intense heat and humidity that is often found in tropical regions. The extended roof on the north and south sides are designed to provide shade. Ventilation in the roof allows heat to escape. The roof and walls of the house are thin to reduce heat absorption, and to facilitate ventilation. It is a tree-house, because the house is built on stilts. Lifting the house off the ground on stilts reduces the heating of the house because of the ground beneath it being heated by the sun. In addition, heat can be lost through the floors as well as through the walls. It is a house designed with nature in the hot and humid regions of the earth.

<c>***Hot Arid: The Pueblo dwelling*** (Figure 16.10) – In hot arid regions one of two strategies is often applied. According to Drake (2009), the first strategy is the house as an oasis. In discussion of the Moorish influence in chapter five, Figure 5.20 shows the Torre de las Damas in The Alhambra in Granada, Spain. It is an outdoor room that contains a water feature such as a pool or fountain (Carpenter et al, 1977, p.19). The water evaporates and provides localized cooling of the surrounding area. Also, there is usually a large massive barrier that absorbs the sun's energy during the day and radiates it outward in the cool of the evening.

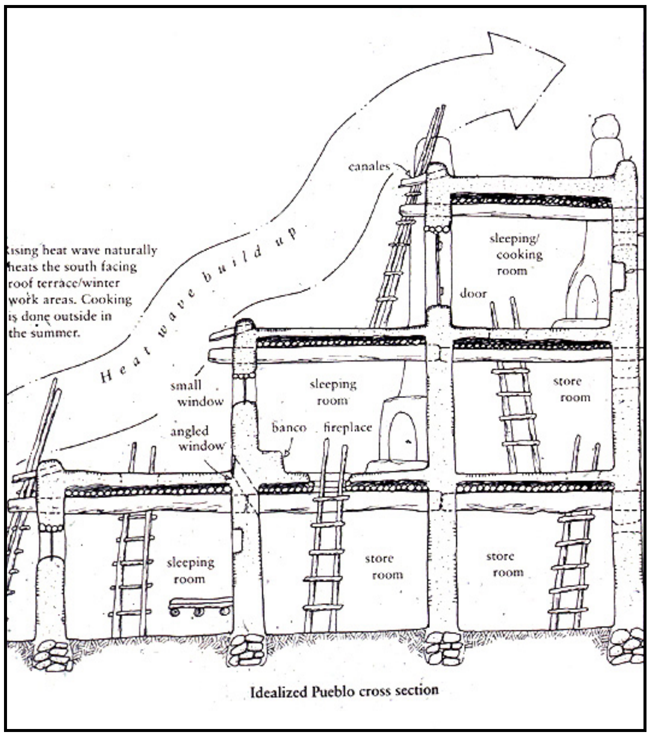


Figure 16.10 – Hot Arid: The Pueblo dwelling – Caption: The Pueblo dwelling is designed to minimize the intense heat of the sun during the day but utilize that same heat to heat the dwelling at night. In addition, it utilizes the cooling and moderating effects of the earth in its design. Note: Storage is in the coolest portion of the house, and sleeping areas are both heated by the sun and cooled by the earth. – Source: http://dkiarc.blogspot.com/2012/02/rr6-san-francisco-switzerland-hopi.html – [fig:\MalaysianHouse.jpg]

The second approach was typified by the Pueblo Indian structures which buried the dwelling in the earth to moderate the temperature in the dwelling (Figure 16.10). Moderating the temperature means that it is naturally warmer in cold weather and cooler in warm weather. Examination of the structure reveals that the storage rooms are embedded within the structure to take full cooling advantage of the earth. The sleeping rooms are on the outside of the structure and benefit from both solar heating. Their thick walls and roofs create a time lag where the transmission of heat is retarded by half a day. The energy is absorbed from the sun and radiates it back into the room during the evening. In addition, small windows limit the amount of light and heat that can enter the sleeping rooms. The fireplace allows for indoor cooking during the winter as well as supplemental interior heating. Similar construction principles are demonstrate in Kiva construction at Mesa Verde (Figure 15.11).

<c>***Warm Temperate: Outdoor room*** (Figure 16.12) – Building in warm temperate regions can utilize many of the strategies used to keep out heat in the tropics as well as some of the methods used to retain heat in the winter. They are often built with overhangs to provide shade when the sun is overhead during the summer, but allow the sun into the building during the winter when the sun is lower in the sky. The house may be built on a slab which will moderate temperatures and cool the house during summer, and warm the house during winter. This is similar to the floor in the greenhouse that acts as a heat sink which can store energy from the sun. Heavy masonry walls may be used on the northern side of the house to store energy and release it later in the day. Drake (2009) notes that because of the generally warm temperatures, the building need only provide some protection and provide for basic living functions such as sleeping and washing. It is an outdoor room because the temperate temperatures encourage many of the daily activities to be conducted outdoors.

Figure 16.11: Hot Arid: Kiva – Kiva construction is an underground dwelling construction. The walls are hollowed out of the ground and the roof is lined with juniper logs and covered over with dirt. The structure will moderate temperatures. Mesa Verde National Park, Colorado. Source: author – [fig:\MV166[vg].jpg]

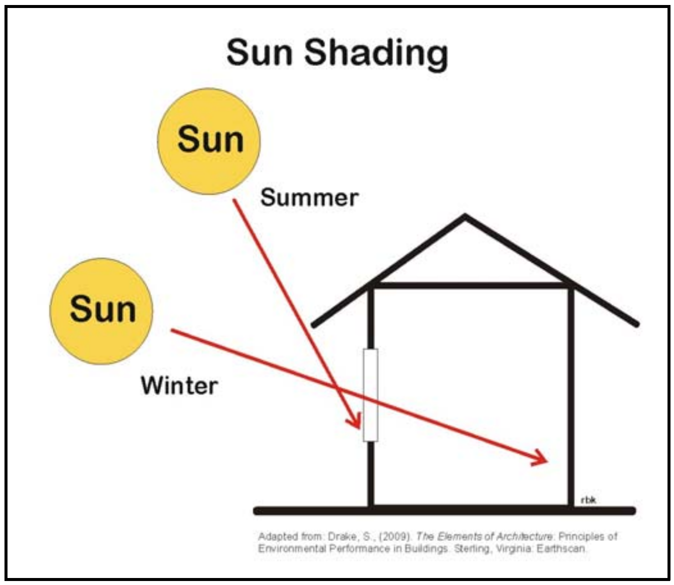


Figure 16.12 – Sun Shading and the Outdoor Room – Caption: Showing the basic concept of sun shading, roofs and overhangs can block the hot overhead summer sun but allow the winter sun that is lower in the sky to heat the house. – Source: adapted from Drake, (2009, p.8) – [fig:\SunShading04.jpg]

<c>***Cool Temperate: Home as a Hearth*** (Figure 16.13) – In the temperate climates, there are mild summers and cool winters. Drake (2009, p.12) suggests that the hearth or fireplace becomes the center or focus of the house because it was originally used to heat the house. Buildings are often huddled or terraced together as row homes to conserve heat. Heat lost to the adjacent home helps to conserve heat and is more efficient. Walls are heavily insulated and windows on the north side of the house are small to conserve heat. Floor plans remained small to help conserve heat.

<c>***Modern Buildings as a Refrigerator*** (Figure 16.14) – Often, the modern building is conceptually built like a refrigerator. The building is a well insulated box with a compressor or heat pump that cools the inside air when the outside temperature is warm. In addition, it warms the interior air when the outside air is cool. Thick closed cell foam or fiberglass bats are used for insulation. The primary method of insulation is to form a barrier against convection losses. Often membrane roofs are covered with black tar and covered with a layer of gravel to reduce light absorption.

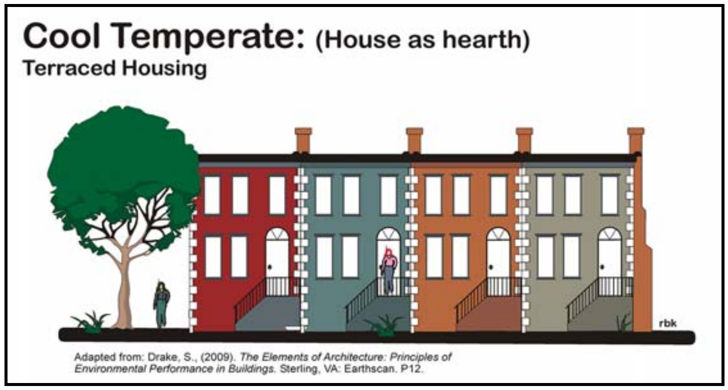


Figure 16.13 – Row Homes – Caption: Terraced buildings or row homes conserve heat by grouping homes together. Since heat is lost to the adjacent building, this creates efficiency and conservation of energy. – Source: Author; adapted from Drake (2009, p.12) – [file:\TerracedBuildings.jpg]

Windows are minimized or eliminated altogether. Windows are a major source of heat gain and heat loss. It is easier to simply cool the box. Refrigerators don't have windows. If windows are necessary, they are minimal in size and in the office area only. Illumination is provided by energy efficient and inexpensive florescent lights.

