



# Environmental Effects of Reclaimed Water on Soil Properties; Public Acceptance of Reclaimed Water Use in Oklahoma



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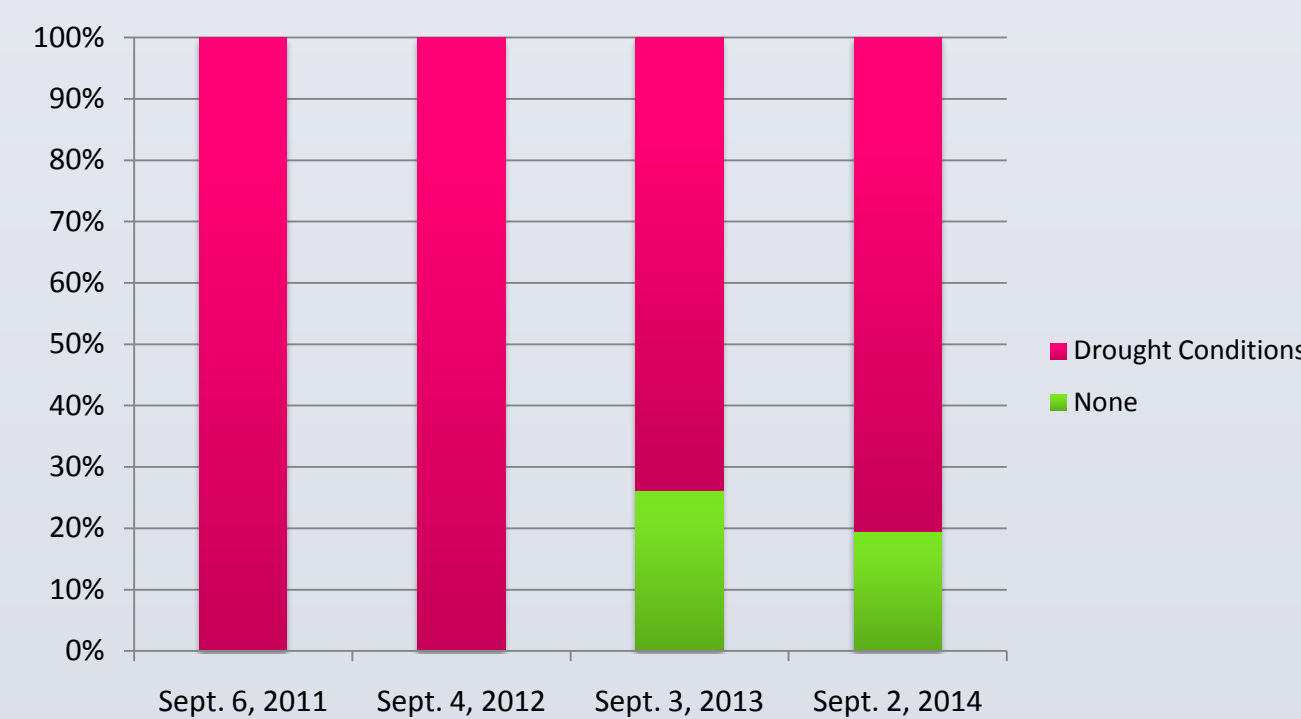
## Introduction

Currently, Oklahoma is experiencing incessant drought conditions, in conjunction with temperature and rainfall variability. In addition to these environmental factors, the expanding populations of municipalities across the state are causing a strain on water resources (Oklahoma Water Resources Board, 2012). Given the increasingly growing need for water and the conflict over existing water supplies, it is imperative that municipalities invest in alternative sources of water.

Oklahoma City owns four water supply lakes including Overholser, Hefner, Atoka, and Draper, as well as water rights in Lake Canton and McGee Creek Reservoirs. To minimize impacts, some cities across Oklahoma, such as Norman, are relying on reclaimed water use instead of searching for and exploring possible additional water supplies (Layden, 2014).

Reclaimed water, also known as recycled wastewater, is waste water that has been treated to levels suitable for reuse. Reclaimed water use reduces the need for purchasing water located in other parts of the state, and decreases pressure on water municipalities in times of severe drought. Water reuse can directly replace municipal drinking water for irrigation purposes, or supplement existing drinking water supplies if further treated. Irrigating golf courses with reclaimed water is an economical way to reduce demand on municipal water infrastructure. The concerns that arise with reclaimed water use stem from public acceptance and potential environmental risks. To date, no studies have evaluated the environmental implications of reclaimed water use on soil and water quality, as well as public acceptance, in Oklahoma.

