

PLANNING FOR REUSE IN NORTH CAROLINA

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ABSTRACT

In 1996, North Carolina adopted rules governing the use of reclaimed water, allowing for the beneficial reuse of reclaimed water. Since that time, communities have begun looking at reuse to reduce discharges to the state's waterways and to offset growing potable water demands. Many communities have initiated reuse distribution systems, particularly in areas that have irrigation demands near the wastewater treatment facilities. This paper will present the regulatory framework for reuse distribution in North Carolina, including a summary of the rules and incentives for reuse. The City of Raleigh is one of those communities that recognized the value of reuse water and began a reuse program in 1996. This paper will provide a history of Raleigh's reuse program and its plans for the future.

The rules allow reuse water to be used for most non-potable applications, including irrigation, industrial uses, toilet flushing, and fire protection. The rules also specify requirements for reuse water quality, buffers, labeling, and cross-connection control. Communities are allowed to approve irrigation systems, provided they demonstrate the resources and standards to oversee the expansion of their reuse distribution system.

The rules also state that "It is the intent of the Commission to encourage the beneficial use of the state's water resources concurrent with the protection of public health and the environment." In light of this, many state programs are offering incentives for reuse or dictating that reuse be evaluated. Funding agencies are giving priority to projects involving reuse. The North Carolina Department of Environment and Natural Resources is requiring evaluation of reuse before issuing any new or expanded NPDES permits.

The City of Raleigh began developing a reuse program in 1996 to serve a recently constructed golf course near the Neuse River Wastewater Treatment Plant. The facilities also serves a portion of the City-owned agricultural fields. Currently, the City is developing a Reuse Water System Master Plan for expansion of the system, with intentions to expand the reuse customer base to include additional irrigation users, and industrial and commercial users. The first phase of the program is to educate the public and survey potential customers to determine reuse demand across the region. The demand data is mapped to determine areas of high reuse demand, and hydraulic modeling is used to determine the distribution system requirements.

A reuse water ordinance and design standards are also being developed. The ordinance includes a rate structure for the City to recover some of the capital and operating costs. Cross-connection control and labeling requirements are also specifically addressed.

The master plan is also used to obtain the necessary permits to construct the facility. The plan includes an environmental assessment. The plan will also demonstrate the ability of the City to permit individual irrigation systems to expand the distribution system. This paper will conclude with a discussion of the benefits to the City of Raleigh and surrounding region.

KEY WORDS

reuse, water reuse, reclaimed water, master plan, public education, North Carolina

REGULATORY FRAMEWORK

In 1996, North Carolina amended its statutes that govern the disposal of wastes that are not discharged to streams or other waterways. These non-discharge rules were modified to define and control highly treated wastewater effluent for reuse application. The previous rule governed the disposal of secondary wastewater effluent, biosolids, and some industrial wastes. Reuse is defined in the rules as a tertiary quality effluent with water quality parameters shown in Table 1.

Table 1. **Reuse Water Quality Requirements**

Parameter	Monthly Average	Daily Maximum
Total Suspended Solids	5 mg/l	10 mg/l
Fecal Coliform	14/100 ml	25/100 ml
BOD ₅	10 mg/l	15 mg/l
NH ₃	4 mg/l	6 mg/l
Turbidity	10 NTU (continuous monitoring)	

The rules are similar to many other states and allow for typical reuse applications such as irrigation including public areas, cooling water, toilet flushing, fire suppression, decorative ponds and fountains, and industrial uses. The rules specifically prohibit reuse in swimming pools, hot tubs, and spas. Reuse cannot be used to irrigate edible crops. In addition, the rules prohibit the use of reclaimed water from being used as a raw water supply for potable water systems.

Cross-connection control is another critical component of the rules. All reuse facilities must be colored purple and identified as reuse piping, either by painting, marking tape, and other identification. Hose bibbs or other connections must be in a lockable vault and marked as reuse.

In addition to protecting public health, the rules and intended to protect the State's waterways. Spray irrigation systems are required to maintain buffers from streams and wells. For most streams, the spray influence must not be within 25 feet of any surface water or wetland. For higher quality SA streams, the required buffer is 100 feet. Potable wells are provided with a 100-foot buffer while non-potable wells have a 10-foot buffer. Run-off is not allowed from any reuse application.

