# Water Reuse for Turfgrass Irrigation

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## Introduction

The Department of Environmental Quality (DEQ), Virginia's regulating agency for wastewater and reclaimed water land application, has requested data to justify that irrigation with reclaimed water will not result in N and P impairment of groundwater.

The Hampton Roads Sanitation District (HRSD) treats 40 million gallons of wastewater per day from Norfolk, Portsmouth, and Virginia Beach at its Virginia Initiative Plant (VIP) in Norfolk.

The HRSD VIP employs a biological nutrient removal technology that results in an effluent containing low concentrations of N and P.

HRSD is exploring the feasibility of marketing reclaimed water for irrigation of landscapes, but the benefits and potential detrimental effects on groundwater quality and plant growth and quality had not yet been demonstrated as of 2004.

## Objectives

A joint study of Virginia Tech, Virginia Cooperative Extension, and the Hampton Roads Sanitation District was initiated at the HRSD VIP in 2004 to compare the effects of potable and reclaimed water on:

1. Soil chemical properties that may be affected by irrigation water of varying ionic composition
2. Turfgrass nutrient uptake, growth, and quality
3. Leaching of N and P

**Table 1. 2005 mean water quality data for potable (PW) and reclaimed (NPW) irrigation sources and groundwater standards (GW).**

| Parameter | Units | PW | NPW | GW |
|---|---|---|---|---|
| $BOD_5$ | mg/L | <2 | 8.2 | |
| TSS | mg/L | 1.0 | 4.5 | 1000 |
| EC | dS/m | 0.27 | 1.5 | |
| Na | mg/L | 36 | 238 | 100 |
| Cl | mg/L | 16 | 317 | 50 |
| TKN | mg/L | 0.8 | 2.1 | |
| $NO_3$-N | mg/L | 0.6 | 5.2 | 5.0 |
| TP | mg/L | 0.25 | 0.42 | |
| pH | | 7.53 | 7.00 | 6.5-9.0 |

## Materials and Methods

Plots established in 2004 on constructed sand-based profiles meeting U.S.G.A. specifications for putting greens and plumbed to deliver irrigation with potable (PW) or reclaimed (NPW) water.

### *Treatments*

- Water source: PW and NPW
- Turfgrass species:
  - Creeping bentgrass (*Agrostis palustris* var. L-93)
  - Hybrid bermudagrass (*Cynodon dactylon x transvaalensis* var. Tifsport)
- Experimental Design: CRD, 3 reps/treatment

### *Fertilization*

- Bentgrass: 2002 kg N $ha^{-1}$, 8 kg P $ha^{-1}$
- Bermudagrass: 253 kg N $ha^{-1}$, 10 kg P $ha^{-1}$

### *Sampling and Analysis*

Clippings collected 3-4 times per week. Cumulative monthly dried clippings weighed for biomass and analyzed for N and P. Soil collected in July 2004 and April 2006 and analyzed for soil chemical properties.

### *Leachate collection*

Two lysimeters in each plot sampled bi-monthly for analysis of N and P.

### *Irrigation*

Irrigation was supplied 3-4 times/week with pop-up sprinklers to prevent turfgrass moisture stress.

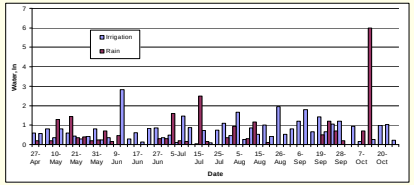



**Fig. 1. Clipping yield of 'L-93' creeping bentgrass was higher with reclaimed water in 2005.** Monthly treatment differences significant at 0.05 level of probability.

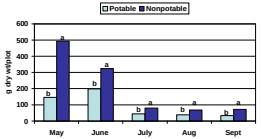



**Fig. 2. Clipping yield of bermudagrass was lower with reclaimed water in 2005.** Monthly treatment differences significant at 0.05 level of probability. NS = Not significant.

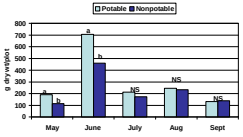



**Fig. 3. Effects of irrigation source on visual quality of 'L-93' creeping bentgrass in 2005.** 9 = highest and 0 = lowest quality. Monthly treatment differences significant at 0.05 level of probability. NS = not significant.

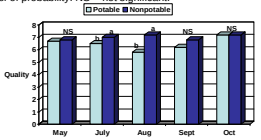



**Fig. 4. Effects of irrigation water source on visual quality of 'Tifsport' hybrid bermudagrass in 2005.** 9 = highest and 0 = lowest quality. Monthly treatment differences significant at 0.05 level of probability. NS = not significant.

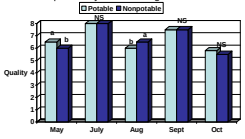



**Table 2. Effects of irrigation source on soil pH, P, base saturation and exchangeable Na percentage.**

| Soil property | July 2004 | April 2006 | |
|---|---|---|---|
| | | PW | NPW |
| pH | 5.87 | 5.40b | 6.40a |
| Bray 1-P | 6 | 17 | 13 |
| BS | 77 | 72b | 90a |
| ESP | nd | 7b | 20a |

**Table 3. Effects of irrigation source on N and P plant uptake.**

| | Bermuda | Bentgrass |
|---|---|---|
| | N uptake, kg/ha | |
| PW | 453a | 112d |
| NPW | 335b | 205c |
| | | |
| | P uptake, kg/ha | |
| PW | 44a | 12c |
| NPW | 41a | 27b |

**Fig. 5. Higher concentrations of nitrate N were leached from bermudagrass than bentgrass in 2005.**

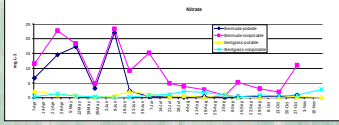



**Fig. 6. Higher concentrations of ammonium N were leached from bermudagrass than bentgrass in 2005.**

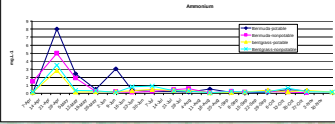
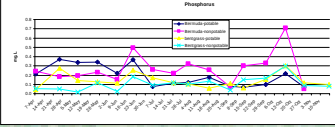



**Fig. 7. Higher concentrations of ortho-phosphate were leached from bermudagrass than bentgrass in 2005.**




## Conclusions

- Bermudagrass growth and quality was reduced by reclaimed water upon breaking dormancy, when N use was also reduced.
- Bentgrass responded positively to reclaimed water except during turfgrass establishment, when extra N favored shoot over root growth.
- Turfgrass species or water source did not affect N and P leaching. Mean amounts of N and P leached during May to October were 21 kg N $ha^{-1}$ and 3.4 kg P $ha^{-1}$.
- Routine irrigation with the HRSD reclaimed water should not result in N and P impairment of groundwater, but additional soluble salt removal (esp., $Cl^-$ and $Na^+$) is desirable for long-term unrestricted use.