

Shade Planning for America's Schools



Division of Cancer Prevention and Control
National Center for Chronic Disease Prevention and Health Promotion
Coordinating Center for Health Promotion
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Centers for Disease Control and Prevention
Atlanta, Georgia

William Graham, School Board Member
Palm Beach County School Board
Lake Clark Shore, Florida

Robert Howe, Superintendent
Leslie Public Schools
Leslie, Michigan

David Kemp, School Board Member
Burbank Unified School District
Burbank, California

Mark Morgan, Principal
Elizabeth Middle School
Percer, Colorado

Norman Ridder, Superintendent
Colorado Springs School District
Colorado Springs, Colorado

Fred Varn, School Board Member
Leon County School District
Tallahassee, Florida

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What Is the Purpose of This Manual?

In 2002, the Centers for Disease Control and Prevention (CDC) published the *Guidelines for School Programs to Prevent Skin Cancer*, which outlines steps that school communities can take to develop a comprehensive approach to reducing the risk for skin cancer among students, teachers, staff, and visitors. The guidelines include the following recommendations:

- Establish policies that reduce exposure to solar ultraviolet (UV) radiation.
- Provide and maintain physical and social environments that support sun safety.
- Provide opportunities for students to gain the knowledge, develop the attitudes, and practice the skills needed to prevent skin cancer.
- Involve family members in skin cancer prevention efforts.
- Provide pre-service and in-service skin cancer prevention education for school administrators, teachers, coaches, school nurses, and other professionals who work with students.
- Support sun-safety policies, sun-safe environments, and skin cancer prevention education with school health services.
- Evaluate the implementation of policies, environmental change, education, family involvement, professional development, and health services.

This manual has been created to support school communities in their implementation of the *Guidelines for School Programs to Prevent Skin Cancer* and, specifically, to help schools create and maintain a physical environment that supports sun safety by ensuring that school grounds have adequate shade.

Why Should Schools Care About Skin Cancer?

Cancer of the skin is the most commonly diagnosed cancer in the United States and perhaps the most preventable. Melanoma and non-melanoma cancers, including basal cell cancer and squamous cell cancer, account for as much as 50% of all cancers. Because the reporting of non-melanoma cancers to cancer registries is not required, the exact number of non-melanoma cancer cases is not known. However, estimates indicate that as many as 1 million cases of basal cell and squamous cell skin cancer occur each year.[2] Melanoma, which accounts for only about 5% of skin cancer cases, also accounts for 79% of skin cancer deaths. From 1973 and through the early eighties, the incidence rate of melanoma among white men and women in the United States increased by about 6% per year. Since the early eighties, the increase has been around 3% annually. Approximately 55,100 new melanomas were diagnosed in the United States in 2004, and about 7,910 people died of melanoma that same year.[3]

Between 68% and 90% of all melanomas result from exposure to ultraviolet radiation.[1]

1 MMWR 2002; 51(RR04):1-16. Available at http://www.cdc.gov/mmwr/review/mmwrhtm/rr5104a1.htm

2 American Cancer Society. What Are The Key Statistics For Nonmelanoma Skin Cancer? Available at http://www.cancer.org/docroot/CRI/content/CRI_2_4_1X_What_are_the_key_statistics_for_skin_cancer_51.asp?sitearea=

3 American Cancer Society. What Are The Key Statistics For Melanoma Skin Cancer? Available at http://www.cancer.org/docroot/CRI/content/CRI_2_4_1X_What_are_the_key_statistics_for_melanoma_50.asp?sitearea=

Almost all of these cancers are preventable.[4] In most cases, exposure to solar UV radiation is the cause of the cancer. Using multiple methods for estimating the incidence of melanoma that might be attributable to exposure to the sun, Armstrong and Kricker, reporting in *Melanoma Research*, suggest that between 68% and 90% of all melanomas result from exposure to UV radiation.[5]

> **Solar Radiation Added to the List of "Known" Carcinogens**
>
> ***The federal government's 11th edition of the Report on Carcinogens listed the sun and any other source of broad spectrum ultraviolet radiation as "known" causes of cancer.***
>
> ***"The report cites data indicating a cause-and-effect relationship between this radiation and skin cancer, cancer of the lip and melanoma of the eye. The report goes on to say that skin cancers are observed with increasing duration of exposure and for those who experience sunburn."***
>
> **From National Institutes of Health News Release dated December 11, 2002**

Why Shade?

There are many reasons that a school might want to improve the quality and increase the amount of accessible shade on school grounds. The most obvious and one of the most important reasons is that shade provides protection from solar UV radiation. Due to the scheduling complexities of physical education classes, sporting events, and other outdoor activities, students are often exposed to solar UV radiation during the peak sun hours of the day—between 10:00 a.m. and 4:00 p.m. For some schools and for some students, using sun protective methods, such as hats or sunscreen, or implementing policy changes could prove to be problematic. Providing shade in areas where students already participate in outdoor activities can afford passive protection from the sun's damaging rays.

What Are the Additional Benefits of Shade?

Extending the Classroom

Schools are often looking for ways to extend their classrooms. Two strategies for increasing shade on school grounds can also help schools create novel classroom experiences for their students. These strategies may be employed independently or in concert. The first is to modify existing structures or build new ones to provide shade where students play and socialize. The second calls for the strategic planting of additional shade-producing trees, vines, and shrubs. Structures built to provide shade can also be designed as covered outdoor learning areas, thereby extending the classroom beyond the school walls. Planting shade-producing vegetation affords schools the opportunity to create and maintain natural outdoor classrooms where students can enjoy hands-on experiences in the natural world. Both strategies could potentially provide teachers with new ideas for curricula and new reasons to take their students outdoors.

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4 American Academy of Dermatology. *Skin Cancer*. Available at http://www.aad.org/pamphlets/skincan.html

5 Armstrong BK, Kricker A. How much melanoma is caused by sun exposure? *Melanoma Res* 1993;3:395-401.

Extended Periods of Physical Activity

In adults, regular physical activity is linked to enhanced health and reduced risk for the development of many chronic diseases. Lifelong physical activity patterns are often developed in childhood and adolescence. In the section on preventing physical activity-related injuries in *CDC's Guidelines for School and Community Programs to Promote Lifelong Physical Activity Among Young People,* the use of shaded spaces or indoor facilities to reduce the incidence of heat-related illnesses is recommended. Not all schools have indoor facilities designed for active play; however, providing shade on existing outdoor play areas could reduce the temperature in those areas by as much as 10° to 20 °, increasing the period of time that students could engage in active outdoor play.

School Grounds Aesthetics

All too often, school grounds are an environment of concrete, asphalt, steel, turf grass, and chain link fences. In planning strategies to provide or increase shade on school grounds, schools have a second chance to improve the aesthetics of the school property, making the grounds more inviting to students, teachers, staff, parents, and visitors. A well-planned shade implementation project engages the entire school community in making the school a more pleasant place to learn.

Who Should Read This Manual?

A school includes not just the principal, teachers, students, and staff, but also key stakeholders and decision-makers that comprise the school community. In addition to school officials, the school community includes parents, neighbors, and members of the broader community, all of whom have a stake in helping to protect the community's children and adolescents from skin cancer. This manual was written as a reference tool for the entire school community, encompassing both the school district and the individual school.

How Can This Manual Be Used?

Chapter 1 School board members, superintendents, principals, and school health advisory councils can use this manual to acquaint themselves with issues relating to the damaging effects of solar UV radiation, skin cancer prevention, and planning for shade implementation at their schools. The first chapter gives information on both the short- and long-term effects of UV radiation on health and provides a rationale for developing sun-safe policies in schools.

Chapter 2 The second chapter addresses strategies for providing shade at schools and includes some of the advantages and disadvantages of each strategy. School board members, superintendents, principals, school health advisory councils, and school shade planning teams will find this information useful in determining the strategies that will work best at their school.

Chapter 3 The third chapter presents an overview of the process of planning a shade implementation project. School board members, superintendents, principals, and school health advisory councils can use it as a brief overview of the process. School shade planning teams can refer to this chapter for an introduction to the process and to chapters 4 and 6 for more detailed information to guide them through the steps of shade planning.

Chapter 4 The fourth chapter presents information about schools and school districts that have engaged in shade planning projects and reveals some successful strategies. The needs of every school differ; there is no one-size-fits-all solution to providing shade at schools. This chapter offers a glimpse of shade strategies that others have employed.

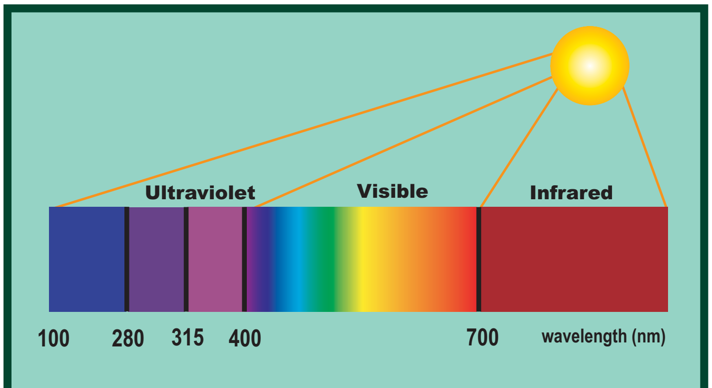
Chapter 5 The fifth chapter gives the reader a basic introduction, or reintroduction, to solar geometry and the relationship between the Earth and Sun. Illustrations are included showing the effects of daily and seasonal changes in solar angles on the length and direction of shadows.

Chapter 6 The sixth chapter guides shade planning team members through the process of conducting a shade audit. The shade audit allows planning teams to consider the needs of the school in relation to the quantity and quality of shade already available to students, teachers, and staff.

CHAPTER ONE

What is UV Radiation?

Ultraviolet (UV) radiation is one component of a broad spectrum of electromagnetic radiation emitted by the sun. The spectrum also includes visible light, which we see, and infrared radiation, which we feel as heat.



The Sun's Radiation Spectrum

The ultraviolet area of the spectrum can be further divided into three bands, ultraviolet A (UVA), ultraviolet B (UVB), and ultraviolet C (UVC). All UVC radiation and almost all UVB radiation are absorbed in the ozone layer of the atmosphere. UVA radiation penetrates the atmosphere unimpeded and, until recently, had been considered innocuous.

What Are the Factors That Affect UV Radiation Levels?

Time of Day

At solar noon, the sun is at its highest point of the day. As much as 30% of total UV radiation is received in the hour before and the hour after solar noon, and as much as 75% is received during the 3 hours before and the 3 hours after solar noon.[1]

Time of Year

Because the angles of the sun change throughout the year, the intensity of UV radiation changes as well. In the northern hemisphere, UV radiation tends to be greater in the summer months.

Geographical Latitude

UV radiation decreases as the distance from the equator increases.

Altitude

Because the atmosphere is thinner at higher altitudes and less able to absorb UVB, total UV radiation is greater at higher altitudes.

Weather Conditions

Although clouds reduce the full spectrum of solar radiation, they do not reduce UV radiation to the same extent that they reduce visible light and

Q: What time is solar noon?

A: That depends on the day of the year, your latitude and longitude, and your location within your time zone.

On July 4, solar noon is at:
12:48 (EDT) in Boston
1:40 (EDT) in Knoxville
12:51 (CDT) in Nashville
12:53 (PDT) in San Diego

On February 1, solar noon is at:
11:57 (EST) in Boston
12:49 (EST) in Knoxville
12:00 (CST) in Nashville
12:02 (PST) in San Diego

To find out what time solar noon occurs on any day of the year at any location, visit the National Oceanic and Atmospheric Administration (NOAA) Surface Radiation Research Branch web site at http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html.

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[1] Diffey, BL. Solar ultarviolet radiation effects on biological systems. *Physiology Medica; Biology* 1991; 36(3):299-328.

infrared radiation. Clouds may make us feel cooler and block our view of the sun, but they do not fully protect us from UV radiation.

Atmospheric Ozone

The stratosphere's ozone layer provides us with an enormous amount of protection against the damaging effects of UV radiation. Unfortunately, in certain areas, ozone has been depleted to a dangerous extent, primarily due to the release of chlorofluorocarbons (CFCs) and other ozone-depleting chemicals, such as carbon tetrachloride and methyl chloroform, into the atmosphere. Both carbon tetrachloride and methyl chloroform are solvents that have been used in industrial applications, and CFCs have, in the past, been used as refrigerants and aerosol propellants. The use of all three of these chemicals has since been restricted or prohibited.[2] Nonetheless, much of the damage that has been done remains.

What Are Direct and Indirect UV Radiation?

Direct UV radiation, or UV radiation that travels from the sun in a straight line, may pose the greatest risk to our health, but we are also at risk from exposure to indirect (scattered and reflected) UV radiation. Scattered UV radiation results from being bounced around by atmospheric dust and water droplets in clouds. Throughout the day, the level of indirect UV radiation varies, as does the level of direct UV radiation. In the early morning and late evening when the sun is low on the horizon, indirect UV radiation may exceed direct. Likewise, on a cloudy day, UV radiation scattered by atmospheric particles may result in greater exposure to indirect than to direct UV radiation.

UV radiation can also be reflected off buildings and the terrain. Smoother surfaces, such as concrete or asphalt, whether they are dark in color or not, typically result in greater reflectance of UV radiation than irregular surfaces. Surface irregularities, such as that found in grass or bark nuggets, reduce the level of reflectance, thereby reducing exposure to reflected UV radiation. One exception, however, is water. Smooth water absorbs almost all UV radiation, whereas the irregular surface of choppy water reflects a considerable amount of UV radiation. The following table lists surfaces and terrains commonly encountered on school grounds and their UV radiation reflectance. Materials with a lower reflectance are more desirable.

Ultraviolet Radiation Reflectance for School Grounds Surfaces

Surface	UV Radiation Reflectance[3,4,5]
Grass	1% – 4 %
Still water	3% – 8 %
Soil	4% – 6 %
Asphalt	4% – 9 %
Concrete	7% – 12 %
Choppy water	8% – 13%
Dry sand	15% – 18 %
Fresh snow	85% – 88 %

2 United Nations Development Programme, Montreal protocol on substances that deplete the ozone layer. Available at http://www.undp.org/seed/eap/montreal.htm.

3 Williams ML, Pennella R. Melanoma, melanocytic nevi, and other melanoma risk factors in children. *J Pediatr* 1994;124:833-45

4 Moore LA. Ocular protection from solar ultraviolet radiation (UVR) in sport: factors to consider when prescribing. *The South African Optometrist* 2003;62(2):72-79.

