



The Drought Simulator Description and Operation Instructions



A Final Report Submitted to the San Antonio Water System

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For the Project: *The Evaluation of Sixty Day Drought Survival
in San Antonio of Established Turfgrass Species and Cultivars*

CONTENTS

SUMMARY

OVERVIEW OF THE 60-DAY TURGRASS STUDY

DROUGHT SIMULATOR DESCRIPTION

ACKNOWLEDGEMENTS

APPENDIXES

OPERATION INSTRUCTIONS

MAINTENANCE SCHEDULE

The Drought Simulator

SUMMARY

This report provides a description of the Drought Simulator and an overview of the project that it was constructed for: “*The Evaluation of Sixty-Day Drought Survival in San Antonio of Established Turfgrass Species and Cultivars*” (Turfgrass Study). In the Appendix are operational instructions and the maintenance schedule for the Simulator.

The Simulator is one of the largest and fastest deploying rainout shelters in the United States with a unique, sleek design unlike any other. It is designed to cover the plot area during rain events to maintain a drought period for turfgrass and other plants material.

For the Turfgrass Study, during the first year of the project, the Drought Simulator properly functioned six times to protect the test plots from 3.77 inches of rainfall. In 2007, there were 17 days with recorded rainfall, and the Drought Simulator properly functioned 34 times to protect the test plots from 15.2 inches of rainfall.

OVERVIEW OF THE TURFGRASS STUDY

The Turfgrass Study was initiated in order to support ordinances recently enacted in San Antonio which require new home construction to have at least 4-inches of topsoil in place prior to lawn establishment and to plant grasses that are most likely to survive a 60-day drought.

The project was conducted in 2005-2007. Extension Soil and Crop Sciences was the lead on the Turfgrass Study, while Extension Agricultural Engineering was responsible for the design, construction, operation and maintenance of the Simulator. Funding for the Turfgrass Study was provided by the San Antonio Water System (SAWS) and the Turfgrass Producers of Texas (TPT), with in-kind assistance provided by Bladerunner Farms, Inc.

Grasses were sodded from washed sod in replicated 4 by 4 foot plots and included:

- bermudagrass (Celebration; Common; GN-1; Grimes EXP; Premier; TexTurf; TifSport and Tifway-419)
- St. Augustinegrass (Amerishade, Common, Delmar, Floratam, Palmetto, Raleigh, and Sapphire)
- Zoysiagrass (Cavalier, El Toro, Emerald, Empire, Jamur, Palisades, Y-2, Zeon and Zorro)
- buffalograss.

Grasses were planted on both native soil without restriction to rooting depth and on 4-inches of native soil over an impermeable plastic barrier to simulate 4-inches of topsoil.

TPT members supplied the sod for the study. Soil and Crop Sciences Extension and Research personnel established and managed the test plots. The study was divided into three phases over two project years:

Project Year 1

- establishment period: Sept. 2005 – July 22, 2006
- imposed 60-day drought: July 23 – Sept. 20, 2006
- 60-day recovery phase: Sept. 21 – Nov. 19, 2006

Project Year 2

- establishment period: Sept. 2006 – July 4, 2007
- imposed 60-day drought: July 5 – Sept. 2, 2007
- 60-day recovery phase: Sept. 3 – Nov. 1, 2007

Data was collected during both the drought and recovery periods and included turfgrass quality, density, leaf firing due to moisture stress, and color as percent green turf cover.

Basically, none of the grasses planted in the 4-inch top soil recovered within 60 days of drought termination, while all grasses in soils of unrestricted depth recovered to various extents. For details, see the 2006 study report which is posted on the ITC website. The final report for the 2-year study is expected to be posted on the ITC website by February 2008.



Figure 1. Photograph taken on November 11, 2007.

DROUGHT SIMULATOR DESCRIPTION

The Drought Simulator is one of the largest and fastest moveable rainout shelters in the U.S. It is a premier 5,000 square foot roof structure that is capable of mechanically deploying and retracting along a 350 ft rail system in less than one minute. This is the first facility in San Antonio for the Irrigation Technology Center (ITC) and will be used for years to come to determine the water requirements of turf and other plants, and their ability to survive and recover during periods of limited rainfall.



Figure 2. Photo of the south side of the simulator taken in November 2007.

