

Reclaimed Water Use for Irrigation of Texas Golf Courses

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Abstract

Reclaimed water is proving to be a beneficial source of irrigation water for golf courses around the world. To gain a better perspective of issues associated with reclaimed water use, 487 golf course superintendents in Texas were surveyed over the spring and summer of 2007. Of those, 150 surveys were returned (31% response rate); and 40 respondents (27%) indicated they were using reclaimed water at their facility. Costs and availability were the biggest impediments to reclaimed water use and the most commonly cited problems associated with reclaimed water use were salinity, algae growth, and clogged irrigation heads. Benefits of using reclaimed water included a reliable water source, conservation of fresh water, and costs. Eighty-three percent of superintendents that were using reclaimed water at their facility stated they would continue to use reclaimed water at their facility in the future.

Introduction

In Texas, rapidly increasing population, regulatory restrictions on ground and surface water usage, and periodic droughts combine to create an ever increasing demand for sources of potable water (12). Golf generates substantial economic activity as a source of outdoor recreation, while also generating a substantial demand on municipal water sources. However, golf courses can also be potential users of reclaimed wastewater thereby mitigating some demand on municipal water supplies. Irrigating with reclaimed water yields more benefits for golf course superintendents than just conservation of fresh water. However, transitioning from potable water use to irrigating with lower quality, recycled wastewater demands changes in both management and regulatory practices (6,7).

The purpose of this research was to analyze the inherent benefits and potential problems associated with wastewater reused to irrigate golf courses in Texas. To examine the extent of wastewater reuse on Texas golf courses, a survey questionnaire was drafted and sent to 487 United States Golf Association (USGA) member courses in the state.

The Survey

Thirty-three questions were selected to be included on the survey (see Appendix 1). These questions were selected after reviewing relevant literature on the topic and also to provide some commonality to a previous survey conducted by Cisar et. al. in Florida (2). Surveys were mailed to course superintendents of 487 USGA member clubs in Texas. Included with the surveys were self-addressed stamped envelopes to encourage and facilitate the response process.

Of the 487 surveys sent, 150 were returned, providing a 31% response rate. Forty responses indicated reclaimed water use and another forty expressed interest in future use of reclaimed water. Descriptive statistics were used to determine commonality of benefits and issues.

Characteristics of Courses Using Reclaimed Water

The majority of courses using reclaimed water are private facilities (53%), and the average number of acres being irrigated by those courses is 142 acres. Eleven superintendents reported treated effluent comprised 100% of their irrigation water while treated effluent makes up over 90% of the irrigation water used at eight additional courses. Many courses have been using recycled water for a number of years, with six courses indicating recycled water use for over 25 years, while another 12 have used recycled water for over 15 years. The highest monthly mean use of recycled water is 14,331,586 gal [43.9 acre ft (AF)] and the lowest monthly mean use is 1,148,669 gal (3.5 AF), providing a monthly mean of approximately 7,740,000 gal (23.7 AF) of recycled water per course. The areas most commonly irrigated with recycled water were the primary playing surfaces, including greens, fairways, primary roughs and tees, with each being irrigated by at least 95% of the respondents who used reclaimed water (Fig. 1). Similar use was found in Cisar's survey (2). Only 37% of courses receive their reclaimed water under adequate pressure to apply to the course, which likely contributes to the fact that 83% of superintendents store the water in open ponds. Open pond storage of reclaimed water is susceptible to algae growth, and this was ranked as the second most important problem by the superintendents (Table 1). Only three courses receive their water under sufficient pressure to not require use of open ponds for storage.