5 Sliney, DH. Physical factors in cataractogenesis: ambient ultraviolet radiation and temperature. *Invest Ophthalmol Vis Sci* 1986; 27(5):781-790.

How Is UV Radiation Measured?

In the past, different countries measured and reported solar UV radiation intensity in different ways. One common way of reporting UV radiation intensity was in the form of estimated "burn time" or "time to burn," expressed as the number of minutes of solar exposure required for the reddening of a fair-skinned person's exposed skin, assuming a clear sky. Although there may be some advantages to this method of reporting UV radiation intensity, there are a number of disadvantages. In 1994, international agreement was reached on standardizing the measure of UV radiation intensity.

***Q:** Where do I find the UV Index for tomorrow?*

***A:** In most communities, the UV Index is reported in newspapers and on television with the daily weather forecast.*

Every day at approximately 1:30 PM Eastern, the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA) post the UV Index for the next day at the EPA's Website, http://www.epa.gov/sunwise/uvindex.html.

Revised by the World Health Organization in 2002 and adopted by the Environmental Protection Agency and the National Oceanic and Atmospheric Administration's National Weather Service in 2004, the UV Index is the internationally accepted system for reporting the intensity of UV radiation. Although the mathematical model developed to determine the UV Index might be complicated, the measurement is easy to understand. The UV Index is a measure of the amount of damaging UV radiation that reaches the earth's surface at noon on a given day and at a given location, expressed as a risk scale. It is predicted daily on a scale of 0 to 11+, where 0 represents a minimal risk of overexposure to UV radiation and any number higher than 11 represents an extreme risk of overexposure to UV radiation.

What Are the Health Effects of Exposure to UV Radiation?

Few people would dispute the beneficial effects of solar radiation. The sun warms the earth, fuels photosynthesis, and ensures the continued existence of life on earth. Many of us enjoy the warmth of the sun on our skin. But at some point in our lives, most of us have experienced the painful effect of too much sun exposure in the form of sunburn. Having experienced sunburn, many would agree that there must be some negative health effect to exposure to the sun. Although many different conditions occur as a normal response to exposure to UV radiation, they all fall into one of two classifications, acute or chronic. Acute effects of UV radiation exposure usually have a rapid onset and are of short duration, such as sunburn, tanning, and synthesis of vitamin D_3. Chronic effects of UV radiation exposure usually have a gradual onset and are of long duration, such as skin cancer and photoaging.

Sunburn

Sunburn is an acute injury resulting from excessive exposure to the sun. The redness associated with sunburn results from the dilation of superficial blood vessels in the skin. Redness usually appears within 4 hours of exposure, reaches a maximum within 12 hours, and fades after a few days. High doses of UV radiation can result in blistering and peeling.

Skin color, hair color, eye color, and freckles all are characteristics that help predict an individual's susceptibility to sunburn. Individuals are typically grouped into one of six sun-reactive types, ranging from those with blue or green eyes and very light skin that never tans to those with very dark hair and eyes and dark skin that almost never burns. Although sunburn is not as common among blacks, compared to whites, blacks are susceptible. Approximately 15% of the African American respondents to a national health survey reported experiencing mild to severe sunburns.[6] Differences also exist in the sun-sensitivity of different parts of the body. The face, neck, and trunk are two to four times more sensitive than the limbs.[7]

Tanning

Tanning, or melanin pigmentation, is a consequence of overexposure to the sun that many people find desirable. UVA exposure results in the skin's production of more melanin, the substance responsible for skin's pigmentation. There are two ways in which our skin can tan, by immediate tanning and by delayed tanning. Immediate tanning occurs as quickly as 5 to 10 minutes after exposure to the sun and will last as long as 2 hours. One's ability to exhibit immediate tanning is directly related to the genetically determined pigmentation of the skin. Delayed tanning, which is the more familiar form of tanning, is noticeable 1 to 2 days after exposure, increases for several days, and lasts for weeks or months. Although having a tan provides some degree of protection from UVB, melanin is not an effective sunscreen for Caucasian skin.[8]

Photosynthesis of Vitamin D_3

The only positive health effect associated with exposure to solar UV radiation is the synthesis of vitamin D_3. Without UVB, the body cannot synthesize vitamin D_3, which is essential for regulating calcium metabolism. Few studies have examined the effect of sun avoidance or the use of sunscreen on the production of vitamin D_3 in children or adults. Therefore, the American Academy of Pediatrics has recommended that infants, children, and adolescents who do not consume at least 500 mL (16.9 oz) of vitamin D-fortified milk or formula daily should take one of the many available daily multivitamin supplements that contain 400 IU of vitamin D_3. [9]

Photoaging of the Skin

Exposure to UVA and UVB radiation, and perhaps to radiation in the infrared range as well,[8] causes photoaging, a process in which the skin's elastic fibers break down leading to wrinkled and leathery-looking skin. Dryness, deep wrinkles, sagging, loss of elasticity, and mottled pigmentation are all photoaging symptoms .

Eye Damage

Eye damage from solar radiation is a risk factor for developing a number of eye disorders including cataracts, skin cancer around the eyes and degeneration of the macula. Although the evidence is not conclusive, such damage appears to have a dose-response relationship and to be cumulative; that is, the more unprotected solar radiation exposure to the eyes over an entire lifetime, the greater one's risk for developing cataracts.[8, 10, 11]

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6 Hall HI, Rogers JD. Sun protection behaviors among African Americans. *Ethnicity and Disease* 1999;9(1):126-31.

7 Olson RL, Sayre RM, Everett M A. Effect of anatomic location and time on ultraviolet erythema. *Arch Dermatol* 1996;93(2): 211-15.

8 Diffey BL. Ultraviolet radiation and human health. *Clinics in Dermatology* 1998;16:83-9.

9 Gartner LM, Greer FR. Prevention of rickets and vitamin D deficiency: new guidelines for vitamin D intake. *Pediatrics* 2003;111(4 Pt 1): 908-10.

10 West SK, Duncan DD, Munoz B, Rubin GS, Fried LP, Bandeen-Roche K, et al. Sunlight exposure and risk of lens opacities in a population-based study: the Salisbury Eye Evaluation project. *JAMA* 1998;280:714-8.

11 Rosmini F, Stazi MA, Milton RC, Sperduto RD. Pasquini P, Maraini G. A dose-response effect between a sunlight index and age-related cataracts. Italian-American Cataract Study Group.[comment]. *Annals of Epidemiology*. 4(4):266-70.

Basal Cell Cancer

Typically occurring on the most sun-damaged parts of the body, basal cell carcinoma is a slow-growing cancer that begins as a raised lump on the skin and eventually breaks open to form an exposed sore. Although most of these types of cancers are colorless, some are dark in color. Like other skin cancers, basal cell cancer usually appears in middle age, as a result of UV radiation exposure during childhood or adolescence.

> **Sun Protection Is the Key**
>
> ***The vast bulk of skin cancers in the U.S. are due to excessive skin exposure to UV radiation from the sun, so sun protection is the key to preventing the disease.***
>
> ***Martin Weinstock, MD, PhD***
> *Director of Dermatoepidemiology at Brown University and Chair of the American Cancer Society (ACS) Skin Cancer Advisory Board*

Squamous Cell Cancer

Squamous cell cancer is a more aggressive form of skin cancer that ultimately resembles basal cell cancer in appearance. It often follows a pre-cancerous condition called actinic keratosis, which is a dry and crusty area on the skin. Both basal cell and squamous cell carcinoma usually result from chronic exposure to UV radiation over a period of years.

Melanoma

By far, the most serious consequence of exposure to UV radiation is malignant melanoma. Unlike the other two types of skin cancer, basal cell and squamous cell, melanomas involve the dark pigmented cells of the skin, the melanocytes. A growing body of evidence indicates that intermittent sun exposure, as opposed to chronic sun exposure, causes this most deadly of skin cancers. Of particular concern, findings from certain studies point to childhood exposure to sunlight, especially severe childhood sunburn, as an indicator for melanoma as an adult.[12, 13, 14, 15]

Where Can I Find More Information?

Chapter 5, "The Earth-Sun Relationship," provides more information on seasonal sun angles and their effects on shade design. On the following pages are internet links to more information on skin cancer and its prevention as well as to sun-safety curricula.

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[12] Westerdahl J, Olsson H, Ingvar C. At what age do sunburn episodes play a crucial role for the development of malignant melanoma. *Eur J Cancer* 1994; 30A(11):1647-54.

[13] Zanetti R, Franceschi S, Rosso S, Colonna S, Bidoli, E. Cutaneous melanoma and sunburns in childhood in a southern European population. *Eur J Cancer* 1992;28A(6-7):1172-76.

[14] Elwood JM, Whitehead SM, Davison J, Stewart M, Galt M. Malignant melanoma in England: risks associated with naevi, freckles, social class, hair colour, and sunburn. *Int J Epidemiol* 1990;19(4):801-10.

[15] Gandini S, Sera F, Cattaruzza MS, et al. Meta-analysis of risk factors for cutaneous melanoma: II. Sun exposure. *Eur J Cancer* 2005;41:45-60.

Information on Skin Cancer and Its Prevention

The Centers for Disease Control and Prevention	
www.cdc.gov/cancer/nscpep/skin.htm	CDC provides leadership for nationwide efforts to reduce illness and death caused by skin cancer. Although these efforts comprise a variety of approaches and strategies, their common focus is education and prevention. CDC's Web site describes programmatic approaches to skin cancer prevention and education.
The National Cancer Institute	
www.nci.nih.gov/cancertopics/types/skin	The National Cancer Institute (NCI) is a component of the National Institutes of Health (NIH) and is the federal government's principal agency for cancer research and training. Articles related to the causes of cancer, diagnosis, prevention, treatment, and the most current cancer statistics are available at NCI's Web site.
The United States Environmental Protection Agency	
www.epa.gov/ebtpages/humasunprotection.html	The Environmental Protection Agency's mission is to protect human health and to safeguard the natural environment. The agency's Web site contains information about the health risks posed by UV radiation and describes the steps people can take to protect themselves from overexposure to the sun.
The National Council on Skin Cancer Prevention	
www.skincancerprevention.org	The mission of the National Council on Skin Cancer Prevention is to facilitate national skin cancer awareness and prevention efforts through education and promotion of sun-safe behaviors. The council, comprising of 30 separate organizations, increases awareness and prevention behaviors among all populations by providing special programs addressing high-risk populations, including infants, children, young adults, parents, educators, outdoor workers, and athletes. Back issues of NEWSLINK, the council's quarterly electronic newsletter, are available at the ogranization's Web site.
The American Cancer Society	
www.cancer.org	The American Cancer Society is the nationwide community-based voluntary health organization dedicated to eliminating cancer as a major health problem by preventing cancer through research, education, advocacy, and service. The organization's Web site provides the latest research , information about activities and resources at the local level, and educational and advocacy materials.
The Skin Cancer Foundation	
www.skincancer.org	The Skin Cancer Foundation is the only national and international organization that is concerned exclusively with the world's most common malignancy—cancer of the skin. The foundation's Web site offers information on the three types of skin cancer; information on skin cancer prevention; news of local and national events; and public information posters, pamphlets, and brochures.

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Sun Safety Curricula

National Safety Council—Environmental Health Center	
1025 Connecticut Avenue, NW Suite 1200 Washington, DC 20036 www.nsc.org/ehc/sunwise/activity.htm	The National Safety Council's Enviromental Health Center developed the Sun Safety Activity Guide for elementary school representatives who would like to incorporate sun safety into their school curricula. The guide includes cross-curriculum classroom activities and background information packaged as a 1-hour "core" sun-safety lesson. The core is divided into three 20-minute units, including the effects of UV, risk factors for overexposure to the sun, and sun protection habits. Included in the guide are developmentally appropriate activities for primary (grades K through 2) and intermediate (grades 3 through 6) learning levels.
Project S.A.F.E.T.Y.	
The University of Texas M. D. Anderson Cancer Center with Texas Cancer Council www.mdanderson.org/departments/projectsafety/	Project S.A.F.E.T.Y. (Sun Awareness for Educating Today's Youth) is a cross-curricular, multimedia skin cancer prevention program for grades 4 through 9. It is available free of charge to any school in Texas. It is also available to schools outside of Texas for a minimal cost.
The SHADE Foundation	
10510 N. 92nd Street Suite 100 Scottsdale, AZ 85258 www.shadefoundation.org	The mission of The SHADE Foundation, a non-profit organization, is to eradicate melanoma through the education of children and the community in the prevention and detection of skin cancer and the promotion of sun safety. In collaboration with the Environmental Protection Agency (EPA), the Foundation has developed partnerships with schools which implement the EPA SunWise School Program and, in turn, are awarded shade structures to the schools.
Sunny Days, Healthy Ways	
Klein Buendel, Inc. 14023 Denver West Parkway Suite No. 190 Golden, CO 80401 (877) 258-2915 www.info@sdhw.info/	Sunny Days, Healthy Ways is a sun-safety curriculum that uses a comprehensive, cross-curricular approach to teaching skin cancer prevention skills to children in grades K through 5. The curriculum provides an average of 8 hours of sun-safety instruction per grade that can be tailored to the teacher's time frame and needs. The curriculum includes prepared lesson plans, student activity sheets, experiment materials, story books, and assessments.
The SunSafe Project	
Norris Cotton Cancer Center Dartmouth Medical School One Medical Center Drive Lebanon, NH 03756 (603) 650-8254 http://sunsafe.dartmouth.edu	The SunSafe intervention aims to enhance and promote sun protection of children ages 2 to 9 years through the delivery of a multicomponent intervention in three settings: elementary schools and day care centers, town beach areas, and primary care practices. The school/day care component consists of an age-specific (2 to 9 years old) and grade-specific curriculum promoting sun protection. Child-care providers and elementary school teachers need 2 theme days or 2 class periods to deliver SunSafe materials. Ongoing reminder activities are suggested as a means for reinforcing the SunSafe message.