The facility is designed so plots can be established at either end of the simulator (see Fig. 3). The retractable roof structure normally rests in the center of the facility, and is set to automatically deploy to cover either the east or west plot areas. The two separate plot areas allow for one to be used for drought research while the other is being used for plant establishment.

Detailed design specifications, photographs and other information on the design and construction of the Simulator are on the ITC website: <http://itc.tamu.edu/rainout.php>.

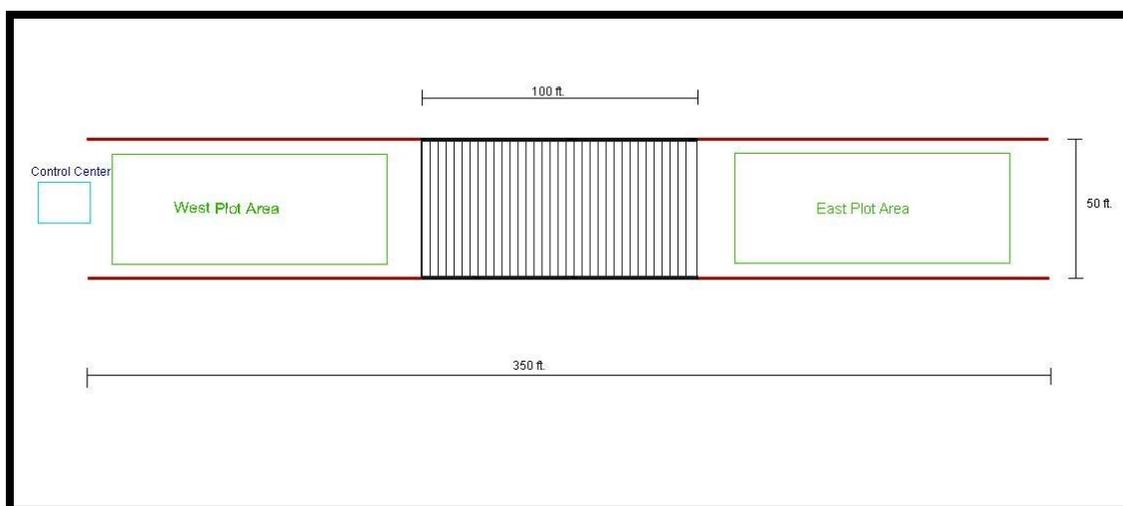


Figure 3. Schematic of the drought simulator showing the roof structure in its normal resting position at the center of the facility.

Concrete Track System

The track system consists of two parallel, 350 ft long concrete beams (1 ft x 2 ft high). The track was constructed in two stages:

- (1) First a concrete footing/foundation was constructed by pouring concrete into a 2 ft wide by 2 ft deep trench.
- (2) The second stage consisted of building forms on top of the footing for the concrete beams. The beams are made of 3000 PSI concrete and reinforced with #4 rebar.



Figure 4. Construction of the track system composed of a footing and a concrete slab.

The Rail System

The railing consists of two sets of 350 ft long I-beams (18, 40 ft long beams welded together). Angle iron runs along the top of the I-beams that matches the size of the grooves in the wheels/casters that support the roof. The I-beams are bolted into the concrete tracks with slotted washers to allow movement as the rail and track expands and contracts due to changes in temperatures.



Figure 5a. The base of the rail system is composed of I-beams welded together.



Figure 5b. The I-beam base of the rail system is bolted into the concrete tracks with slotted brackets to allow for expansion and contraction.



Figure 6. Angle iron forms the top of the rail system and is welded onto the I-beams. Also shown is the C-channel that forms the base of the roof structure to which the wheels are attached.

Roof Structure

The roof structure is a 50 ft x 100 ft clear span, continuous roof with five, 20 ft bays. The roof material is composed of 53 ft PBC panels and 26 gauge Galvalume Plus. Twenty-two V-grooved wheels are bolted to 6" C-channel to support the roof structure and allow it to move along the rail system. The roof structure is elevated to provide 4 ft of ground clearance by vertical (4.5 inch OD) pipe welded to C-channels (Fig. 7).



Figure 7. The roof is elevated to provide 4 foot of ground clearance using pipe welded to the c-channel forming the base of the roof structure.

