Project Background
The key water management challenges in Arizona are increasing demands for water, fully allocated existing water resources, and groundwater depletion. Groundwater depletion, or overdraft, is a result of excessive groundwater pumping and is problematic for numerous reasons, including its environmental impacts. Groundwater sustains rivers, streams, lakes, and wetlands providing the riparian habitat for wildlife. In the 19th century, wetlands, marshlands or cienegas, were common along rivers in Arizona; however, heavy pumping of groundwater beginning in the mid-20th century led to dewatered rivers and streams and loss of riparian ecosystems (Glennon, 2002).

Just south of Atlanta, Georgia, the Clayton County Water Authority (CCWA) provides water, sewer, and stormwater services to more than 280,000 county residents and portions of adjacent counties. Since its creation in 1955, CCWA’s need for water supply and wastewater treatment has increased steadily with population growth, despite limitations on water supply and the assimilative capacity of the small local streams. CCWA began water reuse in the 1970s when a land application system (LAS) was selected as a way to increase water supplies for its growing population while minimizing the stream impact of wastewater discharges.

CCWA operated two LASs for almost 30 years as the County matured into a densely developed urbanized area. In response to the need for additional wastewater treatment capacity and as part of CCWA’s master planning process, numerous wastewater treatment alternatives were evaluated. With their consultant, CCWA reviewed existing treatment wetlands in Georgia (Inman et al. 2001) and identified constructed wetlands as the most reliable and sustainable option for both treatment and water supply augmentation (Inman et al., 2000).

CCWA constructed its first wetland reuse system in the southern end of the county. The Shoal Creek LAS was converted into a series of treatment wetlands (Panhandle Road Constructed Wetlands, Figure 1) and the existing wastewater treatment plant was replaced with an advanced, biological treatment plant (Inman et al., 2003). Following this success, CCWA began developing a larger wetlands complex on the E.L. Huie Jr. Site (Figure 2). Wetland construction was phased with portions of the existing LAS taken out of service and replaced with wetlands.

Figure 1
The Panhandle Road Constructed Wetlands (Photo credit: Aerial Innovations of Georgia, Inc.)

Figure 2
The E.L. Huie Constructed Wetlands (Photo credit: Aerial Innovations of Georgia, Inc.)
Capacity and Type of Reuse Application

The wetlands consist of a series of interconnected, shallow ponds planted with native vegetation. The cells follow the site topography to allow water to flow passively through the wetlands by gravity. Even though a portion of the water in the wetlands is expected to infiltrate into the groundwater supply, the vast majority flows into two of CCWA’s water supply reservoirs, Shoal Creek and Blalock Reservoirs. Water typically takes 2 years under normal conditions to filter through wetlands and reservoirs before being reused; the detention time is less than a year under drought conditions (Thomas, 2005).

The Panhandle Road Constructed Wetlands consists of three multi-cell treatment trains, in parallel with a treatment capacity of 4.4 mgd (190 L/s) (CCWA, 2011). The E.L. Huie Constructed Wetlands consist of nine multi-cell treatment trains built in four phases with a total treatment capacity of 17.4 mgd (760 L/s) (Table 1).

<table>
<thead>
<tr>
<th>System</th>
<th>Date</th>
<th>Sites</th>
<th>Wet Area (ac)</th>
<th>Capacity (mgd)</th>
<th>Total Capacity (mgd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panhandle Road Constructed Wetlands</td>
<td>2002</td>
<td>North, Central, South</td>
<td>53</td>
<td>4.4</td>
<td>4.4</td>
</tr>
<tr>
<td>E.L. Huie Constructed Wetlands</td>
<td>2005</td>
<td>G</td>
<td>54</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>D, E, F</td>
<td>40</td>
<td>2.6</td>
<td></td>
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<tr>
<td></td>
<td>2007</td>
<td>B, C, H, I</td>
<td>47</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>A</td>
<td>123</td>
<td>8.1</td>
<td></td>
</tr>
</tbody>
</table>

Water Quality Standards

Both wetland systems polish highly treated effluent from primary and secondary wastewater treatment facilities that include nutrient removal followed by disinfection. These treatment processes provide a multiple-barrier approach to water reclamation and enhance the removal of nutrients, microbial contaminants, and other trace organic compounds, providing a safe and secure supply of water. In addition, the constructed wetlands buffer the reservoirs in the unlikely event of a treatment plant upset.