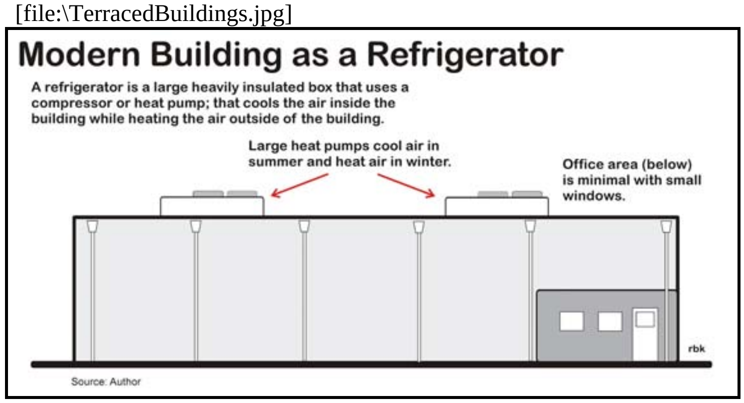


Figure 16.14 – The Building as a Refrigerator – Caption: A refrigerator is a large insulated box with a compressor (heat exchange) that cools the interior and heats the exterior. Windows, doors and other openings are minimal to minimize energy losses. – Source: Author – [fig:\RefrigeratorBuilding.jpg]

Water and Hydrology

This section looks at the water and hydrology cycle in terms of storm water runoff and retention. In this respect, this section presents the basic water retention system and what might be considered normal in a natural setting without development. This state can be considered the norm or the desired end product for any water retention measures taken. Conceptually, the water is traced from the roof, through down spouts and eventually into the river system. This section looks at traditional methods to increase water retention and to begin to return it to a retention level consisted with a forested state. Also, it should be noted that this section is delimited to water and hydrology systems. A similar analysis could be performed for other systems such as soils.

Looking at Earth from outer space, the Earth is the blue planet. It is the planet of water. Water serves as the major moderating force of the Earth's temperature. The water cycle is part of this process (Figure 16.15). Water currents (convection currents) such as the Gulf Stream seek to equalize the differential in solar heating of the Earth in the temperate regions with the polar regions. Water absorbs the sun's energy and it evaporates into the atmosphere. Plants transpire moisture into the atmosphere. Evaporation and transpiration losses to the atmosphere are referred to as *evapo-transpiration*. Moisture in the atmosphere forms clouds which reflect solar radiation and creates a greenhouse effect. *Precipitation* falls in the form of rain or snow. The water and melted snow enters the ground where it increases the amount of *groundwater* and increases the height of the *watertable*. Water moves through the ground (*interflow*) and drains into rivers and streams. Precipitation that is not absorbed into the ground flows as direct runoff into the streams and rivers. The rivers and streams flow back into the oceans and the cycle begins again.

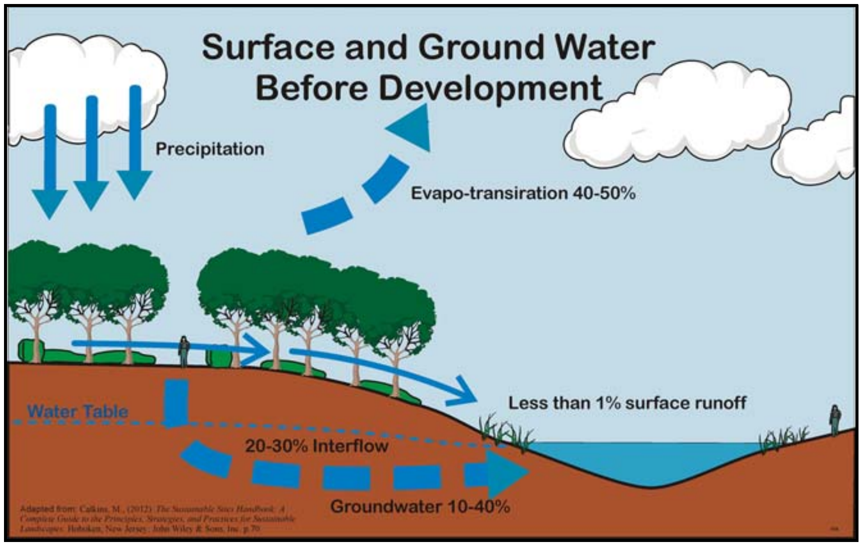


Figure 16.15: Primer on the Water Cycle (Forest) – The typical water cycle before and after development showing the effects of development on the water cycle. This scene shows the before condition. Water is absorbed into the ground increasing the ground water and water table. Interflow or the movement of water through the ground is increased also. Source: author; adapted from Calkins, M., (1999, p.70) – [file:\WaterCycleAfter[144].jpg]

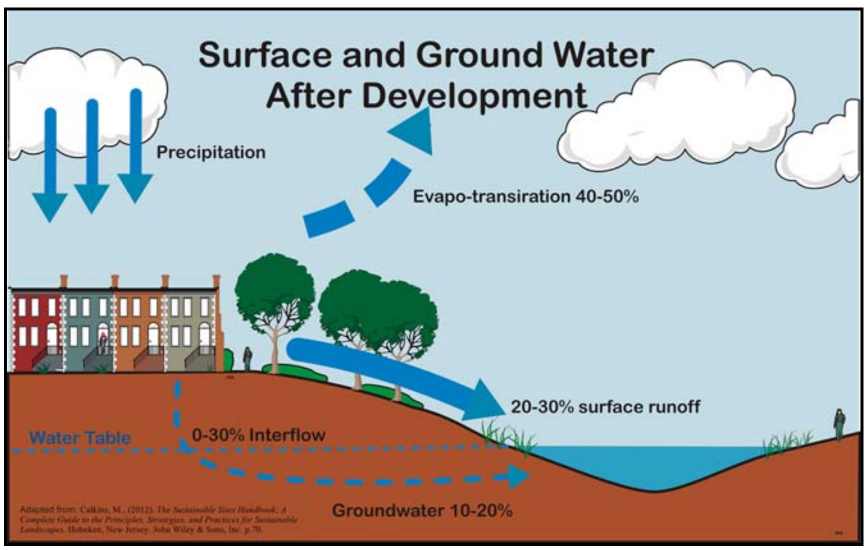


Figure 16.16: Primer on the Water Cycle (after development) – The typical water cycle before and after development showing the effects of development on the water cycle. This is the after development situation. Because of impervious surfaces, runoff directly into the water ways increases. The ground water decreases as does the interflow of water through the ground. Source: author; adapted from Calkins, M., (1999, p.70) **)** – [file:\WaterCycleBefore[144].jpg]

The water cycle is a homoeostatic model where the water cycle adjusts to changing inputs in solar heating, land use and other factors. Conceptually, it is easy to determine the normal state. Unfortunately, since the dynamics of the Earth are ever changing, the implementation of what is natural is much more difficult in terms of policy and regulations. It is difficult to adjust a changing environment to a moving target.

<b>**Concepts and Principles** (Figure 16.16) – In terms of water systems, Calkins (2012, p.22) notes that there are four strategies: conserve, reuse, balance, and regenerate. Although these approaches can be applied to all water systems including graywater and blackwater, the primary focus of this section is delimited to stormwater management. *Balance* focuses on creating *net zero use* of onsite water use. *Regeneration* involves capturing and reusing all onsite water such as capturing, purifying, and reusing all water onsite.

There are some philosophical concerns with seeking sustainable approaches in this case *net zero use* of onsite water use. Consider the following example which contrasts the use of septic systems versus centralized sewage treatment plants. The use of septic systems recycles wastewater onsite and increases localized infiltration. Collectively, the use of septic systems is a variation of the tragedy of the commons where the collective harm becomes the non-point pollution contributed by leaking septic systems leaching into waterways. In addition, there is the issue of the land consumed in urban environments to install septic systems or their more sustainable versions. Some areas require a building lot with a minimum of two acres to support current and future septic systems. Readers will note that this discussion parallels the discussion of using retaining ponds later in this section. In contrast, centralized sewage treatment plants are cost efficient and they are efficient in terms of purifying wastewater. By concentrating the treatment process, they are much more efficient than the collective treatment of individual septic systems. It is important not to fall into the trap of inadvertently creating a more harmful situation environmentally and economically.

Development has a localized effect on the water cycle (Figure 16.16). Development includes not only urban and suburban development but agriculture. In general, the results of development increase direct run-off and decreases the amount of water entering the ground and the interflow of water through the ground.

