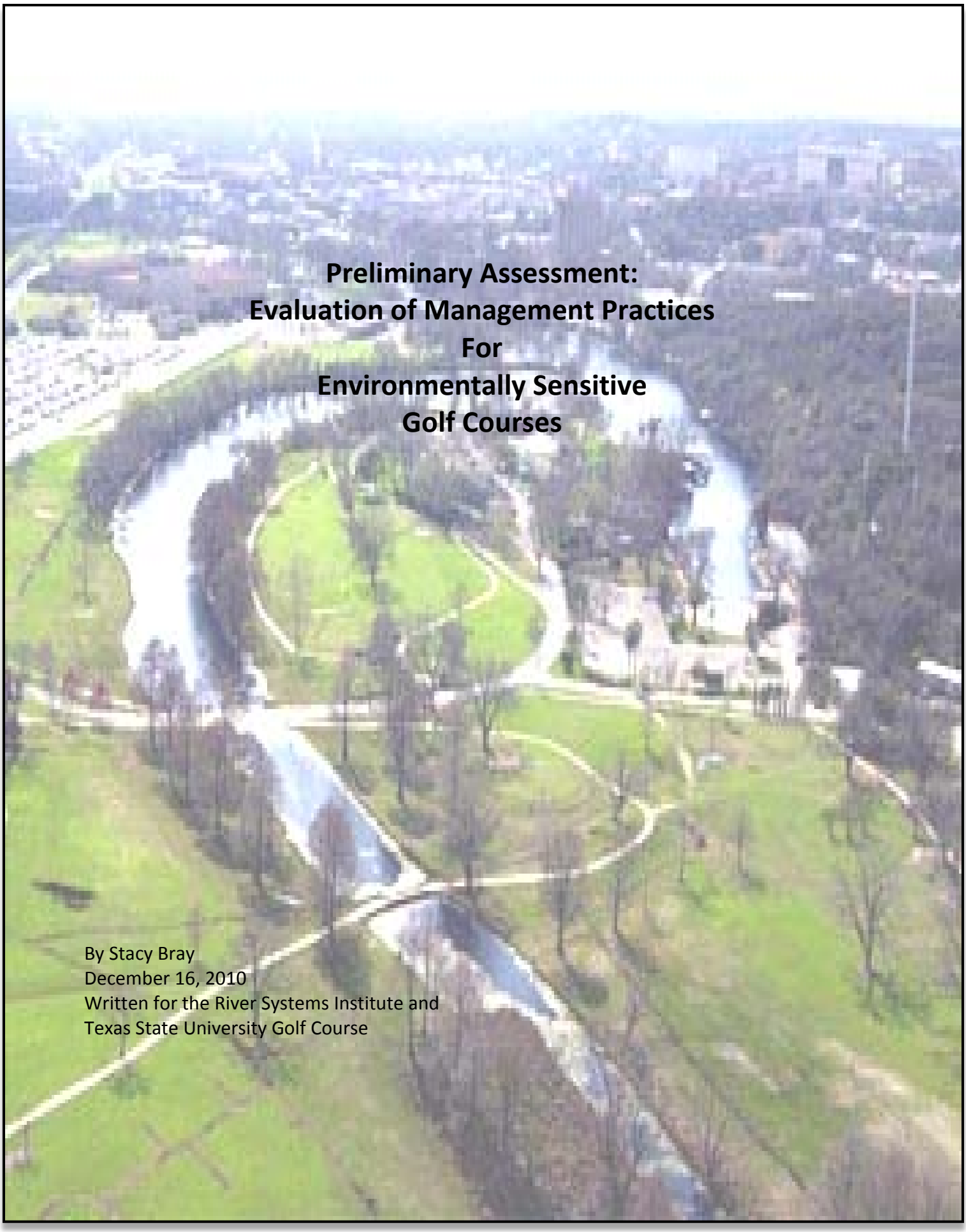

Preliminary Assessment: Evaluation of Management Practices For Environmentally Sensitive Golf Courses

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December 16, 2010
Written for the River Systems Institute and
Texas State University Golf Course

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Introduction and Purpose

The River Systems Institute's (RSI) main focus is to promote a holistic approach to sound water policy and river management systems where sustainability practices are encouraged. A river system encompasses streams, springs, and riparian and streambed habitats, and is integral to shallow aquifers, tributary watersheds, and related lakes, bays and estuaries of the system. At the core of sustainable practices, the RSI mission statement is "to develop and promote programs and techniques for ensuring sustainable water resources for human needs, ecosystems health, and economic development" (The River Systems Institute n.d.).

Education about the issues and problems centered over water resources and teaching proper water management principles is essential to protecting and conserving water resources. In San Marcos, the springs and dam have created Spring Lake, where the Aquarena Center educates over 100,000 visitors annually. The River Systems Institute is taking a leading role in increasing awareness of water policy by fostering relationships with stakeholders, whose interest in the economy, and social and environmental responsibility, invokes them to protect water resources. In addition, RSI has led several initiatives to further develop educational outreach and community involvement.

Figure 1. Aquarena Center (Aquarena Center n.d.)

The San Marcos River flows through the Texas State campus on the edge of the Texas Hill Country. RSI has a natural affinity for research in river systems and watersheds, as the headwaters of the San Marcos River are located adjacent to the Institute. In this location, the San Marcos Springs percolate beneath Spring Lake within the artesian zone of the Edwards Aquifer, and are related to unique headwaters, spring and lake systems with specialized habitats. The unique waters provide critical habitat for numerous threatened and endangered species. In addition, the springs are central to understanding the Edwards Aquifer that is the second largest artesian aquifer west of the Mississippi River (The River Systems Institute n.d.). In addition to RSI, the university golf course and Aquarena Springs, an educational facility for the public with regard to spring lakes and groundwater, are located in the area around San Marcos Springs and the lakes. The sensitive nature of the area and the university setting of RSI have led to the development of the Institute's research and educational roles and community outreach. Moreover, RSI is committed to its responsibilities as a leader in protecting local and global water resources. Through research and partnerships, the Institute has developed relationships with all levels of government involved with protecting water resources through effective water policy.

Figure 2. San Marcos Springs - Spring Lake (Aquarena Center n.d.)

Due to its core research interests in river systems and watersheds, assessing Best Management Practices (BMP) for environmentally sensitive golf courses is a natural fit for RSI and the Texas State University Golf Course. The Institute and golf course are adjacent to the sensitive Spring Lake and Sink Creek. From irrigation waters to pest mitigation measures, any applications on the golf course for soil and grass development have the potential to impact water quality of the lake, creek, river, and the underlying aquifer. Texas State University Golf Course has taken the responsibility of leading an *organic* golf course movement in Texas (Pennington 2010). As well as assessing BMPs for environmentally sensitive golf courses through this research, this report was developed to share with other golf courses that require environmentally sensitive practices.

Figure 3. Hilton Head Arthur Hills Golf Course (World Golf 2010)

Organic golf courses care for the environment by implementing an integrated pest management system whereby the course uses fewer chemicals and conserves water, two key elements for an organic golf course management plan. To meet qualifications, chemicals applied to organic golf courses must not contain any active ingredients. Water quality monitoring combined with education outreach to the staff, golfers, and local community is instrumental in implementing practices that will protect the environment. There are a number of golf courses that increasingly employ standards to protect the sensitive areas where they are located, including policies that target fewer chemicals and less water. Some golf courses meet

the requirements of the National Wildlife Federation's Wildlife Habitat Certification that recognizes the steps taken towards supporting wildlife and environmental stewardship.

This preliminary research study was developed for golf courses located in sensitive areas. The report is also intended for use as an educational tool for other golf courses to understand and implement environmental stewardship practices. Golf course environmental management is moving away from traditional standards and water policies towards environmental stewardship and land and water management. Golf course environmental ethics are developing to invoke practices and employ methods that reduce the use of chemicals and that increase water conservation. While this preliminary assessment of BMPs for environmentally sensitive golf courses targets the foundational steps to establish BMPS, additional studies and collaborative work are necessary to establish final BMPs and environmental ethics guidelines for golf course management.

Figure 4 Texas State Golf Course (Texas State University Golf Course 2010)

Eco-Friendly Golf Courses

Can a golf course be environmentally friendly? In environmental circles, there are negative connotations with the golf industry for using excessive water, pesticides, herbicides and fertilizers, as well as producing large volumes of non-point source pollution (Knox 2009). However, as with other land management practices that have become more environmentally aware, it is not only possible to be eco-friendly, but also to utilize practices towards becoming an *organic* golf course.

Figure 5. Machrihanish Dunes Golf Course – Scotland (Morgan 2008)

An organic golf course strives to conserve water and energy with a naturalist approach to managing the grounds on the course in addition to awareness of possible impacts in the local watershed. For example, the use of nitrogen as a slow release fertilizer is an accepted practice for organic golf courses, which prohibit the use of active ingredient products.

There are several examples of organic golf courses where the playability for golfers is excellent and their rewards are the natural features of the course. Scotland has courses where pesticides, chemicals, and other unnatural treatments are prohibited. Some golf courses, such as the Machrihanish Dunes in Scotland, prohibit any chemicals or irrigation on the fairways (Machrihanish Dunes n.d.). Rather than heavy machinery, Machrihanish Dunes use sheep to

Figure 6. Hebridean Sheep at Machrihanish Dunes (Kentyre Forum 2009)

trim the course grasses as done by the founding fathers of golf. This golf course has a high regard for the environment and is charged with protecting the Regal Pyramid Orchid, which is exclusively located on their grounds (Machrihanish Dunes n.d.). It is the only golf course designated as a Site of Special Scientific Interest (SSSI), United Kingdom's protected sites. Machrihanish Dunes' sustainable BMPs allow the golf course to co-exist with the environment and have earned certification from Golf Environmental Organization (GEO) that encourages organic and sustainable golf course management practices.