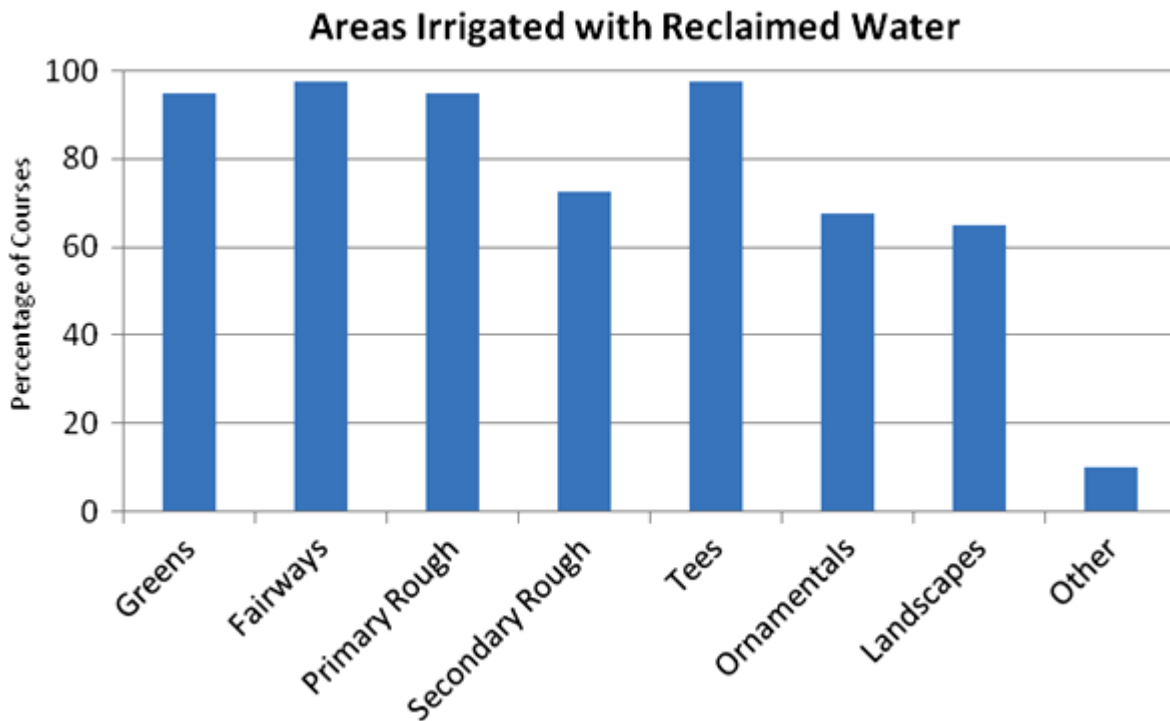


Fig. 1. Percentage of courses using recycled water to irrigate specific areas of their course.

Table 1. Ranking of potential problems of using recycled water (1 = most important, 5 = least important).

Problem / rank	1	2	3	4	5
Salinity	30	4	3	0	0
Algae growth	5	16	6	3	0
Clogged irrigation heads	7	8	10	3	4
Equipment rust	2	1	8	15	5
Complaints from golfers/neighbors	1	2	2	7	19

Costs and Availability

Costs and availability are major considerations when deciding to use reclaimed water, and may be the determining factor on the feasibility of reclaimed water use (6). The main impediment to reclaimed water use appears to be irrigation system construction and retrofit costs, as well as availability (3,5). This concern was present in the survey responses as costs and availability were the most frequently cited reasons for not using reclaimed water. It has been shown to be more costly to retrofit a course after construction than to install a dual distribution system during course construction (6).

In many locations, recycled wastewater has been priced to competitively compete with tertiary treated potable municipal water. Many places have adopted a philosophy that reclaimed water should be priced at 80% of potable water prices (4,9). Similar to the Cisar et al. survey (2), we found that 48% of the respondents do not pay for the recycled water they receive. Twenty-five percent reported a monthly fee, and another 18% pay a flat fee. Of those who do pay for their water, costs range from \$1,000 to \$200,000 annually, with a median price of approximately \$50,000.

Water Quality and Management Considerations

The federal government does not identify specific parameters for wastewater reuse (although the EPA provides Guidelines for Reuse); therefore the regulatory power is extended to individual states. The Texas Commission on Environmental Quality (TCEQ) regulates water quality for reuse application in Texas. Water quality parameters regulated by the TCEQ are Biochemical Oxygen Demand (BOD₅) or Carbonaceous Biochemical Oxygen Demand (CBOD₅) turbidity, and fecal coliform levels (11). This means that individual courses should monitor and perform chemical analysis of the water they receive. Thirteen percent of the superintendents receive detailed chemical analysis from their reclaimed water provider, and another 23% noted that an analysis is available by request. Eighty percent of the superintendents obtain their own water quality analysis. Salinity, sodium/sodium absorption ratio (SAR) and pH are the most commonly monitored water quality parameters, but boron, chlorine, chloride, bicarbonates, carbonates, nitrogen, phosphorous, potassium, and suspended solids are all monitored by a significant proportion of the superintendents (Fig. 2). As expected from review of the relevant literature, salinity was identified as the most important problem associated with using recycled water, followed by algae growth, clogged irrigation heads and equipment rust (Table 1). Another important statistic, which was also found by Cisar et al. (2), is that complaints from golfers and neighbors were considered the least important problem associated with recycled water use.

