Innovative approaches
Practical results
Outstanding service

CONSOLIDATED LANDSCAPE/TURF IRRIGATION AND MANAGEMENT PROGRAM

Prepared for:

Texas State University

September 2015

Prepared by:

FREESE AND NICHOLS, INC.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109
817-735-7300

USM15231

FREESE AND NICHOLS

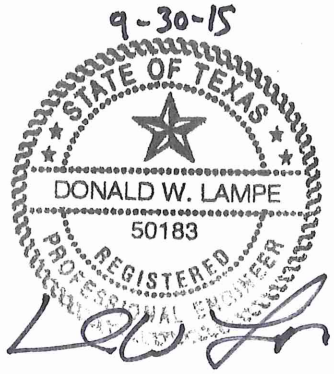
Innovative approaches
Practical results
Outstanding service

CONSOLIDATED LANDSCAPE/TURF IRRIGATION AND MANAGEMENT PROGRAM

Prepared for:

Texas State University

September 30, 2015



Prepared by:

FREESE AND NICHOLS, INC.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109
817-735-7300

USM15231

TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

1.0 INTRODUCTION 1

1.1 Purpose 1
1.2 Regulatory Overview 1

2.0 DEPARTMENTS 2

2.1 Athletic Department 2
2.2 Department of Campus Recreation 2
2.3 Department of Housing and Residential Life 4
2.4 Parking Services 4
2.5 Grounds and Waste Management Operations 4

3.0 LANDSCAPE/TURF BEST MANAGEMENT PRACTICES 4

3.1 Campus-Wide Practices 4
3.1.1 Plant Selection 4
3.1.2 Cultural Practices 5
3.1.3 Nutrient Management 6
3.1.4 Pest Management 7
3.1.5 Maintenance Operations 8
3.2 Department-Specific Practices 9
3.2.1 Athletic Department 9
3.2.2 Department of Campus Recreation 9
3.2.3 Department of Housing and Residential Life 9
3.2.4 Parking Services 10
3.2.5 Grounds and Waste Management Operations 10

4.0 IRRIGATION BEST MANAGEMENT PRACTICES 10

4.1 Campus-Wide Practices 11
4.1.1 Precipitation Distribution and Control Frequency 11
4.1.2 Evapotranspiration Principles 12
4.1.3 System Inspections, Monitoring, and Maintenance 12
4.1.4 Rain Water Harvesting and Reuse 13
4.1.5 Drought Contingency Plans 14
4.2 Department-Specific Practices 15
4.2.1 Athletics Department 15
4.2.2 Department of Campus Recreation 15

4.2.3 Department of Housing and Residential Life 15
4.2.4 Parking Services 15
4.2.5 Grounds Operations 15
5.0 WATER SUPPLY FOR LANDSCAPE IRRIGATION 16
5.1.1 Water Supply 16
6.0 CONSERVATION AND DROUGHT RESTRICTIONS CONCLUSION 16
6.1.1 Conservation and Drought Restrictions Conclusion 16

Table of Tables

Table 1. Responsibility by Group

APPENDICES

Appendix A. Photographs

EXECUTIVE SUMMARY

The San Marcos Springs bubble up from the Edwards Aquifer to fill Spring Lake and the San Marcos River, and is the second largest spring system in Texas. They have never stopped flowing in recorded history and have more environmental stability and flow of any spring system in the southwestern United States. Spring Lake constitutes the headwaters of the San Marcos River that extends 68.2 miles to its confluence with the Guadalupe River, and continues another 196 miles to the Gulf of Mexico. The San Marcos River supplies drinking water for many communities in the watersheds of the San Marcos River and Guadalupe River, including San Marcos and Victoria. Spring Lake and the San Marcos River also provide critical habitat to several threatened or endangered species protected by the federal Endangered Species Act of 1973.

Because of the critical nature of the environment surrounding these waterways, Texas State University is at the forefront of water conservation and protecting water quality at these headwaters. Multiple departments within Texas State University take personal ownership of the unique aquatic resources, and work to protect these resources. The Consolidated Landscape/Turf Irrigation and Management Program documents the practices implemented by multiple University departments responsible for maintaining the aesthetics, safety, and playability of the University's landscape and sports fields.

1.0 INTRODUCTION

1.1 PURPOSE

Texas State University (the University) is located at the headwaters of one of Texas's largest spring systems and unique aquatic ecosystems, the San Marcos River system including Spring Lake. Rare and protected species inhabit this aquatic ecosystem, and the University implements conservation and management practices to protect this resource. The University grounds and sports fields, consisting of green spaces, lawns, shrub beds, varsity sports fields, intramural fields, a 9-hole golf course, and a restored natural area are an integral part of the University. These spaces are aesthetically pleasing; provide recreation and open spaces for students and faculty; provide habitat for a variety of wildlife; absorb rainwater and improve drainage; and help prevent soil erosion.