For many years, the Scottish have experimented with the organic side of golf course management and have experienced the environmental benefits of such practices. As Scotland is surrounded by sensitive ecosystems and water resources, organic management of their golf courses has been a natural progression for the courses to become the organic leader in the golf industry.

Figure 5. Collier Reserve Country Club (Collier Reserve Country Club 2008)

There are several golf courses in the United States listed as organic, many of which are located in environmentally sensitive areas such as the Collier Reserve Golf Course in Naples, Florida. Collier Reserve has achieved the distinction from Audubon International to become the first golf course in the world awarded as a Signature Cooperative Sanctuary (Collier Reserve Country Club 2008).

The golf course industry faces many challenges involving the care and management of golf course grounds. The height of golf popularity came in the 1990s, when golf courses were

established more frequently throughout world. During this time, the US built golf courses at a rate of 400 courses per year, earning the slogan *"A Course A Day"* by the National Golf Federation (NGF) (David Hueber 2010). Often built in communities close to large populations, many people gravitated to the green spaces provided by the golf course on acres of well-maintained turf with ponds and trees that golfers and communities enjoyed, and where wildlife found habitat. As the golf industry grew, so did the concerns with unintended consequences to the water resources and wildlife. As more was learned about the harmful effects of chemical use, a swell of concern for the environment overcame the golf course industry that threatened the economic livelihood of many golf courses (James Snow 2001). The United States Golf Association (USGA) was instrumental in researching the issues and finding alternatives to improve the environment around golf courses, realizing that such research would support improvements in the economy for golf courses and associated businesses and communities. The USGA found that when changes were made to positively enhance the environment, the golf course saved money through efficient watering and using fewer chemicals on the golf course (Leuzinger 1994). The golf course industry began to understand that positive changes for the environment could also provide positive effects for golf course budgets.

Figure 6. Golf Course Construction (Mattawoman Watershed Society n.d.)

In the US, the economic impact of golf course revenue is significant, with $18 billion spent annually on the game (USGA 2010). In addition, more than 24.5 million people spend 2.4

billion hours playing on one of over 14,500 golf courses. The impact to the community is significant, particularly in light of the observation that 78% of the golf rounds played are at public golf courses.

The positive benefits to the community, both economically and environmentally, are important to understand in the context of golf course management. A well-managed golf course can be eco-friendly as well as providing an opportunity for the golf course to show its leadership role as an environmental steward. The golf course can also lead outreach efforts and foster environmental awareness to golfers and the public. The leadership role is important to the community, given that approximately 70% of grass (turf) is in residential lawns, 10% in parks and sport facilities, 9% in golf courses, 9% in educational facilities, 2% in cemeteries and 1% in industry (Christians 1995). Golf course Superintendents have access to research methods that help determine the environmentally appropriate care needed for turf and demonstrate increased awareness in turf management practices. Another example of improved turf management practices in which the community may benefit is research on fertilizer products. The golf course industry can reaches out through educational programs to provide information to the public on how making changes in residential yards where the majority of the turf is located.

Figure 7. PGMS Green Star Award - Stone Mountain Golf Club (PGMS n.d.)

Golf Course Superintendents may be aware of the products and techniques available for environmental improvements in golf industry research provided by the USGA, the National Golf Foundation (NGF), the Golf Course

Superintendents Association of America (GCSAA) and the Environmental Institute for Golf (EIG). Many Superintendents will incorporate innovative ideas discussed at meetings and found in industry publications (The Environmental Institute for Golf n.d.) However, some Superintendents may not understand the implications of refusing to make changes, and/or they do not have the support of stakeholders, including the golf course owners and members. In addition, it is not economically feasible in all circumstances to fully make the changes necessary to protect the wildlife and environment. Very few Superintendents are willing to make changes that might lose golfers who disapprove any occurrence of weeds on the golf course.

The golf industry is making great strides with offering products that minimize or eliminate harmful ingredients while benefiting the health of turf and vegetation. Knowledge of product selection and impacts is a step forward in increasing overall awareness concerning the environmental consequences of applying harmful chemicals. The golf industry is pro-active in educating and communicating to golf course Superintendents about the choices in products available. "A pesticide product today has typically undergone more than 120 studies at a cost of $50 million before it is registered by the Environmental Protection Agency." (GCSAA n.d.) The industry is also teaching proper techniques in applying products to limit exposure to the environment and make the best impact on the golf course. "Superintendents are the nation's leading practitioners of integrated pest management, a philosophy that reduces the potential environmental risks of pesticide usage." (GCSAA n.d.)

Figure 8. Liberty National Golf Course - New Jersey (Joseph n.d.)

An increasing number of Superintendents recognize the benefits of environmental practices at their golf courses and see improvements to the overall health of the golf course. For example, changes to a golf course can include protection of topsoil from wind and runoff, resulting in healthier turf and vegetation. A healthy turf improves the absorption capabilities of soil and grass, thereby becoming a better filter for runoff that may contain pesticides or herbicides. Golfers enjoy the benefits of a healthier golf course in addition to its enhanced playability through improved turf.

There are also the added benefits of fewer mosquitoes, ticks, and chiggers when organic compost tea is used as a pest management solution (Wickland, Murray and Jimerson 2001). Wildlife and native plants may become more abundant in areas around golf courses that utilize organic treatments. With increased instances of wildlife sightings, golfers may become more aware of the positive changes to the golf course environment. The community will benefit from golf course improvements; as the Superintendents make aesthetic changes, environmental improvements around the course will make the region more economically valuable. The community may enjoy the wildlife in and around golf course when given the opportunity to explore the course before and after tee times. In an urban setting, increased

access to green spaces can be a vital part of the community. The green spaces at the golf course can improve air quality of the overall area and support increased capture and filter of runoff that may be occurring from impervious cover outside of a golf course. When a healthy golf course is a leader in its community, it can improve economic and environmental benefits throughout the region (USGA 2010).

Turf Management

Turf management through careful use of resources is one key to a successful golf course. The traditional image of a beautiful golf course is lush green grass, carefully maintained to prevent weeds and pests from invading the green carpet. A common public perception of a perfect golf course is that golf course management must involve the excessive use of chemicals to create the lush green grass (Kaufman 2009). Most managers know that harsh chemicals are not good for the environment and that proactive choices in product selection will benefit the golf course. The Turf Manager is typically an outdoor enthusiast, tuned to current environmental issues that golf courses face. However, Turf Managers must be sensitive to the golfers' needs while understanding environmental laws and policies.

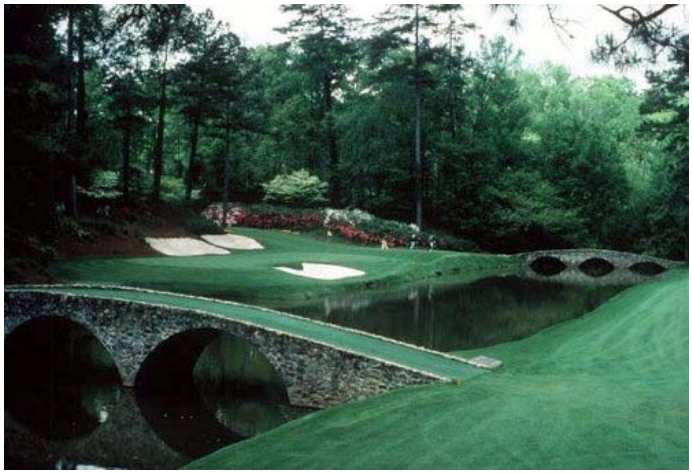


Figure 9. August National Golf Club (David Cannon n.d.)

With improvements in selection and timing of turf products in the turf management industry, Turf Managers are instrumental in protecting the environment around the golf course. Knowledge of soil type, native plants, runoff and pesticides and fertilizers provide a good basis for creation of a sound management plan.

The US Golf Association's (USGA) concern with pesticide and fertilizer initiated research on the issue to give golf courses direction for products that have less impact on the environment than products used in previous years of turf management. USGA found that key

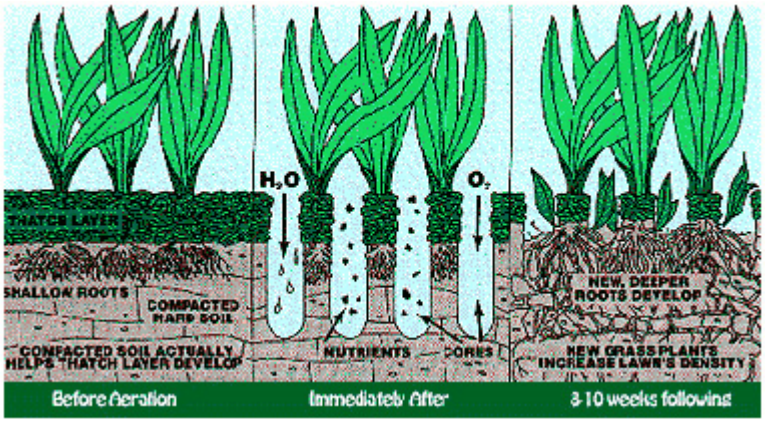


Figure 10 Healthy roots improve sorption (TurfMedic 2010)

factors in selecting the chemicals applied on golf courses are: 1) solubility, 2) sorption, 3) degradation by microorganisms, 4) chemical degradation and photo-decomposition, 5) volatilization and evaporation, and 6) plant uptake (USGA 1995).