Sun Safety Curricula (continued)

The United States Environmental Protection Agency	
SunWise School Program www.epa.gov/sunwise/	The SunWise School Program is an environmental and health education program that aims to teach children and their caregivers how to protect themselves from overexposure to the sun. Using classroom-based, school-based, and community-based components, the SunWise School Program seeks to develop sustained sun-safe behaviors in schoolchildren. The program's learning components build on a solid combination of traditional and innovative education practices already in use in many U.S. elementary and middle schools. Through the program, students and teachers will increase their awareness of simple steps that they can take to protect themselves from overexposure to the sun. Students will demonstrate the ability to practice health-enhancing behaviors and reduce health risks. Children also will acquire scientific knowledge and develop an understanding of environmental concepts related to sun protection. Currently, more than 12,000 schools are registered for the SunWise program, representing all 50 states, the District of Columbia, and Puerto Rico.

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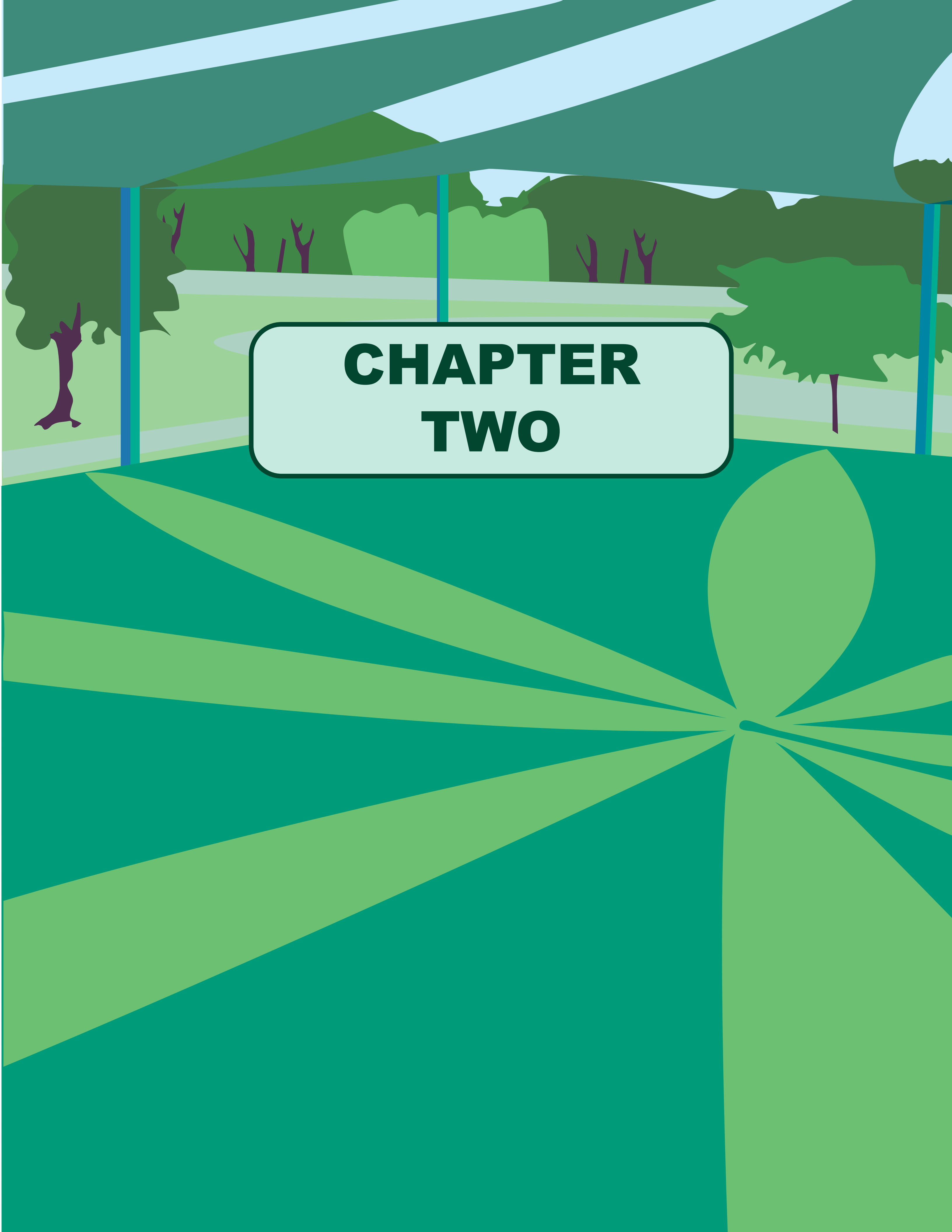
CHAPTER TWO



Strategies for Providing Shade

A number of strategies for providing shade on school grounds are available; however, no single approach is best for all schools. This chapter introduces three strategies for providing shade on school grounds: solid roof structures, shade cloth structures, and natural shade. Some of the advantages and disadvantages of each approach are discussed. This information will assist schools in determining how best to provide shade for their students, teachers, staff, and visitors. Regional differences in vegetation, the need for winter warmth, playground usage patterns, and seasonal weather threats to playground structures factor into the decision process of determining the best approach for each school. For many schools, a combination of strategies that capitalizes on the advantages of several approaches will be the most effective.

Solid Roof Structures

Solid roof structures are permanent structures that provide protection from the sun's harmful rays and can be designed to serve a multitude of purposes. Typically, the structures are designed to be open on at least three sides and often include furniture that can be moved around. To maximize flexibility, the design can include lighting and plumbing.

Advantages

- Provides "all-weather" protection.
- Provides additional classroom space.
- Provides exercise space during inclement weather.
- Provides flexibility of design.
- Can be used as a lunch or picnic area.
- Has a long life span.

Disadvantages

- Requires drainage and guttering.
- Can be more expensive than other strategies.

Outdoor classroom at Poplar Creek Elementary School—Siler, Kentucky

With little more than a few hundred dollars, the support of local businesses, and a State environmental education grant, Principal Tom Shelly and the teachers at Poplar Creek Elementary School, along with the students and their parents, were able to fund the construction of this outdoor classroom and nature trail on their school grounds that otherwise would have cost as much as $30,000.

Considerations

- Schools considering any type of construction project will need to determine which of their local building codes and fire codes are applicable to their project.
- Careful planning will result in the positioning of the structure so that it creates shade at the right place, at the right time of day, throughout the year.
- Schools located in areas that experience heavy snowfall will need to consider the snow load when designing the roof of the structure.
- Likewise, schools located in areas that experience high winds will need to design accordingly.

- Exposed roof supports may be attractive nesting sites for birds. Strategies to deter this should be incorporated into the building's design.
- Lighting will allow for evening use of the building.
- To provide additional light during daytime hours, polycarbonate panels can be incorporated into the roof design and provide a great deal of light while blocking up to 99% of ultraviolet (UV) radiation.
- No matter what type of design is selected, all buildings require maintenance. A maintenance schedule and estimated costs should factor into the design selection process.
- In the design of the structure, efforts should be made to close off the view of the sky by extending the eaves as far as possible. If the sky can be seen by people under the structure, they are at risk for exposure to indirect UV radiation.
- The design of any structure should ensure access for people with disabilities.
- If the structure is to be used as a classroom or meeting room, the acoustics of the building should also be addressed.

Outdoor classroom at Hermantown School
Duluth, Minnesota

Constructed by the Duluth Skyline Rotary Club as a gift to the Hermantown School District, the outdoor classroom is directly behind the Hermantown Elementary School. Besides serving as an outdoor classroom, the building is accessible to elementary school students during recess periods. According to Fred Majeski, the Superintendent of the Hermantown School District, the building, with its metal framing and roof and concrete floor, would have cost the school well over $25,000 to build, had it not been donated by the Rotary Club.

Shade Cloth Structures

Another strategy for providing shade on school grounds is the use of shade cloth or structural fabric supported by a framework or poles. This strategy often is used when the goal is to cover large play areas without employing extensive structural support. Shade cloth is typically a knitted or woven fabric that is rated as to how much sun is blocked. Transmission of the sun's rays through the fabric depends on the tightness of the weave or knit, with more densely woven or knitted fabric blocking out more of the sun's radiation. Fabrics with a looser weave transmit between 50% and 80% of the sun's harmful rays and are typically designed for horticultural applications.

Shade cloth that blocks 80% of solar radiation provides the approximate protective equivalent of sunscreen with a sun protection factor (SPF) of 6.7, whereas shade cloth that blocks 94% of solar radiation provides the approximate protective equivalent of sunscreen with an SPF rating of 15. Shade cloth rated to block 94% of solar radiation is the minimum that schools should consider.

Sun Protection Factor (SPF)

Advantages

- Can be relatively inexpensive to construct.
- Generally requires minimal upkeep.

Disadvantages

- Provides varying UV radiation protection.
- Can be susceptible to weather damage.
- Has a shorter life span than solid roof structures.

> **What Does SPF Mean?**
>
> ***The common interpretation is how much longer skin covered with sunscreen takes to burn as compared to unprotected skin. Sunscreens can be rated for their protective factor against either UVA or UVB radiation or both. The thickness and thoroughness of application, the type of sunscreen, and the frequency of reapplication factor into whether or not sunscreen delivers the protection for which it is rated.***

Considerations

- Because the UV protection qualities of shade cloth and other structural fabrics vary widely, care should be taken in determining the most appropriate fabric.
- Care must be taken in the positioning of supporting posts so that they do not create a danger to children at play.
- As with any other structure, one of shade cloth should be positioned for maximum sun protection.
- The structural integrity of a fabric structure is related to its curvature and positioning. Structures must be designed to withstand the snow and wind loads that can be expected in their locations.
- The design and installation of these structures should be left to specialists. Names and contact information of organizations that design and install fabric shade structures can be found at the end of this chapter.

Natural Shade

Incorporating natural shade into the overall design offers several advantages. The best approach to creating shade is one that provides protection from the sun's harmful radiation during the spring, summer, and fall, yet does not completely block the sun's warmth during winter months. Incorporating deciduous trees, shrubs, and vines into the design provides the seasonal variation in protection that structures alone cannot provide. Likewise, evergreen trees, vines, and shrubs planted alongside structures can serve to block wind in the winter and provide protection from scattered UV radiation during the rest of the year.

Advantages

- Reduces the ambient temperature more so than structures.
- Provides seasonal sun protection.
- Provides low-cost alternatives.
- Improves the aesthetics of the school grounds.
- Provides an opportunity for students to learn about nature.

Disadvantages

- Vegetation takes time to grow.
- Trees can create litter, such as leaves, nuts, and fruits.

Considerations

- There are regional differences in vegetation. Plants native to a particular region have evolved to thrive in the conditions prevalent there. Whenever possible, locally grown native varieties of trees, shrubs, and vines should be used in the design. The United States Department of Agriculture (USDA) Cooperative Extension Service agent in your area can help determine the best species for your design.
- The effectiveness of trees and vines in providing UV radiation protection is directly related to the density of the plant's foliage.
- As a rule of thumb, trees should be planted to the south and west of where you want to shade so they can provide it during the midday and afternoon hours. Chapter 5, "The Earth-Sun Relationship", gives information on creating shade in the right place at the right time.
- Some plants are poisonous or cause allergic reactions. Other plants can attract bees or have dangerous spikes or thorns. One needs to become familiar with the possible harmful effects of the species that are being considered.
- Trees may interfere with a school's electrical service, plumbing, and drainage systems. Care should be taken that vegetation is not planted where it might later present a threat to the school's utility systems.
- Many trees will not tolerate root compaction, which occurs when foot traffic compacts the soil around the roots of a maturing tree. Several strategies will prevent it, including a temporary fence around the maturing tree or specially designed pavers to absorb the impact of busy feet.
- A short-term or transitional structure can be built to provide shade while the vegetation is maturing.
- The first year after planting vegetation is the most important for ensuring the survival of trees, shrubs, and vines. Plants must be watered at regular intervals if rainfall is inadequate. The USDA Cooperative Extension Service agent in your area can help you determine an appropriate watering schedule.
- Some communities have restrictions on water use that might affect decisions on which plants would be most appropriate.

Transitional shade

Designed by Shade 'n' Sails of Victoria, Australia

Where Can I Find More Information?

Chapter 5, "The Earth-Sun Relationship", gives more information on providing shade at the right place, at the right time, throughout the year. The following pages contain links to information about selecting trees, vines, and shrubs; sources for plants and products related to natural shade strategies; information on creating natural wildlife habitats; organizations that manufacture and install fabric shade structures; and contact information for the USDA's Cooperative Extension Service.

Wildlife Habitat Creation

American Forests: A Tree for Every Child	
www.americanforests.org/resources/kids/a_tree_for_every_child	The "A Tree for Every Child" project is a hands-on, flexible environmental education program that allows students to see how practical action can create a better world. The project allows schools to teach students the benefits and rewards of planting trees as part of American Forests' Global ReLeaf 2000 campaign to plant 20 million trees for the new millennium.
Acorn Naturalists	
P.O. Box 2423 Tustin, CA 92781-2423 Toll Free: (800) 422-8886 http://acornnaturalists.com/store	This organization offers resources for science and environmental educators. Offerings include educator guides, interpretative tools, and books on nature and the environment. An online catalog is available.
Cornell Lab of Ornithology	
159 Sapsucker Woods Road Ithaca, NY 14850-1999 Toll Free: (800) 843-2473 http://birds.cornell.edu	This site describes classroom projects and provides educational materials that support habitat development. Projects include the Great Backyard Bird Count (which is held every February) and the Classroom Feeder Watch. The curriculum description for the Classroom Feeder Watch can be found at http://www.birds.cornell.edu/cfw/index.html
Project Wild	
555 Morningside Drive, Suite 212 Houston, TX 77005 Phone: (713) 520-1936 www.projectwild.org	Project Wild provides instructional materials that can be adapted for academic disciplines ranging from science and environmental education to social studies, math, and language arts. Numerous education materials, Web links, and guidebooks are available at this site, including the publication *Wild School Sites: A Guide to Preparing for Habitat Improvement Projects on School Grounds.*
Kidsgardening.com	
National Gardening Association 1100 Dorset Street South Burlington, VT 05403 Toll Free: (800) 538-7476 www.kidsgardening.com	This site is an online source of information and materials for environmental science in the classroom. A keyword-searchable resources directory provides links to regional resources.