The purpose of the Consolidated Landscape/Turf Irrigation and Management Program (the Program) is to detail the water quality and water conservation practices implemented by the University during day-to-day maintenance of the grounds, sports, and athletic fields. This document is intended to demonstrate compliance with multiple regulatory initiatives because numerous overlapping initiatives apply to the San Marcos River system.

1.2 REGULATORY OVERVIEW

Water rights and water quality rules and regulations have been changing in Texas for over a hundred years, and litigation and court decisions involving the Edwards Aquifer have repeatedly dictated water management in the State. Since there is no single regulatory authority in regard to water quality, quantity, conservation, or natural resource management for the area, numerous initiatives administered under different authorities apply to the headwaters of the San Marcos River system. As such, the University works with numerous organizations and regulators to meet the requirements of both voluntary and regulated initiatives. Examples of different written plans or documents to address the numerous laws, rules, regulations, guidance documents, and initiatives that apply to the area include the **Texas State University Stormwater Management Program** (part of the Texas Pollutant Discharge Elimination System administered by the Texas Commission on Environmental Quality under the authority of the Clean Water Act), **Edwards Aquifer Recovery Implementation Habitat Conservation Plan** (approved by the U.S. Fish and Wildlife Service under the authority of the Endangered Species Act), **draft Water Quality Protection Plan** (part of the Habitat Conservation Plan)**, Watershed Protection Plan for the Upper San Marcos River**

(part of the Impaired Waters and Total Maximum Daily Load Regulations under the authority of the Clean Water Act), **Complying with the Edwards Aquifer Rules Technical Guidance on Best Management Practices** (part of the Edwards Aquifer Rules found in Title 30 Texas Administrative Code Chapter 213), **Edwards Aquifer Groundwater Conservation Plan** (administered by the Edwards Aquifer Authority and approved by the Texas Water Development Board), the **Texas State University's Spring Lake Management Plan** (under the responsibility of the Executive Director of the Meadows Center for Water and the Environment), and support of the **City of San Marcos Water Conservation and Drought Response Plan**. Each of these initiatives have different rules, regulations, statutes, and/or guidance documents specific to different jurisdictions, industries, and project types. These plans were reviewed prior to development of this Program.

2.0 DEPARTMENTS

There are five groups responsible for maintaining the University grounds and sports fields: the Athletic Department, Department of Campus Recreation, Department of Housing and Residential Life, Parking Services, and Grounds and Waste Management Operations (Grounds Operations). Table 1 summarizes the responsibilities of the groups, and photographs of representative facilities are located in Appendix A.

2.1 ATHLETIC DEPARTMENT

Texas State University competes at the National Collegiate Athletic Association (NCAA) Division 1 level, which is the pinnacle of amateur sports in the Country. Premier playing surfaces are a vital part of the success of a Division 1 athletic program, and top quality playing surfaces are the norm at Texas State University. Consistent playability and aesthetics are attributes of a safe and desirable sports field, and Athletic Department employees work year-round to ensure the football facilities, softball field, baseball field, and track facility are in top condition for student athletes.

2.2 DEPARTMENT OF CAMPUS RECREATION

The Department of Campus Recreation provides students and staff at Texas State University with opportunities for vigorous physical activity, healthy competition, and an introduction to a number of lifetime leisure activities. This department offers a variety of activities ranging from the traditional team sports of football and basketball, to individual activities and outdoor recreation. Multiple outdoor intramural fields and a 9-hole golf course is managed by this department.