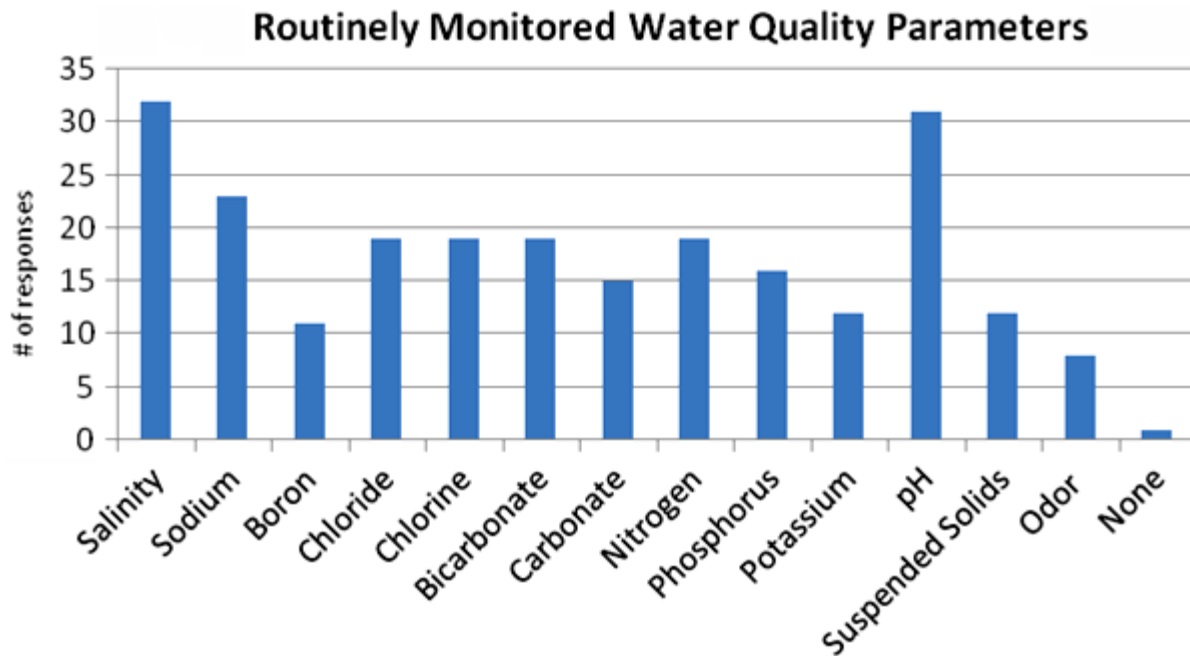


Fig. 2. Number of respondents monitoring particular water quality parameters in their recycled water.

Increased levels of some constituents in reclaimed water pose significant risks to soils and turfgrasses, creating "degradation of aggregate stability, a decrease in the soil hydraulic conductivity, surface sealing, runoff and soil erosion problems, soil compaction and a decrease in soil aeration" (8). While many constituents in reclaimed water can have a detrimental effect on turfgrass growth, some nutrients can have positive effects on soils and turfgrass (7). The increased nutrient load in reclaimed water can be used efficiently by the turfgrass, having a substantial economic value by reducing the amount of fertilizer needed to maintain the aesthetics and playability of the course (7). Water and fertilizer savings were cited as the second most common management issue when using recycled water. The need to periodically leach soils was at the top of the management issues most important to superintendents (53%); equipment deterioration was also considered significant by 23% of the superintendents. Several of the respondents (35%) acknowledged that they were limited in the time they could irrigate with reclaimed water, typically at night when there are no golfers present. The employment of low water use grasses and plants is another management practice adopted on thirty-one of the courses. The survey responses noted in this section are evidence of the increased management issues that accompany the use of reclaimed water for irrigation.

Increased management issues also bring with it increased benefits. Superintendents were asked to rank the potential benefits of using recycled water based on their experience using a Likert scale (with one ranking most important and three least important). Guaranteed water supply received the best ranking, followed by conservation of fresh water and finally overall cost savings. Respondents displayed an overall satisfaction with using recycled water. Again employing a Likert scale rating system (one indicating high satisfaction and five indicating high dissatisfaction), 27 respondents were either satisfied or highly satisfied with their reclaimed water experience, while only two responses indicated dissatisfaction or high dissatisfaction and 83% of the golf course superintendents reported they would continue to use the treated effluent if the choice was theirs alone.