The difference between groundwater after development with that of the forest can serve as an objective for water management efforts (Figure 16.17). If the forest situation is considered the natural state, the suburban/residential environment has less evapo-transpiration (roughly 15%) because there are fewer plants to transpire moisture and because there is more direct run-off (25%) because of impervious surfaces (roads, buildings, etc). Since there is more direct run-off, there is less water absorbed into the ground and there is less interflow of the water laterally though the ground.

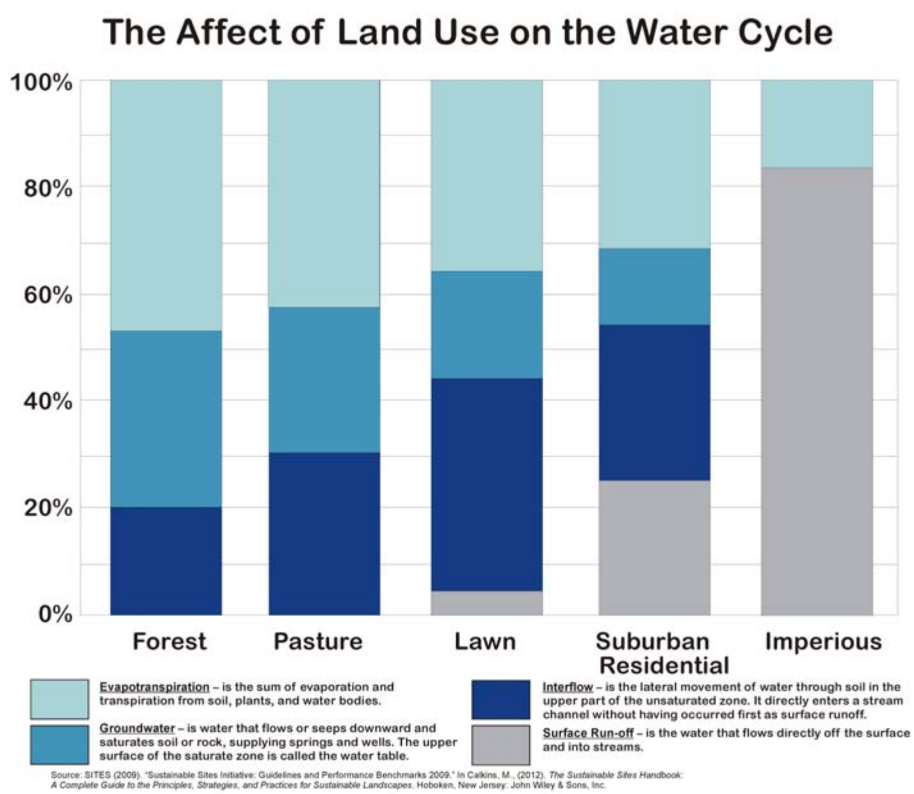


Figure 16.17: Stormwater Runoff – This graph shows the effects of development on the typical water cycle. In comparison with the forest, the suburban/residential setting has more surface runoff and a significant decrease in groundwater flow. In terms of sustainable designs, what can be done to mimic forest conditions in the suburban/residential. Source: King County, WA, Department of Natural Resources (1999) – [file:\StormwaterRunnoff.jpg]

In terms of sustainable designs, water management seeks to develop strategies and practices that approximate the forest situation in Figure 16.15 (conserve, reuse, balance, and regenerate). These strategies seek to reduce direct run-off, and increase groundwater absorption. Although these strategies build upon each other for creating the most efficient system, they can be used independently of each other although doing this can place more pressure on the technique. Also, the systems complement each other.

<b>**Stormwater Management Techniques** – The following are a series of storm water management techniques that can be used in concert with each other to reduce direct runoff and increase infiltration of water into the ground. Traditional storm water management was to collect it and transport it as quickly as possible in drains and culverts where it was deposited into the local stream or river. In terms of designing with nature, the philosophy of storm water management has changed significantly. It is one of holding and retaining the water to disperse it into the ground (see Figure 16.15 and Figure 16.16). This is an approach that seeks to facilitate a more natural condition.

The presentation of sustainable storm water management techniques is presented starting with its source and following it to where it is eventually dumped into the streams and rivers. Some techniques like retention ponds have received wide acceptance and other techniques such green roofs have yet to gain similar acceptance. Although the techniques work better in concert with each other, they can be applied independently of each other. For example, the installation of retention ponds can significantly reduce the amount of water dumped into streams and rivers but they work better if other techniques reduce the input of water into the retention pond. If other methods such as green roofs are not used, the size of the retention pond can be increased to compensate for the increased runoff from traditional roofs. In terms of designing with nature or sustainable designs, the objective is to reduce runoff and return water into the ground, similar to what would normally be found in a forest.

<c>***Green Roofs*** (Figure 16.18 and Figure 16.19) – Normal roofs collect rainwater and transport it through gutters and down spouts to the ground. There the water can be collected for future use (cisterns), or dispersed directly into the ground. It can be moved along slowly through a swale. Or it can be collected in a micropool. Prior to these method, the water was rapidly moved through drains and pipes and quickly dumped into streams. The square footage area of building roofs is individually and collectively significant. Green roofs are the first line of stormwater management that helps to return the system to a more natural state (Figure 16.18 and Figure 16.19).

Figure 16.18: Robinson Nature Center Green Roof – Normal roofs collect and quickly disperse the water through down spouts away from the building. Green roofs are the first line of stormwater management. They hold water and slow its dispersal. It returns the system to a more natural state. Robinson Nature Center, Montgomery County, Maryland. Source: author – [file:\RNC005.jpg]

The two biggest benefits of green roofs are heat mitigation and storm water reduction. Green foliage absorbs energy and provides shade to the building beneath it. In terms of stormwater reduction, Calkin (2012, p.115) reports that research has shown that extensive green roofs (<6" deep), can reduce the volume of annual runoff by 50% to 90%. In addition, for the runoff that does occur, the runoff time is greatly extended.

Green roofs can provide additional benefits in urban areas. They can provide mini-parks on the top of buildings. They can create wildlife habitat, or a garden area. A problem with green roofs is that the roof needs to be designed to support its increased weight. If retrofitting, this can be problematic. Sloping roofs are potentially problematic also. However, green roofs can be designed for them also. Other potential problems include many of the same problems that occur in creating any habitat. The vegetation can encourage vermin and evasive species. Also, the vegetation on green roofs requires maintenance.

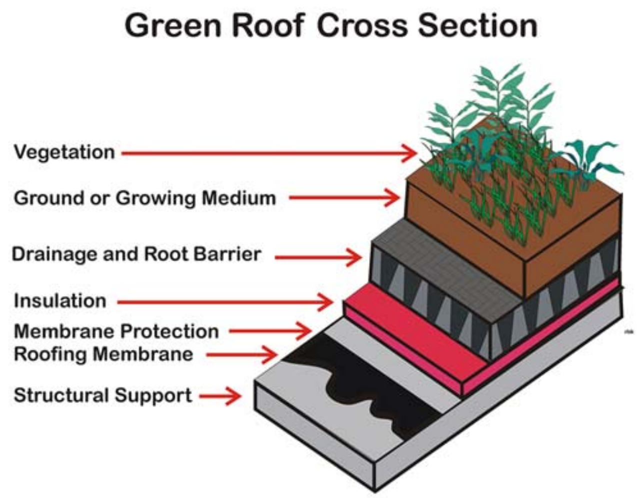


Figure 16.19: Typical Cross-Section of a Green Roofs – Typical cross-section of a green roof. Source: author – [file:\GreenRoofCrossSection.cdr]

Green roofs can enhance the visual landscape also (Figure 16.20). Visually, this green roof on the restroom at Romare Bearden Park in Charlotte, North Carolina provides a continuation of the greenery from the elevated park where the picture was taken. In contrast, the view would be that of black asphalt. Also, note the fence on the rock in the left portion of the photo. It is a proactive risk management measure to provide a physical barrier to prevent people from climbing onto the roof.

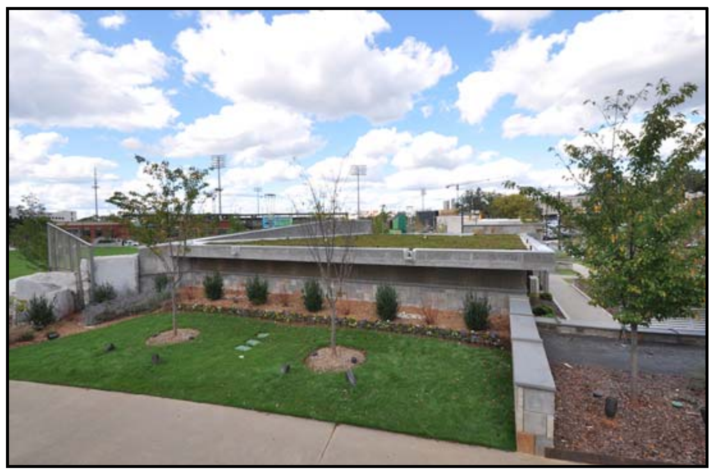


Figure 16.20: Restroom Green Roof – Visually, this green roof on the restroom at Romare Bearden Park in Charlotte provides a continuation of the greenery from the elevated park where the picture was taken. Second, note the fence on the rock in the left portion of the photo. It is a proactive risk management measure to provide a physical barrier to prevent people from climbing onto the roof. Romare Bearden Park, Charlotte, North Carolina. Source: author – [file:\ROM035[gd].cdr]

<c>***Rainwater Collection*** (Figure 16.21, Figure 16.22 and Figure 16.23) – Rainwater from the roof can be collected and stored in holding tanks or cisterns for later use or dispersion into the groundwater. The harvested water can be used for irrigation of landscaped areas, supporting a pond or wetland, or released at a later date to infiltrate the ground.

