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WHITE PAPER

# Proposed Conceptual Framework for Evaluating Consumptive Use Credits for the Beneficial Reuse of Wastewater Effluent

**TO:** Interested Parties

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## Introduction

The Water Management Districts (WMDs) in Florida are responsible for issuing consumptive use permits (CUPs) to utilities for the withdrawal of groundwater or surface water to provide their customers with water for residential or commercial, industrial, and institutional (CII) purposes. Similarly the WMDs permit withdrawals for individual agricultural, CII, and other users planning to withdraw 100,000 gallons per day (gpd) or more. All of this permitted water is used for a variety of purposes in which a portion of it is lost to the atmosphere and the remaining water is returned to natural systems by a variety of methods. Once this water is used for its intended purpose it becomes classified as wastewater and is regulated separately by the Florida Department of Environmental Protection (FDEP). In the case of utilities, this water is treated in a water reclamation facility (WRF) before being discharged to a surface outfall, rapid infiltration basin (RIB), sprayfield, infiltrating wetland, reclaimed water system, or deep injection well. Waters discharged to RIBs, sprayfields, and infiltrating wetlands can be expected to return to the Upper Floridan Aquifer (UFA) in a large part of the state where there is little or no confinement between the surficial aquifer and the UFA. This recharged water is then available for future withdrawal or to provide environmental flows to springs, lakes, or rivers. Water discharged to surface water or placed in deep injection wells can be considered lost from the UFA and to be unavailable at a reasonable cost to meet future needs.

Water that is recharged to the UFA does not all have the same water quality because of varying treatment methods and permit requirements. The impact of this recharge in conjunction with other discharges of nutrients to the UFA from non-point sources has been examined by FDEP in their development of total maximum daily loads (TMDLs) for waters of the state with water quality impairments. These TMDLs have been followed by Basin Management Action Plans (BMAPs) that target specific ways to reduce water quality pollutants to a point that the water bodies are no longer impaired. Concurrently FDEP has developed the Numeric Nutrient Criteria (NNC) for all water bodies in Florida. The NNC provide guidelines for nutrient concentrations that will not adversely impact the designated uses for water bodies of different types. Specifically for the numerous springs within Florida, the NNC is a target concentration of 0.35 mg/L or lower of nitrate nitrogen ($NO_x$-N). With increased urbanization, agricultural fertilizer use, and stormwater inputs many springs have experienced and continue to experience degradation as a result of increased nutrient concentrations. For other water bodies, NNC values are higher than they are for springs, but are still lower than most traditional treatment methods can achieve.

As a parallel process, the WMDs have been developing minimum flows and levels (MFLs) for rivers and springs within their boundaries. These studies have evaluated the minimum flows and/or stages that are required to maintain the ecosystem and provide continued use of the resource for the intended purposes. MFLs for many areas of the state have shown that spring fed rivers are approaching or have even exceeded the MFLs and might be unable to satisfy their intended uses if continued declines occur in stages and/or flows.

Because of the combined impacts of reduced water availability, increasing populations, and increased nutrient loads, the historic method of dealing with CUPs and wastewater treatment and recharge separately is no longer an optimal management strategy. Furthermore "consumptive use" is fundamentally a misnomer for many utilities and other CUP users that return a significant portion of their withdrawals to the UFA as recharge. However, the quality of this recharge may be a concern because permit requirements for wastewater discharge may be one to two orders of magnitude higher than NNC values for springs and other groundwater-connected systems. For these reasons developing a comprehensive approach to managing water quality and quantity concerns is timely and of great importance. This paper presents an alternative permitting strategy for CUPs that balances incentivizing recharge and water quality improvements by providing utilities credit for recharging larger quantities of higher quality water. These credits are proposed as offsets to the total volume on the CUP and are calculated as the combination of a water quantity and water quality credit. This paper presents a conceptual framework and multiple examples for different disposal systems.

# Consumptive Use Credits based on Water Quantity

There is currently no clear regulatory incentive for utilities to increase recharge to the UFA rather than, or in addition to, providing reclaimed water to reduce withdrawals for potable supplies. However, there is increasing pressure for the WMDs to reduce the total volume of CUPs to reduce impacts on natural systems. By providing credit to utilities for recharging water they can be incentivized to return more of their treated effluent to the UFA. This is discussed in additional detail for each of the primary disposal types that recharge the UFA or offset pumping from the UFA: reclaimed water use, RIBs, sprayfields, and infiltrating wetlands.