While most superintendents are happy with their experience using reclaimed water, there are still a variety of problems indicated in the survey. Two superintendents indicated dissatisfaction and high dissatisfaction with reclaimed water use on their course. Reclaimed water constitutes 100% of irrigation water on both courses. One superintendent did not elaborate on his dissatisfaction, although chloride was the only water quality parameter routinely monitored and the respondent also noted that they have not performed an irrigation audit. The other dissatisfied superintendent receives his recycled water from the city wastewater plant where the water is not screened before distribution. This has resulted in a continuous problem of clogged intake screen baskets due to trash in the effluent. The maintenance required to keep the intake screens clean costs the superintendent an estimated \$10,000 annually. Besides these two responses, reclaimed water appears to be making a positive impact on Texas golf courses.

Discussion and Conclusion

Once connected or retrofitted to receive and irrigate with reclaimed water, the major concern is with salinity of the water, algae growth, and clogged irrigation heads. To understand if these problems were consistent among old and new reclaimed water users, respondents' surveys were classified into two groups; one group consisted of courses that have used reclaimed water for over fifteen years and another for courses that have used reclaimed water for less than fifteen years. The order of importance of problems remained constant among both groups, and most ranking scores were similar, although clogged irrigation heads received a higher mean importance rank (3 to 2.28) for courses in the second group as did equipment rust (4 to 3.35). The difference in perceived importance of these issues may be related to management practices and that older courses may have adapted to manage these issues over time.

A similar approach was taken to determine if there is a difference in problem identification between courses that exclusively use reclaimed water for irrigation compared to courses that use a mix of treated effluent and fresh water. Surveys were divided into two groups; the first consisting of courses that indicated reclaimed water use constituting over ninety-five percent of irrigation water and those using a mix consisting of less than ninety-five percent reclaimed water. The importance rank once again remained the same and means were consistent, except for clogged irrigation heads and equipment rust. Clogged irrigation heads had a higher importance mean for courses using less than 95% recycled water (2.88 compared to 2.33), and equipment rust had a higher mean score for courses using over 95% recycled water (3.84 compared to 3.56).

Two distinct regions of reclaimed water use emerge through the survey responses. The first region is the Interstate 35 corridor between Georgetown and San Antonio. The abundance of reclaimed water use in the Edwards Aquifer region is attributed to the need for alternative water sources in the face of exploding populations in the last several decades and the legislative push to reduce demands on groundwater. The San Antonio Water System has an extensive reclaimed water infrastructure, increasing availability in the city (10). Austin also conserves considerable water through wastewater reclamation, though not as extensively as San Antonio (1). The Houston area also has widespread reclaimed water use among golf courses. Regions lacking in recycled water use are the Dallas-Fort Worth region and the Texas Panhandle.

In conclusion, the survey results show many benefits to recycled water use for irrigating golf courses and are consistent with the Cisar et al. survey from Florida (2), in that 83% of superintendents would continue to use reclaimed water if the choice was theirs alone. The guarantee of a reliable water source was the most commonly cited benefit to using reclaimed water, and surprisingly, conservation of fresh water ranked above cost savings, even though almost half of the responding superintendents do not pay for their water. Costs are a major benefit once initial retrofit costs are covered but retrofit costs and availability were considered a significant limitation to reclaimed water use by many of the course superintendents. For many superintendents, it is not economically feasible to connect to a treatment facility and frequently there is no facility

nearby. Another regularly cited benefit was the reduction of fertilizer needed, and one superintendent even replied that more people come to his course during droughts because the course still has green fairways. Additionally 40% of superintendents have systems in place to educate golfers about the use of recycled water and 38% have systems in place to manage golfers' expectations of aesthetics of the course versus the playability of the course.

As evidenced in the survey results, irrigating a golf course with recycled water commands more rigorous management and regulatory oversight than irrigating with potable water. However, with proper implementation and management, recycled water can be an effective conservation measure as potable water supplies become more limited in the years ahead.

Acknowledgments

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Appendix:
Recycled Water Use Survey for Texas Golf Courses, 2007

Recycled Water Use Survey

The purpose of this survey is to determine the extent of recycled water use on Texas golf courses. Your participation in this voluntary survey is appreciated. If you have any questions on the survey please contact Dr. Rich Dixon of the Texas State University Geography Department at 512-245-7436 or rd11@txstate.edu.