Oklahoma Drought Conditions: 2011-14 (% Area)



\*United States Drought Monitor, 2014

## Goals and Objectives

- Evaluate the environmental impacts and sustainability of irrigating recreational landscapes with recycled municipal water in Oklahoma City.
  - Determine the effects of irrigation water from four different sources including: reclaimed, treated, surface, and groundwater on the soil chemical properties on golf course greens, fairways, and non-irrigated roughs through sample analysis.
- Identify and analyze the socio-demographic and psychological factors that influence public acceptance of water reuse in municipal drinking water supplies versus irrigated public landscapes.
  - Conduct an internet survey distributed to Oklahoma citizens involving water conservation, environmental behaviors, drought conditions, water pricing, reclaimed water, and socio-demographic factors.
  - Interpret and evaluate the survey results using the contingent valuation method to decipher what factors influence public acceptance of water reuse.

## Materials and Methods

### Reclaimed Water Effects on Soil Properties Case Study

Five golf courses in Central Oklahoma were chosen for sampling. Each golf course consists of 18 holes with similar turfgrass species. Approximately 65 samples will be taken at 4-6 inches deep with a soil probe. Twelve samples will be taken from holes 3, 6, 9, 12, 15, 18, with 6 samples taken from the greens and 6 samples taken from the fairways. A base sample will be taken from a non-irrigated rough. The greens samples will be taken with a ½" diameter soil probe, while the fairways and non-irrigated rough will be taken with a 1" diameter soil probe. Approximately 10-15 soil cores will be taken per green and fairway to be mixed and submitted for the 12 individual composite samples. Approximately two cups of each composite sample will be bagged and sent to the Soil, Water, and Forage Analytical Laboratory (SWFAL) in Stillwater, OK. Three 4 ounce bottles will be thoroughly rinsed with the water source and filled. These three water samples will be labeled and submitted to SWFAL for analysis. A list of the soil and water testing procedures is listed below. Additional water sample will be tested for Fecal Coliform levels. Golf superintendents will also fill out a form pertaining to their corresponding course's management information to be considered in the analysis.

Soil Testing Procedures	
<b>Soil Fertility</b>	
Routine Soil Test	pH(1:1), Lime Requirement (Sikora), NO3-N, Soil Test P&K (Mehlich 3)
Secondary Nutrients	Mg, Ca (M3), and SO4
Micronutrients	Fe, Zn, B, and Cu
<b>Soil Salinity</b>	
Salinity Mgmt.	(1:1 Soil to water extraction), - Na, Ca, Mg, K, B, EC, TSS (total soluble salts), SAR, ESP, pH
<b>Soil Organic Matter</b>	
	OM% (Combustion or LOI)