Figure 16.21: Above Ground Cistern – Rainwater can be collected and stored in a holding tank or cistern where it can be used for irrigation, ponds or wetlands, or released at a later date to infiltrate the ground. This above the ground cistern collects rainwater and can us a gravity feed to water plans at a later date. Note the small pipe is from the air conditioner. Brookside Gardens, Wheaton, Maryland. Source: author – [file:\BSG-020[gd].JPG]

Figure 16.22: Below Ground Cistern – Aesthetically pleasing and functional, the nature center's two roofs funnel rain water into the channel above the walkway which drains with a waterfall into the cistern underneath the large rock. Killens Pond State Park Nature Center, Felton, Delaware.
Source: author – [file:\KP002[gd].jpg]

Figure 16.21 shows a typical above ground cistern using a prefab container. It is discretely hidden by the surrounding vegetation. It is worth noting that the small pipe at the top of the container is the condensation from the air-conditioning system. The advantage of the above ground cistern is that a gravity system can be used to disperse the water at a later date. It does not require a pump for dispersal of the water.

In contrast, the underground cistern depicted in Figure 16.22 is aesthetically pleasing while functional. The water funnels from the two roofs into the sluiceway and spills into the underground cistern beneath the large rock. It must be spectacular during a rain storm. In contrast to the above ground cistern, the water must be pumped out of the cistern for eventual distribution (Figure 16.23).

<c>***Porous Pavements*** (Figure 16.24)– Roads and parking lots are impervious surfaces that result in considerable runoff. The traditional solution for handling runoff is to collect the runoff in retention areas which act as temporary holding bins for the water. The use of interlocking pavers is also an easy solution that increases groundwater infiltration and reduces direct runoff. Although more expensive than their nonporous counterparts, porous concrete and asphalt are recent options to aid in groundwater retention (Figure 16.24). The sign in Figure 16.24 notes that up to five gallons of water can pass through each square foot of porous concrete per minute. Because there is less run-off, the capacity of retention ponds is decreased also.

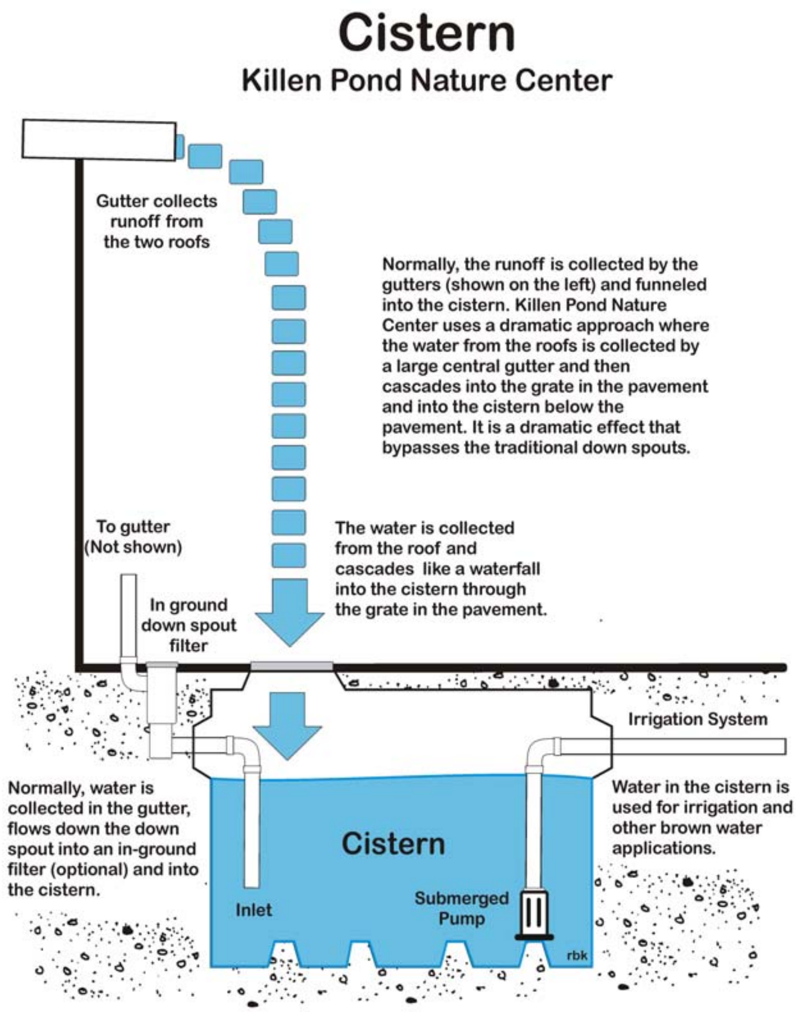


Figure 16.23: Below Ground Cistern Diagram – This diagram explains a below the ground cistern. It requires a pump to distribute the water. Killens Pond State Park Nature Center, Felton, Delaware. Source: author – [file:\Cistern01.cdr]

Figure 16.24: Porous Concrete – Pavements and roadways are a significant source of rain runoff. Porous concrete can allow up to five gallons of water to pass through each square foot per minute and reduce the need for retention ponds. Robinson Nature Center, Howard County, Maryland. Source: author – [file:\RNC002.jpg]

<c>***Rain Gardens and Rain Pockets*** (Figure 16.25) – Rain gardens are low spots that collect water and temporally store water where it either infiltrates the ground or where it is absorbed by plants. They are smaller then retention ponds. Usually, they are six to eight inches deep. Since these areas are prone to temporary flooding and drought, plant species need to be tolerant to temporary flooding and sustainable through periods of drought or non-flooding. In Figure 16.25, the cypress tree planted in the middle of the rain garden is tolerant to flooding.

Figure 16.25: Rain Gardens/Rain Pockets – Rain gardens are small depressed areas that can capture and temporarily hold water until it is absorbed into the ground or absorbed by the plants. Robinson Nature Center, Howard County, Maryland. Source: author – [file:\RNC024.JPG]

<c>***Retention Areas*** (Figure 16.26) – In terms of storm water management, retention areas are the most familiar of the retention techniques. They were first conceived in the 1990s and they are designed to capture the 95th percentile of storms. Normally, the retention areas utilize five to ten percent of the land for the purposes of containment which is land lost to development. Typically, retention areas are identifiable by their overflow system which is usually constructed from concrete or steel. They need to utilize permeable soils and plants that can tolerate temporary innundation. The soil should be sufficiently permeable to drain water in less than a day. Some retention areas are below the water table and have a permanent pond or wetlands in them. They can become micropools. This can encourage waterfowl and aquatic life.

Figure 16.26: Retention Areas – Conceived in the 1990s, retention areas have become the most widely used storm water management technique. Water enters from the lower right corner of the photo where the retention area with natural vegetation holds the water. A second entry point is in the upper right corner of the photo. The out-take is in the upper left corner of the photo. Eagle Rock, near Hazleton, Pennsylvania. Source: author – [file:\ER1239.jpg]

<c>***Infiltration Basins and Trenches*** – Traditionally, culverts and raceways have been designed to move water quickly to retention areas or to directly dump the water into streams. These trenches can be filled with large aggregate to slow the movement of the water and to encourage water infiltration (Figure 16.27). The technique can significantly contribute to water infiltration.