Historically, reclaimed water has been provided to customers for a flat rate or lower cost than potable water for three primary reasons (RCC 2003):

1. Specifically for flat rate water, no meters were required reducing the cost of installation.
2. The availability of lower cost or free water encouraged customers to use the reclaimed water that might have been considered less desirable.
3. Low or flat rates reduced the utility disposal quantities saving the utility money.

With time, the public acceptability of reclaimed water has been shown to be less of a concern as customers have become familiar with the quality and appropriate uses of this resource. New research by Knight *et al*. (2015a and 2015b) has shown that customers in the absence of a commodity charge or with a low commodity charge consume significantly more water than required to maintain the visual appearance of a traditional grass-dominated landscape. Furthermore, customers that experience higher potable water rates reduced their demand to a level that averaged 82% of the “optimal” landscape irrigation requirement (Knight 2015). For this reason reclaimed water should have a variable offset credit based on the ratio of the reclaimed water rate to the average potable water rate. This would encourage improved efficiency by discouraging over-irrigation. For flat rate water, this offset credit might be as low as 30% (Andrade and Scott 2002), but would increase to 100% as the price reached the average potable water rate as shown in Figure 1. Industrial customers and larger irrigation customers (e.g. golf courses) would be evaluated on a case by case basis to determine appropriate offset credits. However, in all cases the adequacy of offset credits would be reviewed and could be amended on a five year frequency.

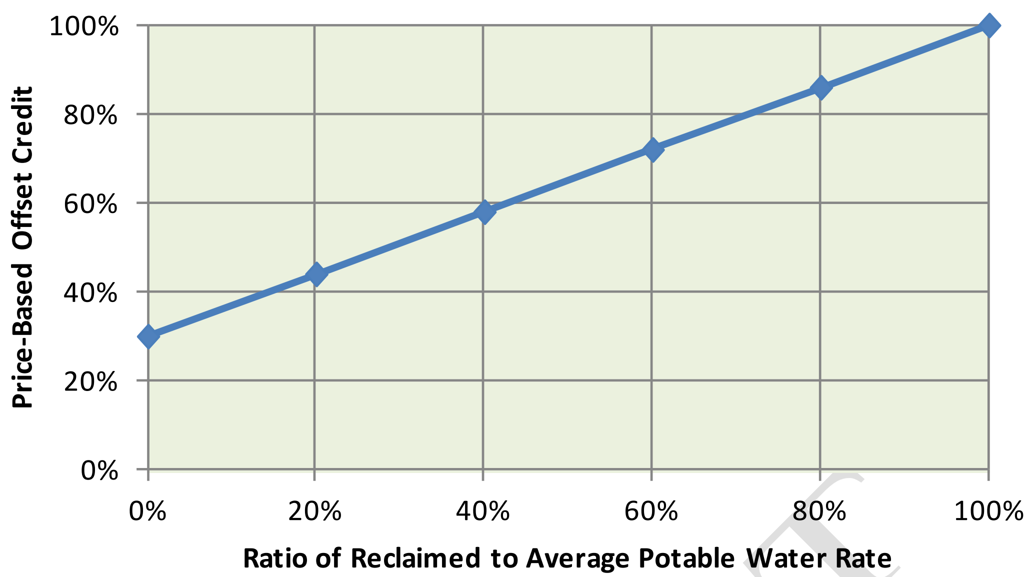


**Figure 1. Price-Based Reclaimed Water Offset Credit**

Currently, utilities receive no credit for water that is recharged at their facilities through rapid infiltration basins (RIBs), sprayfields, infiltrating wetlands, or other types of land-application methods. These practices have traditionally been considered as disposal methods only, regardless of the beneficial effect they may provide in replenishing aquifer levels. This has encouraged some utilities with the assistance of WMD cooperative funding programs to preferentially pursue reclaimed water projects that send water to residential or CII customers because this approach reduces their permitted water withdrawals. However the water provided to these customers to offset potable water use can and often does carry high concentrations of nutrients. When applied at the higher application rates observed for residential customers (Andrade and Scott 2002), this might convert a point source discharge through a RIB or sprayfield to a non-point source discharge that can be difficult to manage or quantify. Furthermore, residential irrigation reuse could be expected to reduce the quantity of water recharged to the aquifer by increasing evaporative losses (over-spray onto impermeable areas and evaporative surface area of droplets) and transpiration losses by vegetation when compared to RIBs.

