Using Reclaimed Water for Landscape Irrigation[1]

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Why irrigate with reclaimed water?

Using reclaimed water to irrigate landscapes has increased in recent years as a way of conserving surface and groundwater resources. Reclaimed water irrigation conserves fresh water resources by replacing drinking quality water with reclaimed water. When used to irrigate residential areas, golf courses, public school yards, and parks, reclaimed water receives treatment and high-level disinfection and is not considered a threat to public health (FDEP 2012; US EPA 2015). However, the water quality of reclaimed water differs from that of drinking quality water or rainfall and should be considered when used to irrigate landscapes. Of particular importance to landscape health and environmental quality are the salts and nutrients in reclaimed water. Special management practices may be required depending on the quantity of salts supplied in reclaimed water and the salt-sensitivity of the plants irrigated. Depending on the quantity and timing of nutrients supplied by reclaimed water, the need for additional fertilizers could be significantly reduced. Applying fertilizers at recommended rates without accounting for the nutrients in reclaimed water could result in applying more nutrients than is necessary or that can be used by the plant or retained by the soil, potentially resulting in excess nutrients running off or leaching to groundwater and degrading water quality.

More information on reclaimed water, how it is produced, and Florida's reuse program can be found at http://edis.ifas.ufl.edu/AE448, and the Florida Department of Environmental Protection Reuse Program website: http://www.dep.state.fl.us/water/reuse/.

Salinity

All reclaimed waters contain some amount of dissolved mineral salts. The salinity of reclaimed water may be the single most important parameter in determining its suitability for irrigation (US EPA 2012). Water salinity is the sum of all elemental ions (e.g. boron, calcium, chloride, sodium, sulfate, etc.) contained within the water. The salinity of a particular reclaimed water can vary greatly from source to source. These salts in reclaimed water come from:

- Ions naturally found in the water (from the original source);
- Ions remaining in dissolved form after separation of solids during treatment of the water;
- Any salts added during the treatment process; and
- Infiltration of salt water into sanitary sewer lines prior to treatment (a possibility in coastal areas with high groundwater tables and older sewers in need of repair).

The salinity of water is measured as the electrical conductivity (EC) or total dissolved solids (TDS) in the water. The amount of total dissolved solids is determined by allowing a sample of water to evaporate and then weighing what remains. Total dissolved solids is usually reported as milligrams of solids per liter of water (mg/L) or parts per million (ppm). These units are approximately equivalent:

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$$1 \text{ mg/L} = 1 \text{ ppm} \quad (1)$$

In water, EC is a measure of the flow of an electrical current. The current is carried by the ions in the water. The more ions in the water, the higher the EC. The EC is measured in units of milli-mhos per centimeter (mmhos/cm) or deci-Siemens per meter (dS/m). These two units of measuring the EC in water are equivalent:

$$1 \text{ mmho/cm} = 1 \text{ dS/m} \quad (2)$$

Electrical conductivity can be used to approximate TDS using the following equation:

$$\text{TDS (mg/L or ppm)} = \text{EC (mmho/cm or dS/m)} \times 640 \quad (3)$$

Soil Salinity

Of most concern to landscape plants is the salinity in the soil, which can be affected by irrigating with water that has a high salt content. The rate that salt can build up in soil to undesirable levels depends on:

- The salt content of irrigation water;
- The amount of irrigation water applied;
- The amount of rainfall;
- The rate of evapotranspiration (transpiration of water from plants and evaporation from soil); and
- The characteristics of the soil.

Applying large amounts of high salinity water could affect the salt content of the soil which could then affect landscape plants. However, climates that receive large amounts of rainfall (like Florida) are less affected by salt accumulation in the soil for two reasons: 1) large and frequent rainfall events reduce the need for irrigation and 2) large and frequent rainfall events periodically leach salts from the soil, preventing it from accumulating. Rainfall has very low salinity. For more information on irrigating with high salinity water see Haman et al. (2005) online at http://ufdc.ufl.edu/IR00003289/00001.