Figure 16.27: Infiltration Trenches – Filling raceways with rock aggregate slows the speed of the water and encourages greater water infiltration. – Eagle Rock, near Hazelton, PA. Source: Source: author – [file:\ER1254.JPG]

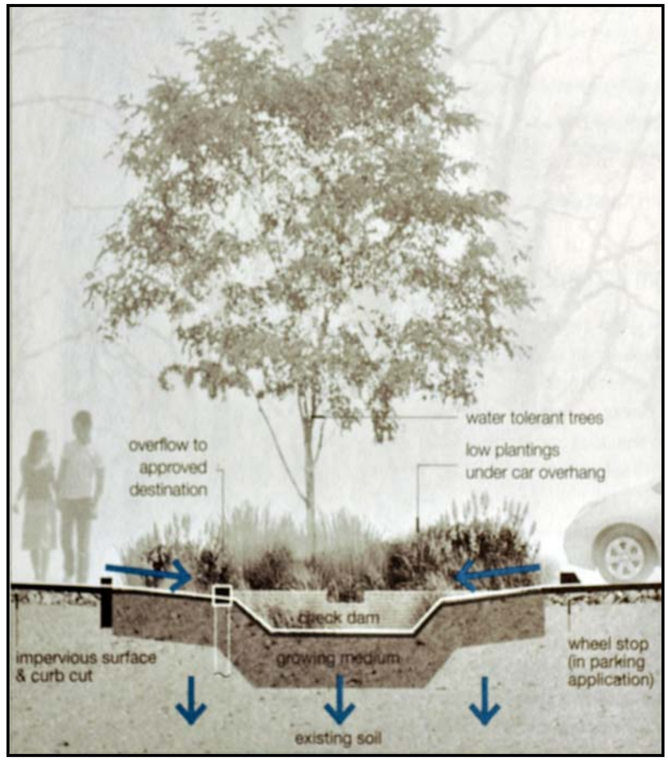


Figure 16.28 – Swales and Bioswales – Caption: Swales are vegetative lined channels that slow the speed of runoff, increase infiltration, and increases opportunities for transpiration. – Source: Calkins, M., (2012, p.130) – [file:\Calkins-Bioswales.jpg]

<c>***Swales and Bioswales*** – Swales are vegetative lined channels that slow the speed of runoff, increase infiltration, and increase opportunities for transpiration (Figure 16.28). Vegetation can simply be grass or a planting of native species. Often swales include a series of check dams to pool and further slow the movement of runoff. Swales are recommended on a 2:1 or less slopes. They require maintenance, and care needs to be taken so that the water doesn't erode away the soil.

Figure 16.29: Micropools – Micropools are deeper and more permanent rain gardens or rain pools. They can offer a source of aquatic wildlife. This area included an abundance of fish, turtles and other aquatic life. Renaissance Park, Chattanooga, Tennessee. Source: author – [file:\RenaissancePk002.jpg]

<c>***Micropools*** (Figure 16.29) – Micropools are deeper and more permanent than rain gardens or rain pools. Usually, they are at the level of the water table resulting in ponds or if shallow, wetlands. Often micropools are connected and fed with runoff by swales. Usually, micropools become a source of aquatic life.

<c>***Naturalizing Stream and River Floodplains*** (Figure 16.30) – In part, the health of streams and rivers is determined by the use of the previously mentioned measures taken to manage runoff. Conceptually, streams can be viewed as a continuation of large bioswales except there is a stream of water in them. The previously mentioned methods can reduce the amount of flood waters, decrease sedimentation, decrease turbidity, and potentially increase water quality.

Rivers and streams flood. Traditionally, the approach to flood control has been to build levees and to move the water as quickly as possible past the area being protected (Leopold and Maddock, 1954). This increases the amount of water downstream and the problem of moving the water quickly past one protected area is dumped into the next protected area downstream. And the need to move the water quickly past the protected area is repeated again downstream. To facilitate the movement of water, the levees are seeded with grass, and trees and other vegetation that would normally slow the movement of water are systematically removed.

Figure 16.30 – Buffalo Bayou Trail – Caption: Everything in this picture including the trail on the left are designed to be periodically inundated with flood waters. Good design can facilitate healthy waterways along with park and recreation uses. – Source: author – [file:\BBT1058.JPG]

In contrast to the traditional approach, the sustainable design movement seeks to restore streams and rivers back to a free flowing condition. Conceptually, it is a continuation of the previously mentioned methods of slowing and retaining stormwater runoff to increase water absorption into the ground (see Figure 16.15 and Figure 16.16).

Returning streams and rivers to a more natural state has significant implications for park and recreation interests. Water is a natural attractant of people and with the proper design, park and trails can easily be incorporated into the flood plain use and management. The Buffalo Bayou Trail in Houston, Texas is an example where the trail, benches, and fixtures are designed to be periodically inundated (Figure 16.30). Railings, lamp posts, and bollards utilize galvanized metal extensively. Electric panels are placed above the 100 year flood plain.

<b>**<u>Graywater and Blackwater</u>** – Sustainable designs can also focus on graywater and blackwater management. Graywater is water used for washing, laundry and similar functions. Although it is not potable or drinkable, it can be recycled as irrigation and similar uses. Blackwater refers to sewage. It contains potentially harmful bacteria and requires more sophisticated methods of handling. It is worth noting the concern expressed in the concepts and principles section regarding the use of individualized wastewater treatment versus a centralized system.

Use of Vegetation

Vegetation affects the amount of groundwater, interflow and direct runoff (see Figure 16.15, Figure 16.16, and Figure 16.17). Although in these figures evapo-transpiration remains the same after development at 40%-50%, direct runoff increases from less than 1% to 20%-30% of the water losses. Loss of vegetation plays a significant role in reducing these losses. Reflecting increased runoff, the groundwater is reduced as is interflow.

In terms of designing with nature and creating sustainable designs, the use of vegetation is either *functional, aesthetic* or both. The use of vegetation functionally or aesthetically are not necessarily mutually exclusive of each other and the use of vegetation can accomplish both functional and aesthetic uses simultaneously. Most of the literature tends to focus on the functional or technical aspects of sustainable designs rather than the aesthetic aspects which tend to be more of an afterthought or secondary benefit.

<b>**Aesthetic Use of Vegetation** (Figure 16.31) – The urban park is a visible sign of the concept embodied by sustainable designs and designing with nature. Just as the garden is a metaphor for civilization (see Chapter 4), urban parks in an urban environment can easily become the metaphor or a symbol for nature, a sustainable environment, and designing with nature. A major theme of this book is designing space to create an experience. A brief review of the aesthetic use of vegetation is provided here in terms of the previous discussions.

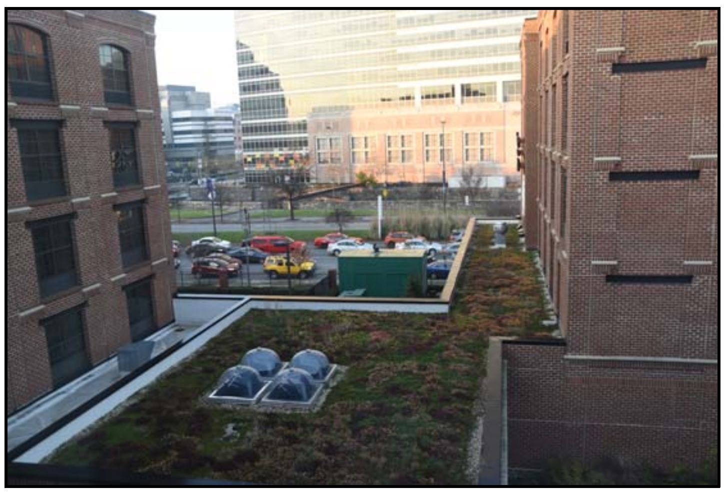


Figure 16.31: Green Roof in Baltimore – The green roof provides both functional and aesthetic benefits. Green roofs can change the viewscape of urban environments. The garden on the roof in downtown Baltimore makes a statement about man and his environment, sustainability, and designing with nature. Source: [file:\FairfieldBaltimore01.jpg]

In tracing the English Landscape Movement in Chapter 5, the thesis was advanced that they planted landscapes to create picturescapes that are "picturesque." Repton's designs in his Red Books were both aesthetic and functional plans for large estates at the beginning of the industrial revolution. Later, the Victorian approach of John Paxton and Birkenhead Park sought to bring nature and the outdoors into the tenements of the urban industrial cities. Olmsted and Vaux imported the movement to this country with Central Park. Historically, the purpose of the park movement has been to make a philosophical statement about the environmental condition of people, how they live, and to improve upon it. In this respect, the purpose of the Robinson Nature Center and other nature centers to demonstrate sustainability within an urban environment is not inconsistent with the history of the parks movement (see Figure 16.39).

Although the use of techniques such as green roofs and other techniques can be argued on their functional benefits, they also create an aesthetic statement that becomes the face of sustainable designs (Figure

16.31). This statement is no less important that Repton's Red Books, Paxton's Birkenhead Park, or Olmsted and Vaux's Central Park. The statement made by the use of vegetation in urban designs is equally as important as the functional benefits in creating an experience. In a less grandiose way the green roof on the restroom at the Romare Bearden Park, Charlotte, North Carolina provides an aesthetic benefit in maintaining the visual viewscape (see Figure 16.20).

<b>**<u>Functional Use of Vegetation</u>** – The use of vegetation can serve important functional benefits with sustainable designs. These are in addition to the techniques discussed under the sun and water sections. Many of the techniques such as windbreaks, sun shading, and sun shielding are not new and have been practiced for years by architects and designers. Chapter 11 discussed the use of vegetation in terms of physical and visual barriers. In addition, vegetation can provide additional functional benefits when designing with nature. These include windbreaks, sun shading, sun screening, the heat island effect, and the use of indigenous plants.