To determine the losses attributable to RIBs, sprayfields, infiltrating wetlands, or other land application methods it is preferable to use a water budget approach. Because of the availability of weather data throughout the state from the Florida Automated Weather Network (FAWN) this calculation can be performed during the design phase based on existing site conditions. For a range of infiltration (recharge) rates, the percentage of applied water lost to evapotranspiration (ET) can be calculated based on values of ET available from FAWN. As an example, for the SWFWMD springs region the FAWN stations of Dade City and Lecanto were evaluated and had an average ET in 2014 of 0.113 inches per day. This was compared to a range of infiltration rates from 1 in/week up to 9 in/day (63 in/wk) with the resulting estimated loss to ET shown in Figure 2. This shows that ET losses for sprayfields with low-end application rates of 2 in/wk would be large (about 40%), while methods recharging more than 2 in/day would have estimated losses less than 6%.

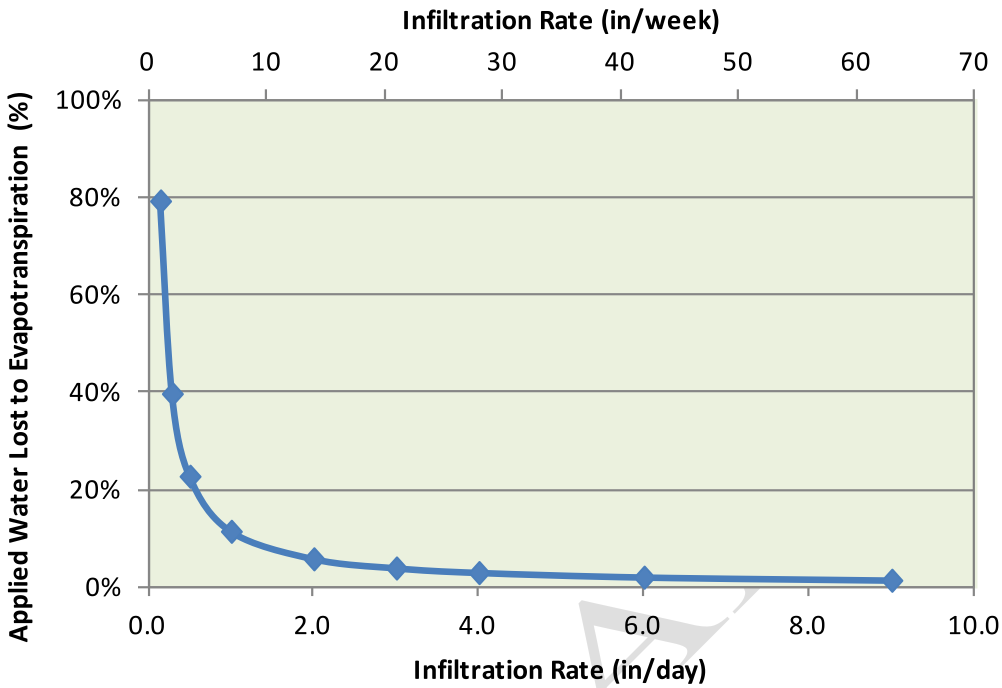


Figure 2. Percentage of Water Lost to Evapotranspiration as a Function of Infiltration Rate



# Consumptive Use Credits based on Water Quality

In the current regulatory framework, permits for wastewater treatment, reuse, and disposal are issued and monitored by the FDEP. In most areas of the state, water discharged to either slow-rate (sprayfield) or high-rate (RIBs) systems is required to have a $NO_x$-N concentration less than 10 mg/L at the property line, or a total nitrogen concentration less than 12 mg/L. This has resulted in generally maximizing the distance between the disposal facility and the monitoring wells to provide the most dilution possible. The result of this strategy is that even high concentration vertical discharges may appear to meet permit requirements at the property line monitoring wells. Fortunately, improvements in design, construction, and operation of wastewater treatment facilities have allowed many utilities to reduce nutrient concentrations within the existing wastewater treatment process and to provide higher quality water to disposal facilities. Unfortunately, the availability of cost-effective treatment options to reduce total nitrogen (TN) to concentrations less than 3 mg/L within the treatment plant are limited and may still produce water with $NO_x$-N significantly higher than the desired spring concentration of 0.35 mg/L.