STATUS OF REUSE IN NORTH CAROLINA

Many communities in North Carolina have begun a reuse program. Charlotte-Mecklenburg Utilities (CMU) was the first permitted facility in the State. Their Mallard Creek Water Reclamation Facility serves a nearby park and golf course. CMU is currently adding reuse to its other waste treatment facilities. The Town of Cary has recently completed the first phase of its reuse distribution system that supplies an up-scale residential development, as well as cooling water for office buildings. Brunswick County is pursuing reuse as a means for a zero-discharge waste treatment facility. The County is a coastal resort area that includes 18 golf courses as potential reuse sites. Others including Johnston County, Clayton, Orange Water and Sewer Authority, Sanford, and Goldsboro are at various stages in the development of reuse programs.

The City of Raleigh has also initiated an aggressive reuse program. Shortly after the rules were promulgated, the City entered into an agreement with a golf course to provide reuse water from the Neuse River Wastewater Treatment Plant (NRWWTP). Design and construction were subsequently undertaken and the facilities were completed in 1999. The City also supplies reuse water for non-potable water at the NRWWTP and uses reuse for agricultural irrigation on City-owned farms.

The success of reuse systems in the State is a function of many items. The climate is conducive to a relatively long growing season, providing for ample irrigation opportunities. Many of the reuse systems include one or more golf courses as the primary users. Although North Carolina is not considered an arid State and typically has adequate water resources, recent droughts have shown many communities that their water resources are limited and continued growth requires protection of those resources. One of the driving factors for the Town of Cary's reuse system is the lack of adequate water resources within its watershed. The Town pumps raw water from an adjacent watershed that requires an Interbasin Transfer Certificate, which requires extensive permitting.

The receiving waters of the State are becoming impaired in some areas. The Neuse River has been classified as nutrient-sensitive water. As such, the State has required all dischargers in the Neuse River to reduce nitrogen discharges by 30 percent. One of the drivers for the City of Raleigh is to minimize the discharge of nitrogen into the Neuse River.

The North Carolina Department of Environment and Natural Resources (DENR) is another proponent of reuse. The rules adopted by North Carolina state that "It is the intent of the Commission to encourage the beneficial use of the state's water resources concurrent with the protection of public health and the environment." As such, the State has done several things to promote reuse. The Clean Water Management Trust Fund provides grants to communities for capital projects that will benefit the quality of the State's waters. They have identified reuse as a critical component in the evaluating projects to receive funding. Similarly, the State uses reuse as a criteria for prioritizing projects applying for State Revolving Loans. The State has also mandated that any proposed wastewater expansion must evaluate reuse opportunities before the expansion will be permitted.

CASE STUDY

The City of Raleigh currently operates a water reuse system at the NRWWTP. The vision for the City is to provide a regional reuse water system that satisfies non-potable water demands with high quality reclaimed water. To that end, the City has undertaken a master planning effort to distribute reuse water to users throughout the City of Raleigh as well as many of the surrounding municipalities and Wake County. By expanding the reuse system throughout the region, the City will gain the following benefits:

- Reduce demand on the potable water system
- Make better use of the available raw water supply
- Reduce nutrient loadings on the Neuse River
- Provide a new water resource to the citizens of Raleigh and surrounding areas

Existing Reuse System

The existing reuse system utilizes the effluent from the NRWWTP, which includes filtration and UV disinfection. A sodium hypochlorite feed system provides a chlorine residual to the reuse water. Four vertical turbine pumps deliver reuse water to the distribution system which serves the adjacent agricultural fields, the plant non-potable water system, and the nearby River Ridge Golf Course. The existing pumping facility can deliver as much as 5 mgd for irrigation. Current demand is approximately 0.9 mgd.

MASTER PLAN APPROACH

The master plan is a comprehensive study that will provide all necessary components to implement a large reuse distribution system. Key components of the master plan include public education, identifying customers and associated demand, hydraulic modeling of the distribution system, identifying costs and rate structures to recover the costs, updating the City's design and construction standards to include reuse facilities, developing a reuse ordinance to set the City's policies governing the development of the reuse system, and permitting of the reuse facilities.

Public Education

The public education is a critical component for the success of the program. Irrigation of parks and school grounds are among the many reuse opportunities available in Raleigh. Without public acceptance of reuse water, these potential reuse sites would not be available. The City's education program includes a reuse brochure and information on the City's web site. The brochure was distributed with all of the demand surveys that were mailed and will also be located at each of the major reuse facilities. In addition, the brochure and other materials will be used for site-specific educational opportunities. Reuse was added to the City's WaterFest 2001 celebration and will continue to be a significant component of that annual event.

Demand Projections

Several methods were used to identify and survey potential reuse customers. The City's water meter sales records were evaluated for potential reuse customers. Data from all large water meters (1 ½-inch and larger) were compiled for the year 1999. The data was segregated by

potable water meters and irrigation meters. The records included almost 3,500 large water meters with an average daily demand of 24 mgd. Approximately 300 irrigation meters registered an average daily demand of 1 mgd.