Table 1: Responsibility by Group

Facility Name	Managing Group	Maintaining Group	Irrigating Group
Baseball Field	Athletics	Athletics	Athletics
Bobcat Stadium	Athletics	Athletics	Athletics
Jowers Field	Athletics	Campus Recreation	Grounds Operations
Practice Field	Athletics	Athletics	Athletics
Softball Field	Athletics	Athletics	Athletics
Track & Field Center	Athletics	Athletics	Athletics
Bobcat Village Fields	Campus Recreation	Campus Recreation	Campus Recreation
Golf Course	Campus Recreation	Campus Recreation	Campus Recreation
Intramural Fields	Campus Recreation	Campus Recreation	Campus Recreation
Sewell Park	Campus Recreation	Grounds Operations	Grounds Operations
West Campus Fields	Campus Recreation	Campus Recreation	Campus Recreation
Arnold Hall	Housing and Res Life	Contracted	Grounds Operations
Beretta Hall	Housing and Res Life	Contracted	Grounds Operations
Bexar Hall	Housing and Res Life	Contracted	Grounds Operations
Blanco Hall	Housing and Res Life	Contracted	Grounds Operations
Bobcat Village Apartments	Housing and Res Life	Contracted	Grounds Operations
Brogdon Hall	Housing and Res Life	Contracted	Grounds Operations
Burleson Hall	Housing and Res Life	Contracted	Grounds Operations
Butler Hall	Housing and Res Life	Contracted	Grounds Operations
College Inn	Housing and Res Life	Contracted	Grounds Operations
Chautauqua Hall	Housing and Res Life	Contracted	Grounds Operations
Elliot Hall	Housing and Res Life	Contracted	Grounds Operations
Falls Hall	Housing and Res Life	Contracted	Grounds Operations
Gaillardia Hall	Housing and Res Life	Contracted	Grounds Operations
Hornsby Hall	Housing and Res Life	Contracted	Grounds Operations
Housing and Residential Life Office Building	Housing and Res Life	Contracted	Grounds Operations
Jackson Hall	Housing and Res Life	Contracted	Grounds Operations
Lantana Hall	Housing and Res Life	Contracted	Grounds Operations
North Housing Community Building	Housing and Res Life	Contracted	Grounds Operations
Retama Hall	Housing and Res Life	Contracted	Grounds Operations
San Jacinto Hall	Housing and Res Life	Contracted	Grounds Operations
Sayers Hall	Housing and Res Life	Contracted	Grounds Operations
Sterry Hall	Housing and Res Life	Contracted	Grounds Operations
The Tower	Housing and Res Life	Contracted	Grounds Operations
Smith Hall	Housing and Res Life	Contracted	Grounds Operations
San Marcos Hall	Housing and Res Life	Contracted	Grounds Operations
President's House	Grounds Operations	Grounds Operations	Grounds Operations
Parking Garages and Lots	Parking Services	Parking Services	Grounds Operations
Campus Grounds*	Grounds Operations	Grounds Operations	Grounds Operations

*Grounds Operations maintains and irrigates all landscaped and natural areas within the University grounds, including the Meadows Center for Water and the Environment.

2.3 DEPARTMENT OF HOUSING AND RESIDENTIAL LIFE

The Department of Housing and Residential Life provides welcoming living communities that foster academic success, campus engagement, and personal development. An aesthetically pleasing and maintained landscape is part of the healthy community atmosphere for campus residents. All of the day-to-day landscape maintenance like mowing and tree/shrub pruning is outsourced to a professional landscaping company and overseen by the Department. Irrigation of the residential facilities is overseen and maintained by Grounds Operations

2.4 PARKING SERVICES

Parking Services help provide students, faculty, staff, and visitors safe and efficient access to University facilities. Parking Services maintains the landscape around 10 parking garages and 49 parking lots.

2.5 GROUNDS AND WASTE MANAGEMENT OPERATIONS

Grounds Operations maintain an impressively landscaped campus of 457 acres. Grounds Operations employees are responsible not only for the upkeep of the University Grounds, but are also responsible for irrigation, landscape design, planting and tree maintenance. Their mission is to preserve the aesthetics of the University landscape while promoting a safe and sustainable environment for students, faculty, and staff through tree maintenance, water efficiency, composting, recycling and promoting drought resistant plants. A large scale native restoration project at the Meadows Center for Water and the Environment (former Aquarena grounds) near Spring Lake is also maintained by Grounds Operations.

3.0 LANDSCAPE/TURF BEST MANAGEMENT PRACTICES

Texas State University has implemented the following campus-wide practices to maintain the University landscape while protecting the environment and valuable aquatic resources.

3.1 CAMPUS-WIDE PRACTICES

3.1.1 Plant Selection

A plant palette, or list of allowed plants to be used for landscaping, was developed by the University. Plants well-suited to their specific environment do not require excessive irrigation and fertilization and are naturally resistant to pest infestations. The plant palette was developed based on site conditions to include only non-invasive, water efficient, and low maintenance plant species. The University's plant

palette is under Facilities Planning Design and Construction (FPDC) available on the Facilities website www.facilities.txstate.edu.