Use of only one of these factors is not the best indicator of healthy turf. For example, the combination of solubility and the ability of the chemical to adhere to the soil should be considered (USGA 1995). High sorption rates are associated with the binding capabilities of chemical application on the golf course. A compound with high sorption rates is intended to bind with the soil, thus producing less runoff and leaching when watered. Degradation rates are influenced by a number of factors which depend on the temperature, water content, pH, oxygen levels and prior fertilizer and pesticide use on the soil (USGA 1995). Volatilization of a chemical compound, or the rate that the chemical is changed from a solid or liquid to a gas, is affected by course conditions of temperature, wind and moisture. Therefore, watering is recommended immediately after application of volatile compounds (USGA 1995).

Implementation of a sound management plan can aid Turf Managers in controlling runoff, increasing absorption, and maintaining degradation rates consistent for effectiveness. Protection of the water resources surrounding the golf course is supported with monitoring plant uptake and transpiration rates (USGA 1995). An understanding of the chemistry and possible interactions of products used on the golf course is part of good turf management.

Along with the care of the turfgrasses, the Turf Manager is responsible for other vegetation on the golf course. Awareness of the importance of irrigation management is another key to turf management. Through proper irrigation, the watering schedule can be managed by using a volume of water sufficient for the needs of the golf course. The irrigation schedule is as vital to the overall condition of the golf course as is the management of chemical applications to the golf course. Irrigation methods combined with the fertilizing and pesticide schedule will ensure effective treatment and control runoff to the water resources. Combining irrigation timers with manual manipulation of the schedule due to weather events (rain, wind, and heat - either dry or humid) are key to applying an appropriate amount of water to the grounds. In addition, mapping the golf course is important to locate contours of the course that will affect water management. The Turf Manager should determine problem areas that need more or less water, indicating the need to adjust sprinklers to control irrigation. The amount of water

Figure 12 Bank erosion and runoff filter (Lampman

Figure 11. Buffer Zone Texas State University GC (Texas State University Golf Course 2010)

needed on the golf course is also determined by the mowing height and frequency. Efficient watering will protect water resources from runoff, leaching of chemicals applied to the golf course, and over-use of natural resources due to excessive watering.

The Turf Manager wears different hats, that of an environmental steward, a chemist, and a horticulturalist. Managers must be aware of native turfgrasses and native plants that consume less water resources and adapt to the region. Planting the proper native vegetation for the area is instrumental in consuming less water while creating a habitat for native plants and animals. Native plants create diversity while providing an abundant food and habitat source for the ecosystem. Native vegetation strategically planted on the golf course creates a buffer in sensitive areas that benefits insects, birds, and mammals. A buffer created with native plants may support reduction in the water needed for turfgrasses on the golf course. As well, buffers can improve water quality by acting as filters for surface water runoff prior to that water's entry into nearby creeks or streams (Frankenberger n.d.). Erosion caused by runoff can be controlled with buffers and ponding opportunities in low lying areas (McCoy n.d.). The following Table 1 is an example of time for runoff flow to pass a buffer-strip on a golf course in Louisiana. The higher the height of the mowed buffer-strip, the longer the time interval before runoff starts and the greater the reduction in runoff volume may be.

Table 1. Time to start of runoff and total runoff water for buffer-strip mowing height treatments in the July 1996 simulated rainfall event.

Mowing	Time to Start of Runoff		Runoff Volume	
Height	Mean	SD	Mean	SD
(in)	(min)	(min)	(L)	(L)
0.5	7	4	733	121
1.5	16	7	731	151
1.5*	16	4	705	259
3	24	9	433	298

*Untreated Control.

(Bird, et al. 1995)

Chemical Use

During the 1990s, the USGA's Turfgrass and Environmental Research Committee sponsored an environmental study on the effects of fertilizers and pesticides applied to golf courses. Twelve universities participated in the studies to determine the movement, sorption, effects and residence time of various chemicals applied to golf courses. The universities and study sites were selected to represent a wide range of climatic zones and turf variations (Snow 1996).

In one study, it was determined that thick turf cover reduces runoff losses of nitrogen (Snow 1996). Significant runoff losses occurred on compacted soils and buffer strips runoff carrying nitrogen loads dependent on soil moisture (Snow 1996). Compacted soil due to uses such as excessive cart tracks on the turf allowed increased volumes of runoff. It was also found that under conditions of heavy chemical applications and excess watering, nitrogen leaching through the turf was significant and could threaten nearby water sources. With light application and light but frequent watering, less than 1% of the applied nitrogen was found to have leached through a 4-foot study profile (Snow 1996). "Averaging results over all seven leaching projects during year 1, nitrogen leaching from pure sand rootzones was about 11%, from sand/peat rootzones about 4%, and from loamy sand, sandy loam, and silt loam rootzones about 1% or less" (Snow 1996). Soil types on golf courses were determined to be a significant part of turf management and chemical application schedules. Light applications with slow release nitrogen applied using frequent watering intervals provided the best protection from nitrate leaching (Snow 1996).

Pesticide leaching studies show very little pesticide leaching had occurred with most products: generally less than 1% of the total applied product as tested at eight universities across the United States (Snow 1996). Products that exhibited high water solubility, low soil absorption potential, and greater persistence were more likely to leach and be present in surface water. The soil type and volume of applied water were leading factors in determining the propensity of a product for leaching and runoff.

Integrated Pest Management (IPM) is defined as a process where techniques are applied to effectively treat pests and diseases economically in an environmentally friendly manner. Through IPM, the golf course can sustain a healthy turf and vegetation while reducing risks to the environment and human health. An IPM system must begin with healthy turf that is less likely to be affected by disease, insects, and invasive weeds. Improper water management and mowing will stress the turf, and excessive water management is listed as one of the largest producers in runoff and leaching. There are low-risk techniques that the golf course Superintendent can apply to limit the risk and exposure to the environment. The golf course Superintendent should have a system in place and use common sense when using pesticide applications (Skorulski 1991).

Non-point and Point Source Control

Nonpoint source pollution has been determined through many studies to be the leading cause of water quality problems (EPA 2010). Surface water runoff from rain and snowmelt carry natural constituents and manmade pollutants to lakes and rivers. The contaminants affect drinking water, water reservoirs, water recreation, and wildlife. Contributing factors are applied chemicals, fertilizers, herbicides and insecticides on agricultural, residential and commercial properties.

On golf courses, controlling runoff begins with golf course design and continues through maintenance practices to mitigate problem areas. Runoff is triggered from either a rain event or excessive irrigation. Mapping contours on the golf course points to problematic locations with potential for erosion and increased runoff. Depending on the specific golf course conditions, various erosion and runoff control techniques can be used to minimize non-point source impacts on the environment.

Figure 13. Migration of pollutants (Brikowski 2010)

One such technique is directing runoff to wet and dry ponds where vegetation and sediments act as filters for constituents, before runoff makes its way to the ground and surface water sources. Wet ponds (retention ponds) are established to hold runoff water. When combined with a dry or detention pond, the two slow the velocity of the runoff and capture sediment. When the two ponds function with buffer zones, the overall system creates a defense in non-point source pollution control on the golf course by preventing excessive pollutants from entering the water source.

Edge treatments and buffers also work as filters and help to minimize erosion. When no mowing practices are adopted, these water edge treatments provide increased structural stability of the river banks. However, the buffer zone can affect the playability of a golf shot favorably or unfavorably. When selections of plants are poorly managed it can be detrimental to the golfers' view and playability of the shot. The landscape design is important in planning the buffered zone where solutions can be created to improve the playability on the golf course. Solutions can include: raising the fairway above the pond, creating a double shelf in the pond for safety, and selecting low growing plants while discouraging cattails and willows, which may create a visibility problem for the golfer (Colorado Nonpoint Source Task Force 1996). The golfer will be less frustrated with proper selection of vegetation and it allows for runoff and erosion control.

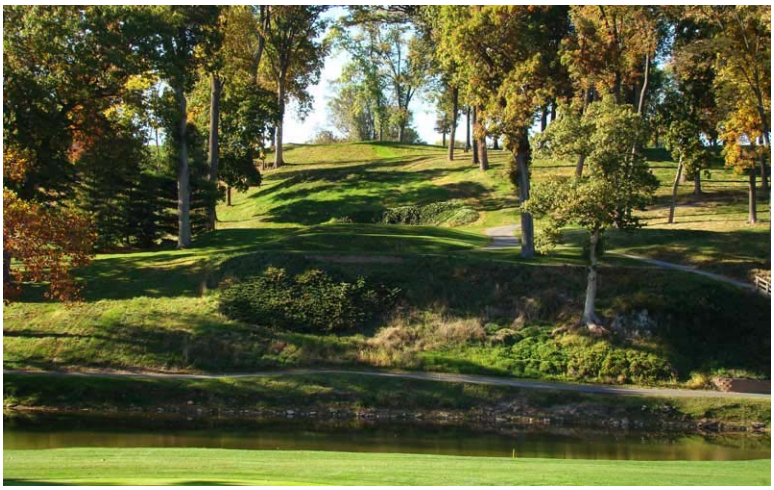


Figure 14. Erosion Control (Golf Club Atlas n.d.)

Figure 15. “Turf Stone™ preserves your green space while reducing storm water run-off. Provides 60% concrete surface with 40% open area for planting grass or ground cover.” (Northwest n.d.)

Topsoil is an irreplaceable natural resource, which can be retained and protected through proper plant selection and reseeding topsoil (Colorado Nonpoint Source Task Force 1996). Good topsoil is needed for healthy plant growth, which acts as a filter to remove contaminants before entering the water source. Reseeding in autumn helps with erosion control, and the winter grass is used for moisture absorption as it is tolerant of cold temperatures. The summer grasses go dormant, leaving the course brown and less absorbent when winter grasses are not present.

Runoff is a concern after the golf course applies fertilizers and pesticides. Proper fertilization and pesticide application lowers the risk of leaching and runoff into water sources. An abundance of fertilizer can increase fungus, and dissolved oxygen levels inhibit higher rates of algae growth. Time release fertilizer and limited applications decrease the threats that fertilizers pose to the ecosystem. There are methods and techniques that lower the need for watering, such as reclaimed water use, which, when used for irrigation, lowers the need for fertilization. Similar practices may likewise improve the economic and environmental condition of the golf course.