<c>***Windbreaks*** (Figure 16.32) – Trees can be used as windbreaks or to reduce the effects of harsh winds. Carpenter (1975, p.167) reports that dense plantings can reduce the effects of the wind speed by 75% to 85%. In the northern hemisphere, trees are often planted on the western side of homes to provide a wind barrier to prevailing western winds as well as providing a barrier to the sun. Conversely, vegetation can be planted to help funnel the air flow toward a building or open area (not shown).

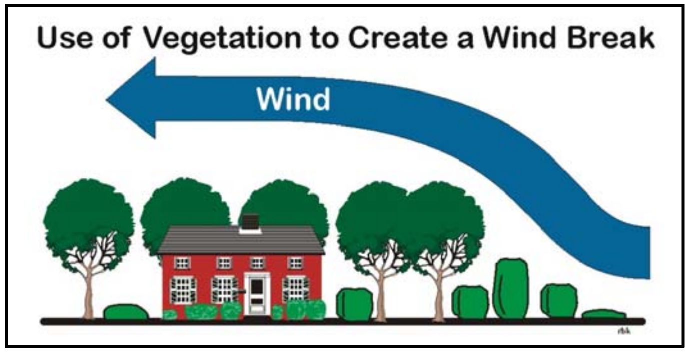


Figure 16.32 – Use of Vegetation as a Windbreak – Caption: The planting of trees can significantly reduce wind speed (75%-85%). – Source: author; Carpenter (1975, p. 167); Calkin (2012, p.209) – [file:\Windbreak01.jpg]

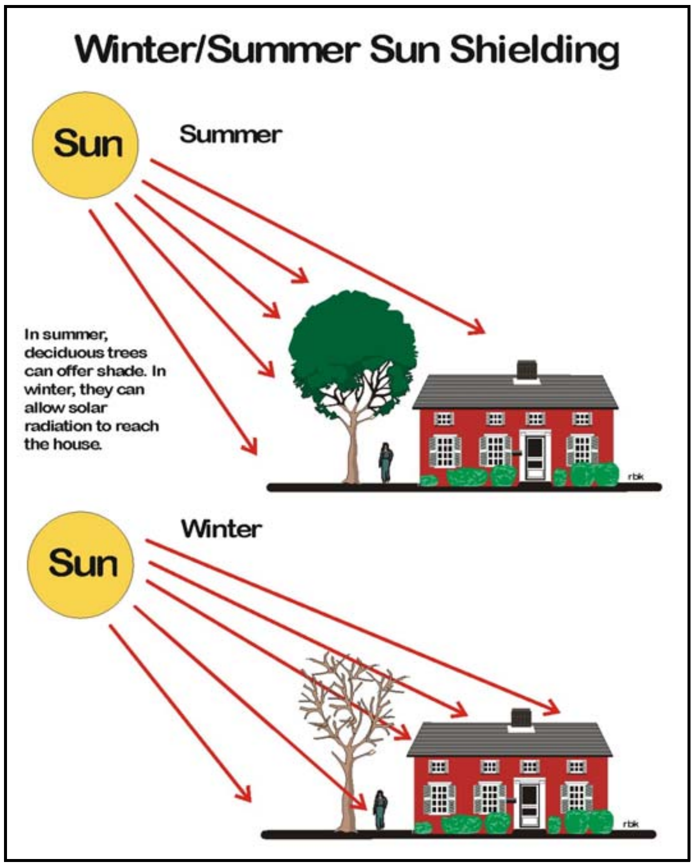


Figure 16.33 – Use of Vegetation for Sun Shading – Caption: Planting of trees can significantly reduce wind speed (75%-85%). – Source: author; Carpenter (1975, p. 167); Calkin (2012, p.209) – [file:\SunShading02.jpg]

<c>***Sun Shading, Sun Shielding, and Microclimates*** (Figure 16.33 and Figure 16.34) – Trees can be used as blinds to allow the sun to heat buildings or to reduce the heating effects of the sun. Planting deciduous trees on the southern side of a building can act as these blinds. In summer, the leaves on the trees block sunlight and reduce the heating impact of the sun on the building. In winter, the leaves are off the trees and the sunlight can pass through

the trees and heat the house.

Trees can create a canopy over a building or patio that reduces the heating effects of the sun (Figure 16.34). This is an example of creating a *microclimate* where the temperature and localized conditions are different from that of the prevailing area. The outdoor room was discussed in Chapter 8 in terms of its visual impact. It can also be discussed in terms of its functional impact in reducing heat buildup from the sun during the day. Illustrating this principle, the building in Figure 16.29 shields the patio from the morning sun and the deciduous trees help to protected the patio from a heat build up from the late afternoon sun.

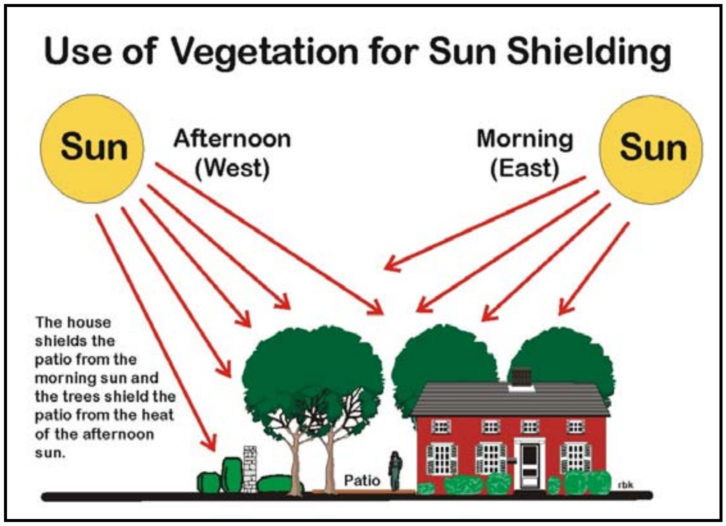


Figure 16.34 – Use of Vegetation for Sun Shielding – Caption: The building shields the patio from the morning sun and the deciduous trees help to protected the patio from a heat build up from the late afternoon sun. – Source: author; Carpenter (1975, p. 166); Calkin (2012, p.210) – [file:\SunShading03.jpg]

Review the photo of the Greenhow patio at Williamsburg in Chapter 8 (see Figure 8.39). The trees create a ceiling and the building on the sides protect the patio area from the sun's heat build up during the day. However, a potential drawback of this enclosure is that it can prevent air circulation which in a humid climate accentuates the humidity.

<c>***Heat Island Effects*** – Traditional urban development removes trees and forests and replaces them with buildings and asphalt parking lots. Asphalt is black and absorbs solar radiation. Unfettered, the morning sun, followed by the overhead sun of midday, and the late afternoon sun can result in considerable localized heating. The differential in heating versus an equal area of forest or even pasture with vegetative shading can be significant. Even air conditioning can contribute to the localized heat island effect. Remember, air conditioning is a heat exchanger. As it cools the building's interior, it heats the outside environment.

Both conceptually and practically, the heat island effect is the lack of sun shading. Hence, the simple solution is to introduce sun shading (see Figure 16.33 and Figure 16.34). Planting trees and other vegetation can reduce the heat island effect as well as provide aesthetic benefits. Green roofs can provide sun shading of buildings that reduce the heating effects of the sun.

<c>***Using Native (Indigenous) Plants*** – When designing with nature, consider using native plants. Native species are generally more suitable to the site or region. For example, planting lawn grass in the arid southwest consumes water and creates a habitat unnatural to the region. It is an example of people moving in from the eastern states desiring to bring their former habitat with them. Although it is understandable, it is unnatural. Using native plants provides habitat for native organisms, and it creates a human habitat that is more consistent with that of the region.

There is the issue of what is an indigenous species. Generally, exotics tend to be invasive species. Calkin (2012, p.219-220) notes several characteristics that the literature tends to associate invasive species. Intuitively, they grow rapidly. They tend to spread rapidly and they tend to crowd out other indigenous species. Also, rather than creating diversity, invasive species tend to create mono-cultures.

Philosophically, this author has a slightly different view regarding indigenous and exotic species. The opinion crystalized when designing an arboretum for the National Colonial Farm which is located on the other side of the Potomac River across from Mt Vernon. Its purpose was to maintain a background setting consistent with colonial times. The issue was what was indigenous and what was exotic? It became abundantly clear that one simply chose a year and the species that were there prior to that year or in this case prior to the era of George Washington were indigenous, and those species present after that year were exotic. If the demarcation year becomes 1850 rather than 1776, some plants that were exotics will become indigenous. Stated another way, *every indigenous species was once an exotic*.