3.1.2 Cultural Practices

The commitment to utilize mechanical cultural practices whenever practicable to minimize the need for chemical applications is an essential part of a consistent landscape maintenance program. Mowing, aerification, verticutting, topdressing, rolling, overseeding, weeding, and pruning are all examples of mechanical cultural practices used to optimize plant vigor and health without the use of chemical applications. Mechanical cultural practices must be implemented under certain conditions to have beneficial impact on the health of the plant, which requires expertise by landscape and turf managers. The University has multiple full-time professionals with many years of experience implementing cultural practices and detecting plant stress indicators. Below are mechanical cultural practices used by the landscape and turf managers to improve plant health:

- Mowing height and mowing frequency greatly influence turfgrass health. Optimal mowing practices vary by species, time of year, intended use of the area, and playability requirements. If grass is mowed too low or infrequently, the plant can become stressed and prone to disease. In stressful periods like during a period of drought, increasing the height of cut and decreasing the frequency of cutting can reduce stress. Grass clippings from mowing activities are a significant source of nutrients and promotes healthy soils. Clippings are typically not bagged but are allowed to fall back into the playing surfaces where it is decomposed by soil organisms. This minimizes nutrient requirements and promotes healthy soil conditions. Collected grass clippings are taken to the University compost area.

- Aerification, or coring, has multiple benefits including reducing soil compaction and increasing infiltration rates. Healthier root zones and increased rooting are typical results of a successful aerification program, which greatly affects overall plant health. Other benefits include more efficient uptake of nutrients and increased soil microorganism activity.

- Verticutting or vertical mowing is used to reduce thatch, which is a layer of non-decaying organic matter between the soil surface and the green shoots. Excessive thatch reduces infiltration and prolongs humidity which can result in an increase of disease causing fungi and insect damage. The removal of thatch can greatly reduce incidence of disease and drought stress from low infiltration rates.

- Topdressing, which is the application of a uniform, thin layer of sand to turfgrass, is often used to modify soil and dilute organic matter. It helps protect turfgrass, improve infiltration, reduce disease, and improve playing quality.

- Rolling certain areas like golf greens and baseball infields can improve turf consistency by affecting the smoothness and uniformity of the playing surface. One major benefit to periodic rolling is increased performance without lowering the height of cut and potentially stressing the turfgrass.

- Weeding undesirable plants with manual or mechanical methods improves plant quality. Weeds compete with desirable plants for nutrients and water, so their removal reduces the demand for irrigation and fertilization. Herbicides are used periodically for specific situations.

- Pruning of shrubs and trees improves aesthetics, helps promote strong structural integrity, and increases light penetration and air movement around the tree or shrub. Many understory plants need multiple hours of direct sunlight, and shade management by pruning is crucial in providing optimal growing conditions for the desirable understory plants.

3.1.3 Nutrient Management

Proper nutrient management is one of the most important components of an environmentally responsible landscape and turf maintenance program. The primary objective of a nutrient or fertilization program is to create a soil environment for optimal plant health with no risk to water quality. Nutrients are essential for plants to grow, recover from stress, sustain satisfactory aesthetics, and resist diseases. Various nutrients are not present in adequate amounts in many soils so many plants require periodic fertilization. The three primary nutrients needed are nitrogen, phosphorus, and potassium (i.e., N, P, and K).

Nitrogen influences turfgrass color, shoot and root growth, and water requirements. It is the most important nutrient for plant maintenance, and enough nitrogen should be applied to meet the nutritional requirements for maintaining growth, recuperative ability, color, and quality. Nitrogen generally increases shoot growth, shoot density, and leaf width. However, excessive nitrogen application is thought to negatively influence root growth and result in nitrate leaching. When turfgrass is fertilized excessively with nitrogen, top growth is promoted over root growth, which results in less drought-tolerant turfgrass in the long term. When nitrogen is applied at appropriate rates, a strong root system can develop.

Phosphorus is another essential element for plant growth, and is involved in the transfer of energy during metabolic processes. It is often the limiting nutrient in many aquatic systems, and therefore, many ecosystems are highly sensitive to excess phosphorus. The Upper San Marcos River has a proposed water quality criterion of 0.3 parts per million for phosphorus. Phosphorus has very low leaching potential because it quickly binds to soil particles in a process called adsorption. Therefore, potential phosphorus pollution is typically associated with soil erosion. In many areas of Texas where soils have adequate, or even excessive amounts of phosphorus, phosphorus fertilization is not necessary for healthy growth of

plants. Sand-based root systems on many sports fields do not have high levels of plant available phosphorus, and require phosphorus fertilization.

Potassium is another essential nutrient for plant survival. Optimum potassium fertilization increases leaf turgor and has been correlated with disease and pest resistance. Potassium is very important to root growth and a plant's overall health. Clay particles attract potassium ions so there is little to no potassium leaching except in very sandy soils.