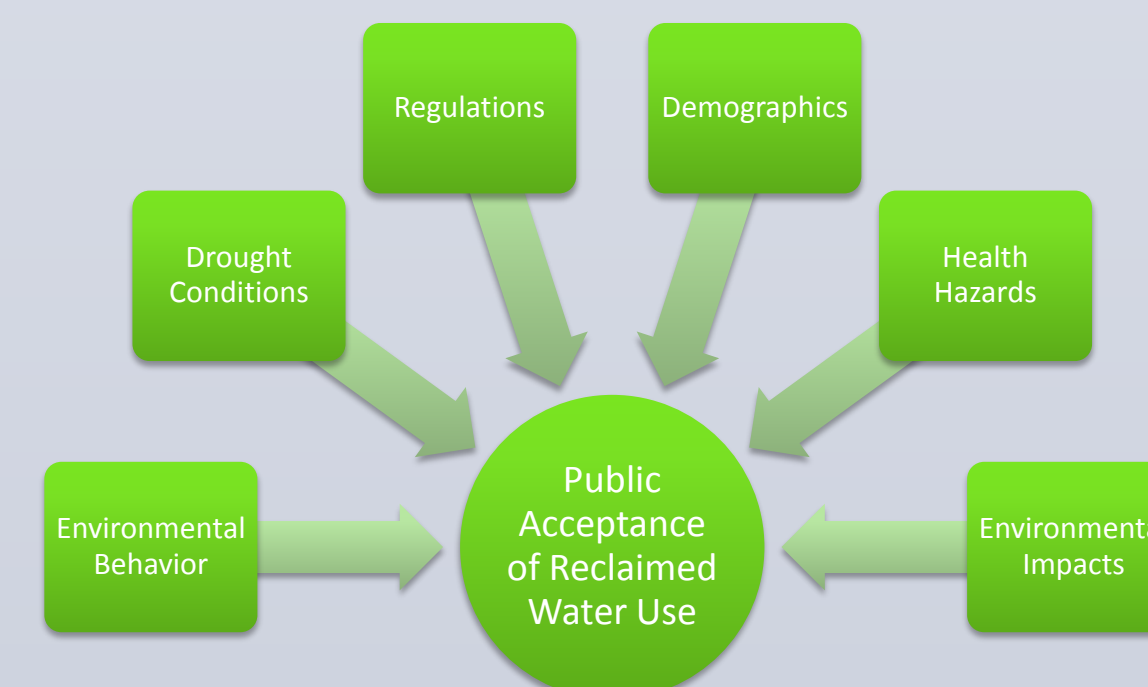
Water Testing Procedures	
Irrigation Water	Na, Ca, Mg, K, B, Cl-, NO3-N, SO4-, CO3-, HCO3-, pH, EC, SAR, TSS, Hardness, Alkalinity
Nitrate & Ammonium N	NO3-N and NH4-N
Ortho-P or Total Dissolved P (TDP)	Ortho-P (colorimetric), TDP (ICP)

Golf Course	Location	Water Source	Soil Texture Classification
Gaillardia	Oklahoma City	Reclaimed Water	Silt Loam
Lake Hefner	Oklahoma City	Lake Hefner, untreated	Silt Loam
Lincoln Park	Oklahoma City	Treated surface water	Sandy Loam
Quail Creek	Oklahoma City	Groundwater (Garber-Wellington)	Silty Clay Loam
Jimmie Austin	Norman	Reclaimed Water	Sandy Loam



**Bid Question Example:** In Oklahoma, water prices are increasing due to decaying infrastructure, urban growth, and the need for water conservation. New pricing rates are often based on usage. Currently water costs \$4.90 per 1000 gallons (\$2.73 per 1000 gallons in OKC; \$3.18 per 1000 gallons in Tulsa). The average household uses 7000 gallons per month in the summer.

Would you be willing to pay \$5 (bid: 2.65, 3, 3.50, 4, 4.50, 5, 5.50, 6, 7) per 1000 gallons to increase reclaimed water use, and maintain water supply and infrastructure?



### Public Acceptance of Reclaimed Water in Oklahoma Survey

An email survey will evaluate the public acceptance of reclaimed water use in Oklahoma for either irrigating public landscapes or augmenting municipal drinking water supplies. The Contingent Valuation Method (CVM) will be used to economically assess how Oklahomans value reclaimed water use when trading off water supply uncertainty under drought conditions (Mitchell and Carson, 1989). The CVM will use randomly assigned bids concerning increasing water prices per 1000 gallons that reflects increased reclaimed water use and conservation measures. Half of the surveys include water quality data as it pertains to reclaimed water standards and surface water standards in Oklahoma. This survey will be distributed via the internet to approximately 500 Oklahoma citizens, 250 homeowners and 250 non-homeowners, through Survey Sampling International.

## Expected Outcomes

### Environmental Sampling Study

To determine the significance of the soil and water sample results, data will be interpreted by analysis of variance. The Statistical Analysis Systems (SAS) software will be used for analysis. Each of the golf course superintendents will also be sent a copy of the analysis and results of the sampling. This information will be also be sent to the Oklahoma City Water Utilities Trust for consideration in future water planning.

### Public Acceptance of Reclaimed Water in Oklahoma Survey

To interpret and analyze the results of the survey, regression analysis will be applied. Regression models will be used to evaluate the responses based on the stated different variables. This information will be useful to the future of reclaimed water use and potential policy development in Oklahoma.

### Literature Cited

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