In the current regulatory environment, particularly as it relates to surface water and groundwater interactions, quality and quantity are not necessarily managed holistically. To incentivize the production of higher quality water that would be more protective of the environment, utilities need a justification for the increased rates that would be paid by their customers. To improve the management of wastewater quality and quantity, utilities need clear guidance on what strategies can be applied and credits can be earned to optimize the end uses of their effluent. Clearly, recharge of low nutrient water is desirable to reduce existing levels of nutrients in the UFA. To encourage higher quality effluent recharge, credits should be available for all forms of recharge including RIBs, sprayfields, infiltrating wetlands, and reclaimed use; but the determination of credits should also be directly related to the quality of the effluent produced. This could take the form of a variable maximum credit based on the water quality produced after the final treatment step as shown in Table 1.

**Table 1. Maximum Offset Credit based on Effluent Quality**

| Total Nitrogen (mg/L) | Maximum Credit |
|---|---|
| >12 mg/L | 0% |
| 10-12 | 10% |
| 8-10 | 30% |
| 6-8 | 50% |
| 4-6 | 70% |
| 2-4 | 80% |
| <2 mg/L | 100% |



# Combined Credit Determination Approach

By applying the water quantity and quality offsets discussed in this memo a combined wastewater offset credit can be calculated for water that recharges the UFA or directly offsets additional withdrawals. This technique incentivizes utilities to address the goals of both the WMDs and FDEP of maximizing water quantity and quality, respectively. Credits for recharged water would be calculated as a function of both the maximum credit allowed based on the effluent quality and the applicable measure of reuse or recharge efficiency (Figure 1 for residential users and Figure 2 for commercial irrigation or recharge projects). This credit would be used to modify the CUP to incorporate four key values: the total permitted withdrawal, the current average withdrawal, the current recharge credit, and the resulting current consumptive use. Using these values the utility could project their future consumptive use based on planned wastewater or efficiency improvements.

$$Consumptive\ Use\ Credit = (Water\ Quality\ Offset)\ x\ (Water\ Quantity\ Offset) x\ (Recharge\ Flow)$$

Several examples for a variety of reclaimed water management strategies are presented below to illustrate how the combined quantity/quality credit calculations could be implemented. It is certainly the case that unique situations may arise, particularly for industrial reuse. In some of these cases, there may be no water recharged to the Floridan Aquifer so water quality may not be a concern and the reclaimed water may completely replace aquifer withdrawals. These would typically be higher volume customers and should be evaluated on a case-by-case basis. For each of the examples presented below, we will consider a utility with a CUP for 4 MGD that has 50% of their flow (2 MGD) available for reuse or recharge after wastewater treatment. These examples consider all of the wastewater flow going to a single use, but it could be calculated individually based on the destination of the water if multiple options are used.

## Example 1: Residential Irrigation

A utility provides reuse water to residential customers at a cost equal to 60% of the potable rate with a TN concentration of 7 mg/L. From Table 1, the utility would be eligible for an offset of 50% based on water quality. From Figure 1, based on the reclaimed-to-potable cost ratio, the utility would be eligible for a water quantity credit of 72%. The final offset credit would be 36% of 2 MGD or 0.72 MGD, reducing the consumptive use to 3.28 MGD as shown below.

$$Consumptive\ Use\ Credit = 50\% \times 72\% \times 2\ MGD = 0.72\ MGD$$

If the utility instead provided reclaimed water at 3 mg/L TN, the final credit would increase to 57.6%, or 1.152 MGD reducing the consumptive use to 2.85 MGD.

$$Consumptive\ Use\ Credit = 80\% \times 72\% \times 2\ MGD = 1.152\ MGD$$

## Example 2: Commercial Irrigation (e.g. Golf Courses)

Commercial or large-scale irrigators (e.g. golf courses) would be anticipated to maintain similar irrigation practices regardless of the water source, reducing the influence of variable pricing for reclaimed versus potable water. This was acknowledged by Andrade and Scott (2002) with their proposed offset credit of 75%. Arguably in the presence of a charge for reclaimed water this value would be expected to approach 100%. However, in accounting for water quantity offsets, storage of reclaimed water typically in lined ponds would need to have evaporative losses considered, which would reduce the water quantity offset.