Nitrogen and phosphorus are the nutrients most likely to affect water quality, as they are necessary to support the growth of algae and aquatic plants. Too much nitrogen and/or phosphorus can cause excessive algae which can harm water quality. Potassium fertilization has a relatively low risk to the environment and water quality. Below are campus-wide practices to prevent fertilization activities from negatively impacting sensitive water resources:

- Soil tests are used to help determine the level of fertilization necessary to meet quality expectations and field playability.
- Plant tissue analyses are completed periodically as a supplement to soil tests, and are especially useful in determining nitrogen requirements.
- Fertilizers are only applied when necessary to meet expectations of quality and field playability. Fertilizers containing phosphorus are mostly avoided except when soil tests indicate a need. Phosphorus application is restricted to address specific and localized issues to avoid runoff into waterways.
- A vegetated buffer that is never fertilized is located around sensitive water resources like Spring Lake.
- Fertilization applications are scheduled based on careful analysis of weather conditions. No fertilization is scheduled with impending precipitation events.
- After fertilizing, timely irrigation is applied to minimize potential runoff and volatilization.
- A drop or gravity spreader is used instead of a broadcast spreader near sensitive water resources

3.1.4 Pest Management

A successful pest management program uses many different methods to keep pests at acceptable levels while minimizing the effect on the environment. Pesticides are only one of several options available for use in pest management, and the University prioritizes plant selection and mechanical cultural practices to optimize plant health to resist the need for chemical pesticides. A sound pest management program is

based on the acceptance and tolerance of pests at a damage level which does not significantly reduce the acceptability of the plant. It is this reduced reliance on pesticides which is an important factor in managing the landscape with an emphasis on water quality. Below are campus-wide practices to prevent pesticides from entering sensitive water resources:

- All pesticides are stored in a lockable and protected location and disposed of in compliance with the Texas Department of Agriculture and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).
- All pesticides are applied by individuals trained and licensed by the State of Texas in their use. Continuous education is required and helps keep applicators on the leading edge of best practices.
- All pesticide uses are documented.
- All stored pesticides are inventoried.
- An emphasis is placed on cultural practices that increase turf vigor and health to ward off pests and injury.

3.1.5 Maintenance Operations

Equipment storage and maintenance operations including fueling, washing, and repairing of equipment, are a potential source of pollutants. Environmentally sound practices are dependent upon facility design and location. Proper storage and disposal of used wastes like oils, solvents, pesticide containers, and hazardous materials is necessary to prevent pollution. The campus "Good Housekeeping/Pollution Prevention Program" in the Municipal Separate Storm Sewer System (MS4) Stormwater Management Program (SWMP) Plan requires inspection of these areas to ensure consistent practices. Below are campus-wide practices to prevent pollution from maintenance activities from entering sensitive water resources:

- Fueling and equipment washing facilities are located away from aquatic resources, and the use of detergents is minimized.
- Compressed air is used to blow off equipment. Occasionally a small amount of water used to clean equipment is reduced by using a high-pressure stream of water with low volume.
- Maintenance equipment is stored indoors.
- Bulk materials like sand and mulch are stored in covered bays to prevent runoff during precipitation events.
- Equipment in disrepair and/or leaking fluids are removed from operation as soon as an issue is identified until the equipment is repaired.

3.2 DEPARTMENT-SPECIFIC PRACTICES

In addition to the previously identified campus-wide practices, specific departments implement additional landscape and turf management practices to address resources specific to the area.

3.2.1 Athletic Department

The sports fields maintained by the Athletics Department all drain to vegetated swales located over 2,000 linear feet from the San Marcos River. Vegetated swales are effective biological buffers between the fields and the ecologically sensitive San Marcos River system. During normal conditions in the absence of high intensity precipitation events, the vegetated swales are mostly dry and do not convey surface water all the way to the river system. During these normal conditions, limited amounts of runoff from the sports fields would be completely retained within the swales and would not reach the river system before infiltrating the soil, resulting in significant pollutant removal. Another benefit of the vegetated swales receiving all runoff from the fields is that an irrigator can easily observe when the sand-based root zone is completely saturated or when too much irrigation has been applied.

3.2.2 Department of Campus Recreation

The Texas State Golf Course is maintained according to their Integrated Pest Management (IPM) Plan. This plan is governed by *SA/PPS No. 08.07 Integrated Pest Management Program for the Texas State Golf Course* and is reviewed by the Associate Director of Campus Recreation and the Chair of the Spring Lake Environmental Review Committee. Maintenance of the course and grounds according to the IPM plan is the responsibility of the Golf Course Manager. The golf course is routinely monitored by the Lake Manager, including routine water quality tests of Spring Lake. The IPM plan is found on www.campusrecreation.txstate.edu/golf.