Plant Sensitivity to Salinity

Plants differ in their sensitivity to salinity, so the salt content of a reclaimed water source should be evaluated so it can be used most appropriately. Many turfgrasses grown in Florida show moderate to high tolerance to salinity levels (Table 1), so the use of reclaimed water for irrigation should not impact the quality of the turf, particularly if irrigation is not applied when it is not needed. However, other landscape plants show large variations in their sensitivity to salinity levels. For example, crape myrtle (*Lagerstroemia* spp.) and azaleas (*Rhododendron* spp.) have fairly low salt tolerance (Crook 2005). For a comprehensive list of salt tolerances of a variety of Florida landscape trees, shrubs, and groundcovers see Black (2003) online at: http://ufdc.ufl.edu/IR00001713/00001. Additional salt-tolerant plants can also be found in the report by Wu and Dodge (2005) online at: http://slosson.ucdavis.edu/files/215300.pdf [10/30/15], however many of the plants listed are not grown in Florida.

Salinity Control

For salt-sensitive plants it is important to consider their irrigation requirements since over-irrigation could affect plant health by allowing salts to accumulate, particularly in the dry season when frequent rains do not occur that would otherwise leach salts from the soil. For salt sensitive plants that are irrigated appropriately (not over-irrigated), periodic heavy rains will leach salts that have accumulated in the root zone and the plant will not be constantly exposed to the salts.

Special management may be required when reclaimed water with high salt content is used for irrigating salt sensitive plants. First, over-irrigation during dry periods should be avoided to limit the total amount of salt supplied to the soil. Second, periodic intentional leaching may be required to remove accumulated salts from the soil. Intentional leaching may be most important during periods of low rainfall or when there is a lack of heavy rains that would leach the salts naturally. For more information on irrigating with high salinity water, salinity effects on plants, and controlled leaching to remove salts from the soil see Haman et al. (2005) online at http://ufdc.ufl.edu/IR00003289/00001.

Nutrients

An often overlooked aspect of reclaimed water is the nutrients it contains, particularly nitrogen and phosphorus. When reclaimed water is used for uses other than irrigation, such as for industrial cooling water, these nutrients can be detrimental since nutrients can encourage biological growth which can cause equipment fouling. In these situations an additional treatment process is often used to remove nutrients and avoid any problems. However, for application to the landscape these nutrients can be beneficial and can supply a significant portion of plant needs (US EPA 2004). This can then reduce the amount of fertilizer that might be applied (King et al. 2004; Lazarova et al. 2005b; US EPA 2004). Supplemental fertilization with specific nutrients not provided by reclaimed water may still be required depending on plant species and the recommended rates for desired results.

Nutrient Content of Reclaimed Water

The nutrient content of reclaimed water varies depending on the treatment processes used. In general, treatment plants that use advanced treatment methods typically produce reclaimed water with lower nutrient levels than those that use secondary treatment methods. However, advanced treated reclaimed water still often contains higher nutrients than drinking-quality water or rainfall. More information on secondary and advanced treatment methods and the production of reclaimed water can be found at http://edis.ifas.ufl.edu/AE448. The amount of nutrients contained in reclaimed water also varies from utility to utility and can vary at different times of year, so it is important to know the nutrient content of the water you receive so you can incorporate this source into a landscape fertility plan. Contact your local utility to find out the nutrient content of your reclaimed water.

Plant Availability of Nutrients in Reclaimed Water

The nitrogen and phosphorus in reclaimed water are mainly present as inorganic ammonium, nitrate, and phosphate ions with a smaller proportion of organic forms. The organic forms are typically composed of dissolved and fine particulates and are a mixture of amino acids, proteins, sugars, and starches (Lazarova et al., 2005a). The exact composition of a given reclaimed water will vary from utility to utility. The simple organic forms found in reclaimed water are products of the decomposition of more complex forms during treatment at the wastewater treatment facility. In warm climates such as Florida these simple organic nutrient forms are typically readily converted to inorganic forms (ammonium and phosphate) by soil microorganisms (Lazarova et al., 2005a). Ammonium is then rapidly converted to nitrate in well drained soils. However the exact amount of the organic forms that can be converted to inorganic forms and used by plants may vary by reclaimed water source and is a topic in need of further research.