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Resources for Natural Shade Solutions

United States Department of Agriculture ***Cooperative State Research, Education, and Extension Service***	
www.csrees.usda.gov/qlinks/partners/state_partners.html	This site provides links to the county offices of the Cooperative Extension Services system in each state. The Cooperative Extension Services system has field agents assigned to each county. That agent will be able to answer your questions regarding the best species to plant for the application that you are considering; provide you with sources for the trees, shrubs and vines; and offer detailed instructions on the proper way to plant and care for them.
United States Department of Agriculture ***U.S. Forest Service/Urban and Community Forestry***	
www.fs.fed.us/ucf/	The goal of the USDA Forest Service Urban and Community Forestry Program is to provide technical and financial assistance to help improve the livability of cities and communities by managing urban forest resources to promote a healthy ecosystem. This Web site provides links to the regional coordinators.
U.S. Department of Agriculture ***Natural Resources Conservation Service***	
www.plants.usda.gov	The PLANTS Database provides standardized information about plants of the United States and its territories. The databse includes names, distributional data, species abstracts, characteristics, images, and links to related Web sites with information on the region-specific culture for each species.
Treelink	
www.treelink.org	This Web site provides information, research, and networking for people who work in urban and community forestry. Tips on grant writing and fund-raising are also included.
The National Arbor Day Foundation	
www.arborday.org	The National Arbor Day Foundation helps individuals and groups plant and care for trees and encourages the celebration of Arbor Day to advance global environmental stewardship for the benefit of this and future generations.
The International Society of Arboriculture	
www.treesaregood.com	The International Society of Arboriculture is a worldwide professional organization dedicated to fostering a greater appreciation for trees. The Web site was created to provide the public with quality tree care-related information.
U.S. Environmental Protection Agency ***Landscaping with Native Plants***	
Ariel Rios Building 1200 Pennsylvania Avenue, N.W. Washington, DC 20460 Phone: (202) 272-0167 www.epa.gov/glnpo/greenacres/nativeplants/factsht.html	This Environmental Protection Agency site promotes landscaping with native plants and discusses the environmental benefits of using native plant material. Topics discussed include attracting birds and butterflies and being considerate of local weed laws. *The Wild Ones Handbook* is a compendium of practical information for landscaping with native plants.

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Resources for Fabric Structures

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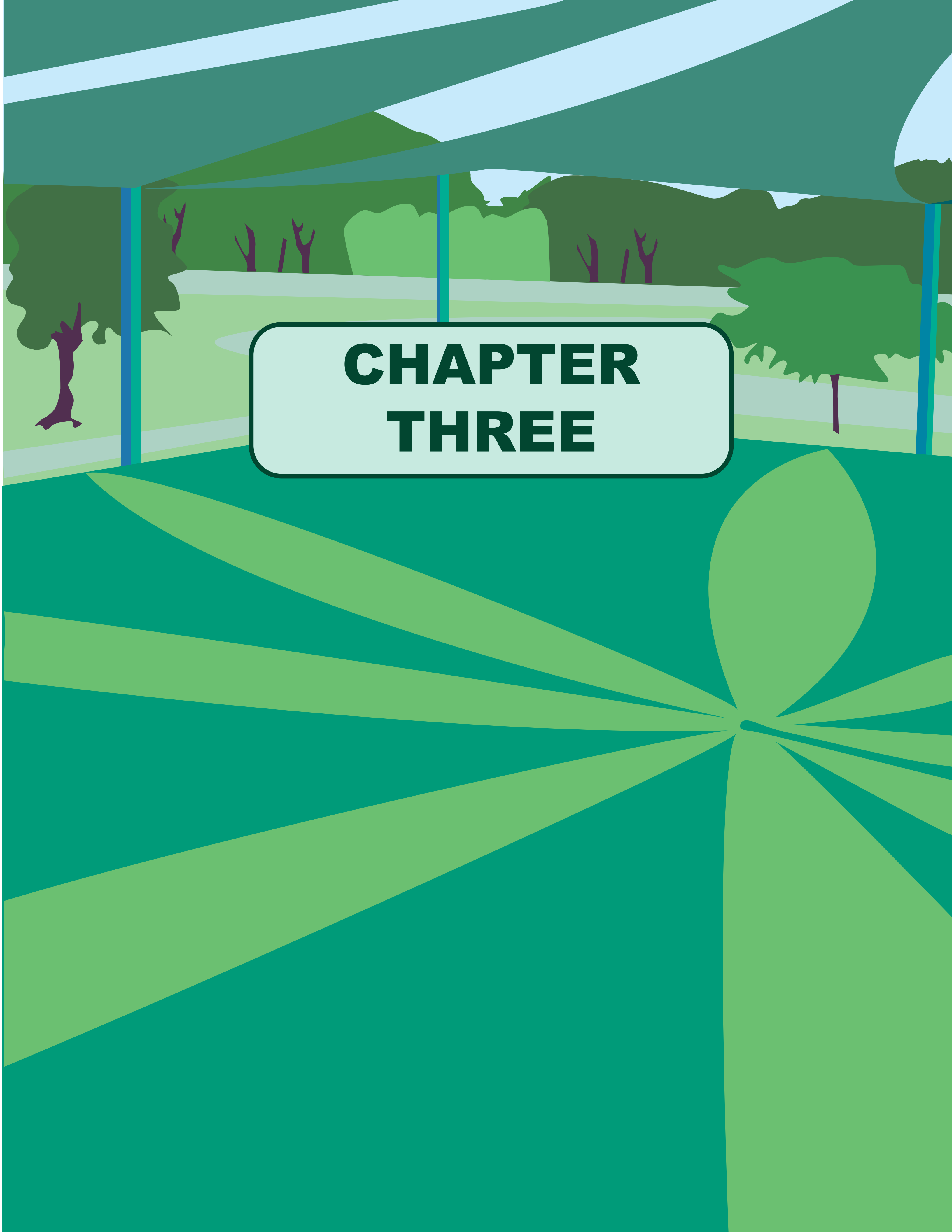
CHAPTER THREE



Planning for Shade

Planning for shade requires the completion of a series of interrelated tasks. These include convening a planning team, conducting a site audit to determine whether the existing level of shade is adequate, determining the most appropriate strategies if more shade is required; and developing a plan to increase the amount of shade accessible to students, teachers, staff, and visitors. The process can be lengthy, taking as long as 1 year. This chapter briefly describes each step. In chapter 6, “How to Conduct a Shade Audit,” the reader will find more detailed information on the steps for shade planning.

The Shade Planning Team

It is important for any school undertaking a shade planning project to first identify the stakeholder groups that may have an interest in, or be affected by, the resulting plan. Representatives of these groups should be included on the planning team. For most schools, the stakeholder list would include school administrators, the school nurse, coaches, teachers, students, parents, groups that use the school grounds after hours, and neighbors living adjacent to the school. In addition to stakeholder representatives, the planning team may need to call on professions with expertise in horticulture, landscaping, and architecture. Although it may not be necessary to include such individuals on the planning team, taking the time to identify and recruit them during the earliest stages of the planning process will keep the project moving when their expertise is required.

The process will be well served if the goals of the team, the roles and responsibilities of its members, and a method for decision making are determined at the outset. In the course of developing and proposing a shade plan, many decisions will need to be made. One method for decision making that lends itself to a participatory process is decision by consensus.

The Shade Audit

Once a planning team has been assembled and its roles, goals, and procedures determined, the group’s first major task will be to conduct a shade audit. The audit will help the planning team determine how much shade is currently accessible on the school grounds and if more is needed. The audit consists of a series of user interviews, behavioral observations, and environmental observations. All of the information collected through the audit will be used by the planning group to develop their recommendations.

Interviews

Although members of the planning team may be very familiar with their school, their expertise may not be comprehensive. Any shade planning endeavor should begin by interviewing several members of each of the identified stakeholder groups. In those interviews, the planning team can collect important background information regarding:

- When and where outdoor activities occur.
- Which areas of the school grounds are off-limits.
- Any long-term plans for the school grounds, including new construction.
- Opinions regarding the adequacy of existing shade.
- Expectations regarding the plans for additional shade.

Chapter 6, “How to Conduct a Shade Audit,” contains sample interview questions for school principals, teachers, and students. Planning teams will need to tailor interview questions to issues and concerns specific to their school.

Prior to conducting stakeholder interviews, the planning team should secure a site plan. This is a drawing of the school grounds and buildings that has been drafted to scale. Often site plans are prepared by surveyors or architects, and may be available from the school's principal or the office of the superintendent of the school district. With a site plan, interviewees can refer to activities in relation to the zones and features of the school grounds and interviewers can record the information directly onto the plan.

Behavioral Observations

The next step in the planning process involves collecting data at the school site. Adequate data collection will require several visits to the school. Initial visits will be to observe outdoor activities conducted on the school grounds and document the usage patterns of students, teachers, and staff. Knowing in advance at what times the students can be expected to be outdoors will facilitate the process. Observers will want to document the types of activities taking place, the location in which they are occurring, the number of students participating, and their duration. Once again, it will be helpful for observers to have a site plan on which to make notes regarding outdoor student and teacher activities.

Environmental Observations

Other visits to the site are recommended in order to take measurements on school grounds without interfering with the school's day-to-day activities. On these visits, an accurate site plan will be essential. If none is available, the planning team will need to draw a freehand plan of the site, recording the distances between the various buildings and play equipment. It might be helpful to name different zones if they do not already have names, such as queuing area or passive play area. It is also important to document any significant topographical features, such as low spots, slopes, or ravines, as these will influence decisions about which shade planning strategies will be most appropriate. The site plan should indicate the boundaries of the school's property, which direction is north, and whether it is magnetic north or true north. Often there is an appreciable difference between the two. Determining true north will be important to ensure that shade is cast in the right place, at the right time of day, at the right time of year.

It may also be important to mark the locations of important features outside of the school boundaries, such as the neighboring homes or businesses.

Shade Planning Toolbox

When Is North Not Really North?

The short answer is "Almost always!" There is almost always a difference between true north and magnetic north. Fluid motion in the outer core, which is the molten metallic region of Earth, causes the magnetic field to change unpredictably both over time and by location.

Magnetic declination is the measurement of the angle between magnetic north and true north. For example, on July 4, 1955, the magnetic declination for Washington, D.C., was 6 degrees west of true north. On the same day in 2003, the magnetic declination was 10 degrees west of true north.

To find out more about magnetic declination, visit The National Geophysical Data Center at: http://www.ngdc.noaa.gov/seg/potfld/declination.shtml

Because ground and building surfaces can reflect ultraviolet (UV) radiation, the planning team should make notes regarding the surfaces and finishes of each building and play area on the school grounds.

It will be important for the planning team to also consider the school's sports areas, such as baseball diamonds, soccer fields, and basketball courts. In thinking about these features of the school grounds, the planning team should take into account the shade needs of the students and coaches who are participating and those of the spectators.

The next task will require some degree of horticultural expertise. The planning team should inventory each tree and planted area on the school grounds. Trees should be numbered on the site plan, and a separate set of notes should record the team's findings for each tree, including the following:

- Species.
- Estimated height.
- Trunk diameter.
- Condition (e.g., broken branches, dead limbs), paying particular attention to any that appear to be unhealthy.
- Estimated diameter of the tree's canopy, that is, the upper part which includes the branches and leaves.
- Density of the tree's canopy.

Notes should also be made on the predominant vegetation for areas of densely planted mixed species.

The final task of the shade audit is to estimate the amount of existing shade on the school grounds. Measurements should be taken of all of the shade, regardless of whether it is in an off-limits area. There are two methods for measuring shade, one of which is highly technical and requires a detailed knowledge of sun projection techniques. The second method requires only that the planning team mark the shade patterns on the ground at the times of day that students are outdoors. The ground can be marked with chalk, rope, or baking flour, then measured and marked to scale on the site plan. Measurements will need to be taken at several times during the day and throughout the school year to ensure that seasonal changes in the shade patterns are recorded.

Assessing the Findings

Having completed interviews with representatives of stakeholder groups, observed usage patterns, and plotted the seasonal shade patterns at the school, the next step in the planning process is to analyze the quantity and quality of shade that is accessible on school grounds, and determine if and where additional shade is needed. The following questions will guide the analysis:

- Will future growth of existing trees result in additional accessible shade?
- Are any areas currently off-limits that could provide additional shade if they were accessible?
- Are any areas protected from direct UV radiation, but not protected from indirect (reflected or diffuse) UV radiation?
- Are there future building plans that might be modified to provide additional shade?

Shade Design

Based on the shade audit, the planning team should present its recommendations in text and graphic format. Recommendations should clearly state the shade goals for each specific zone of the school property, such as bus queuing area, sports venues, active play areas, or informal social gathering places, along with strategies for achieving those goals. The team should consider the range of options at the same time that it is considering the nature of the shade to be provided. Questions that the planning team should take into account when developing a shade plan include:

- Is there a need for protection from rain?
- What are the initial costs for each strategy considered?
- What are the long-term maintenance costs associated with each strategy?
- Is the strategy safe, considering the local weather conditions?
- Is there risk of vandalism, and how can that risk be minimized?

Consulting with knowledgeable architects, landscape architects, or horticulturists is advisable at this point. Not only will they know the species of vegetation that will meet the shade requirements for natural applications and the local building codes for any structural applications, they also can advise the planning team on the potentially complicated tasks of obtaining local building permits and contracting with builders and landscapers.

Funding

At the same time that the planning team is finalizing the shade design, team members can explore potential funding sources and volunteer resources for the project. Several potential sources for funding and hands-on participation are discussed further in chapter 4, “Case Studies” and in the appendices of this manual. Some possibilities include:

- Contributions from local and national corporations, including in-kind contributions.
- State and federal grants.
- Volunteers and financial contributions from community service organizations.
- Local fund-raisers.
- Support from environmental organizations.
- Advice from local master gardeners associations and programs.
- Volunteer project work for Boy Scout or Girl Scout troops.
- Student class projects.

Where Can I Find More Information?

Chapter 6, “How to Conduct a Shade Audit,” provides more detailed information on the steps of conducting such an audit, including examples of questions that would be appropriate for interviews with stakeholders. On the following pages are resources for facilitating participatory decision-making processes, funding, and working with volunteers.