3.2.3 Department of Housing and Residential Life

The Department of Housing and Residential Life hires contractors to maintain the landscape and turf around their facilities. As a result, an oversight process is in place to ensure the contractors meet the terms of their contract while also minimizing pollution. This practice is monitored under the MS4 Stormwater Management Program.

3.2.4 Parking Services

Parking Services maintains the landscape around 10 parking garages and 49 parking lots according to the campus-wide practices detailed above.

3.2.5 Grounds and Waste Management Operations

In addition to maintaining the majority of the traditionally landscaped University grounds, Grounds Operations also maintains the restored natural areas at the Meadows Center for Water and the Environment. This area is not mowed or fertilized and is consistently weeded to control invasive species. The natural area serves as a buffer between the Golf Course and Spring Lake to reduce stormwater runoff and provide natural infiltration through native grasses.

4.0 IRRIGATION BEST MANAGEMENT PRACTICES

Landscape Irrigation systems provide supplemental precipitation (water) for the health of turfgrass and landscape plants. Water conservation, while maintaining the optimum health of plant products, is the goal of the irrigation system. Inadequate irrigation can cause the plant to fail if it is allowed to reach the permanent wilting point. However, overwatering and over-saturated soils can cause mold, fungus, plant and soil diseases, in addition to flushing away the nutritional products and supplements applied for the health of the plant. Maximum plant health is achieved through a combination of soil and irrigation water management. Landscape Irrigation systems include two primary functions: control and distribution. Control functions dictate the time and frequency of irrigation whereas distribution systems include pipe, valves, and irrigation application components such as sprinklers and drip irrigation systems. Considerations for effective irrigation systems include:

- Landscape plant product type, effective root zone management, and crop water use rate.
- Soil type, percolation rate, and soil moisture holding capacity.
- Micro-climate (shade or sun, flat or sloped surfaces, open areas vs. covered or concealed from prevailing winds).
- The time available to water (i.e., “water window” or the period available for application of irrigation) vs. the usage of the turfgrass fields in site specific locations (sports fields, recreation areas, etc.).

- Capability of control systems.
- Precipitation rate and effectiveness of the irrigation distribution system.
- Experience and training of landscape irrigation managing personnel.

4.1 CAMPUS-WIDE PRACTICES

Generally, each department manages their own landscape irrigation system. Each department has specific irrigation requirements based on plant types, site specific area function, and available watering windows. The general landscaped areas include turfgrass, trees, shrubs, groundcover and annuals. Watering windows for these general areas are more flexible but must consider the times that students and faculty travel from place to place. Site specific areas include the golf course and sports field areas which generally include high grade turfgrass and require precise control and distribution of irrigation. Water windows are narrow because these areas must have playable surfaces at specific times. The inclusion of native and adapted species of plant products throughout the University benefit the water conservation program because these species require less water and are more drought tolerant.

4.1.1 Precipitation Distribution and Control Frequency

Distribution systems on campus utilize most of the available new irrigation technologies including *matched precipitation rate* (MPR) rotary spray heads, rotary gear driven heads, spray heads and drip irrigation. MPR sprinklers are those that deliver even precipitation over the area covered regardless of the arc of the sprinkler. This is important for turfgrass because even precipitation maximizes water use by not over/under watering areas within the same zone which is a water conservation principle. As mentioned above, the rate and timeframe for precipitation application differ in general landscaped areas from recreation and sports fields. General landscaped areas in beds which are well mulched utilize drip irrigation and shrub sprays. General turfgrass areas utilize the MP Rotators and are managed to avoid spray and runoff onto streets, sidewalks and other hard surfaces. Large turfgrass areas utilize rotary gear driven sprinklers.

Currently, landscape irrigation controls at the University vary between state-of-the-art soil monitoring sensors which control Smart Technology central controllers, conventional controls, weather station controllers, and hand watering.

The Director of Grounds and Waste Management Operations embraces the principles of Smart Water Application Technologies (SWAT) which is a coalition of water purveyors, equipment manufacturers, and irrigation practitioners with shared interests in the Irrigation Association (IA) program to maximize irrigation water conservation. These principles, as well as proven local area practices, are incorporated into the Grounds Operations programs.