The largest total water users and irrigation meter sales were identified and surveyed. In addition, zip codes were used to identify the general location of the users. The zip code including the NRWTP was of significant importance because it helped identify customers for the first phase of development. From this listing, 68 specific customers were identified. Questionnaires were mailed to each potential customer along with the educational brochure. Only a small fraction of the questionnaires were returned. Therefore, additional efforts for determining reuse demand were required.

Golf course irrigation was identified early in the project as a large customer base. In addition, other types of uses were identified including industries, parks, schools, institutional users, nurseries, construction, and commercial irrigation. A listing of potential customers for each type of use was developed, and telephone interviews were conducted to assess potential reuse demand. A variety of methods were used to develop the lists, including the industrial pretreatment program, meetings with key officials in the parks and school systems, and the yellow pages.

The large number of golf courses provides a significant reuse opportunity. In addition, there are a number of smaller golf facilities including executive courses and driving ranges. Moreover, 9 of the golf courses are located within six miles of the NRWTP. To gauge the interest and estimate the irrigation demand, each golf course was interviewed. Overall, the golf courses were very interested in reuse, even though most have a low cost supply of irrigation water. Over 75 percent of the courses expressed some level of interest in using reuse for irrigation. Several courses could not meet their irrigation demand with their existing facilities and were primarily interested in augmenting their existing irrigation ponds. Two courses currently use potable water for irrigation and would recognize a significant cost savings by converting to reuse.

There are primarily two users of agricultural irrigation: the City of Raleigh and North Carolina State University (NCSU). Each owns and operates over 1,000 acres of agricultural land. The City of Raleigh has an estimated demand of 3.5 mgd. The demand at the NCSU facilities varies significantly and is largely dependent on on-going research. The NCSU sites near the NRWTP do not currently have any reuse demand.

The City surveyed the significant industrial users participating in the pretreatment program. Most industries were receptive to the idea of reuse, particularly for cooling water and irrigation. Nineteen responses were received for a total reuse demand of 350,000 gpd.

Commercial landscape irrigation was estimated with the metered water sales data. From the list of top water users, seventeen commercial irrigation meters were identified that used 200,000 gpd of irrigation water. These users represent approximately 20 percent of the total commercial irrigation demand.

Plant nurseries also offer a potential reuse demand. The reuse service area includes 20 nurseries. Telephone interviews were conducted with a sampling of nurseries to determine an average irrigation usage of 25,000 gpd. This represents a potential reuse demands of 500,000 gpd for all the nurseries. One advantage of nurseries is the demand will be throughout the year because of greenhouse irrigation demands.

Institutional users include the local universities and hospitals. The six universities offer many reuse opportunities including irrigation, cooling water, and possible research opportunities. The four hospitals include irrigation and cooling water as significant reuse demands. The North Carolina State Fairgrounds could use reuse water for irrigation, dust control, and street cleaning.

The reuse service area is home to 12 high schools and 16 middle schools that all have ball fields that can be irrigated. Typically each school has a baseball, football, and soccer field, at a minimum.

The City of Raleigh Parks & Recreation Department operates over 100 park facilities. Those facilities include a total of 60 ball fields that are irrigated. In addition, the Cities of Garner, Knightdale, Wendell, and the Capital Area Soccer League operate many other park facilities.

The residential irrigation is a practical alternative for two major developments in southeast Raleigh. One development is associated with the River Ridge Golf Course and includes approximately 200 homesites. The estimated irrigation for this development is 125,000 gpd assuming a 50 percent participation in the program by the homeowners. The second development is a proposed golf course community located 3 miles from the NRWTP. The development is expected to include 1,600 estate homes. The estimated residential irrigation component is 500,000 gpd assuming 75 percent participation.

Hydraulic Modeling

The reuse distribution system will be designed much the same as the City's potable distribution system. A combination of elevated storage, ground storage, and booster pumping stations will be used to maintain the system pressure. However, there are several unique challenges in modeling the reuse distribution system, including very high peaking factors, wide ranging pressure requirements, and development of a large regional model from a small local system.