Several studies have evaluated the ability of turfgrasses to use nutrients supplied in reclaimed water. Sidle and Johnson (1972) found bermudagrass-annual ryegrass capable of taking-up up to 90% of the nitrogen applied in wastewater (between 13–26 ppm) at irrigation rates between 1.3 and 2.8 inches per week during active growth. In a study in Arizona using common bermudagrass overseeded with perennial ryegrass Hayes et al. (1990a, b) found that the secondary effluent used for irrigation supplied approximately 5 lbs of nitrogen per 1000 square feet of turf. Menzel and Broomhall (2006) found that reclaimed water could supply 23% of the nitrogen and 98% of the phosphorus required for maximum shoot growth in several warm-season turfgrasses.

Incorporating Reclaimed Water into Fertilization Plans

A significant amount of the nutrients in reclaimed water are readily available to plants and should be incorporated into landscape fertilization plans. Incorporating nutrients supplied in reclaimed water into golf course fertility plans has been recommended by several turfgrass experts (Duncan et al. 2000; Harivandi 2004; Huck et al. 2000; King et al. 2000). The nutrients in reclaimed water are believed to be efficiently used by turfgrasses since they are applied on a regular basis by irrigation even if they are only present in low concentrations (Harivandi 2000). Depending on the nutrient content, using reclaimed water for irrigation has the potential to provide a significant portion of the nitrogen and potentially all of the phosphorus required by turfgrass (Menzell and Broomhall 2006). Incorporating nutrients from reclaimed water into the nutrient budget can also allow for the reduction in high-dose applications of nitrogen fertilizer which could in-turn increase nutrient uptake efficiency (King et al. 2000). The value of nutrients in reclaimed water can be an important economic consideration, particularly as the cost of fertilizers increase with the cost of energy used to produce them.

When incorporating nutrients from reclaimed water into landscape fertilization plans it is also important to account for the timing of application since the relatively constant, low dosage provided by irrigation with reclaimed water may not supply the right amount of nutrient at the right time.

Storage Loss

Depending on how a utility manages reclaimed water there is a possibility that some of the nutrients in the water will be lost between the point they are measured (at the treatment plant) and the point of irrigation. Some loss of nutrients can occur if storage is in open ponds where algae and other microorganisms can take up some of the nutrients and remove them from the water. Loss during storage is of less concern when closed tanks are used. Closed tanks are sometimes preferred by utilities since the algae produced in open ponds can sometimes clog irrigation systems and increase maintenance requirements by the utility before the water enters the distribution system.

Potential Environmental Impacts

Use of reclaimed water can significantly reduce demand on high quality fresh water, allowing those resources to be conserved for more important uses. However, nutrients in reclaimed water, if not managed appropriately, can result in impacts to downstream environments. All nutrient applications to the landscape should be accounted for whether they are in the form of fertilizers or reclaimed water. Soil tests should be used to determine the need for fertilizer application. Special caution should be taken when using reclaimed water in soils that already contain adequate phosphorus for plant growth. Overspray of reclaimed water onto impervious surfaces such as roads, driveways, and sidewalks should be avoided since this results in reclaimed water entering the stormwater system, increasing nutrient loads to retention ponds and increasing plant and algal growth. Grass clippings and fertilizer left in a curb or gutter also will be washed down the drain in the next storm and can create problems downstream. The same scenario applies to nutrient rich reclaimed water that finds its way into the stormwater system. Additional fertilization at recommended rates without accounting for the nutrients within reclaimed water could result in applying more fertilizer than is necessary or can be used by the plant, potentially resulting in excess nutrients leaching to groundwater or running off and degrading water quality of surface waters.

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Table 1. Salinity tolerance levels of Turfgrass in Florida.

Very Sensitive (< 1.5 dS/m)	**Moderately Sensitive (1.5 to 3 dS/m)**	**Moderately Tolerant (3 to 6 dS/m)**	**Tolerant (6 to 10 dS/m)**	**Very Tolerant (10 to 18 dS/m)**	**Superior Tolerance (> 18 dS/m)**
Centipedegrass	Most Zoysiagrasses	Bahiagrass	Common Bermudagrass	St. Augustinegrass	Seashore paspalum
		Annual Ryegrass		Hybrid Bermudagrasses	