Ten removable heavy-duty tarps (30 ft x 20 ft with D rings) are attached to the Simulator in order to keep blowing rain from entering through the north and south sides of the roof structure.

Drive and Control Systems

We decided to go with a cable/pulley type drive system for safety reasons, so that there would be a minimum exposure to moving parts. The Drought Simulator is powered by a 7.5 horsepower motor attached to a 15:1 speed reducer. In total, over 1200 ft of cable is used to move and direct the movement of the Simulator (see Figures A1 - A4).

The control system consists of a PLC (programmable logical controller) and a datalogger. On the north concrete beam, several 2-way micro-switches are used to monitor the location, control the speed, and stop the shelter's movement (Fig. A2). All electrical components are located inside the air-conditioned storage shed.



Figure 8. The control system consists of a datalogger and a PLC.

Two tipping bucket rain gauges are used to monitor rainfall amounts. The Drought Simulator is set to automatically deploy (to cover the research plots) when both rain gauges detect 0.01 inches or when one gauge detects 0.02 inches. In less than one minute, the research plots are covered from the rainfall. Warning lights located on both ends of the simulator flash before and while the shelter is in motion (Fig. 9)



Figure 9. Photograph of the west end of the simulator and the air-conditioned control center.

The Drought Simulator is set to retract to its center position 30 minutes after it stops raining.

During the study, Deployment history and status is automatically posted on the ITC website. The deployment record for the 2007 study is at the following web address: <http://itc.tamu.edu/rainoutdeploy.php>.

ACKNOWLEDGEMENTS

The San Antonio Water System provided funding for the construction of the Drought Simulator. The Rio Grande Basin Initiative¹ supported this project through the time and effort of Extension personal, and covered the costs of the redesign of the drive system in 2007, the side tarps among other expenses. Texas AgriLife Extension Service provided the services of Guy Fipps at no cost to the project.

Guy Fipps designed the simulator. The drive system was designed by Wayne LePori (retired) Professor, TAMU and David Flahive, (former) System Analyst. Also Assisting with the design, construction and operation of the Drought Simulator for this project were Chris Braden (former) Extension Associate and Kendall Chilek, (former) Extension Assistants.



Figure 10. In this 2006 photograph are (from left to right) Wayne LePori, Kendall Chilek, Chris Braden and David Flahive.

¹ Partial support for this project is through the Texas AgriLife Extension Service, Irrigation Conservation in the Rio Grande Basin Initiative supported by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture under Agreement No. 2005-45049-03209. For program information, see <http://riogrande.tamu.edu>.

APPENDIX A: OPERATION INSTRUCTIONS

Instructions on how to operate the shelter for automatic and manual operation are described below.

Automatic (Rainfall) Operation

- 1) Set the AUTO/MAN switch on the top right side of the controller box to AUTO.
- 2) Set the E/W on the center right side of the controller box to E for eastside coverage or W for Westside coverage.

Manual Operation

- 1) Set the AUTO/MAN switch on the top right side of the controller box to MAN.
- 2) If the shelter is in the center, flip the E switch up to move the shelter to the eastside or flip the W switch up to move the shelter to the Westside.
- 3) If the shelter is at one end or the other, flip the C switch up to move the shelter back to the center. Once the shelter is in the center, use the E or W switch to move to the respective sides.
- 4) Setting the shelter to MAN with all manual control switches down will hold the shelter in its current position indefinitely.

Note

Only one of the C/E/W switches may be up at any 1 time. The shelter may only be moved in increments (from east to center, then from center to west, etc.).

APPENDIX B: MAINTENANCE SCHEDULE

The following procedures should be carried out prior to and while the Drought Simulator is in operation mode.

Prior To

- Grease cable drive bearings (Fig. A-1, red circles).
- Grease all castor bearings (Fig. A-2, black boxes).
- Inspect cables for frays or breaks.
- Inspect corner and end pulleys.
- Check micro switches for grass or other obstructions.
- Check seals on gear box and oil level.
- Check power and fuses on electrical components.
- Reduce the speed and test the alignment of the tracks.
- In automatic mode, test the rain gauges to activate the Drought Simulator.
- Ensure the Drought Simulator is traveling in the proper direction and stopping accordingly.
- Clean or replace window air conditioning filter.
- Clean electrical components.