Irrigation even if well timed, would be expected to cause some recharge to the Floridan Aquifer. Additionally if fertilization practices are not altered to account for nutrients in the recharge, then excess nutrients could build up in the soil profile and infiltrate during rainfall events. For this reason, the combined offset credit would be calculated based on the maximum water quality offset and the estimated water quantity offset as shown below for a TN concentration of 10 mg/L to a golf course with a 95% water quantity offset. This would yield an offset of 28.5%, for a credit of 0.57 MGD and a final consumptive use of 3.43 MGD.

$$Consumptive\ Use\ Credit = 30\% \times 95\% \times 2\ MGD = 0.57\ MGD$$

## Example 3: Sprayfields

Sprayfields were once considered a better way to dispose of treated effluent than RIBs. In some cases this water is used to produce a crop (typically hay) that may require additional fertilizer for improved production. Over time the drawbacks of fertilizer application have been realized and the practice has been largely discontinued. The typical design disposal rate for sprayfields is about 2 in/wk as recommended in the Florida Administrative Code 62-610. For a sprayfield receiving an effluent with a TN concentration of 10 mg/L at an application rate of 2 in/wk (with an assumed ET loss of 40%) the offset credit is shown below.

$$Consumptive\ Use\ Credit = 30\% \times (100\% - 40\%) \times 2\ MGD = 0.36\ MGD$$

## Example 4: RIBs

The use of RIBs for disposal is common in areas of the state with suitable soils. Recommended disposal rates in RIBs are 3 in/day, but may be as high as 9 in/day if engineering data supports the higher rate for the most restrictive soil layer. Because infiltration rates are high for RIBs, the anticipated evaporative losses are generally low. If a facility is discharging effluent with a TN concentration of 10 mg/L to a RIB with an infiltration rate of 3 in/day, the offset credit would be calculated as shown below.

$$Consumptive\ Use\ Credit = 30\% \times (100\% - 4\%) \times 2\ MGD = 0.576\ MGD$$

## Example 5: Infiltrating Wetlands

Infiltrating wetlands or "leaky" wetlands represent a relatively new adaptation of constructed treatment wetlands. Treatment wetlands have been used to provide additional treatment for wastewater effluents for decades, but the purposeful design of leaky wetlands represents a recent modification based on the experience of unplanned infiltrating wetlands and several subsequent, intentional pilot studies (WSI 2012). Treatment wetlands are particularly efficient at removing $NO_x$-N because they provide favorable conditions for denitrification in anaerobic sediments and accreted detrital material (Kadlec and Wallace 2009). With extensive supporting performance data available, wetlands should be considered a unit process that can be engineered to produce effluent with a desired average quality. By converting RIBs to wetlands or constructing new wetlands, additional treatment can be accomplished prior to infiltration. These systems would be used to polish final effluent with nutrient concentration data collected immediately below the wetland bottom. This would require a split compliance point with chlorine residuals checked end of pipe and nutrients collected below the bottom of the wetland. For a wetland hydraulic loading rate of 6 cm/day (2.36 in/day), average TN removals for wastewater facilities within the SWFWMD's first-magnitude springsheds were conservatively estimated to be about 75% (WSI 2015). The offset credit for this scenario is shown below for an assumed wastewater with a TN concentration of 10 mg/L after chlorination, 2.5 mg/L below the wetland bottom, and an infiltration rate of 2.36 in/day.

$$Consumptive\ Use\ Credit = 80\% \times (100\% - 5\%) \times 2\ MGD = 1.52\ MGD$$

## Summary

Despite efforts by regulators and utilities alike to promote conservation, develop alternative water supplies, and reuse treated wastewater, some areas of Florida are still experiencing deficits between the supply of groundwater available for pumping and the demand created by residents, agriculture, industry, and natural systems. Areas dominated by karst geology and the presence of springs are especially vulnerable to reduced aquifer levels. As utilities evaluate the best uses of treated wastewater effluent, there may be cases where the net environmental benefits provided by direct or indirect aquifer recharge equal or outweigh those achieved by directly offsetting potable water consumption for irrigation purposes. Under current regulatory guidelines, utilities may be credited for constructing reclaimed water distribution systems to provide water for irrigation but not for recharging the aquifer. This crediting is also not consistent across the state with different credits and methods in different WMDs.

This document presents a conceptual framework that would expand the credit program to include groundwater recharge projects and to encourage utilities to produce higher quality effluent than may be required by current FDEP rules. These credits could be used as offsets for the average consumptive use and would provide an improved consumptive use value for WMD CUPs. The intended result of implementing this strategy is to incentivize utilities to develop effluent management alternatives that maximize benefits by offsetting potable water consumption, recharging the UFA, and reducing nutrient mass loads to the environment.

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