Integrated Pest Management is the best management practice used to limit the use of pesticides on the golf course. Native varieties of plants and grasses are more adaptable and

resistant to pests, therefore fewer pesticides to needed to manage the golf course. Using fewer pesticides also reduces the need for frequent watering that can lead to irrigation runoff and leaching. When using IPMs, fewer applications of pesticides are needed when combined with other methods, for example nematodes and compost teas that are used to control pests and disease. Spot applications will control the weeds at onset, allowing the possibility of eliminating pest control applications completely. USDA studies on other organic methods, such as compost tea, microorganisms and Vermicompost, will help prevent fungus and improve the overall health of the turf and plants. (USDA 2009)

Irrigation design and management is the key to controlling runoff. When excess fertilizer and pesticides are applied with excessive watering, there is the potential for chemicals to runoff into surface water or leach into the ground water. Proper Irrigation Management Practices (IMP) will indicate the need to avoid watering during high evaporation rate times. Irrigation management evaluates the amount of water needed through evapotranspiration rates, a calculation method that determines the frequency and quantity needed for proper irrigation. The adoption of proper irrigation methods combined with high-tech methods, such as the use of sensors to indicate water needs and leakage, will help to cut the consumption of water (Sorrow 2009). "Applewood Golf Course in Colorado reduced annual water use by 30 to 40 percent with this approach." (Colorado Nonpoint Source Task Force 1996)

Water sensitive locations require addition management to control runoff and leaching. Lake management controls should monitor nutrients in the water source to determine when there is a change that should be evaluated. Through careful monitoring, the water quality of the sensitive water source can be managed and protected. Some vegetation may be harmful to

water sources, such as weeds, algae and invasive species along the shoreline, which must be removed to avoid an imbalance of necessary nutrients for the health of the aquatic system. Allowing lake and pond water to become stagnant will encourage a breeding site for algae and mosquitoes, so installing a fountain will keep the water moving, discouraging these undesirables. During the winter months, lowering lake levels will allow invasive plants to dry and freeze.

Figure 16 Irrigation Pond (Glencoe Golf Club n.d.)

Another potential NPS pollution is spillage from improper chemical handling. A quick response to the spill and ensuring proper measures will limit water source exposure to chemicals. Equipment wash areas must be in safe protected locations and must limit exposure to chemical leaching and runoff into the water supply.

Water Quality Management

Water is one of the most precious resources for all living things, whose wellbeing is dependent on the quality of surface and groundwater. There are many factors that contribute to contamination of water sources, such as industry, agriculture, high-density urban areas with large impervious cover, golf courses and even natural disasters (US EPA EPA841-F-96-004A). With regard to management of golf courses and water quality management, the USGA is instrumental in encouraging an environmental approach to managing golf courses.

Based on results of research, the USGA made three conclusions with respect to how golf courses affect surface and groundwater: 1) turfgrass is an effective filter, more so than cropland in the study sites; 2) appropriation fertilization and pesticide application show little potential for affecting groundwater and surface water quality; and 3) the potential for contamination is present (USGA 2009). Future studies will address proper fertilization practices and pesticide application in combination with soil types, climates, runoff and volatilization (USGA 2009).

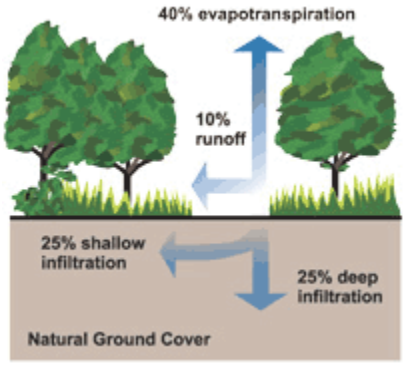


Figure 17 Rural (EPA 2010)

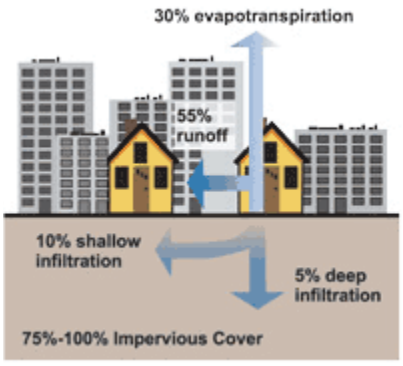


Figure 18 Urban (EPA 2010)

Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface runoff. As little as 10 percent impervious cover in a watershed can result in stream degradation.

The life expectancy of product applied to the golf course is important as a short life product is less likely to leach through soil and root layers and move into water systems (USGA 2009). A product that degrades slowly has a lower potential for moving through the root zone,

through the turfgrass, and into a water supply system. The USGA tested insecticides, herbicides, fungicides, and fertilizers in a variety of soils on golf courses to determine impacts on groundwater and surface water. The results indicated that with a combination of products, proper application, and the appropriate volume of water irrigation, it is possible to minimize contamination (Branham, Milnert and Rieke 1995).

With regard to watering of golf courses, irrigation audits should be frequently performed to ensure that sprinkler heads work properly. Irrigation can be challenging on slopes that are susceptible to high wind or contours that may lead to water pooling. Water applied to the grounds will vary throughout the course. Effective irrigation will help ensure that applied chemicals will not runoff and leach, thereby potentially affecting the ecosystem near a golf course.

Nitrogen abundance is common problem with many fertilizers, especially those containing phosphorous and potassium. When fertilizer is used in excess, water quality monitoring has shown a higher level of nitrate nitrogen. However, a study conducted at experimental sites on ten golf courses, indicated lower potential for nitrogen pollution due to thick turfgrass. On these courses, little inorganic nitrogen leached from the turfgrass system and the potential for water pollution was low (Tom Rufty 2004). The turfgrass root system was found to be a very dense matrix, several inches deep, with a main root system extending as far as two to three feet, which allowed nitrogen to

Figure 19. Algae Growth (Mad Russian Golf Course 2009)

be taken up by the soil and root system (Tom Rufty 2004). As discussed previously, a healthy and well-maintained turf can minimize the impacts that a golf course may have on the environment.

The introduction of fertilizers into water sources can result in excessive algae growth and decreased dissolved oxygen (Angela Bramble 2009), and excessive algae growth can hinder the survival of micro-organisms (Munn and Hamilton 2003). Planting buffer zones with native vegetation can slow runoff containing fertilizers, lowering the impact on aquatic ecosystems near the golf course. In addition, retention and detention ponds are often located in lower elevations of the golf course and are used to control chemical runoff from the turfgrass (Connecticut Department of Environmental Protection 2006). Carefully designed retention and detention ponds, in conjunction with the buffer zones, will help in filtering or slowing the flow of runoff that may contain chemicals.

The phrase “less is more” can be applied to watering schedules and chemical applications on a golf course. When grass clippings are left on the turf, over time they naturally release nitrogen, a key nutrient in fertilizers. This practice, along with other turf management measures, can minimize the need for fertilizers. In locations where native plants are established on golf courses, fewer chemicals may be needed over time as these plants adapt to their native environment and require less maintenance than non-natives (Dorner n.d.).

Reclaimed water, or treated waste water, may be applied to golf courses so as to provide important nutrients needed for plant growth. When used correctly, reclaimed water should not have adverse effects on the environment. This helps the golf course sustain healthy vegetation while conserving potable water resources. “Proper use of this resource, coupled

with reduced fertilizer applications, could potentially retard pollution of rivers, streams and other water bodies beyond golf course boundaries" (Kevin W. King 2000).

Monitoring and Evaluation

Monitoring the effectiveness of golf course BMPs through regular water quality testing provides data important to long-term planning, changes in applications, and pest management. Water quality test records are important tools for maintenance and adjustments to scheduled applications. Analysis of the data on a regular basis will provide information for corrective action as necessary to improve the golf course BMPs. According to Audubon International the following parameters should be included in water quality testing:

- pH
- Temperature
- DO (dissolved oxygen)
- Turbidity
- Physical characteristics
- Pesticides
- Macro-invertebrates
- Total phosphorous
- Nitrate-nitrogen

Water quality tests may also include chlorophyll content and nutrient (nitrogen and phosphorous) levels (Angela Bramble 2009).

Thorough record keeping assists in monitoring the maintenance and operational movements of the golf course. Chemical storage records should note what products have been and are currently stored, and how the products are stored, to ensure proper care and prevent spillage or leakage. Good records inhibit easy referencing during annual reviews of golf course policy and laws, which affects the storage and clean up of spills. Spill notification ensures proper clean-up. Regular audits and review of maintenance facility practices will aid in finding potential issues and insure that practices are in line with protecting the environment.

The following information is needed to evaluate and monitor activities on the golf course. Effective management will involve reviews of the course maintenance plan and a process to make changes as necessary. Golf course maintenance records will include a review of BMPs and monitoring data over time.

- Amount, type and date – fertilizer applied
- Amount and process – irrigation usage
- Amount and type – products in storage
- Amount, type and date – pesticide use
- Water quality sample results
- Climatic conditions
- Pest infestations
- New practices implemented

Analysis of water quality monitoring data can indicate when over-application of golf course chemicals has occurred. Water quality should be monitored consistently in multiple areas, and measurement data should indicate the effects of chemicals on the water supply. Monitoring water samples upstream and downstream from the golf course will allow a comparison of possible pollutants. When compared to fertilizing and watering schedules, water quality data will indicate the effects of chemical applications on the golf course. Analyzing results from water quality samples will indicate if changes are necessary in fertilizing and irrigation schedules and amounts. Turf Managers can be pro-active in protecting nearby aquatic ecosystems when water quality testing reveals unbalanced ecosystems due to golf course practices.