1. Facility name: _____

2. Type of facility:
Private _____ Municipal _____ Daily Fee _____ Military _____ Resort _____
Number of holes? _____

3. Do you presently use recycled water at your facility? Yes _____ No _____
(if yes please skip to question 6)

4. If no, are you considering its use in the future? Yes _____ No _____

5. If no, what is the most important reason for your answer?

(Please return survey. Thank you for your participation)

6. What is your primary source of recycled water? _____

7. How many acres do you irrigate with recycled water? _____

8. Which areas do you irrigate with recycled water (check all that apply)?
Greens _____ Fairways _____ Primary rough _____ Secondary rough _____
Tees _____ Ornamentals _____ Landscapes _____ Other (list) _____

9. How many years have you been using recycled water at this facility?

10. What is your average recycled water usage for the highest and lowest usage months of the year?
Highest _____ Lowest _____

11. What other sources of irrigation water do you use?
Lakes or springs _____ Wells _____ Other (list) _____

12. What percentage of your total irrigation water is met by recycled water? _____

13. Is your recycled water received under sufficient pressure for immediate use?
Yes _____ No _____

14. How is your recycled water stored on your facility?
No storage _____ Tanks _____ Open ponds or lakes _____
Other (specify) _____

15. How does your provider charge you for supplying recycled water?
 No charge _____ Flat fee _____ Pumping expense only _____
 Monthly usage fee _____ Is this fee staggered by usage? _____
 Other (describe) _____
16. What is your annual cost for recycled water? _____
17. Does your recycled water supplier provide you with a detailed chemical analysis?
 Yes _____ Available by request _____ No _____
18. Do you perform (or have performed at your expense) a detailed chemical analysis of the recycled water?
 Yes _____ No _____
19. Which of the following do you routinely monitor in your recycled water.
 Salinity _____ Sodium/Sodium Adsorption Ratio _____ Boron _____
 Chloride _____ Chlorine _____ Bicarbonate _____ Carbonate _____
 Nitrogen _____ Phosphorus _____ Potassium _____
 pH _____ Suspended solids _____ Odor _____ None _____
20. Please rank the following potential benefits of using recycled water based on your experience. Rank the most important benefit to you as 1.
 Guaranteed water supply _____ Cost _____ Conservation of fresh water _____
21. Please list any other benefits you experience in using recycled water.
22. Please rank the following potential problems of using recycled water based on your experience. Rank the most important problem as 1.
 Salinity _____ Algae growth _____ Clogged irrigation heads _____
 Excessive equipment rust _____ Complaints from golfers/neighbors _____
23. Please list any other problems you experience in using recycled water.
24. Which of the following regulatory issues impact your use of recycled water.
 Positive cross-connection prevention _____ Line separation distances _____
 Employee training _____ Public notification of use _____
 Regulatory inspection _____ Plan submission to regulatory body _____
 Other (specify) _____
25. Which of the following management issues impact your use of recycled water.
 Equipment deterioration _____ Retrofit cost recovery _____
 Water/fertilizer savings _____ Over-seeding issues _____
 Need to periodically leach soils _____ How often? _____
 Restricted use of plant species due to salt tolerance issues _____
 Other costs or savings (specify) _____

26. Overall what is your satisfaction level in using recycled water. _____
 (1 = highly satisfied, 2 = satisfied, 3 = neutral, 4 = dissatisfied, 5 = highly dissatisfied)

27. Are you limited in the time when you can irrigate using recycled water?
No ____ Yes ____ Please explain _____
28. If the choice was mine alone to make I would continue to use recycled water.
Yes _____ No _____
29. How often do you perform an irrigation audit? _____
30. Do you attempt to incorporate low water use grasses and plants where appropriate?
Yes _____ No _____
31. Do you have systems in place to educate golfers as to the use of recycled water?
Yes _____ No _____
32. Do you have systems in place to manage golfers expectations of the "aesthetics" of the course versus the "playability" of the course?
Yes _____ No _____
33. Approximately how many rounds per year are played on your course? _____

Thank you for your participation in this survey. If you would like to be kept apprised of this research, please provide contact information below.

Name: _____

Course: _____

E-mail: _____

Please return this survey in the enclosed envelope to:

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