Designing Buildings with Nature

Two topics are discussed in this section illustrating the principles of designing building with nature. These are Frank Lloyd Wright's concept of organic architecture and LEED. Frank Lloyd Wright's country house at Fallingwaters is used to illustrate the concept of organic architecture. The LEED discussion is a more generalized discussion regarding designing green, sustainability and its certification process.

<b>**Organic Architecture** – Frank Lloyd Wright characterized his design philosophy as organic architecture. It is a philosophy which designs with nature both aesthetically and functionally. His designs attempted to integrate the site, its surroundings, the building, and its furnishings into a unified, interrelated composition. Built in the 1930s Fallingwaters illustrates a design with nature that is modernistic and seemingly devoid of any connection with nature. However, it is connected with nature on numerous levels. The design demonstrates that modernistic designs can mimic the experience experienced in the outdoors and man's relationship with the natural environment.

<c>***Aesthetically Designing with Nature*** (Figure 16.35) – Although there are numerous examples that could be used, three examples are used to illustrate the concept of aesthetically designing with nature. The first example is the use of sashless windows. Although a seemingly small example, it is a very powerful example. Examine the photograph of the stonewall and window in Figure 16.35. Notice how seamlessly the eye moves from the interior to the exterior of the house. The stone wall is continuous and virtually unobstructed by the window. Normally, windows are placed in a sash or frame that securely holds the glass in place. Using a sash is a normal building practice. As a sidebar, the construction workers most likely considered Wright insane for having one side of the window sashless and glazed directly into the rock wall. However, from a

Figure 16.35 – Sashless windows – Caption: Wright conveys the subtly of organic architecture by using the rock as the window sash (i.e. there is no vertical frame). The simple design allows the eye to smoothly transition from inside (left) to outside (right). As a sidebar, think of the quandary of workmen installing this type of non-traditional window. Fallingwaters, Ohiopyle, Pennsylvania. – Source: Author – [file:\FW034 office.jpg]

design perspective and the aesthetic desired, Wright was correct. It works seamlessly.

The second example mimics the rock strata in the falls with the floors of the house (see Figure 7.19). The floors of the house form a series of plates that mimic the rock strata of the waterfalls. This is illustrated in the photograph. The mimicking includes both the lighter areas of the rock and floors and the dark or more subdued areas created by the shadows underneath the floors and the rock. Also, it reinforces the principle discussed in Chapter 7 that the eye is attracted to light areas before dark areas.

Figure 16.36: Connective Concrete Beams – Illustrating the aesthetic design with nature is the use of three concrete beams to link the house with the rock outcropping. They serve no functional purpose. Fallingwaters, Ohiopyle, Pennsylvania. Source: Author – [file:\FW130.jpg]

Conceptually, Fallingwaters is cantilevered into the rock of the hillside. Reinforcing this aesthetic is the view from the carriage road (Figure 16.36). The concrete beams linking the house with the rock outcropping are strictly aesthetic. They have no functional or structural purpose. Aesthetically, they reinforce the cantilevered concept of the house and tie the building directly into the rock outcropping.

<c>***Functional Design***

(Figure 16.37) – The floor plan of Fallingwaters illustrates a functional design with nature. Drake (2009, p.12) notes that the idea of the house as a hearth was associated with the work of Frank Lloyd Wright (Figure 16.37). Although the hearth may not be the center of the house, Wright places it at right angles with three other unifying elements of the sky, water, and earth. As a footnote, most people consider the natural rock outcropping in front of the fireplace as shear genius design by Wright. Actually, he had planned to remove it.

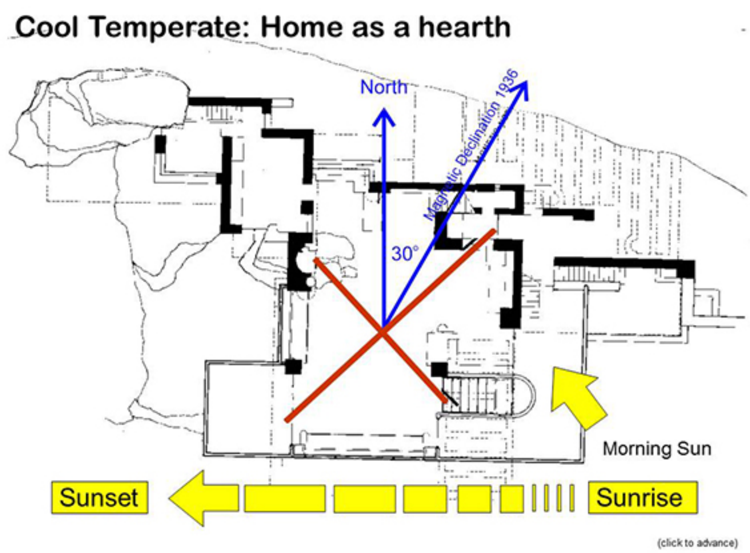


Figure 16.37: Fallingwaters – House is located on east/west axis. Walls prevent early morning sun and overhangs provide sunshading. – Source: Composite graphic – author; Fallingwaters (1886) – [file:\FallingwatersHearth.jpg]

Also, the site placement of Fallingwaters facilitates sun shading (Figure 16.38). The house is situated on an east/west axis. The back of the house is situated into the hillside and the exposed side faces southward. This means that the sun will illuminate the rooms in the morning and during the day. In summer, the trees shield the rooms from heat, and during the winter with the leaves off the trees, sunlight can enter the rooms. However, with the walls on the side of the rooms, the sun will not illuminate the rooms until mid-morning. Fallingwaters was not designed as a residence but as a retreat. It was designed as a place where individual family members could come and seek solitude. It was a place where they entertained guests. For this reason, residents or guests don't want the morning sun intruding too early on the day after. The walls prevented this from occurring, but when the sun rose in the sky by mid-morning, the rooms were illuminated by the morning sun.

Figure 16.38: Sunshading – Looking west, this is a view of Fallingwaters depicts the impacts of the sun and the concept of sunshading. During the summer, the deciduous trees help to provide protection from excessive solar heating. During the winter, it encourages heating and the balconies become heat sinks that radiate stored solar radiation. Source: Author – [file:\FW154.jpg]

<b>**LEED Certification** – Originated in 1998, LEED (Leadership in Energy and Environmental Design) was designed by the USGBC (U.S. Green Building Council) to incorporate green building technologies into building practices. LEED has an activist agenda. It has gained considerable momentum with several states requiring state funded building projects to meet LEED standards. Many recreation and parks departments that have built facilities have participated in the program (Figure 16.39).

Figure 16.39: Robinson Nature Center – The Robinson Nature Center is a demonstration facility for LEED and sustainability by Howard County and Maryland Department of Natural Resources. As a footnote, the green roof in Figure 16.18 is visible in this photo between the stone wall and main building. Howard County, Maryland. Source: author – [file:\RNC001.jpg]

<c>***Purpose of LEED*** – The purpose of the program is to create a "market transformation tool." Consistent with this transformation, there are seven major categories that are referred to as "impact categories." These categories are designed by the USGBC (U.S. Green Building Council) to create LEED projects that accomplish the performance objectives listed below. Clearly, these objectives suggest an agenda with a political component on the part of the program:

- Reverse Contribution to Global **Climate Change**
- Enhance Individual **Human Health** and Welfare
- Protect and Restore **Water Resources**
- Protect, Enhance, and Restore **Biodiversity** and Ecosystems
- Promote Sustainable and Regenerative **Materials Resources** Cycles
- Build a **Greener Economy**
- Enhance Social Equity, Environmental Justice, and **Community Quality Life**

LEED is a comprehensive program. Although they claim that it is a certification program, it is really more akin to an accreditation program. Certification programs certify that people have met prescribed qualifications. Accreditation programs focus on the ability of institutions and agencies to deliver a program, product, or in this case green buildings, green interiors, green neighborhoods or green homes. Conceptually, LEED is really more of an accreditation than a certification program.

<c>***Certification Process*** (Figure 16.40) – Structurally, there are five overarching categories in LEED's comprehensive system. These are Green Building Design and Construction, Green Interior Design and Construction, Green Building Operations and Maintenance, Green Neighborhood Development, and Green Home Design and Construction. The LEED assessment is based on a point system where designs are assessed based on green criteria. These criteria are based on the previously noted LEED objectives.