Water Conservation

Water conservation has historically been met with negative connotations from the golf course community. Water conservation is associated with using less water which may result in the death of plants or grasses on or near the golf course. As a golfer, there are certain expectations that the course will have lush green grass with white sand in the sand traps. However, these expectations now are shifting to concerns over protection of water resources and the environment. As Superintendents learn more about water conservation that positively benefits their golf courses, application of that knowledge creates a positive effect for the livelihood of the plants and animals while the economic stability of the golf course improves. However, Superintendents must communicate the protective measures necessary to improve the environment through education and outreach to the local community. The positive affect that water conservation can have on the community as a whole is instrumental in the success of the golf course.

Figure 20. Alternative Water (Chandler Arizona 2010)

Conservation must begin with course design, including plans for proper irrigation and alternate water sources, such as rain water capture and the use of runoff and reclaimed water. While the initial capital expense to retrofit the golf course with the proper irrigation system for

reclaimed water and rainwater and runoff capture can be high, long-range budget studies on water conservation have demonstrated varied benefits, including future reduced water costs.

Conservation measures can produce positive changes in the golf course environment; for example, cart paths with curbs can be used to direct runoff to retention and detention ponds for irrigation. Cart paths can be made from porous material, called permeable pavements or pavestones; these materials allow runoff to be absorbed into the ground, lowering the amount of runoff that reaches surface water sources. Rainwater capture mechanisms can be incorporated into the roofing of onsite facilities, allowing surfaces to funnel rainwater into cisterns, barrels or other capture tanks. Rainwater capture systems thus provide an alternative source for water, using less municipal (potable drinking) water. In addition, rain water naturally has a good pH balance and is better for plants than tap water that typically contains additives such as salt, chlorine and fluoride (Zilker Botanical Garden n.d.).

Water conservation in the outdoors includes use of native plants wherever possible. Golf course landscape designers are increasingly considering the benefits of native plants in specific areas of a course. When ornamental plants are used, additional maintenance and water is required (Wade and Sparks 2009). Native turfgrass typically requires less water and exhibits a greater resistance to local diseases and pests (Natural Resources Defense Council n.d.). Using native plants can support reduction in water use as well as application of lower volumes of pesticide, herbicide and fertilization products. Golf course design that accounts for low-maintenance, low-water native plants and turf grasses for the region, can in term limit excessive use of water resources.

Excessive use of water can be minimized through the correct selection of plants and grasses. Once the selection of plants has been made, the next design element is the irrigation plan, which should take into account the type of water used in the region. Some areas have brackish water or hard water that affect the efficiency of irrigation systems. Part of the irrigation plan will incorporate alternative water sources such as reclaimed water. Large quantities of reclaimed water are available at lower costs than potable water, resulting in a cost effective solution in overall golf course water conservation.

Using reclaimed water is a clever way to manage irrigation because golf courses are generally located in populated areas where wastewater is generated in large quantities. This source of water is obtainable at a much lower cost, sometimes free, because the utility district costs are higher to produce safe drinking water than to produce reclaimed water (DSRSD, Dublin San Ramon Services District 2006). Impacts to golf courses and the environment are minimized because the final reclaimed water product used on the golf course is regulated by the EPA (US EPA 2004). Primary treatment of wastewater will remove suspended solids, but the water product is inferior to drinking water. Therefore, the golf course will need the proper irrigation system to manage reclaimed water (Zupancic 1999). Also, reclaimed water has more nutrients that are environmentally friendly, such as nitrogen and phosphates that are found in fertilizers (Agricultural Water Stewards n.d.). Where such nutrients are present in reclaimed water, the quantity of applied fertilizer can be lessened because reclaimed water will fertilize the plants much like manure does. Golf courses designed and built with the latest technology possess environmental and economic advantages over their existing courses, despite the additional expenses.

Research has developed positive changes in the golf industry, where sophisticated computerized systems can now be used to control turf irrigation. Golf course Superintendents have the capability to use portable handheld controllers to apply water to the golf course turf. This will allow the selective watering of areas that need more or less water, possibly due to higher amounts of wind exposure or greater threats of irrigation runoff. Selective watering allows for just the right amount of water to be applied, allowing golf courses to conserve more water.

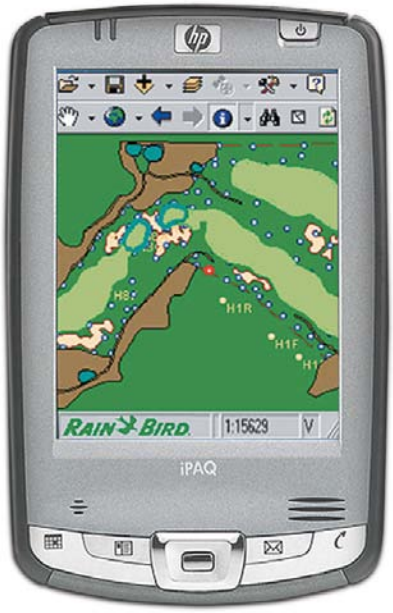


Figure 21. Golf Irrigation Mobile Controller (Rainbird 2010)

Another conservation approach can include something as simple as checking for sprinkler leaks while checking on the course in general. The golf course water conservation plan should include regular, recorded audits on the whole irrigation system. The golf course plan should develop a variety of sustainable landscaping practices to protect the environment.

Educating golf course employees is important when incorporating water conservation plans to ensure that all employees are good stewards of the environment. There are educational opportunities available to golf course personnel through many trade magazines, and through organizations such as the Golf Course Superintendent's Association, the USGA and the Audubon International Association. Educational outreach for golfers, and the public, is also important. Successful water conservation programs will help shift expectations of lush green turf to a green environment obtained through sound land management, using a lower amount of chemicals, and conserving water. For example, signage on the golf course that point out

sensitive areas such as plant and animal habitats, can be educational opportunities to explain why the area is protected. Reaching out to the community, such as showing important habitats, is a great opportunity to offer photographers time on the golf course to photograph nature in their community.

A successful water conservation plan will be transparent to the community and engage in activities that build environmental awareness. Partnering with water conservation organizations and water districts will improve the region's environmental and water conservation efforts. A partner with similar goals in water conservation and water efficiency can join together in sharing issues and resolutions with others, especially in education and outreach efforts. Such actions on the part of the golf courses will foster respect from the community for being pro-active to the environment.

Wildlife and Habitat Considerations

"A healthy environment is good for golf, and golf can play a vital role in enhancing the natural environment" (Peter Stangel 2006). Historically, golf courses' concerns were focused around the fairways, tee boxes and putting greens, but as more emphasis has been placed on environmental issues, the golf courses now recognize areas outside of the playing areas. The golf course can support and protect native wildlife habitats without compromising the golfers' game (USGA; National Fish and Wildlife Foundation 2006). Golf Course Superintendents are rising to the challenge of planning changes that will attract golfers and wildlife. A golf course BMP for environmentally sensitive areas will help the golf course develop a plan for increasing wildlife populations and nurturing habitats for plants and animals.

The first step to designing a wildlife-sensitive golf course is to map plants and unobtrusively track animals that are attracted to habitat locations around the golf course. Wildlife research studies can be used to determine the necessary types of food and shelter needed for specific species. The golf course plan should encourage support for wildlife by adding habitats that provide food, water and shelter, including both natural and alternative sources, such as bird feeders, baths and houses.

Figure 22. Roseate Spoonbill (Barefoot Bay Golf Course n.d.)

The second step is to research how the golf course can provide habitat that will attract new species to the course. The plan can design areas where natural food and shelter already exists or can be enhanced for wildlife habitat.

Figure 23. Shelter (Underwood 2008)

The third step is designing areas for the protection of endangered species. Research on the region's endangered species and what can be done to bring them back to the area is fundamental to this step. Golf courses can be excellent refuges for wildlife, and as the golf courses increase the size of the wildlife habitat, golfers will notice an increase in wildlife activity.

The fourth step in the golf course plan is to use out of play areas as natural corridors, connecting habitats and allowing wildlife to travel safely. Special attention to areas along water will encourage the presence of amphibians and other wildlife where diversity is needed for a healthy ecosystem. The diversity of the buffer zone is dependent upon the area size; a no-mow area and restrictions on chemical application can increase an area to 10-30 feet from the water's edge (Lampman n.d.). When chemicals are limited within 10-30 feet of the water, there will be a noticeable increase in amphibian and other animal life (Peter Stangel 2006, 14). Because most amphibians are nocturnal, the golfers may not notice the increase in population but birds will be attracted to such prey, so an increase in birds frequenting the area may also occur (Mayntz n.d.). To encourage frogs and other amphibians in the area, allow rocks, logs and fallen trees to be used as shelters for these animals (Peter Stangel 2006, 13). Managing the

golf course's wetlands may be the most important component in wildlife protection. This goal may be made easier by planting native plants that can thrive on their own. The wider the buffer zone, the less grass that needs to be treated and mowed. This part of the wildlife plan will reduce the golf course budget by decreasing the needs for mowing and chemical application.

The fifth step in the golf course's plan to encourage wildlife is to educate golf course personnel, the public, and the golfers. The wildlife conservation plan must engage everyone through communication and education for the program to be successful. Implementing an outreach program for the community can engage youth groups in activities, such as building birdhouses or surveying golf courses for plants and animals. Youth organizations can be active members in the plan and can take part in the initial wildlife count before and after changes are implemented on the golf course. Communication of the golf course wildlife management plan to the community is important. Golf courses rely on the positive experiences of their clientele; without golfers, a golf course will be unable to meet its operational costs. It is a challenge is to develop a solid plan to protect wildlife while engaging golfers, as well as the public. There is a delicate balance between the environment and the game of golf that requires ongoing adaptation. As Golf Course Superintendents realize the benefits of building natural habitats for wildlife, they will also achieve recognition as environmental stewards in their communities.