A National Pollutant Discharge Elimination System (NPDES) permit was received for the constructed wetlands following an extensive review and approval process through the Georgia Department of Natural Resources (GAEPD, 2002). The first step in the process was for the Georgia Environmental Protection Division to set discharge limits by determining the allowable pollutant application to the wetlands. Both systems are required to comply with the waste load allocations established in their NPDES permit. These systems have proven to exceed their treatment expectations and effluent quality (Table 2).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Panhandle Road Constructed Wetlands</th>
<th>E.L. Huie Constructed Wetlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow (MGD)</td>
<td>Limit (mg/L) Actual(^2) (mg/L)</td>
<td>Limit (mg/L) Actual(^2) (mg/L)</td>
</tr>
<tr>
<td>BOD(_s)</td>
<td>10/15(^1) 1.35</td>
<td>10/15(^1) 14.45</td>
</tr>
<tr>
<td>TSS</td>
<td>3/45(^1) 4</td>
<td>15/22.5(^1) 5</td>
</tr>
<tr>
<td>NH(_3)-N</td>
<td>4/6(^1) (May-Oct.) 0.03</td>
<td>1.4/2.1(^1) 0.06</td>
</tr>
<tr>
<td></td>
<td>8/12(^1) (Nov.-Apr.)</td>
<td></td>
</tr>
<tr>
<td>TP</td>
<td>2/3(^1) 0.59</td>
<td>0.6(^2) 0.24</td>
</tr>
</tbody>
</table>

\(^1\) Monthly/weekly averages  
\(^2\) Annual average monitored only at the lake discharge  
\(^3\) Average effluent data for 2011

With the completion of the largest phase of constructed wetlands in the fall of 2010, CCWA is able to recycle as much as 65 percent of daily water use into their existing reservoirs. This system augments CCWA’s water supply and reduces the need to withdraw water from the small streams that flow out of the county. During Georgia’s second worst drought on record, this system sustained raw water reserves at 77 percent of capacity or greater. CCWA also has documented reductions in micro-constituents such as pharmaceuticals, hormones, and pesticides (CCWA, 2011).

Funding and Management Practices

CCWA’s innovative water supply system and watershed protection program have required a significant commitment of resources. CCWA built the wetland system on land first purchased for the LAS in the late 1970s. Funding for the land purchase and construction of the LAS was primarily through the Federal Construction Grants program, under the Clean Water Act. Wetland cells were built using low-interest loans from State Revolving Funds, bonds, and rate payer revenue. Approximately four cents of every dollar collected for water and sewer service is set...
aside for watershed protection (American Rivers, 2009).

The transition from LAS to wetlands has saved energy costs through reduced pumping. The wetlands system is less expensive to maintain and operate and has allowed CCWA to reduce maintenance staff, equipment, and materials. Rather than maintaining miles of irrigation pipes and numerous valves and pumps, routine maintenance consists primarily of checking hydraulics and vegetation management.

**Successes and Lessons Learned**

CCWA has been recognized as one of the most innovative and well-managed utilities in the southeastern United States. Most recently, the American Academy of Environmental Engineers awarded CCWA’s wetlands projects the “Excellence in Environmental Engineering” award for environmental stewardship. This approach to total water management has demonstrated that a sustainable water supply can be developed for a dense urban area where fluctuations in rainfall and water supply are common (Patwardhan, et. al, 2007). The wetlands treatment system and indirect reuse program have lowered CCWA’s need for additional reservoir storage and water withdrawals.

The constructed wetlands have proven to require much less land, energy, and maintenance than the irrigation systems while sustainably using natural systems for water reclamation. Environmental benefits include CCWA’s use of the constructed wetlands facilities as an educational tool for customers to explain the importance of protecting water resources. CCWA was recognized by American Rivers as one of America’s “Water Smart” communities in 2009 and has received many awards for operations and innovation (CCWA and CH2M HILL, 2011).

This project is also an example of publicly accepted indirect potable reuse. CCWA has been polishing treated wastewater using natural treatment systems for more than 30 years and has actively communicated the wetlands reuse plan to the community. CCWA uses the constructed wetlands as an educational tool for customers to explain the importance of protecting water resources and hosts numerous community events. The wetlands also support the goals of land conservation. CCWA currently manages a wetlands education center that is open to the public to provide its customer base with information about how CCWA incorporates total water management in its day-to-day operations.

**References**