Upon Site Visit

- No obstructions are on the tracks or in the path of the Drought Simulator.
- Check the micro switches for obstructions.
- Check the wire cable is properly aligned on top guide pulley.
- Check the wire cable is tight.
- Check the wire cable is properly wrapped around the cable drive pulleys (Fig. A-1).
- Check the wire cable is properly entering and exiting the cable drive pulleys (Fig. A-1).
- Drought Simulator has correctly stopped in its center position over the micro switches (Fig. A-2).
- No obstructions are in the rain gauges.
- Check the window AC is cooling.
- Check the window AC filter.
- Check tarp straps for tightness and breaks.

Monthly

- Lubricate the two corner pulleys (Fig. A-3).
- Lubricate the two end pulleys (Fig. A-4).
- Listen to castor bearings for unusual squeaking.
- Listen to cable drive bearings for unusual squeaking.
- Spray weeds around tracks and micro switches.

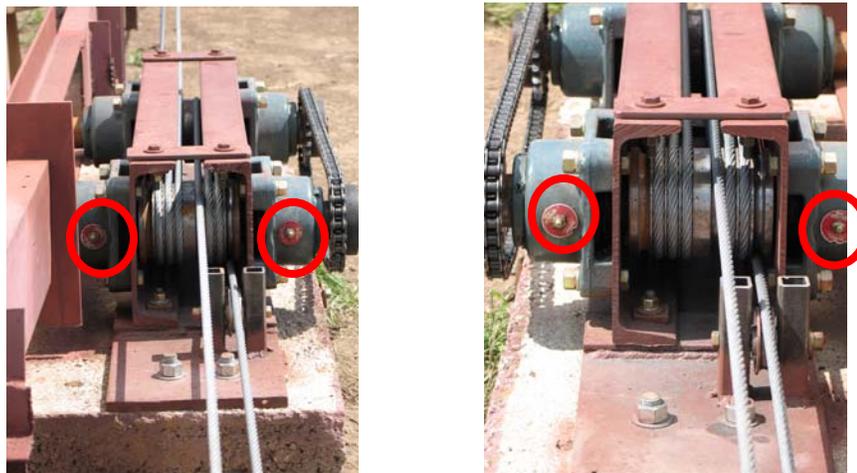


Figure A-1. Cable Drive Pulleys, Properly Aligned cable wire, and Grease Inserts

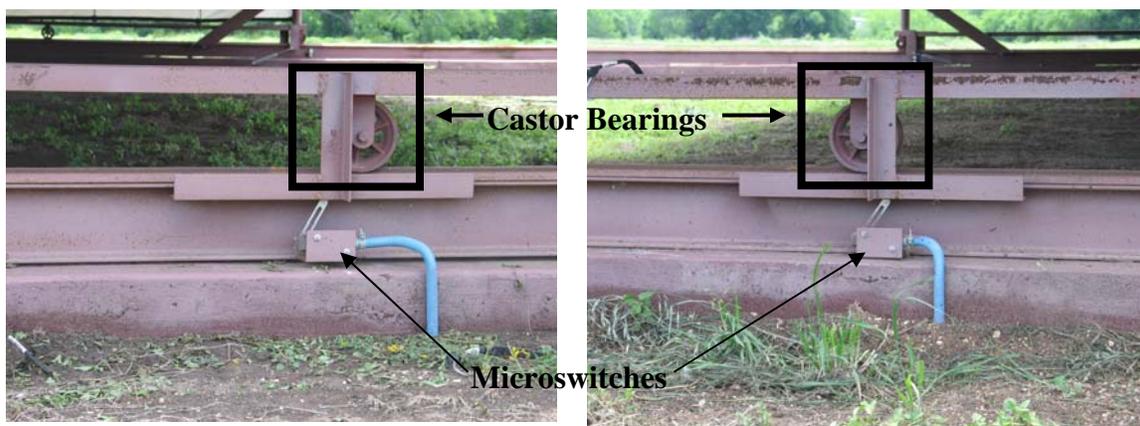


Figure A-2. Caster Bearings and Drought Simulator Centered over Microswitches



Figure A-3. Corner Pulley



Figure A-4. End Pulleys