Golf Course Sustainability

To better visualize golf course sustainability, an appropriate definition of sustainability provides a base. The definition used for this report is *protecting the needs of future generations through economic stability, caring for the environment and being socially responsible* (Mariano n.d.). Yesterday's golf courses were designed to be beautifully manicured with lush green grasses, free of weeds. Golfers who have this vision are affected with "Augusta Syndrome", where they watch The Masters Golf Tournament and have the vision burned into their perceptions of the game of golf (O'Conner 2010). Golf courses designed and built today are more frequently done with a minimalist approach, seeking places within the design to have the least impact on the environment, as seen in the links-type golf courses in Scotland. When environmental sustainability is applied to the golf courses, social responsibility falls into place and economic stability occurs through minimizing daily maintenance of the golf course.

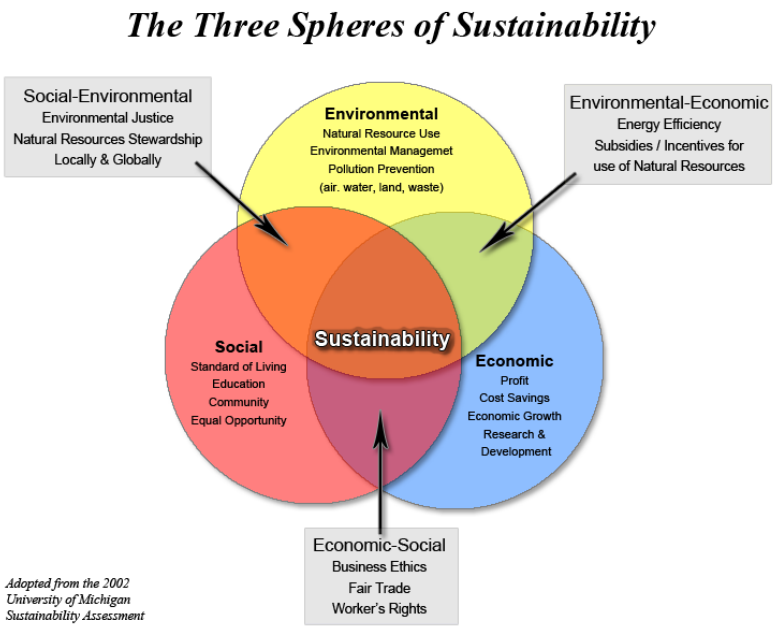


Figure 24. Three Spheres of Sustainability - Economy, Society and Environment (Temple University, Office of Sustainability 2009)

Sustainable targets for golf courses include reductions in the need for potable water by use of alternative water sources and water conservation through proper plant selection. Regularly scheduled maintenance and enhanced irrigation management practices are sustainable targets. To remain economically

and environmentally sustainable, the golf course should not only conserve water and utilize alternative water sources such as reclaimed and captured rainwater where possible, but also maintain water quality standards around the course.

Golf Course Superintendents have begun advancing their pursuit of sustainability through their new organization, The Environmental Institute for Golf, which focuses on water conservation, water quality protection and energy conservation, outlining the foundation of environmental responsibility (Golf Course Superintendent Association 2010). In addition, the American Society of Golf Course Architects defines the value of the golf course through three pillars of value – environmental, social and financial (Architects 2010). This Society is dedicated to educating the golfer and the community through communication of their three pillars of sustainability that demonstrate the contributions of golf and the benefits generated by environmental protection. Golf course sustainability depends on organizations such as these to continue to educational outreach in the importance of considering the environment when designing, playing, and maintaining golf courses.

Certification Programs

Golf courses located in environmentally sensitive regions follow more stringent BMPs so as to safeguard natural resources. As a result, such courses acting to protect the environment will experience benefits such as naturally attract wildlife. In addition, golf courses with strict BMPs will qualify for certification programs that will set them apart as leaders in the golf industry.

Figure 25 Certification Signage (Glencoe Golf Club n.d.)

There are several certification programs available to environmentally friendly golf courses. Golf courses following strict BMPs should apply for at least one certification program, buy may be eligible to apply for other programs in their region. Some certification processes are simple and inexpensive, while others require annual dues or involve lengthy certification periods. Certification programs can be created through local, state, federal, international and private associations. Researching available certification programs can help determine for which programs are eligible for a particular golf course. Most certification programs have similar qualifications including provisions for food, water and shelter for wildlife. After the certification process is complete, budgets should be adjusted for signage that provides educational opportunities.

National Wildlife Federation – Certified Wildlife Habitat

"By providing food, water, cover and a place for wildlife to raise their young--and by incorporating sustainable gardening practices--you not only help wildlife, but you also qualify to become an official Certified Wildlife Habitat™" (National Wildlife Federation 1996). The National Wildlife Federation has a simple, inexpensive process. There are five key features that the National Wildlife Federation requires:

1. **Provide food for wildlife** – Native plants are important to attract local wildlife. Wildlife will seek native plants to provide food and shelter. Supplemental sources of food, such as feeders, are good alternate sources, especially when food is difficult to find during a drought. "***Your habitat needs three of the following types of plants or supplemental feeders:*** Seeds from a plant • Berries • Nectar • Foliage/Twigs • Nuts • Fruits • Sap • Pollen • Suet • Bird Feeder • Squirrel Feeder • Hummingbird Feeder • Butterfly Feeder.

Figure 26. Provide Food (Reeves 2010)

2. **Supply water for wildlife** – Clean water sources are needed for drinking, bathing and, for some species, reproduction. Wildlife will search for natural sources of water as their primary source and bird baths and water garden features are great alternative sources. "***Your habitat needs one of the following sources to provide clean water for wildlife to***

drink and bathe: Birdbath • Lake • Stream • Seasonal Pool • Ocean • Water Garden/Pond • River • Butterfly Puddling Area • Rain Garden • Spring."

Figure 27 Provide Water and Shelter (Lake Park Golf Club 2008)

3. **Create cover for wildlife** – Cover creates a safe environment from predators and weather events. Native plants should be carefully selected with consideration of the habitat environment needed for each species. Alternative safe havens for wildlife can be dead trees, logs, brush and rock piles. "***Wildlife need at least two places to find shelter from the weather and predators:*** Wooded Area • Bramble Patch • Ground Cover • Rock Pile or Wall • Cave • Roosting Box • Dense Shrubs or Thicket • Evergreens • Brush or Log Pile • Burrow • Meadow or Prairie • Water Garden or Pond."
4. **Create a safe place for wildlife to raise their young** – Research the species that the golf course would like to attract and adopt suggestions for their natural habitats. If bird houses will be needed, make a project for a Girl Scout or Boy Scout troop. For example, many butterflies require different plants for laying eggs and pollen for their food source. A variety of species use wildflowers to hide and lay eggs; if there are locations where native wildflower seeds can be introduced, make sure it is a "no mow" area. "***You need at least two places for wildlife to engage in courtship behavior, mate, and then bear and raise***

Figure 28. No-Mow Habitat Buffer Corridor (Weick 2008)

their young: Mature Trees • Meadow or Prairie • Nesting Box • Wetland • Cave • Host Plants for Caterpillars • Dead Trees or Snags • Dense Shrubs or a Thicket • Water Garden or Pond • Burrow."

5. **Let your wildlife area go** – The reduction of chemicals will have a very positive effect on wildlife and the environment. Most golf courses in environmentally sensitive areas have already made the commitment to reduce chemical application to the course due to the regulatory need for protection, such as in wetlands regions (EPA 2009). Native grasses that the golf course selects for turfgrass will be better suited to the area, being drought resistant and more resistant to local pests than ornamental grasses. Using mulching mowers and locating an area for composting will generate good soil to reuse on the golf course. "***You should be doing things to help manage your habitat in a sustainable way.*** **Soil and Water Conservation:** Riparian Buffer • Capture Rain Water from Roof • Xeriscape (water-wise landscaping) • Drip or Soaker Hose for Irrigation • Limit Water Use • Reduce Erosion (i.e. ground cover, terraces) • Use Mulch • Rain Garden. **Controlling Exotic Species:** Practice Integrated Pest Management • Remove Non-Native Plants and Animals • Use Native Plants • Reduce Lawn Areas. **Organic Practices:** Eliminate Chemical Pesticides • Eliminate Chemical Fertilizers • Compost."

Texas Parks and Wildlife – Texas Wildscapes Certification

Texas Parks and Wildlife has a certification program called Texas Wildscapes, which supports habitat restoration and conservation in both rural and urban areas. The program helps citizens of the State to "contribute to wildlife conservation by developing wildlife habitats where they live, work and play" (Texas Parks and Wildlife 2010). The Texas certification is very similar to the National Wildlife Federation, as the key elements provide wildlife with food, water and shelter. Listed below is the checklist for certification (Texas Parks and Wildlife 2010):

Figure 29. Texas Parks and Wildlife Certification (Texas Parks and Wildlife 2010)

- At least 50% native plants
- Food for the wildlife year round. A feeder alone will not be considered, but if at any time there is not food available for the wildlife from plants, a feeder would then be required.
- Shelter for the wildlife. This might include various plant features, should include plants in each of the tall trees, understory, shrubs, bushes and wildflowers; may include nest boxes, brush piles, rock piles, toad houses and other shelter projects.
- Water in a useable, reliable form for the wildlife.
- Wildscapes certification fee is $15.00.
- Best of Texas Backyard Habitat certification fee is $28.00, payable to the National Wildlife Federation.