Resources for Shade Planning Teams

Facilitators Guide to Participatory Decision-Making (1996)	
Sam Kaner, with Lenny Lind, Catherine Toldi, Sarah Fisk, and Duane Berger New Society Publishers Gabriola Island, BC	This guide is designed to help groups increase participation and collaboration; promote mutual understanding; honor diversity; and make effective, inclusive, and participatory decisions.
Evergreen	
355 Adelaide Street West, Fifth Floor Toronto, Ontario M5V 1S2 Phone: (416) 596-1495 www.evergreen.ca	Evergreen is a Canadian non-profit environmental organization with a mandate to bring nature to Canadian cities through naturalization projects. Evergreen motivates people to create and sustain healthy, natural outdoor spaces and gives them the practical tools to be successful. Following are several publications available from Evergreen that should be of interest to shade planning teams. ***Hands for Nature: A Volunteer Management Handbook*** This booklet provides practical tips and ideas for working effectively with volunteers to create and sustain greening projects. It includes many insights and helpful statistics from the Community Greening Volunteerism 2002 Survey as well as generous input and discussions with experienced volunteer coordinators and greening participants. ***Design Ideas for the Outdoor Classroom: Dig it, Plant it, Build it, Paint it!*** This booklet is a collection of ideas and techniques for creating native plant and vegetable gardens, and includes a whole range of built and artistic features for your school grounds. ***All Hands in the Dirt: A Guide to Designing and Creating Natural School Grounds*** This manual will guide you through the planning process, providing tips and templates for designing a site that reflects your local natural environment and the ideas of all involved. ***Nature Nurtures: Investigating the Potential of School Grounds*** This report is a comprehensive review of the literature pertaining to school ground naturalization. It examines the work of some of the most advanced thinkers in the fields of child development, education, and environmental psychology, and it explores the web of benefits that results when an entire school community participates in creating more nurturing and diverse environments for learning on the school grounds.

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CHAPTER FOUR

Case Studies

Schools and school districts across the United States have already begun the process of shade planning. This chapter introduces three case studies. The first, Collier County, Florida, demonstrates the power of a single individual to motivate a school board to erect shade canopies over the playgrounds of all of the school district's elementary schools. The second case study, Pinellas County, Florida, demonstrates the fund-raising capacity of schools' parent-teacher organizations (PTOs) and the effect that they can have on decisions of local school boards. Lastly, the story of the collaboration between Shonda Schilling SHADE Foundation and the United States Environmental Protection Agency's SunWise School Program demonstrates the great potential for partnerships that exists for schools and organizations concerned with preventing skin cancer.

Collier County, Florida

Located in Southwest Florida, Collier County encompasses 2,025 square miles and is home to 296,678 residents, according to the U.S. Census Bureau (2004). The January average high temperature is 77.6°, which is also the lowest average high throughout the year. The county's per capita income for the year 1999 was just over $31,000, approximately $3,000 above the U.S. average for that year, and 10.3% of the county's population lived below the U.S. Department of Health and Human Service's poverty guidelines.

One reason for the county's higher-than-average per capita income may be the large number of retirees who have chosen to take up residence in this county. Even with the large percentage of residents older than 65 years of age, almost 20% of Collier County's residents are 18 years old or younger.

The Collier County school district is home to 44 public schools including 2 charter schools. The policy-making body for the school district is a five-member school board.

Getting Started

Teryl Brzeski is a skin cancer survivor. In 1986, at the age of 37, Ms. Brzeski was diagnosed with melanoma, the most deadly form of skin cancer. Her diagnosis motivated her to research the causes of skin cancer and inspired her to do all that she could to help prevent others from developing the disease. "Having a deadly disease and being lucky enough to have a full recovery is a wonderful thing. In my case, it has instilled a passion for being alive and a desire to share cancer prevention information with others."

Ms. Brzeski became especially concerned about her daughter and the other students at Seagate Elementary School. Other Collier County parents were equally concerned about their children's exposure to ultraviolet (UV) radiation. In fact, during the late 1980s, Seagate's PTO raised the $30,000 necessary to erect a pavilion on the school grounds to provide a shaded area for physical education classes. Other than the covered pavilion, however, much of the playground was not protected from excessive solar radiation, and during recess, children played in areas where there was no shade.

Determined to do something about the situation, Ms. Brzeski began her campaign for a shaded playground by researching options for providing shade on school grounds, eventually presenting her ideas to the Collier County School Board. Along with two dermatologists and a representative from the American Cancer Society, she explained to the school board why it was important to provide children, teachers, and staff with adequate protection from solar radiation. Their presentation included an architectural drawing of their vision for a shaded playground at Seagate. Informational packets were distributed to school board members, making a clear and convincing medical case for providing sun protection on a daily basis. The presenters told the school board that they were prepared to raise funds themselves, if necessary, to have the shade structures built.

Approval and Building Costs

The school board not only approved the request for Seagate, but also approved the construction of shade structures on the playgrounds of all Collier County elementary schools at a cost of $2.1 million dollars. In June 2002, Seagate Elementary School became the first county school to be fitted with a shade structure over the playground. By August 2002, before the school year began, 21 more schools in Collier County were fitted with shade structures. Funding for the project was drawn from the school district's capital budget.

Once the school board decided to build the structures, the project was outsourced to a contractor, with specifications that 95% of the playground of each school should be covered by the shade structure. At Seagate Elementary School, the structure covers 8,100 square feet of the playground.

Seagate Elementary School

Students, teachers, and staff at Seagate Elementary are now protected from ultraviolet radiation during recess.

The shade structure comprises multiple canopies. Each canopy is made of a polyethylene mesh fabric that is supported by steel cables and held up by galvanized steel poles, which are secured to concrete pilings. The canopy over Seagate's playground covers a swing set, three slides, and other playground equipment. The polyethylene mesh fabric blocks 90% to 95% of the sun's UV rays. In addition, it allows heat to escape, promoting air circulation. As a result, the temperature beneath the canopies is about 15° lower than that of the ambient air in the middle of the day.

Maintenance

After the shade structures were built, several potential modifications were identified as necessary to increase the longevity of the structures. For example, additional poles were subsequently added to guard against severe windstorms, and the sails were redesigned and restrung. In 2005 the county incurred additional expenses due to hurricane damage. Consequently, when hurricanes are forecasted, maintenance staff take down the structures. However, contractors must be hired to reassemble them. The county school board will continue their cost benefit analysis and may consider other options in the future.

Continued Efforts

To date, 25 Collier County elementary schools have been outfitted with shade structures over their playgrounds. The scope of the initial project was 22 schools, but since that time, Collier County has built three more schools and has incorporated shade structures into their design and construction.

Since the implementation of shade coverings in the Collier County school district, other neighboring school districts have seen the utility and importance of providing students, teachers, and staff with protection from UV radiation. For example, in the Lee County school district, Bonita Elementary School has begun fund-raising efforts to build a shade structure for the school. The school's parent-teacher organization has pledged to donate a portion of the funds, and solicitations of businesses and service clubs are expected to raise more. The school expects to pay $64,000 to install shade canopies over its two playgrounds.

Teryl Brzeski has won her battle with skin cancer and now fights every day to ensure that her daughter and the children of Collier County will not have to face the same battle. Her efforts to educate others on skin cancer and its prevention and to promote sun safety through the construction of shade structures at elementary schools have motivated not only her county to take action but have also influenced neighboring counties to take the same steps.

Pinellas County, Florida

Pinellas County, Florida, is located on a peninsula bordered by the Gulf of Mexico and Tampa Bay. The 280-square-mile county is home to about 921,500 year-round residents and welcomes an average of 4.5 million visitors each year. Unemployment in Pinellas County tends to be lower than the Florida state average, which tends to be lower than the national average. According to the U.S. Census Bureau, the per capita income for the year 1999 was just under $24,000, and 12.8% of the county's population lived below the U.S. Department of Health and Human Service's poverty guidelines.

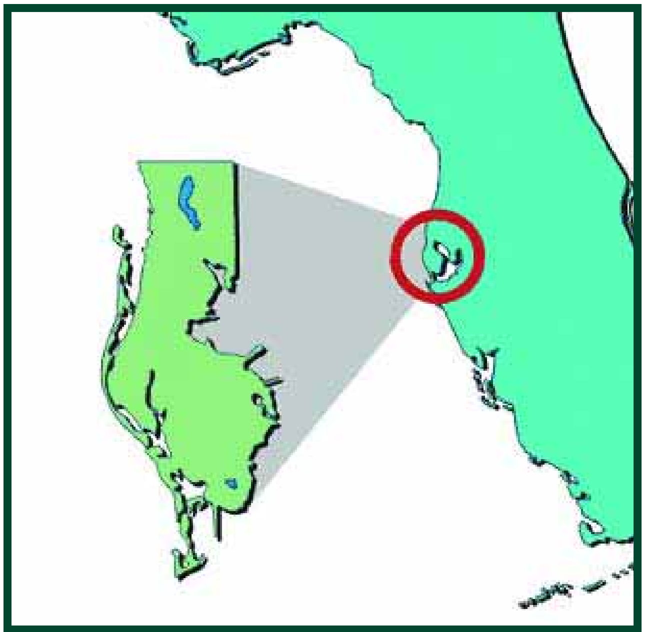


Image source: http://www.pinellascounty.org/

With 114 elementary, middle, and secondary schools, the Pinellas County School District is the 7th largest district in Florida and the 21st largest in the United States.

Getting Started

By 1995, parents and teachers in several of Pinellas County's 82 elementary schools had become concerned about their schools' lack of indoor gymnasium facilities. Physical education classes had to be taught outdoors throughout the year and were canceled when inclement weather required it. The Parent-Teacher Associations (PTA) in those few schools took the initiative to conduct fund-raisers, such as bake sales and jog-a-thons, to collect the $35,000 that each school would need to erect a weather-protected outdoor play area. The schools tapped local expertise in determining the best design for the structures and for executing the construction.

In 2002, the local PTA efforts in Pinellas County paid off for all elementary school children in the county, prompting the Pinellas County school board to determine that all 82 elementary schools in the county should have similar structures to protect students, teachers, and staff. Walter Miller, associate superintendent of institutional services, cites health and medical concerns as the rationale for the school board's decision, "We ensure that the students, faculty, and staff have a clean and safe environment inside of the school, so it's only right that we are concerned about the environment outside of the school as well. Children and physical education teachers were exposed to extreme heat and put at risk for skin cancer, which in Florida is a major concern, so the shade structures buy students and teachers the opportunity to escape the heat and exposure to ultraviolet radiation."

Building Costs

Funding for the construction has been supported through the school district's capital budget. The school district's facilities department identified a general contractor to oversee construction of the buildings, and the contractor received bids from a number of manufacturers. A local firm was ultimately selected, because using a local builder would reduce shipping and travel costs.

To reduce costs, a single design was used for all schools, although each school determined the placement of its shade structure. The structures are 40-by-80 feet, roughly the size of a tennis court, and are constructed of metal with concrete floors. The designers had to consider the threat of strong winds associated with hurricanes or tornados, very real threats in Florida. As a result, a larger foundation was incorporated into the design to create uplift resistance in the event of a windstorm. Each structure approximately cost $60,000, which according to the director of facilities was considerably lower than it would have been if each building had been individually bid. Those schools that had begun fund-raising efforts for a shade structure were allowed to add that money to the school board's budget, and make improvements to the original design, including a larger structure, if that was what the school wanted.

Maintenance

As the oldest of the buildings begin to age, some of the maintenance requirements are becoming more obvious. Most apparent is the need to paint the steel structures regularly to prevent premature rusting. Structures that need repainting must first be sandblasted to remove old paint and rust. In some cases, as more time passes, other maintenance issues will be identified. Recently, some of the schools have experienced problems with birds nesting in the metal framing that supports the roof. Modifications to the design of future buildings and to those already constructed may solve that problem.

Continued Efforts

Currently, 66 of the 82 elementary schools in Pinellas County have shade structures. The school district expects that all schools in the county will have these structures by 2007. This tremendous accomplishment is the result of the efforts of just a few concerned parents, teachers, and principals who recognized the importance of providing sun protection to their students, teachers, and staff.

If you would like to find out more about the efforts to prevent skin cancer at Pinellas County Schools, feel free to contact:

Walter Miller, Associate Superintendent, Institutional Services in Pinellas County
Phone: (727) 547-7167

Jim Ewbank, Supervisor of Pre-K Physical Education
Phone: (727) 588-6078

SHADE Foundation of America and the U.S. Environmental Protection Agency's SunWise School Program

SHADE Foundation of America

In February 2001, Shonda Schilling, a 33-year old mother of four young children and wife of Boston Red Sox pitcher Curt Schilling, was diagnosed with melanoma. Having been a lifelong sunbather, Ms. Shilling felt a need to inform the public about the dangers of exposure to the sun's UV rays. She learned that although Arizona has the highest melanoma rate in the United States, the state had no organizations devoted to preventing the cancer. As a way to fill that gap, Shonda founded the SHADE Foundation.

SHADE Foundation of America is a non-profit organization dedicated to the education, prevention, and detection of skin cancer. Created in September 2002, the foundation's goal is to prevent the development of skin cancer through educational programs and free skin cancer screenings.

The U.S. Environmental Protection Agency's SunWise School Program

First piloted in May 1999, the SunWise School Program, developed by the United States Environmental Protection Agency (EPA), is an environmental and health education program designed to teach children and their caregivers how to protect themselves from overexposure to the sun. The standards-based, cross-curricular lessons in the SunWise Tool Kit were designed to foster sun-safe behaviors in children and to increase their knowledge and appreciation of the environment. In addition, the program encourages schools to create shade structures, adopt sun-safe policies, and develop additional community partnerships.

Since the year 2000, the K–8 curriculum has been available on a national basis, free of charge, to any school registering at the EPA SunWise Web site, www.epa.gov/sunwise. To participate in the SunWise program, schools must adopt a SunWise activity, which may include implementing classroom lessons, collecting and reporting UV radiation data, adopting school-wide sun-safe policies, or engaging in skin cancer prevention community outreach. Schools must also participate in a program evaluation.

Creating a Collaboration

The development of the collaboration between the SHADE Foundation and the EPA began in October 2002. Linda Rutsch, Director of the SunWise School Program at the EPA, was visiting the Web site of a melanoma foundation in Nevada when she noticed a link to the SHADE Foundation. "Usually I will check out various links in order to keep up with what's out there," Ms. Rutsch recalls. She clicked on the SHADE Foundation's link, learned about the Foundation's skin cancer prevention efforts in Arizona, and found a contact name. Ms. Rutsch called Sue Gorham, executive director of the SHADE Foundation, and told her, "I would like to send you a SunWise Kit and tell you a little about our program."

As luck would have it, the SHADE Foundation was in the process of searching for a school curriculum on sun safety. Ms. Schilling and Ms. Gorham decided to develop a program for schools that would allow them to acquire shade structures for their campuses through the SHADE Foundation. The idea was to encourage schools to implement a sun-safe curriculum and to develop sun-safe policies within the school.