4.1.2 Evapotranspiration Principles

Evapotranspiration (ET) is a measurement of the total amount of water needed to grow plants and crops. This term merges the words evaporation (i.e., evaporation of water from the soil) and transpiration (i.e., transpiration of water by plants) and is an industry recognized term. Different plants have different water requirements, so they have different ET rates. An ET controller automatically adjusts the amount of water applied to your landscape based on weather conditions. The "smart" ET controller receives radio, pager, or internet signals with historical evapotranspiration information to replace only the moisture lost to heat, humidity, and wind. The weather station data is acquired from local weather stations distributed throughout the region. Where individual owner provided weather stations are installed, the ET data is transmitted to Smart Controllers at the covered location and are more accurate than historical data. Site located soil monitoring sensors measure the actual soil conditions at the irrigated site and are the most accurate. Conventional controllers are programmed, or not, and seasonally adjusted by a person and are the least efficient method of landscape irrigation control.

4.1.3 System Inspections, Monitoring, and Maintenance

Landscape irrigation in Texas is regulated by the Texas Commission on Environmental Quality (TCEQ). Only Licensed Landscape Irrigators are permitted to sell, design, install, maintain, alter, repair or service landscape irrigation systems (with certain exceptions). The Texas Administrative Code (30 TAC 344) requires the following:

> *All landscape irrigators, installers, irrigation technicians, and inspectors shall be knowledgeable of the current industry standards regarding selling, designing, providing consulting services, installing, maintaining, altering, repairing, or servicing irrigation systems, including the connection of such a system to any source of water and water conservation. These individuals (sic) shall conform to the current adopted version of these*

rules and any local rules that do not conflict with these rules, or that are more stringent than these rules, when performing these activities.

Grounds Operations employs one licensed Landscape Irrigator who complies with this requirement, even though Universities are an exception to the licensing requirement. The Grounds Operations Director is also certified as an Environmental Protection Agency (EPA) WaterSense Irrigation System Auditor, and is certified in four of nine Irrigation Association Professional landscape irrigation programs including the Certified Landscape Water Manager (CLWM). Additionally, this individual is a certified TCEQ Landscape Irrigation Training Provider. Combined with years of experience he provides the staff with exceptional training, which in turn results in the University having one of the best landscape irrigation programs in the State.

4.1.4 Rain Water Harvesting and Reuse

The Texas State Government Code, Sec. 447.004. DESIGN STANDARDS. States:

The state energy conservation office shall establish and publish mandatory energy and water conservation design standards for each new state building or major renovation project, including a new building or major renovation project of a state-supported institution of higher education. The office shall define "major renovation project" for purposes of this section and shall review and update the standards biennially.

In this standard, there are two water conservation standards that apply: Par. C.6 requires the installation of water-conserving landscape irrigation equipment, and Par. C.8 requires the installation of rainwater harvesting equipment and equipment to make use of water collected as part of a stormwater system installed for water quality control.

The harvesting of rainwater simply involves the collection of water from surfaces on which rain falls, and subsequently storing this water for later use. Normally, water is collected from the roofs of buildings and stored in rainwater tanks. This water is then applied to landscape irrigation systems when rainfall is below normal. Fairly well-developed, new rainwater harvesting products are continuously being developed. While rainwater harvesting is an old tradition practiced in all parts of the world, including Texas, it has relatively new acceptance in the commercial market. Suitable roof and gutter materials are now common products and specialized products such as roof washers (pre-filters) are also available. Storage tanks (cisterns) are available regionally and statewide. System designers and installers are present locally.

Condensate water from A/C cooling coils in newer buildings is collected and stored in rainwater storage tanks.

4.1.5 Drought Contingency Plans

Texas is familiar with drought conditions. During these all too often occurrences, the use of this precious natural resource – water – is subject to regulated drought contingency restrictions. Even if municipalities and governing agencies are lenient with water restrictions, it is good stewardship of our natural resources to conserve water as much as possible at all times, particularly during drought conditions. Strategies for water conservation include the use of low water use plumbing fixtures and managed landscape irrigation. Managing and conserving landscape irrigation systems include the application of efficient distribution systems, smart irrigation controls and industry accepted techniques. One of these techniques is the adaptation of prioritized landscape zones where the critical use landscape areas, such as sports fields, are given a priority for irrigation. General use areas are allowed to become dormant by the use of managed plant water stress techniques. These techniques allow plant products to become dormant through deficit irrigation, which is basically keeping the plant alive but not in its premium state and managing the effective root zones of plants. Not all plants can tolerate deficit irrigation and the timing of the deficit is critical. Some species of turfgrass can tolerate deficit irrigation. Deficit irrigation cannot be used during the critical growing cycle of the plant and must be used by a knowledgeable professional familiar with both landscape irrigation and a plant's physiological requirements.