Audubon Cooperative Sanctuary Program for Golf Courses

"The Audubon Cooperative Sanctuary Program for Golf Courses is an award winning education and certification program that helps golf courses protect our environment and preserve the natural heritage of the game of golf. By helping people enhance the valuable natural areas and wildlife habitats that golf courses provide, improve efficiency, and minimize potentially harmful impacts of golf course operations, the program serves as vital resource for golf courses" (Audubon International, Inc. 2009).

Figure 30. Audubon International Certification (Audubon International 2010)

To become a member, a golf course is required to be certified, with annual dues set at $200. Membership and certification is open to all golf courses that meet the requirements. Audubon International has a checklist for the golf course that acts as a guide for planning and organizing the certification process. The checklist is designed to implement changes on the golf course that will compliment the adoption of environmental management practices. Golf courses located in an environmentally sensitive area rich in natural resources, will be familiar with the checklist for certification since most items on the checklist following the BMPs. There are five environmental quality areas as outlined below (Audubon International, Inc. 2009):

1. **Wildlife and Habitat Management**

   "The golf course enhances existing natural habitats and landscaping to promote wildlife and biodiversity conservation. Flexibility is essential to account for each course's location, size, and layout, as well as special wildlife species and habitat considerations."

2. **Chemical Use Reduction and Safety**

   "The golf course implements best management practices at the maintenance facility and on the course to ensure that chemicals are stored, handled, applied, and disposed of safely. In addition, maintenance staff employs integrated pest management strategies to track and target specific pests and minimize chemical use."

3. **Water Conservation**

   "The golf course employs conservation management strategies to maximize the efficient use of water. These include maximizing irrigation efficiency; determining proper irrigation; reducing irrigated acreage where possible; recapturing and re-using water; and incorporating drought-tolerant plant species."

4. **Water Quality Management**

   "The golf course implements Best Management Practices to eliminate potential nutrient or pesticide contamination of water sources. The course also employs environmentally-sensitive management practices in ponds, streams, and wetlands; proper equipment and chemical storage and handling; and water quality monitoring to verify results."

5. **Outreach and Education**

   "Golf course personnel build support for their environmental management program through a variety of communication, education, and outreach activities. They also form a Resource Advisory Group of people who provide technical advice and volunteer assistance to help implement the environmental plan. This helps to ensure the long-term success of environmental management practices, especially if staff assignments change."

The Audubon International certification is very involved and completion will take more time than other programs. The program lists the certified golf courses on the Audubon International website. In North America, there are 760 certified golf courses, resorts and communities (Audubon International, Inc. 2009). A certified golf course will be set apart from non-member courses, as this elite certification program rewards the community with environmental and economic benefits, highlighting the efforts that the golf course has achieved in protecting the environment and local wildlife.

Example of an Environmentally Sensitive Golf Course

The above discussions provide a preliminary evaluation of potential BMPs for environmentally sensitive golf courses. This section reviews and evaluates BMPs and the sustainability of a golf course located in a sensitive region.

Balance within the pillars of sustainability will require economic, social and environmental responsibilities for a golf course to survive (Robinson 2010). The social and environmental responsibility is of equal importance to the economic responsibility of the golf course. Golf courses located in sensitive areas will have more regulations and the amount of applied chemicals and the water allotted to the course will be limited. As an eco-friendly organic golf course, the turf may show signs of neglect through the golfers' eyes when they are unfamiliar with the sensitive nature of the area. The golfer might be unforgiving and choose to not play the golf course in the future. This could affect the economic viability of the golf course if golfers choose other golf courses with greener turf. However, using fewer chemicals and less water will reduce the economic burden on the golf course's budget if golfers continue to play at the golf course.

As noted in the Introduction to this report, the Texas State University Golf Course is located adjacent to a unique water system comprised of Spring Lake, the headwaters of the San Marcos River, and artesian springs of the Edwards aquifer. Spring Lake is one of the most biologically diverse aquatic ecosystems known in the southwestern United States. It has a number of threatened and endangered species, and species that are unique only to the Lake. Artesian groundwater from the Edwards aquifer emerges into the lake from approximately 200 openings. This spring system is the second-most productive in the state. In recorded history,

San Marcos Springs has never run dry. The Lake and river are a vital resource for the community and its sustained health is of the utmost importance for San Marcos, for Texas, and the nation.

The Golf Course is also adjacent to the Sink Creek tributary that feeds the Slough Arm of Spring Lake. The Slough Arm, unlike the main body of the lake, receives most of its water from Sink Creek, and is the lake's only significant surface water tributary. It is a likely source of significant nutrient input into the lake. Currently the Sink Creek watershed is experiencing rapid and major land use changes. Rapid urban development along the I-35 Austin-San Antonio corridor has led to a substantial increase in impervious cover and urban lands in the watershed. Because Sink Creek discharges into the relatively shallow and productive Slough Arm of Spring Lake, incidents of high precipitation and high surface waters inflows may function as the major contributor to the deterioration of lake water quality.

The Texas State University Golf Course sits atop the Edwards limestone which drains directly to the Edwards aquifer. The golf course is located on the edge of the Balcones Fault Zone, where a demarcation of the Edwards limestone can be observed on the 5th fairway. The karstic limestone is porous with fractures, caves, sinkholes and small openings that allow water to flow directly to the Edwards Aquifer.

Because the San Marcos Springs are located within the artesian zone, application of any chemicals and watering must be monitored closely so as to not affect the aquifer and creek. The Texas State University Golf Course management is sensitive to the needs of this environmentally protected area. BMPs for environmentally sensitive golf courses are a natural fit for RSI and Texas State University due to their projects, community awareness, and locations adjacent to the San Marcos Springs. Texas State University Golf Course is cognizant of the

protected area in which they are located and have taken the responsibility to applying as few chemicals to the turf as possible.

Texas State University Golf Course is currently managed by the Assistant Director of daily operations of the golf course and onsite personnel. The University Director of Recreation manages the golf course through Campus Recreation and Student Affairs. The golf course Director's interactions with RSI include setting performance goals for the golf course's reduced environmental impact. Turf management is directed by the Golf Course Superintendent through the golf course maintenance facilities team. Texas State University Golf Course has BMPs that are implemented at the course and maintenance facility. Texas State University retains ownership of the golf course and oversees the course's management practices.

Irrigation methods at the golf course involve the use of water directly pumped from Spring Lake for half of the golf course while the other half uses municipal water. The water pumped from Spring Lake uses a water pump with a timer. To conserve water, the pump is manually shut off by staff when it rains. Irrigation is suspended when excess moisture is in the air, during instances such as fog, dew and high humidity, as the watering schedule is altered to conserve water. The golf course is given an allotment of water from the springs which cannot be exceeded. In fact, the golf course's lake water usage is generally far below their scheduled allotment (Zimmerman 2010). October is generally a time that the golf course uses more water when over-seeding the greens and tee boxes prepares the course for its winter requirements for seed germination.

The Texas State Golf Course uses Integrated Pest Management. The golf course does not use any pest control and they only slow the growth of weeds by using a pre-emergent

fertilizer that slows development of target weeds. The pre-emergent compounds are used infrequently and are only applied to the greens so not to disrupt areas close to the water. A holistic approach allows the Superintendent to use alternatives to chemicals. For example, baking soda and vinegar are used to fight weeds and cornmeal to inhibit fire ants (Green Living Tips 2008). The Superintendent tests these possible solutions at sample areas and evaluates their effectiveness.

The golf course tests for grubs on a regular basis by cutting a section in semicircle and folding the grass back for inspection. They have a standard of acceptable grubs per square inch that they have never exceeded, therefore no treatment has been needed for grubs. On the 9th green, the grass is discolored and they have ruled out grubs as the culprit. They believe that the discoloration of the green is from cypress tree roots tapping into the water and root system of the grass. Nothing has been determined as the cause and no treatments have been applied to this issue. The golf course does not have a pest problem other than complaints about ants.

Fertilizer is applied once a year only to the greens and tee boxes when the Superintendent over-seeds for winter grass. Throughout the year, fertilizer is applied only to the greens, normally up to a few times a year (see the fertilizer log attached). The fertilizer applied to the golf course has only nitrogen (21-0-0), which is short lived for maximum of two weeks. Fertilizers and other products are used sparingly and only on an as needs basis.

Texas State University has a disposal plan for chemicals and spillage and safety standards that the golf course must follow at all times. The University has an extensive spillage cleanup plan that is part of the Safety Manual from the Environmental Health, Safety and Risk Management page (Texas State University 2006). The University is notified if any spill occurs,

and procedures are followed to address the spill properly. Granular fertilizer is stored on pallets in the maintenance facility, where it is carefully stored until it is needed. The Superintendent looks for holes in the bags and if any are found, the bag is sealed with tape and the spill is noted on the bag. Gloves and safety goggles are always worn during clean-up, even when the product does not recommend the use of gloves. The maintenance crew will pour cat litter on the spill and call the university for clean up. The University will then come to remove the litter and dispose of it properly, at which time the University will decide if further action is needed.

Fertilizers and pre-emergent weed compounds are stored in the maintenance facility building. During the winter when the heater is used, the fertilizers, pre-emergents, gas, and oil are stored in the shed. Ronstar, a liquid pre-emergent, is not intended to kill weeds, but is used to create a buffer to prevent weed growth on the turf.

Figure 31 Buffer (Texas State University Golf Course 2010)

Non-point source pollution is a concern around the lake, creek and springs at the golf course. Improvements have been made to limit non-point source pollution from the golf course. Wherever the golf course is adjacent to water, the course design includes an 8-10 foot vegetation buffer to protect Spring Lake and Sink Creek. There are no retention ponds on the golf course to collect runoff. Areas requiring attention is

the Pro Shop, which exhibits poor drainage, and other areas where drainage is a problem during major rain events.

There are four water crossings, two at RSI and the other two on Burt Brown Road, close to the club house. The water crossings share two bridges for golf cart crossings over Spring Lake and Sink Creek.