The nature of reuse demands, particularly irrigation demands, require the system be very flexible in meeting high peak demands. Seasonal impacts on irrigation demands can create daily peaking factors as much as 3 times the average daily demand. In addition, most golf course irrigation takes place during early morning hours, before the golfers begin play. If all courses irrigate during a four-hour period in the mornings, the hourly peaking factor could be as high as 20 times the average daily demand. By comparison, hourly peaking factors for potable water distribution systems typically range from 2.0 to 2.5 times the average daily demand. To mitigate the impacts of peak hour demands, the users were categorized by the type of use, and the times that peak hours would occur. The night time peak hour demand for the system was estimated as 35 mgd, while the day time peak hour demand was estimated as 10 mgd. The night peak hour demand is 6.2 times the average daily demand of 5.7 mgd.

The wide range of flows for the reuse system is accompanied by a wide range of pressure requirements. Many golf courses use irrigation ponds to store water. These systems will discharge to atmosphere. However, other systems prefer to connect directly to the distribution piping and let the system pressure deliver flow to the irrigation systems. In these cases, minimum pressures as high as 50 psi could be required. The specific requirements of each individual user must be clearly understood to ensure a system that meets the customer's needs. The model was designed to provide a minimum of 25 psi residual pressure during peak hour

demands. Users that would take fill ground level ponds from the system will be provided with pressure sustaining valves to prevent them from depressurizing the surrounding distribution system.

Modeling a third utility in a large area that is well-developed offers unique challenges. The extent of the system requires phased construction over many years. The initial phases must economically distribute reuse water to the customers in the first phase and allow for economical expansion for future phases. The distance to some of the reuse sites is extensive and may preclude construction of that portion of the system for many years. However, a comprehensive plan must allow for connection to these sites at some point in the future. Therefore, initial transmission network must consider future demands, while incorporating the time factor of money in determining the most effective phasing of the system.

The total proposed system includes over 750,000 feet of piping ranging from 4 inches to 24 inches in diameter, three elevated storage tanks totaling 2 million gallons, two ground storage and pumping stations, and three inline booster pumping stations. The system was divided into 5 phases for implementation. The primary goal of modeling the entire service area is to determine the size of the main transmission lines. Although the entire system will take decades to construct, the initial construction should allow for future demands.

The first phase encompasses the southeast section of town, which includes six golf courses, several industries and institutional users, and two potential residential developments. The initial phase includes a 24-inch transmission main that connects to an existing 16-inch line and an elevated storage tank to sustain pressure at the outer portions of the system. This configuration also works well in the complete system. With the addition of a booster pumping station and a ground storage tank, the first phase piping network will be able to transmit reuse water to Northeast Raleigh. The second transmission line is required to provide reuse water to the Garner and West Raleigh areas.

IMPLEMENTATION

The master planning effort also includes a number of items that are essential to implementing a successful reuse program. Permitting, rates, design standards, and a reuse ordinance are included in the master plan to allow for uniform and timely growth of the system.

Permitting

The completed master plan will be the basis for the permitting of the proposed facilities. The document will include an Environmental Assessment meeting the State Environmental Protection Act (SEPA) requirements. After receiving the Finding of No Significant Impact (FONSI) is received, the City will use the master plan as the basis for applying for delegated authority to permit expansions to the reuse distribution system.

Rate Structure

After the modeling is complete, the capital and operating costs for each phase of the reuse distribution system will be determined. A rate structure will be developed to recover as much of the costs for the system as practical. The City's goal is to get complete cost recovery with usage rates less than the potable water rate. However, the City recognizes the potential difficulty in

recovering all of the costs initially and is willing to contribute some capital that may take longer than 20 years to recover.

Design Standards

The City currently maintains a Utility Handbook that includes design and construction standards for the water distribution and sewer collection systems. This master plan project includes a new handbook section dedicated to the reuse system. This section will include cross-connection control measures, labeling requirements, and minimum separation requirements from potable water and sewer lines.

The design standards are a critical component of the development of the reuse system, particularly for residential developments. The standards will be implemented by developers installing dual systems.

Ordinance

A reuse ordinance will be developed to set the City's policies governing the reuse system. The ordinance will set policies related to providing reclaimed water inside the City limits as well as areas outside the City limits. Specific requirements for the reuse system, such as cross-connection measures, will also be incorporated into the ordinance.

CONCLUSIONS

Many communities in North Carolina have recognized the value of reuse and are developing programs to distribute reuse water. The City of Raleigh is one example of a community that has significant reuse opportunities and is looking to capitalize on the benefits of reuse. With the need to protect the need to reduce discharges in the Neuse River and protect the finite water resources, the City intends to systematically develop their reuse system. Reuse has become an important water resource to many communities.

REFERENCES

Hazen & Sawyer Environmental Engineers & Scientists, "Neuse River WWTP Wastewater Reuse Study." June, 1996.