The EPA's SunWise curriculum was exactly what the SHADE Foundation was seeking, and the partnership began there. As Ms. Rutsch remembers, "That was in October of 2002 when we first started corresponding. In January of 2003, we had our first face-to-face meeting where we talked about working together."

How the Program Works

The **SHADE SunWise School Program** requires schools to qualify in two steps. The first step is to request the EPA SunWise curriculum, usually via the EPA SunWise Web site. Once a school has reviewed the curriculum and made the decision to implement it, the next step is to apply to the SHADE Foundation to participate in the SHADE SunWise School Program. The written grant statement must include a description of the policy and activities the school proposes to adopt for skin cancer prevention. Upon demonstration of sustained teaching activities and the implementation of sun protection policies, the Foundation gives grants for the consideration of a shade structure.

Cherokee Elementary school:
the first school to graduate with the SHADE Foundation and SunWise curriculum.

The shade structures are an appropriate reward for the school's achievements. Besides protecting students, teachers, staff, and visitors from overexposure to UV radiation, the structures contribute to a more comfortable environment for students to enjoy outdoor physical activities. As Sue Gorham points out, "Here in Arizona, when children slide down the sliding board, it is so hot that it could take the skin off their backs. Under these shade structures, the temperatures will drop as much as 20 degrees."

Building Costs

The cost for providing a school with the 24' x 35' shade structure is between $6,000 and $10,000. The shade structures are of shade cloth, approximately 24' x 35' and hoisted on metal poles. The shade cloth provides 98% protection from UV radiation. Schools have flexibility in determining where on their grounds would be the most appropriate location for their shade structure.

The SHADE Foundation assumes all costs of the shade structures, with money raised through a number of fund-raising events, ranging from auctions to golf tournaments. The first year of implementation was used to demonstrate both the program's needs and SHADE's fiscal responsibility and ability to execute the managerial and administrative duties of the project. Hoping to supplement its fund-raising efforts with grant money, the program began applying for grants in 2004. In 2005, SHADE received its first grant of $25,000 from Teammates for Kids. SHADE, now in its 4th year of giving grants, has funded approximately 50 structures across the nation at a cost of $267,000.

Though some schools have expressed concern over the required maintenance on the structures, to date this has not been a great problem, because the structures have not required much maintenance.

Continued Efforts

To date, the SHADE Foundation has constructed 50 shade structures in U.S. schools and community areas which benefit children. In the coming year, the Foundation plans to raise funds to support 95% of grant applications.

The SHADE Foundation and EPA were recognized for their work by being awarded the "2003 Excellence in Cancer Awareness Award," presented by Congressional Families Action for Cancer Awareness. This award is presented annually to the organization that best exemplifies a total commitment and dedication to assisting others in preventing cancer. This award honors the partnership between the SHADE Foundation and the EPA SunWise program in addressing the issue of skin cancer prevention. "We are so proud of our partnership receiving the award," says Ms. Gorham. "We hope that through qualifying for grants in the future, we will be able to carry on this work in all states."

If you would like to find out more about the SHADE Foundation's efforts to prevent skin cancer, feel free to contact:

Sue Gorham
Executive Director of the SHADE Foundation
www.shadefoundation.org
Phone: (480) 614-2278
Fax: (480) 614-2279
E-mail: sue@shadefoundation.org

To find out more about the EPA's SunWise School Program, contact:

Linda Rutsch
Director of the SunWise Program
www.epa.gov/sunwise
Phone: (202) 343-9924
Fax: (202) 343-2362
E-mail: rutsch.linda@epa.gov

CHAPTER FIVE

The Earth-Sun Relationship

For any shade planning team, the primary objective is to ensure that shade falls in the right place, at the right time of day, throughout the year. A shade planning team should include members with at least a working knowledge of the Earth's relation to the sun. This chapter is designed to:

- Graphically illustrate the effects of daily and seasonal changes in solar angles on the length and direction of shadows.
- Provide a basic introduction, or reintroduction, to the Earth's relationship to the sun and solar geometry.
- Provide a list of resources that can assist the planning team in ensuring that shade falls in the right place, at the right time of day, throughout the year.

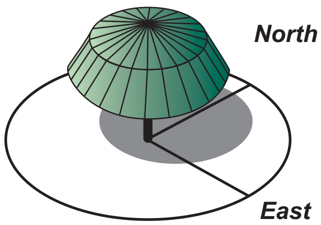
***Latitude** is a north-south measurement of any position on the Earth. Measured in degrees, latitude is 0° at the equator and 90° at the North and South Poles. The line that connects all locations of the same latitude is called a parallel. Shade planning teams will need to know the latitude to determine where a tree or structure will cast its shadow throughout the day.*

***Longitude** is a west-east measurement of any position on the Earth. The line that connects all locations of the same longitude is called a meridian. Longitude, like latitude, is measured in degrees, with 0° occurring at the Greenwich Meridian or Prime Meridian. Measurements of longitude range from Prime Meridian at 0° to 180° going either west or east. The 180th meridian east is the International Date Line. Shade planning teams will need to know their longitude to determine solar noon.*

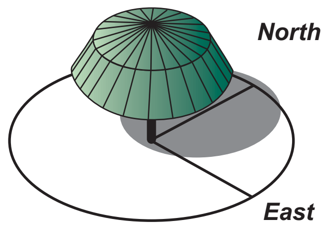
***Solar Noon** is the time of day when the sun is aligned with true north and true south and is specific to each longitude. In the northern hemisphere, a shadow cast by a vertical pole at solar noon will point toward true north. Solar noon is also the midpoint between sunrise and sunset.*

The Sun’s Annual Path and the Creation of Shade

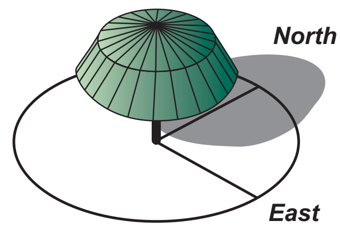
Shadows cast by the sun grow longer from June 21st until December 21st, and then grow shorter from December 21st until June 21st. This is a result of annual changes in the solar altitude angle. The change in shadow length is depicted graphically in the following illustration. A 36-foot tall tree with a canopy spread of 48 feet planted at the geographic center of the contiguous United States (Longitude=98°3'West; Latitude=39°0'North) tree would cast shadows at **solar noon** throughout the year as follows:



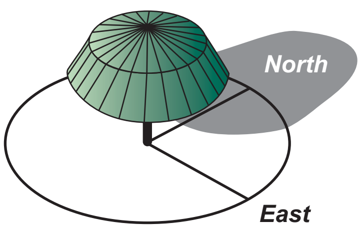
August 21



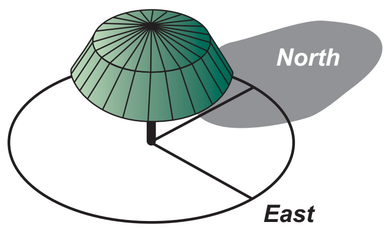
September 21



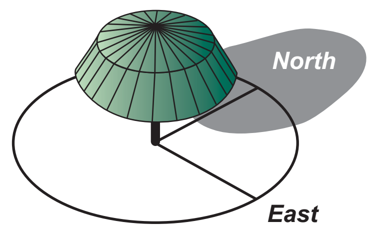
October 21



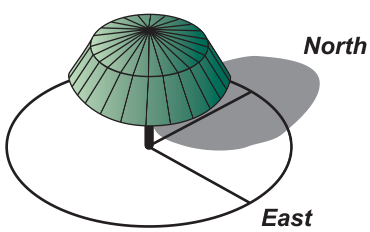
November 21



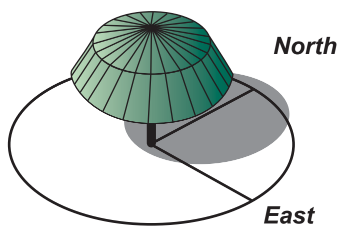
December 21



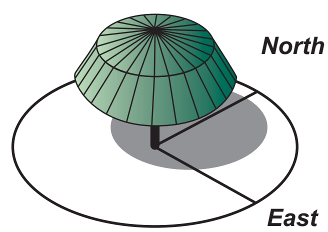
January 21



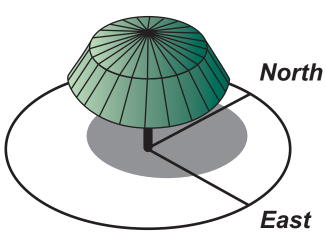
February 21



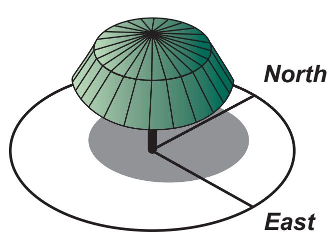
March 21



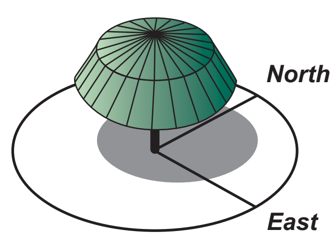
April 21



May 21



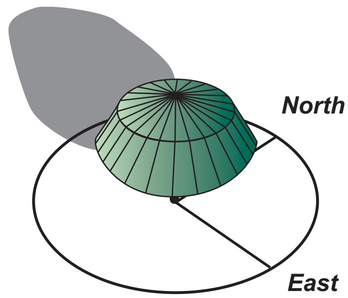
June 21



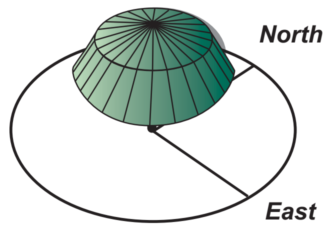
July 21

The Sun’s Daily Path and the Creation of Shade

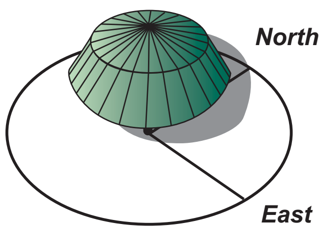
Observing that same 36-foot tall tree, the shadows that are cast move from west to east throughout the day in response to the sun’s east-to-west movement. On March 21st, the shadows that would be cast throughout the school day would appear as follows:



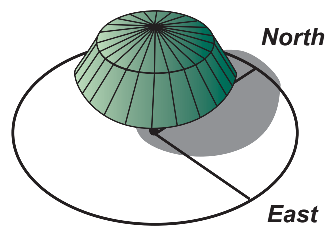
8:07



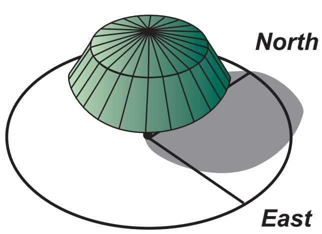
10:07



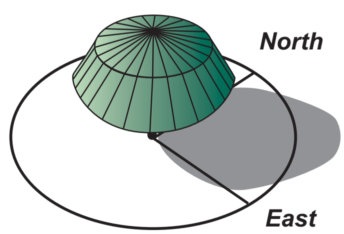
11:07



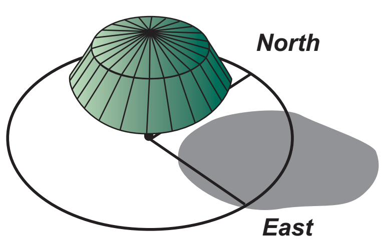
12:07 (Solar Noon)



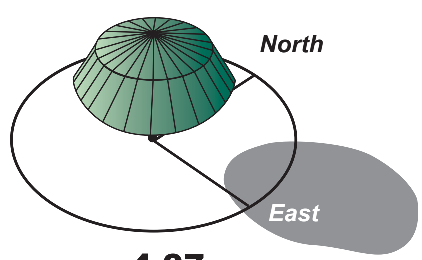
1:07



2:07



3:07



4:07

The Earth's Rotation and Revolution

Every 24 hours, the Earth makes one rotation on its axis; every 365.24 days, the Earth makes one revolution around the sun. If one were to view the Earth spinning on its axis, one would note that the axis is not perpendicular to the Earth's orbit around the sun, but is tilted at an angle of 23.5°, with the North Pole always pointing directly at the North Star. Furthermore, the Earth's orbit around the sun is not circular, but elliptical, causing the Earth's distance from the sun to vary by as much as 3 million miles throughout the year. The annual variation in the Earth's distance from the sun affects the amount of solar radiation intercepted by the Earth by as much as 7%. The changing distance from the sun, however, is not responsible for the changes in seasons. The changes in season are caused instead by the constant 23.5° tilt of the Earth and the Earth's rotation around the sun.

Summer solstice, which is on or about June 21st, marks the beginning of summer in the northern hemisphere. The Earth is positioned so that the North Pole is leaning toward the sun at 23.5°. On summer solstice, the length of the day, from sunrise until sunset is greater than 12 hours for all latitudes north of the equator, and less than 12 hours for all latitudes south of the equator. On summer solstice, the center of the sun lines up with the latitude known as the Tropic of Cancer, which is at 23.5° north.

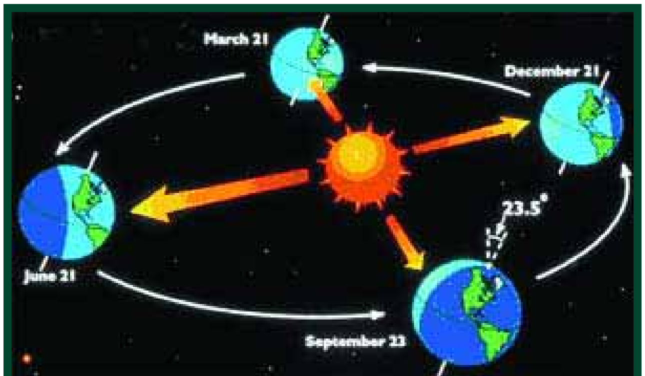


Image Source: National Geophysical Data Center

At the winter solstice, on or about December 22nd, the Earth is positioned so that the North Pole is leaning away from the sun, and all latitudes south

Key Terms and Concepts

***The Earth's axis of rotation is not perpendicular to its orbit around the sun, but is tilted at an angle of approximately 23.5°. Solar Declination** is the angle that a given hemisphere is tilted toward the sun on any given day. It is marked by the latitude on the Earth where the location of the sun is directly overhead at solar noon. Because of the 23.5° tilt, this location is always somewhere between 23.5° north and 23.5° south, depending on the time of the year. Solar declination is 0° when the sun lines up with the equator on the equinoxes.*

***Equinox** is one of the two periods when the declination of the sun is 0°, or the sun is lined up exactly with the equator. The autumnal equinox occurs on or about September 21st, and the vernal equinox occurs on or about March 22nd. Only on these 2 days are the hours of the day and night equal, and only on these 2 days does the sun rise due east and set due west.*

***Solstice** is either the longest or the shortest day of the year. In the northern hemisphere, summer solstice is the longest day of the year and occurs on or about June 21st. Winter solstice occurs on or about December 22nd.*

***True north**, also known as geographic north, is the northernmost point on the Earth as determined by the Earth's rotation. This usually differs from what a compass indicates as north. When a compass points to north, it is pointing toward magnetic north, which in some locations in the United States, may be as far as 20° from true north.*

of the equator experience days longer than 12 hours and all latitudes north of the equator experience days shorter than 12 hours. This marks the beginning of summer in the southern hemisphere and the beginning of winter in the northern hemisphere. On winter solstice, the center of the sun lines up with the latitude known as the Tropic of Capricorn, which is at 23.5° south.