Water quality monitoring is conducted by RSI/Texas Stream Team, the Edwards Aquifer Authority, and the City of San Marcos. Texas State Golf Course monitors its water quality. The Superintendent and the Assistant Director's office is a central location to store records for easy access to analyze data. Water quality sample records have been compiled by the Texas Stream Team, but the records are intermittent, and without a regular schedule it is difficult to compare with the intermittent fertilizing schedule. Should the golf course take charge of water quality monitoring and record keeping, it will speed the process to revealing any signs of water contamination.

Water conservation measures have been determined for the golf course through an established monthly allotment of water usage. Limiting water coverage, the golf course uses less than their allotted amount, even during droughts. The pump house at Spring Lake is located between the ProShop and the 3rd green. The meter is read by the Assistant Director of the golf course and is reported to the Texas State University facilities department via email. The Assistant Director reports only the number on the meter and does not keep the records; keeping these records at the Pro Shop is strongly advised to allow management greater accessibility to the records.

Determining proper irrigation methods is handled by the maintenance crew and the Superintendent. The Superintendent manually turns off the irrigation system when natural moisture events develop. The maintenance crew will monitor the course conditions and weather to determine when watering is needed. If there is an exceptional amount of dew in the morning they will alter the water scheduling to take advantage of the natural source first. After a major rain event, the Superintendent will determine when the normal watering schedule should resume. A rain sensor mechanism can improve water consumption and is preferred to the manual shut off. In addition, the golf course maintenance installed a valve stop that will shut off all water when it reaches the set limit.

As another conservation measure, the golf course should explore rainwater capture. In addition to the small Pro Shop, the maintenance facility has two buildings which can be evaluated for rain water capture, limiting runoff from the area that contributes to non-point source pollution.

Because of the sensitive nature of the water source, the course only uses drought-tolerant plants, most of which are native to the area, and the golf course does not have plans to add additional plants at this time. The maintenance crew does not water any plants, with the exception of accidental irrigation runoff from the greens and tees. The buffer zone is found throughout the golf course, located anywhere that golf course meets water. This buffer zone, planted to protect the water sources, is comprised of native plants and grasses, which were used to prevent the need for addition water.

Buffer zones play an additional role by protecting wildlife habitats. The golf course has received complaints about the buffer zones, but its staff is attempting to educate golfers to the

needs of local protected wildlife, which golfers may encounter while visiting the golf course. Through education, the golfer will understand the protective measures made by Texas State University Golf Course. The buffer zones enhance existing landscaping, and its natural habitats promote the conservation of wildlife and biodiversity.

Figure 32. Hose for watering (Texas State University Golf Course 2010)

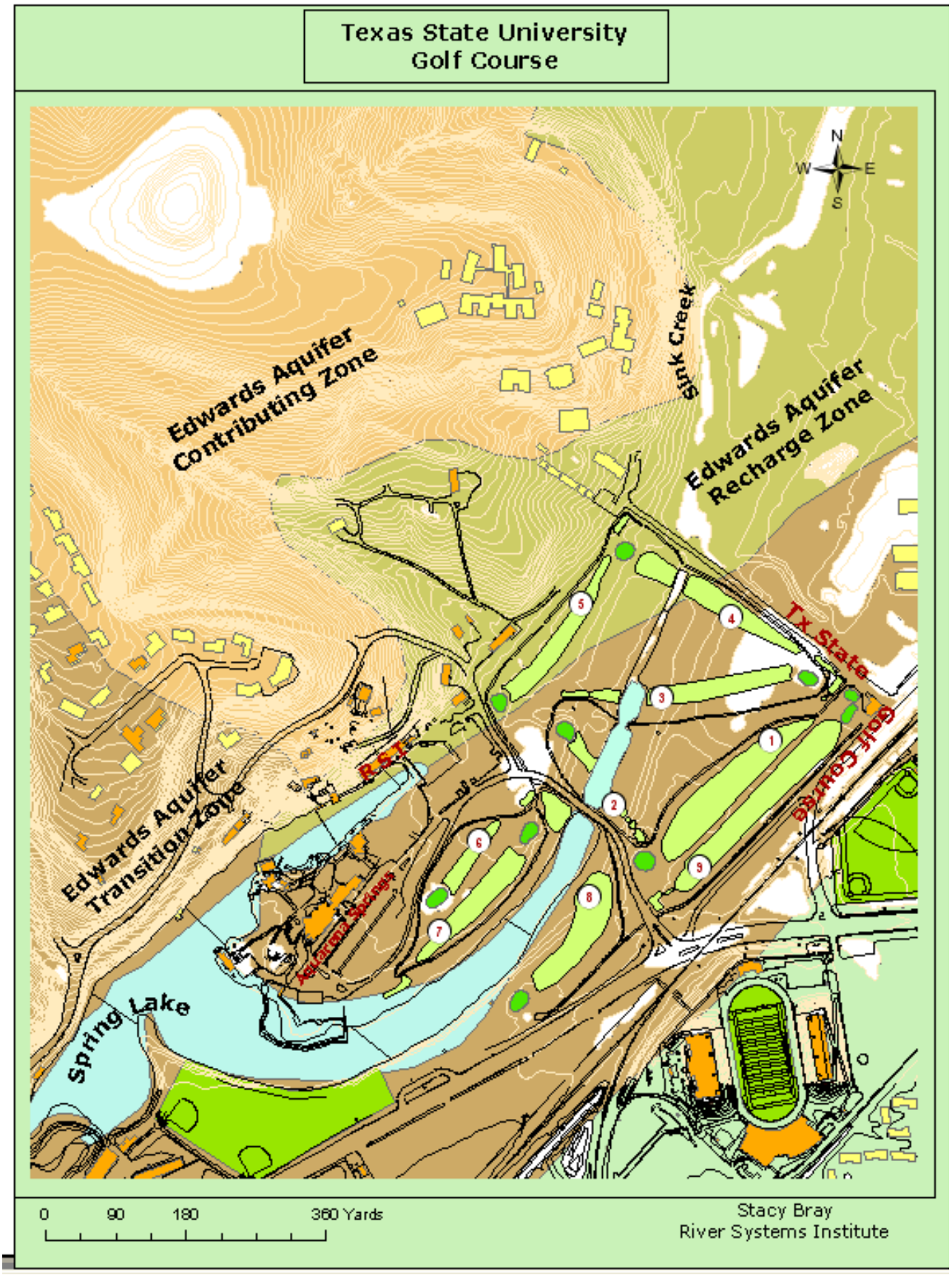
Wildlife sighted on the Texas State Golf Course include hawks, deer, horned owls, coral snakes, several species of turtle, ring tail cats, bobcats, armadillos, black rock squirrels, and deer, among other wildlife.

The black rock squirrel is rare and no longer is found at the golf course because the university removed its rock pile habitat. A rock pile feature can be placed on the golf course to encourage the return of the black ground squirrel. The golf course takes protective measures when turtles reproduce and lay their eggs, such as informing golfers how to care for the turtles and their eggs and especially advising the golfers to not disturb the turtles during mating season.

Texas Parks and Wildlife has expressed an interest in certifying the Texas State University Golf Course as a Texas Wildscape. Texas Wildscape is a conservation plan for the protection of habitats in rural and urban areas. The golf course also qualifies for the National Federation of Wildlife, a certification that will be obtained in 2011 along with the Texas Parks and Wildlife certification. The most difficult certification to obtain is the Audubon International

Sanctuary Certification, where the document preparation and organization of the golf course's records will take several months.

Communication will be instrumental in teaching the public and the golfers about the environment that the golf course is protecting. There will be educational outreach opportunities at every tee box area explaining what to expect along the hole. Interpretive signs will give the golfer information about protected species. Outreach opportunities for youth organizations will engage them in environmental stewardship by building bird houses or other projects that will allow youth to have an opportunity to enjoy nature on the golf course. Before each round of golf there should be something the Pro Shop that gives the golfer information on what they can do to help the environment. Texas State University Golf Course manages 19,000-23,000 rounds of golf annually, therefore outreach is a tremendous opportunity to teach environmental stewardship.


Texas State University
Golf Course
N
W
E
S
Edwards Aquifer
Contributing Zone
Sink Creek
Edwards Aquifer
Recharge Zone
Tx State
Golf Course
R.S.I.
Edwards Aquifer
Transition Zone
Spring Lake
0
90
180
360 Yards
Stacy Bray
River Systems Institute

Conclusion

In many situations, protecting the environment is in line with common sense. The approach of using fewer chemicals creates a sustainable environment that may attract more wildlife. The minimalist approach, using fewer natural resources and leaving more for future generations, is also a basic principal behind sustainability (Sustainable Footprint 2003). This common sense approach of using less at golf courses is economically and environmentally responsible; while using fewer chemicals, the approach also protects the environment and wildlife. Environmentally sensitive areas will be protected, and they will benefit the community now and in the future. Populations are moving to urbanized areas, where they have limited space for yards and wildlife observation (US Census 2000). Golf courses are large tracts of land, available to native plants and wildlife, and beneficial to the environment and golfers. Additionally, the golf course can benefit the community by providing outreach opportunities.

The community benefits by having a golf course that develops habitats for wildlife and native plants, and will result in overall environmental improvements, such as the general limiting of runoff flow into water sources, improving water quality (USGA 2009). When the golf course is in a sensitive area and the minimalist approach is taken to golf course maintenance, it will be beneficial for the environment around the golf course. Golf courses are applying conservation efforts by using fewer chemicals or by eliminating chemical use altogether, on what have been coined “organic golf courses”. Organic golf courses take the minimalist approach seriously and do not mind seeing occasional weeds. *Organic* golf courses encourage

local wildlife by providing natural habitats through community and golfer outreach, encouraging the success of the eco-friendly site.

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