Methodologically, the designs are assessed on their inputs (i.e. designs) and not on their outputs (i.e. do they really deliver green). The subcategories and their overall points are presented in Figure 16.40. The process is a smorgasbord of options where architects select the level of green options desired in the final design. The conceptual and practical impacts of this approach are presented in the next section on LEED effectiveness or evaluation. The more points accumulated using the LEED assessment tool, the greener the project. A total of 106–110 points are possible. The levels of certification and the points necessary for them are listed below:

Certification Levels:

Certified:	40-49 points
Silver:	50-59 points
Gold:	60-79 points
Platinum:	80 points and greater

Figure 16.40: Overarching Categories and Basic LEED Structure

LEED Structure

I. Building Design and Construction (110 pts)

Location and Transportation (16)
Sustainable Sites (10)
Water Efficiency (11)
Energy and Atmosphere (33)
Materials and Resources (13)
Indoor Environmental Quality (16)
Innovation (6)
Regional Priority (4)

III. Building Operations and Maintenance (106 pts)

Location and Transportation (15)
Sustainable Sites (10)
Water Efficiency (12)
Energy and Atmosphere (38)
Material and Resources (4)
Indoor Environmental Quality (17)
Innovation (6)
Regional Priority (4)

IV. Neighborhood Development Plan (110 pts)

Smart Location and Linkage (28)
Neighborhood Pattern & Design (41)
Green Infrastructure & Buildings (31)
Innovation and Design Process (6)
Regional Priority Credits (4)

II. Interior Design and Construction (110 pts)

Location and Transportation (18)
Water Efficiency (12)
Energy and Atmosphere (38)
Materials and Resources (13)
Indoor Environmental Quality (17)
Innovation (6)
Regional Priority (4)

V. Building Design and Construction: Homes and Multi-family Lowrise (110 pts)

Location and Transportation (15)
Sustainable Sites (7)
Water Efficiency (12)
Energy and Atmosphere (38)
Materials and Resources (10)
Indoor Environmental Quality (16)
Innovation (6)
Regional Priority (4)

Note: Along with the basic criteria, the number of points possible in each of the categories and each of the subcategories are presented in parentheses.

<c>***Effectiveness of LEED*** (Figure 16.41 and Figure 16.42) – There are both philosophical and practical concerns regarding LEED. Philosophically, the intention of LEED is noble and worthwhile. As was previously noted, creating self-sufficiency or sustainability at the individual facility level sounds good, but in practice it may be more efficient to provide these services with centralized public utilities. Drinking water, sewage, and electricity are several services that may be better served with centralized systems. Dispersing these services to each individual facility can lead to the tragedy of the commons with its collective harm. The monitoring of dispersed individual water treatment systems to insure properly working wastewater (gray and blackwater) can be costly and problematic. The same is true for insuring quality drinking water. Although there are localized methods of generating electricity such as windmills, a strong case can be made that centralized electricity production is more efficient and pollution controls are more easily implemented and managed when dealing with one centralized plant.

Methodologically, LEED focuses on inputs rather than outputs. Review input/output models in Chapter 3 and making a cake. Using the best inputs (e.g. cake mix, eggs, receipt, etc.) is no guarantee that the cake will taste good. LEED focuses on the design and construction of buildings. It focuses on inputs (see Figure 16.41 and Figure 16.42 for a list of some of these inputs). In this respect, many of the shortcomings found in the USA Today article on LEED certification are not unexpected. The focus on inputs didn't necessarily result in increased energy and water efficiency (outputs) (USA Today, 2013).

The USA Today article noted other shortcomings of the certification process in falling short of delivering green buildings. Usually, a LEED rating results in higher initial costs of design and construction over simply code built buildings. The pursuit of LEED certification is an additional expense. This can be compounded by the lack of available materials that meet LEED specifications. Builders can and do "game" the system. They can get green points for creating healthy spaces and educational displays rather than substantive but expensive cost savings (Figure 16.41 and Figure 16.42). As a counter point, many of these items have nominal point values and in order to gain certification, substantive green criteria must be met also. In addition, the point system does not differentiate between geographic areas. For example, water conservation is more of an issue in the arid southwest rather than the northeast. Yet both areas are treated the same in terms of points awarded.

Some of the problems associated with LEED can easily be addressed and improved in the future. Other issues like its focus on inputs rather than outputs are more problematic to the process.

Figure 16.41: Ten <u>Most</u> Popular Options for Making Buildings Environmentally Friendly Using LEED

LEED Credit	Usage	Description from LEED User Guide
Hire LEED accredited professional	99.7%	"You can easily earn this pointy
Use low-emitting paints and coatings	93.3%	"an easy, no cost credit"
Boost energy performance 10.5%	92.2%	"the most important credit in LEED"
Use low-emitting adhesives and sealants	91.5%	"it shouldn't cost you anything to earn this credit"
Use recycled materials in construction	90.9%	"easy to achieve"
Reduce water use by 20%	90.6%	"its very doable"
Use low-emitting carpet	89.7%	"a pretty easy credit, with minimal additional cost"
Divert half of construction waste from landfill	89.6%	"the ease of difficulty of this credit depends on project-specific and regional conditions"
Boost energy performance 14%	89.0%	"the most important credit in LEED"
Water-efficient landscaping	86.9%	"can be either simple or complex"

Based on an examination of 7,100 LEED buildings by reporter Thomas Frank and database editor Chris Schnaars.

Figure 16.42: Ten <u>Least</u> Popular Options for Making Buildings Environmentally Friendly Using LEED		
LEED Credit	**Usage**	**Description from LEED User Guide**
Reuse 75% of a building exterior	13.2%	"intensive calculations"
Reduce use of potable water in wastewater	12.5%	"can require waterless urinals or on-site waste treatment"
Boost energy performance 42%	9.9%	"the most important credit in LEED"
Use on-site renewable energy	9.9%	"technologies to capture this energy aren't cheap"
Reuse 95% of a building exterior	8.0%	"intensive calculations"
5% of materials such as beams and doors are reused or salvaged	7.3%	"only works for the right kind of project"
Use rapidly renewable materials such as bamboo	7.2%	"can be very easy to achieve"
Use on-site renewable energy	6.6%	"technologies to capture this energy aren't cheap"
Reuse existing building elements	5.6%	"can be labor-intensive"
10% of materials such as beams and doors are reused or salvaged	4.7%	"only works for the right kind of project"
Based on an examination of 7,100 LEED buildings by reporter Thomas Frank and database editor Chris Schnaars.		

Summary

The focus of this book is on designing space to create a desired experience. The focus of this chapter is on designing park and recreational spaces in harmony with nature. Design with nature builds upon the basic theme of this book, designing the experience. Designing with nature was used as the title of the chapter rather that sustainability since it is a more fundamental approach. In part, designing with nature was an outgrowth of the environmental movement of the 1960s and 1970s. An outgrowth of the recent green movement, LEED and green sustainable designs have recently become the current face of designing with nature.

The chapter takes a conceptual approach toward designing with nature. In terms of site design and buildings, it examines the impact of the sun and how people utilize the sun's heating for their benefit or how they protect themselves from its heat. Next the chapter examines the effects of storm water management in altering the ground water levels and uses this discrepancy to prescribe methods to enhance ground water.

Last, the chapter examines designing buildings with nature. It uses Frank Lloyd Wright's Fallingwaters as an example of designing buildings both aesthetically and functionally with nature, a term he called organic architecture. In addition, the chapter introduces the LEED certification process which attempts to design with nature by making buildings more green and sustainable.

References:

Calkins, M., (2012). The Sustainable Sites Handbook: A Complete Guide to the Principles, Strategies, and Practices for Sustainable Landscapes. Hoboken, New Jersey: John Wiley & Sons, Inc.

Carpenter, Philip, Theodore, Walker, and Frederick Lanphear, (1975). *Plants in the Landscape*. San Francisco: W.H. Freeman and Company. Ch.2.

Drake, S., (2009). *The Elements of Architecture – Principles of Environmental Performance in Building.* London: Earthscan.

Fallingwaters (1886). *Fallingwater: A Frank Lloyd Wright Country House*. New York: Abbeville Press.

Fear, G., and Mitchell, J., (1977). *Fundamentals of Outdoor Enjoyment*. Tacoma, Washington: Survival Education Association.

Kauffman, R., and Walke, T., (1990). *Canoe Camping Wallchart*. Fredericksburg, Virginia: American Canoe Association.

King County, WA, Department of Natural Resources (1999). "The Relationship Between Soil and Water How Soil Amendments and Compost Can Aid in Salmon Recovery." In Calkins, M., (2012). The Sustainable Sites Handbook: A Complete Guide to the Principles, Strategies, and Practices for Sustainable Landscapes. Hoboken, New Jersey: John Wiley & Sons, Inc.

"In U.S. building industry, is it too easy to be green?" (2013). USATODAY 11:53 a.m. EDT June 13.

Leopold, L., and Maddock, Jr., T., (1954). *The Flood Control Controversy: Big Dams, Little Dams, and Land Management*. New York: The Ronald Press, Co.

McHarg, I., (1971). *Design With Nature*. Philadelphia: The Falcon Press.

SITES (2009). "Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009." In Calkins, M., (2012). The Sustainable Sites Handbook: A Complete Guide to the Principles, Strategies, and Practices for Sustainable Landscapes. Hoboken, New Jersey: John Wiley & Sons, Inc.