On the equinoxes, those being around September 21st and March 21st, the Earth is positioned so that the North Pole points neither toward nor away from the sun. On those 2 days, the Earth's equator lines up with the center of the sun, resulting in days that are exactly 12 hours long, regardless of latitude.

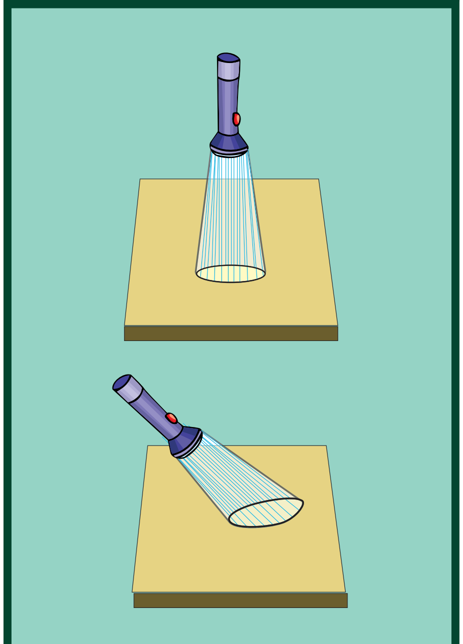
Solar azimuth angle *is the angle on the horizontal plane between the point on the horizon that is directly beneath the sun and true south. The azimuth angle determines the direction of shadows.*

Solar elevation angle *or* ***solar altitude angle*** *is the angle that describes the height of the sun in relation to the nearest point on the horizon. It varies according to the time of day and the season and determines the length of shadows.*

Axis Tilt and Solar Radiation

That the Earth's axis is tilted affects the amount of solar radiation reaching the Earth in three ways. First, the length of the day changes throughout the year. In the northern hemisphere, beginning on the summer solstice, the sun's daily path is increasingly lower in the sky (making shadows longer) until the winter solstice, after which the days become increasingly longer. As days grow longer, the risk of exposure to excessive ultraviolet (UV) radiation is greater.

The more perpendicular a beam is to a surface, the brighter the beam will be on the surface.



Second, when the sun is at a lower altitude, its rays are spread over a larger area, reducing the intensity of the sun's radiation, including UV radiation.

Third, levels of solar radiation are also affected by how much of the atmosphere the sun's rays must pass through. Solar radiation levels, including UV radiation, are greatest when the sun is higher in the sky and solar radiation has a shorter path to travel through the atmosphere. When the sun is lower in the sky, solar radiation has a longer path to travel through the atmosphere, resulting in more of the sun's radiation, including UV radiation, being absorbed or scattered by the atmosphere.

Putting It All Together

In order to create shade that falls in the right place, at the right time of day, throughout the year, it is essential that the planning team model the shade that their proposed buildings and plantings will cast. To do that, the team will need to know:

- Longitude and latitude of the school's location.
- Location of true north and true south.
- Size, shape, and orientation of proposed buildings.
- Growth patterns and locations of proposed plantings.
- Time of day that solar noon occurs throughout the year at that longitude.

Armed with that information and a working knowledge of solar geometry, it is possible to use mathematical and geometrical procedures to model the shade that will be cast by proposed structures and plantings. A number of computer software programs are available to do that work for you. Following are descriptions of two such programs, one of which has been developed for modeling sun and shade patterns for solar collectors, though it may well fit into the budgets and serve the purposes of some schools. The other is a program that has been designed specifically for shade planning.

Visual Sun Chart

www.visualsunchart.com/

Visual Sun Chart is a graphics program that was developed for visualizing solar shading to maximize the efficiency of solar collectors. It allows the user to model trees and buildings and, along with a free download, visualize the shade patterns that are cast. With Visual Sun Chart, a user can:

- Model buildings and trees.
- Export scenes to POV Ray 3.5, a free download that models shade produced by buildings and trees.
- Create reports which give information about positions of the sun, times of sunrise and sunset, horizontal and vertical shadow angles, and angles of incidence.
- View and print 3D models of sun movements.

webShade

www.shadeaudit.com.au
www.webshade.com.au

webShade is an interactive software package that allows users to prepare shade audits without the need for technical skills or expertise. Users can either scan their site plan into the computer or use a simple drawing program to create a 3D model of their site. On completion of the shade audit with webShade, the program produces a printed site plan, complete with shade solutions and simulated outcomes. Available as an internet download, a webShade user can:

- Project existing summer and winter shade patterns.
- Model alternative shade strategies.
- Project the summer and winter shade patterns for those alternatives.
- Prepare presentation-ready materials, including site-specific UV radiation information and design strategies.

Where Can I Find More Information?

To determine a location's latitude and longitude:

- www.pbs.org/wgbh/nova/longitude/find.html
- http://zipinfo.com/search/zipcode.htm
- http://geonames.usgs.gov/pls/gnis/web_query.gnis_web_query_form
- http://tiger.census.gov/cgi-bin/mapbrowse-tbl

To determine the time of day that solar noon occurs:

- http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html
- http://users.vei.net/pelican/sunrise.html
- http://www.spot-on-sundials.co.uk/calculator.html

For more information on solar geometry:

- http://www.geog.ouc.bc.ca/physgeog
- http://education.gsfc.nasa.gov/experimental/July61999siteupdate/inv99Project.Site/Pages/solar.insolation.html

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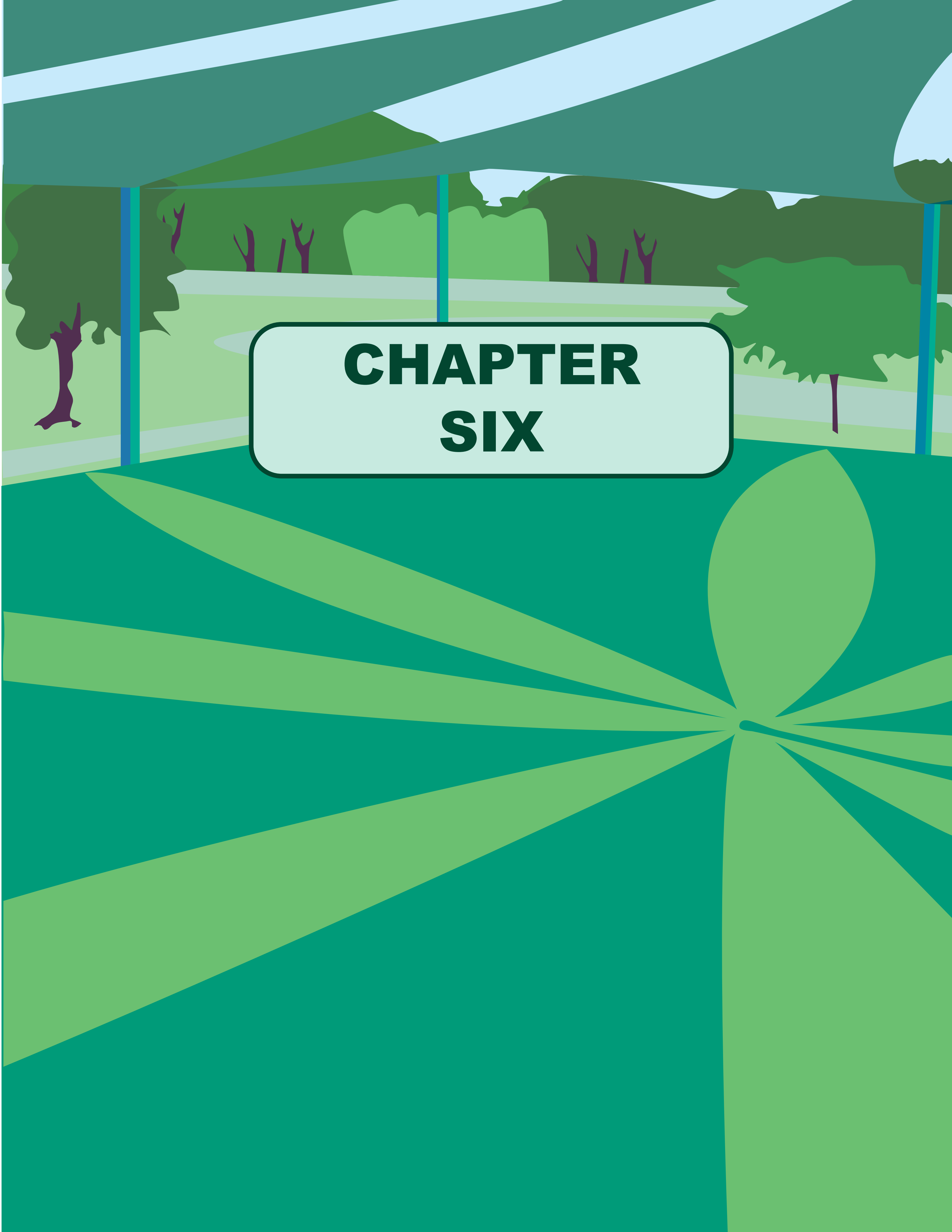
CHAPTER SIX



How to Conduct a Shade Audit

The purpose of the shade audit is to document the usage patterns of the school grounds and determine the amount and quality of existing shade. All of the information collected through the shade audit will be used by the planning group to develop recommendations for making the best use of existing shade and, if required, for creating additional shade. The final product of a shade audit is a written report or presentation of the shade team's findings and recommendations to the school community.

The process includes a series of interviews, behavioral observations, and environmental observations followed by an assessment of the findings and the generation of prioritized recommendations for achieving the goals. The entire process may take as long as 1 year. The first step in the process is to conduct stakeholder interviews.

Stakeholder Interviews

Before the first interview is conducted, the shade planning team should produce a comprehensive list of stakeholder groups that may have an interest in, or be affected by, the resulting plan. The team should identify and invite representatives from each stakeholder group to be interviewed. Ideally, each of the stakeholder groups will be represented on the planning team; nonetheless, it will be necessary to interview members of all stakeholder groups even if they are also represented on the team. For many schools the list would include:

- School administrators.
- Teachers, particularly the physical education teacher.
- Coaches.
- School nurse.
- Students.
- Building maintenance staff.
- Organizers of little league programs or others who may use the school grounds on weekends.
- Residents of the neighborhood adjacent to the school.

Interview Guides

For each stakeholder group, the shade planning team should generate a list of appropriate questions to explore in the interview process. Questions should cover topics with which the interviewee is very familiar. Some may ask the interviewee to discuss outdoor activities that they observe or in which they participate. In order to get the most out of the interviews, interviewers should ask interviewees to reference the school's site plan while describing those activities. This is a scaled drawing of the school grounds and buildings. Often such plans are prepared by surveyors or architects, and may be available from the school's principal or the office of the superintendent of the school district. Referring to a site plan during the interview process allows interviewees to reference activities in relation to the zones and features of the school grounds and allows interviewers to record the information directly onto the site plan. Through the interview process, interviewees may identify school grounds users of whom the shade planning team was not previously aware. Such newly identified stakeholders should be added to the list of interviewees.

Following are examples of questions that would be appropriate for school principals, teachers, students, and other stakeholders. This is not meant to be a comprehensive list, but instead gives samples of questions that might be most appropriate for each stakeholder group. The planning team will need to tailor their questions to the issues and concerns specific to their schools.

Sample Questions for School Principals

- How many students attend the school?
- What is the age range and distribution of the students?
- Does the school have sun-safe policies in effect?
  - Hats?
  - Sunglasses?
  - Long-sleeved shirts?
  - Sunscreen?
- What are the outdoor activities in which students participate?
  - Recess?
  - Lunch?
  - Assemblies?
  - Physical education?
  - Educational activities?
  - Informal social gatherings?
  - Extended day activities?

  Intermural and intramural athletic events?
- For each: Where do they occur? (Have interviewee refer to site plan.)
  - At what time of day do they occur?
  - What is the duration of the activity?
- Do you believe there is adequate accessible shade on the school grounds? If not, where is additional shade most needed? (The interviewee should be asked to refer to the site plan.)
- Is there inaccessible shade on the school grounds that could be made accessible?
- Is there a need for an area on the school grounds that is protected from precipitation?
- Are there plans for making improvements to the school, such as remodeling, adding classroom space, or landscaping projects?
- Does the school currently have problems with, or has it recently experienced problems with vandalism?
- Are there groups that have permission to use the school grounds after school hours and on weekends?
- Are there groups that, without formal permission, use the school grounds after school hours and on weekends?
- Can you think of any barriers to providing additional shade at this school?
- What type of shade do you think would work best at this school (solid-roof structure, shade cloth structure, or natural shade)?

Sample Questions for School Teachers

- What age group do you teach and how many students are in your class?
- What are the outdoor activities in which your class participates?
  - Recess?
  - Lunch?
  - Assemblies?

Physical education?
Educational activities?
Informal social gatherings?
Extended day activities?
Intermural and intramural athletic events?

- For each: Where do they occur? (Have interviewee refer to site plan.)
  At what time of day do they occur?
  What is the duration of the activity?
- Does the school have sun-safe policies in effect?
  Hats?
  Sunglasses?
  Long-sleeved shirts?
  Sunscreen?
- Do you believe there is adequate accessible shade on the school grounds? If not, where is additional shade most needed? (The interviewee should be asked to refer to the site plan.)
- Is there inaccessible shade on the school grounds that could be made accessible?
- Is there a need for an area on the school grounds that is protected from precipitation?
- Are there times that teachers are required to be outdoors, such as to monitor the activities on the school grounds? If so, how often does this happen and for how long?
- If there were outdoor classroom space, would you use it? Do you think that other teachers would?
- Can you think of any barriers to providing additional shade at this school?
- What type of shade do you think would work best at this school (solid-roof structure, shade cloth structure, or natural shade)?