The University posts current water conservation measures and drought restriction information at www.facilities.txstate.edu/utilities. *The Irrigation Conservation Plan for Texas State University* (Plan) documents Best Management Practices which support Central Texas and the City of San Marcos (City) water conservation efforts. This plan addresses landscape irrigation water consumption conservation goals during the Edward Aquifer Authority (EAA) critical management period drought restrictions stages 1 through 5. The University, as a good community member, provided this plan as an alternative to the City standard drought ordinance. The Plan proposes to progressively reduce the University's overall irrigation water usage during drought stages. Texas State University will submit monthly meter readings to the City to demonstrate that the overall water usage goals are being met. The Plan can be found at http://www.facilities.txstate.edu/grounds.html.

4.2 DEPARTMENT-SPECIFIC PRACTICES

4.2.1 Athletics Department

The landscape irrigation for sports fields is one of the more critical areas for water management. Generally, the fields are irrigated using conventional distribution systems and controlled by the managing personnel. These individuals are experienced in the available water windows and the general application rates of the distribution system. They use visual cues of turf and soil condition as an indicator of proper irrigation.

4.2.2 Department of Campus Recreation

The Texas State University Golf Course greens utilize both rotary gear driven sprinklers and spray heads, and a portion of the course is controlled using Hunter Smart Technology ("Solar Sync") control sensors. These sensors are advanced weather sensors that calculate evapotranspiration (ET) and adjusts Hunter controllers daily based on local weather conditions. Solar Sync measures sunlight and temperature, and uses ET to determine the correct seasonal adjustment percentage value to send to the controller. The controller then uses its programmed run time and adjusts to Solar Sync's seasonal adjustment value to modify the actual irrigation run time for that day.

4.2.3 Department of Housing and Residential Life

Generally, Grounds Operations personnel read irrigation meters and provide oversight for the irrigation systems in this department. They utilize conventional landscape irrigation systems including spray heads for turfgrass and some groundcover and drip irrigation in some beds. The systems are operated and maintained by Grounds Operations.

4.2.4 Parking Services

Parking services maintain their landscaping, while Grounds Operations manage the landscape irrigation systems. The irrigation systems for these areas is similar to the other areas that Grounds Operations manages with water conservation a key focus.

4.2.5 Grounds Operations

As mentioned above, Grounds Operations employs a TCEQ licensed landscape irrigator, a certified EPA WaterSense auditor familiar with landscape irrigation principles, water conservation methods, and

irrigation technology. Generally, the Grounds Operations irrigation systems utilize central controls with state-of-the-art soil moisture monitoring with flow sensors and notification capabilities to enable managers to immediately shut down stations if leaks occur in a distribution system. Distribution systems utilize MPR Rotators exclusively for matched precipitation over turf zones.

5.0 WATER SUPPLY FOR LANDSCAPE IRRIGATION

5.1.1 Water Supply

The centrally located University facilities are provided with landscape irrigation water supply from the Campus Water Supply system. Rainwater Harvesting and AC Fan & Coil condensate collection systems supplement the potable water supplies as necessary. The Athletic area irrigation systems are supplied by the City of San Marcos Public Water Supply and the Golf Course is supplied by surface water diversions. To irrigate the Golf Course and fill the ponds off University Drive, the University uses surface water diversion rights. Planned and actual monthly diversions are reported to the South Texas Watermaster Program (STWM) under the TCEQ. Prior to any diversions, approval from the STWM is obtained with the request indicating the beginning time of the diversion and either the expected flow rate or the ending time along with the total gallons or acre feet. The Director of Grounds and Waste Management Operations is responsible for metering, recording and reporting water monthly diversion data from Spring Lake and the San Marcos River to the South Texas Watermaster Program.

6.0 CONSERVATION AND DROUGHT RESTRICTIONS CONCLUSION

6.1.1 Conservation and Drought Restrictions Conclusion

Each department is in compliance with the *Campus Wide Practices* indicated above, including *The Irrigation Conservation Plan for Texas State University*. New irrigation designs and installations incorporate uniform precipitation requirements utilizing matched precipitation sprinklers and are operated with smart control technology, including soil moisture sensors where possible. Continuous training of personnel responsible for the Campus irrigation system and incorporation of system distribution and control upgrades ensure that systems are operating with a focus on conservation.

APPENDIX A
Photographs

Photo 1. University flower/shrub bed.

Photo 2. University flower/shrub bed.

Photo 3. University grounds.

Photo 4. Mowing at Texas State Golf Course.

Photo 5. Mowing greens at Texas State Golf Course.

Photo 6. Aeration practices at Texas State Golf Course.

Photo 7. Aeration practices at Texas State Golf Course.