Sample Questions for Students

- How old are you?
- When you are outside, do you usually play/socailize in the sun or in the shade?
  During recess?
  During and after lunch?
  During physical education class?
  During extended day activities (if applicable)?
  Intermural and intramural athletic events (if applicable)?
- For each, where do you play? (Have student refer to site plan.)
- Does the school have sun-safe policies in effect?
  Hats?
  Sunglasses?
  Long-sleeved shirts?
  Sunscreen?
- Do you believe there is adequate accessible shade on the school grounds? If not, where is additional shade most needed? (The interviewee should be asked to refer to the site plan.)
- Are there shaded areas on the playground that you would prefer not to use? Why?
- Are there areas on the school grounds where you are not allowed to play?

Sample Questions for Building Maintenance Engineers

- Do you believe there is adequate accessible shade on the school grounds? If not, where is additional shade most needed? (The interviewee should be asked to refer to the site plan.)
- Is there inaccessible shade on the school grounds that could be made accessible?
- Is there a need for an area on the school grounds that is protected from precipitation?
- Are there plans for making improvements to the school, such as remodeling, adding classroom space, or landscaping projects?
- How would a plan to plant trees or build a shade structure be affected by the school's utility services? (On the site plan, have the interviewee mark the service lines for the school's utility services.)
- Does the school currently have problems with, or has it recently experienced problems with vandalism?
- Are there groups that have permission to use the school grounds after hours and on weekends?
- Are there groups that, without formal permission, use the school grounds after school hours and on weekends?
- Can you think of any barriers to providing additional shade at this school? For example, would watering trees or removing tree litter be a problem?
- What type of shade do you think would work best at this school (solid-roof structure, shade cloth structure, or natural shade)?

Sample Questions for Neighbors

- Do you believe there is adequate accessible shade on the school grounds? If not, where do you believe that additional shade is most needed? (The interviewee should be asked to refer to the site plan.)
- Do residents of the neighborhood utilize the school grounds for activities on weekends or after school hours?
- In what types of activities have you seen neighbors participate on the school grounds?
- For each: Where do they occur? (Have interviewee refer to site plan.)
On what days of the week and at what time of day do they occur?
What is the duration of the activity?
- Is there a need for a rain-protected area on the playground?
- Do you think that the school currently has problems with, or has recently experienced problems with vandalism?
- Can you think of any barriers to providing additional shade at this school?
- If the school were to plant additional shade trees, are there areas on the school grounds where planting them might create a problem for neighbors?
- If the school were to build a shade structure, would it create a problem for neighbors? Are there areas of the school grounds where a shade structure might create a problem for neighbors?
- What type of shade do you think would work best at this school (solid-roof structure, shade cloth structure, or natural shade)?

Once all interviews have been conducted, the planning group should meet to discuss their findings. Information collected from different stakeholder sources should be synthesized and clarifications on, or answers to, any resulting questions should be sought by the group.

Behavioral Observations

The next step in conducting a shade audit involves observation of students, teachers, staff, and visitors on school grounds. Visits to school grounds after hours and on weekends will be necessary to confirm non-school–related activities that might be affected by the shade plan. Information collected in the interview process should guide the behavioral observations. Observers will want to document the types of activities, their locations, the number of individuals who participate in each activity, and the duration of the activity. Once again, it will be helpful for observers to make notes regarding all activities on a site plan. Participants in this process should model good sun-protective behaviors by wearing sunglasses, hats, and long-sleeved shirts.

Observations should be made on several occasions to capture the many activities that occur on school grounds and, as much as possible, observations should be made unobtrusively. Observers should note whether activities are occurring in a particular location because no other area will accommodate that activity, or if there are other locations where the activity could take place, particularly a shaded area.

Once again, upon completion of this step, the planning team should meet to discuss findings. If there are discrepancies between the information collected in the interview process and the behavioral observations, the team should note the discrepancies and seek clarification.

Environmental Observations

Other visits to the site will need to be planned to take measurements on school grounds without interfering with the day-to-day activities of the school. On these visits, having an accurate site plan will be essential. If none is available, the planning team will need to draw a freehand plan of the site, taking careful measurements of the buildings and recording the location and size of each. The site plan should indicate the boundaries of the school's property, which direction is north, and indicate if it is magnetic or true north, since there is an appreciable difference between the two. Determining true north will be important to ensure that shade is cast in the right place, at the right time of day, throughout the year. (See text box on page 22 of this manual.)

It may also be important to mark the locations of important features outside of the school boundaries, such as the location of neighboring homes or businesses and any buildings not on school property that cast shadows or reflect solar radiation onto the school grounds.

Once at the site, the planning team should number the site plan with all buildings and play equipment on the school grounds, recording the distances between features. The planning team will need to estimate the height of each of the buildings on the school grounds and record it on a separate set of notes, along with other characteristics of the building. Attachment A is an example of a building description sheet. It may be helpful to name areas or zones of the site if they do not already have a name. Zones can be named according to their use, such as "queuing area" or "passive play area." It is also important to document any significant topographical features, such as low spots, slopes, or ravines, because they will influence decisions on which shade strategies are most appropriate.

Because ultraviolet (UV) radiation can be reflected off ground and building surfaces, the planning team should make notes regarding the surfaces and finishes of each of the buildings and play areas on the school grounds.

Creating a Tree Inventory

The next task will require a degree of horticultural expertise. The planning team should inventory each tree and planted area on the school grounds, noting for each:

- Species.
- Estimated height.
- Trunk diameter.
- Condition (e.g., broken branches, dead limbs), paying particular attention to any that appear to be unhealthy.
- Estimated diameter of the tree's canopy, that is, the upper part which includes the branches and leaves.
- Density of the tree's canopy.

Trees should be numbered on the site plan and a separate set of notes should record the team's findings regarding each. Where densely planted areas of mixed species exist, notes should be made on which ones predominate. Attachment B is an example of a tree inventory data sheet.

Estimating the Height and Trunk and Canopy Diameters of a Tree

There are many ways to estimate the height and canopy diameter of a tree. Following is one method:

a. One member of the planning team first measures his or her own height in inches or feet.
b. The team member then stands next to the tree while another team member stands about 20 paces away.
c. With one eye closed, the second team member holds a pencil vertical at arm's length and covers part of the pencil so that the visible part is the same apparent length as the team member standing next to the tree.
d. Still keeping one eye closed, the second team member then moves the pencil up the tree and measures how many times taller the tree is than the team member standing next to it.
e. Multiply that number by the first team member's height and the result is a good estimate of the tree's height.
f. To estimate the canopy diameter, the second team member again closes one eye and holds the pencil at arm's length, covering part of the pencil so that the visible part is the same apparent length as the tree height.
g. The pencil is then turned horizontal and, measuring at the canopy's widest point, used to determine how many times wider the canopy is than the tree's height.

To determine the diameter of a tree, simply measure the tree's circumference, usually at about 3 feet above the ground, and divide it by 3.14.

Describing a Tree's Canopy Density

The task of describing a tree's canopy density is somewhat subjective since there is no common metric. For the purposes of shade planning one could describe the density of a tree's canopy by rating it as "open," "moderate," or "dense." Standing beneath the tree and looking through its branches, if over 90% of the sky is blocked by the tree's canopy, it can be described as "dense." If between 50% and 90% of the sky is blocked by the canopy, it can be described as "moderate," and if less than 50% of the sky is blocked by the canopy, it can be described as "open." An open canopy provides little UV radiation protection.

Measuring Existing Shade

The final task of the shade audit is to estimate the amount of existing shade on the school grounds. Measurements should be taken of all shade, regardless of whether it is off-limits. There are two methods for measuring shade, one of which is highly technical and requires a working knowledge of both solar geometry and computer-assisted design software. The second method requires only that the planning team mark the shade patterns on the ground at the times of day that the school grounds are used. The ground can be marked with chalk, rope, or baking flour, then measured and marked to scale on the site plan. Measurements at several times during the day and throughout the school year will be neccesary to ensure that adequate shade is provided at the right time of day, throughout the year.

> ***If the sky can be seen by those under a tree or structure, they are at risk for exposure to indirect UV radiation.***

Considering Potential Shade Strategies

Having collected information regarding the activity patterns of the different users of the school grounds and the shade patterns cast by trees and buildings, it is now time for the planning team to assess their findings and make recommendations to the school community. The planning team might find that the school grounds provide adequate protection from both direct and indirect UV radiation; however, if not, the team will need to make recommendations for making more shade accessible to students, teachers, staff, and visitors. The team should first consider strategies that increase the amount of accessible shade at very low or no additional cost to the school. These might include revising school policies to allow access to off-limits shaded areas or relocating playground equipment or picnic tables to areas of the school grounds where shade already exists.

The planning team will also need to consider reflected UV radiation in their recommendations. These may include modifying ground and building surfaces to reduce their reflectivity. The planning team might determine that climbing vines would be the best solution for the indirect UV radiation reflected off a smooth wall or that artificial turf would be most appropriate to reduce the UV radiation reflected from a concrete playground.

The team should engage in a process to help them examine the cost effectiveness of strategies that could be employed as they are evaluating whether or not a particular strategy will accomplish the intended goal. More information about this is provided below.

The Shade Planning Matrix

The Shade Planning Matrix is a tool that can assist the planning team with comparing potential strategies for achieving their goals while examining and comparing the cost effectiveness of each of the strategies. The team's stated shade goals must be specific, both at this stage of planning and when it is time to present recommendations to the school community. The planning team should also clearly state any goals that are ancillary to providing shade, such as the construction of an outdoor classroom or the creation of a natural wildlife habitat. Matrices should be developed for each area that is being considered.

Information for completing the Shade Planning Matrix may come from a variety of sources. It could be necessary to request an informal quote from a contractor if the planning team is considering a solid-roof structure. Many vendors will provide prices over the internet if the team believes that a shade cloth structure would be an effective strategy. If a natural solution is being considered, the team will want to enlist the help of their United States Department of Agriculture County Extension Service agent, who can provide information on the most appropriate trees, shrubs, and vines for each geographical area, and the rates at which the vegetation is expected to grow. The Shade Planning Matrix is Attachment C.

Making Recommendations

When the team has considered potential strategies for achieving their shade goals and has arrived at a consensus on a set of recommendations, their final task is to formalize them in a report to the school community. Across schools and shade planning teams, considerable variability is likely in the report format. However, several components are essential:

The Rationale

Besides the most important reason, that shade provides protection from the harmful effects of solar UV radiation, the rationale should include any additional benefits that could be accrued through the strategies that the shade planning team has recommended. Those benefits might include the creation of an outdoor classroom and sheltered area for active play during inclement weather, provision of shade for athletic event spectators, or the creation of a wildlife habitat.

Statement of Goals

With as much specificity as possible, the statement of goals should include a physical description of the location, the amount of shade needed, and a description of the activities that occur. One example is the following:

The planning team has determined that there is a need to increase the amount of shade over the area of the playground bounded to the north by the south wall of the main building, to the east by the chain-link fence, to the south by the edge of the playground pavement, and to the west by the basketball courts. Based on patterns of use by the students, it is estimated that there is a need for a total of 2,500 square feet of shade. This section of the playground is home to the jungle gym and is popular for passive play as well. Because it provides an unobstructed view of the entire playground, this is where the playground monitors usually stand.

Strategies for Achieving the Goals

Strategies for achieving the goals could include moving playground equipment to a shaded area of the playground, revising school policy to make off-limit areas accessible, or building structures or planting trees to provide additional shade. The planning team should present their recommendations, but should also be prepared to discuss alternative plans.

If the team is recommending the creation of new shade, it should be prepared to discuss the performance characteristics of the materials providing shade, including:

- Where the tree(s) or shade structure will be located.
- The amount of shade that will be provided.
- Whether the need is for seasonal or year-round shade.
- The costs associated with providing the shade, including both initial and annual maintenance costs.
- The estimated lifespan of the building or tree(s) providing the shade.

Approaches for Achieving the Goals

The cost of providing shade can range from an afternoon of volunteer labor to the expense of building a large outdoor classroom with electricity and plumbing. The school district's budget for the project often cannot be known until the planning team presents their recommendations. For this reason, modifiable plans and alternate funding sources should be explored. While members of the planning team are completing the shade audit, other members can be exploring potential funding sources and volunteer resources. As the planning team presents their recommendations, they should also be prepared to present the options for advancing their plan. Options could include fund-raising efforts by the parent-teacher organization, donation of building materials by a local builder's supply store, or a tree planting project by a local Boy Scout troop.

ATTACHMENTS

BUILDING DESCRIPTION

Attachment A

School: ______________________________ **Date:** ______________

Building Number	Name of Building	Height at Eaves	Height at Ridge	Wall Material	Wall Color

TREE INVENTORY

School: ______________________ **Date:** ____________

Tree Number	Species	Height	Trunk Diameter	Canopy Diameter	Canopy Density	Age	Condition

Shade Planning Matrix

Area to be Addressed: ______________________

Recommended Total Square Footage of Shade: ______________

Current Status: ______________________

Goal: ______________________

Strategy 1:	Initial Investment	Immediate Amount of Additional Shade	Estimated Annual Cost	Total Five-Year Cost	Total Shade at Five Years	Total Ten-Year Cost	Total Shade at Ten Years	Life Expectancy and Average Annual Cost

Advantages:		Disadvantages:	

Strategy 2:	Initial Investment	Immediate Amount of Additional Shade	Estimated Annual Cost	Total Five-Year Cost	Total Shade at Five Years	Total Ten-Year Cost	Total Shade at Ten Years	Life Expectancy and Average Annual Cost

Advantages:		Disadvantages:	

Shade Planning Matrix (continued)

Strategy 3:	Initial Investment	Immediate Amount of Additional Shade	Estimated Annual Cost	Total Five-Year Cost	Total Shade at Five Years	Total Ten-Year Cost	Total Shade at Ten Years	Life Expectancy and Average Annual Cost
Advantages:				Disadvantages:				

Strategy 4:	Initial Investment	Immediate Amount of Additional Shade	Estimated Annual Cost	Total Five-Year Cost	Total Shade at Five Years	Total Ten-Year Cost	Total Shade at Ten Years	Life Expectancy and Average Annual Cost
Advantages:				Disadvantages: