Reuse For Managing Water Demand and Wastewater Discharge

Cary's Reclamation Program

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PROJECT BACKGROUND - Why Implement a Reclaimed Water System?

In the western United States, where surface water supplies and groundwater supplies are scarce compared to those same water sources in the eastern United States, reclaimed water has been used for non-potable purposes for many years. In North Carolina, it has only been within the past few years that use of reclaimed water has been considered. Since 1996, when the state regulations governing the use of reclaimed water were re-written into a form with the expressed purpose "to encourage the beneficial reuse of reclaimed...wastewater", there has been a substantial increase in the proposed use of reclaimed water for non-potable purposes.

However, for local governments to accept the challenge of beneficially using reclaimed water, there has to be great social value attached to the use of reclaimed water and there has to be an obvious minimization of risk associated with that reuse. For the Town of Cary, both of these criteria have been met.

The social value attached to utilizing reclaimed water is the deferral of potable water demand to help rapidly growing communities stretch scarce water resources further in order to meet their water demands. This water demand deferral contributes directly to the avoidance of increases in wastewater discharges to surface waters, even with increasing flows into the wastewater treatment plants. Both of these phenomena play a big role in the water conservation programs of local governments. It is also these water conservation programs that help communities meet the regulatory requirements of conserving water resources in order to increase surface water withdrawals from regulated water bodies and, if needed, to seek the interbasin transfers of surface waters.

For the minimization of risk associated with the use of reclaimed water, the first step is the acceptance by local governments of the responsibility to provide the highest quality of treated wastewater as possible. In the case of the Town of Cary, this has meant the use of advanced, tertiary wastewater treatment with ultraviolet light disinfection. The next step is for local governments involved in reclaimed water use to provide the finest possible public education and information program to ensure that all customers of the reclaimed water system are informed about the proper uses of reclaimed water and are adequately trained in the proper methods and rates of application of reclaimed water.

Water Demand Deferral

The western Wake County area has been experiencing high growth rates since the early 1980's. Cary, being the largest local government in that area, has seen the greatest portion to date. However, the growth rates in Apex, Morrisville, and Holly Springs have exceeded Cary's in the past few years, as illustrated on Table 1.

Table 1
Populations of Western Wake Municipalities

Year	Cary	Apex	Morrisville
1970	7,640	2,234	209
1975	14,677	2,850	213
1980	21,763	2,940	251
1985	32,551	3,711	534
1990	43,461	4,789	1,489
1993	56,621	6,239	
1995	69,711	8,050	2,088
1998	87,200	13,455	4,927

Increases in population result in increased demand for water and sewer services provided by these local governments. Table 2 shows the calculated annual average daily water demand forecasts for the western Wake water customers, which include the Towns of Apex and Cary, and the other towns and areas which rely on them as a source of potable water - Morrisville, Holly Springs, RDU International Airport, and the Wake County part of the Research Triangle Park. Table 3 shows the calculated maximum daily demand forecasts for these same western Wake water customers.

Table 2
Annual Average Daily Water Demand Forecasts
Western Wake Water System*

Year	DWR's Water Allocation Recommendations (in mgd)	Demand with High Growth Scenario (in mgd)	Demand with Moderate Growth Scenario (in mgd)	Demand with Low Growth Scenario (in mgd)
2000	15.4	15.28	15.01	13.95
2005	18.1	20.63	18.80	17.11
2010	22.6	28.37	23.16	20.32
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2020	27.5	33.03	31.62	25.19

* Western Wake Water System - Towns of Apex, Cary, Morrisville, Wake County portion of RTP, RDU Int'l. Airport, and Town of Holly Springs though 2000.

Table 3
Maximum Daily Water Demand Forecasts
Western Wake Water System*

Year	DWR's Water Allocation Recommendations (in mgd)	Demand with High Growth Scenario (in mgd)	Demand with Moderate Growth Scenario (in mgd)	Demand with Low Growth Scenario (in mgd)
2000	25.41	25.22	24.76	23.01
2005	29.87	34.04	31.02	28.23
2010	37.29	46.81	38.21	33.53
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2020	45.38	54.50	52.18	41.56

* Western Wake Water System - Towns of Apex, Cary, Morrisville, Wake County portion of RTP, RDU Int'l. Airport, and Town of Holly Springs though 2000.

The N.C. Division of Water Resources calculated a water demand forecast for its recommendations to the Environmental Management Commission (EMC) for water allocation requests from B. Everett Jordan Lake by the Towns of Cary, Apex, Morrisville, and by Wake County for the southern part of Research Triangle Park. These recommendations, as well as the water demand forecasts for three growth scenarios for the western Wake County service area, are shown in Table 2. The year 2015 is highlighted because DWR has recommended using that year as the end year of the planning period for its water allocation recommendations from Jordan Lake.

The Towns of Cary and Apex jointly own a 16.0-mgd water treatment plant, which supplies water to the western Wake County area. This plant opened for operation in August 1993 with a maximum rated capacity of 12.0 mgd. In 1995, it received a filter and clarifier re rating which increased its maximum rated capacity to 16.0 mgd. This water treatment plant can sustain a maximum water production rate of approximately 14.7 mgd.

Jordan Lake is the water source for the Cary/Apex Water Treatment Plant. Jordan Lake is a U.S. Army Corps of Engineers multi-purpose reservoir authorized to provide flood control, downstream low flow augmentation, recreation, and water supply. As a water supply, Jordan Lake has a rated yield of 100.0 mgd.

The Cary/Apex raw water intake structure is located on the eastern side of Jordan Lake and is capable of withdrawing over 50.0 mgd from the lake. This raw water intake also provides raw water to the Chatham County Water Treatment Plant, located near the intersection of U.S. Hwy. 64 and Farrington Road.

As shown on Table 2, Cary and Apex need to expand their water treatment plant capacity. The maximum daily demand is 1.65 times greater than the annual average daily demand as shown in Table 3. It is the maximum daily demand forecasts on which water plant expansion plans are based. Cary and Apex propose to expand their water plant to 32 mgd, with the expectation that it might be able to achieve a re-rating up to 40 mgd.

In order to be able to meet the water demand forecast for the intervening years until its water treatment plant is expanded, Cary and Apex have entered into inter municipal agreements with the Cities of Raleigh and Durham to purchase water on a limited basis during the higher water demand months. To assist with peak demand management during that same period, Cary, the largest water user on the system, has implemented a comprehensive water conservation program. Others on the water system are presently evaluating similar programs. The water conservation program goal is a 20 percent reduction in annual average per capita water demand by 2014. This program is staged in two components--the short-range components (0 to 5 years) and the long-range components (5 to 30 years).

There is considerable crossover between the short range and the long range components of Cary's water conservation/demand management program. Cary is still developing a comprehensive plan that will determine the most effective measures for the phase of population and infrastructure development that the Town is in at a given point in time. Until that plan is completed, work on all of the short-range components has started. Work on some of the long-range components has also begun in order to accelerate any possible positive results from such efforts.

One of the short-range components of the program is the establishment of a water reuse and recycling program. This effort links directly to one of the tasks in the long-range component of the program--diversion of water demand to non-potable water sources.

Avoidance of Wastewater Discharge

The discharge of treated wastewater to surface waters into the Neuse River basin has become an extremely sensitive environmental issue over the past few years. The impact of nutrients from all sources, including point source discharges from treated wastewater, has come under scrutiny from environmental and conservation groups, from state regulatory agencies, and from the General Assembly.

In early 1994, Cary chose to use a state-of-the-art, biological nutrient removal process when it increased the capacity of any of its wastewater treatment facilities. This choice was made the year before the now infamous 1995 massive fish kills that occurred in the estuarine part of the Neuse River. However, the impact of the subsequent public scrutiny of the issue of nutrients in treated wastewater being discharged to the Neuse River was not lessened by that treatment process selection. Cary, as well as all other publicly owned treatment works in the Neuse River basin, is having to consider all options and alternatives to reduce the amount of treated wastewater it discharges to surface waters in order to manage its nutrient loading to the Neuse River. One of the options in this regard is the establishment of a water reuse system.

For Cary, avoidance of discharging treated wastewater to surface waters creates the opportunity to continue growth without increasing its permitted discharge to surface waters. Cary has a unique geographic location. It sits on top of a hill, which slopes into four major tributaries of the Neuse River - Crabtree Creek, Swift Creek, Walnut Creek, and Middle Creek.

Since the first three of these streams has its head waters in Cary, and since the last one skirts the perimeter of Cary's municipal utility service area, beginning with its headwaters, Cary has had to deal with small seven-day, ten-year low flow numbers when requesting discharge permits. In fact, it is very doubtful that the North Cary Wastewater Reclamation Plant (WWRP) would ever get its present discharge permit of 12.0 mgd increased because of the nature of the Crabtree Creak watershed downstream from its discharge point. Likewise, it is doubtful that the South Cary Wastewater Reclamation Plant would gets its present discharge permit increased beyond 16.0 mgd, because of the nature of Middle Creek both upstream and downstream from its discharge point. Given the high quality of the treated wastewater which is presently being discharged from each of these plants, the reuse of this water for non-potable purposes seems to be the next logical step.

Regulatory Issues – Jordan Lake Allocations and Interbasin Transfer

Local governments desiring to use Jordan Lake as a water supply must have that water allocation approved by the EMC. In late 1987, the EMC adopted specific rules to control the allocation. These rules set forth the requirements for any request for a water supply allocation--establish certain limits on the initial amount of water from the water supply pool which can be allocated (50 percent); and limit the amount of water which can be transferred out of the Jordan Lake basin for water supply allocations (50 percent). The EMC may review and revise that number based on experience in managing the lake and on the effects of changes in the lake's watershed that will affect its yield.

The U.S. Army Corps of Engineers will only allow two raw water intake structures to be built on Jordan Lake--one on the east side of the lake and one on the west side of the lake. Each of these raw water intakes would have to be capable of withdrawing 50.0 mgd of raw water from the lake.

The Towns of Cary and Apex presently hold a joint 16.0-mgd water allocation from Jordan Lake. In addition, since the discharge of treated wastewater from the Cary and from the Apex wastewater treatment plants flows into the Neuse River basin, and since Jordan Lake is located in

the Cape Fear River basin, Cary and Apex hold a joint Interbasin Transfer Certificate for 16.0 mgd.

Under the Jordan Lake water allocation rules, an applicant for a water allocation must present to the EMC a description of the applicant's water conservation and management practices. This requirement has been addressed by Cary as part of its present water conservation program and is being addressed by the other co applicants, Apex, Morrisville, and Wake County, as a part of their water allocation application commitments.

Under the interbasin transfer rules, an applicant for an interbasin transfer certificate is required to demonstrate that water conservation measures will be used to assure efficient use of the water and avoidance of waste. This requirement has also been addressed by Cary as part of its present water conservation program and is being addressed by the other co-applicants, Apex, Morrisville, and Wake County, as a part of their interbasin transfer application commitments.

Other Issues

In late 1994, Cary requested that the N.C. Division of Water Quality (DWQ) increase its discharge permit for the North Cary WWRP. Cary suggested to DWQ that the increased NPDES discharge permit include total nitrogen and total phosphorus effluent limits, one of the first such permits in the Neuse River basin. At the same time, Cary staff was studying the future possibility of a water reuse system to divert discharge from the North Cary WWRP to productive uses and to help offset demand for potable water.

At the public hearing for its increased discharge permit, the Neuse River Foundation (NRF) challenged DWQ's process in issuing the increased discharge permit to the North Cary WWRP. Subsequently, during the discussions between NRF, DWQ, and the Town to resolve this matter, the concept of reuse of reclaimed water was an important topic. In arriving at a settlement to the challenge to the permit process, the NRF and the Town of Cary agreed that Cary would undertake a reclaimed water reuse project with a goal of reusing up to 2.0 mgd, if practical. That agreement was made after DWQ adopted its new rules for reclaimed water reuse, which made this goal possible.

PROJECT GOALS

When Cary embarked on the development of a water reuse system, it first outlined several goals to be used to guide that program toward success, as follows:

1. Protect the public health.
2. Use the water reuse system to provide a tool for demand management of potable water, effectively offsetting as much potable demand as possible with reclaimed water.
3. Fulfill the commitments of the settlement agreement with the Neuse River Foundation.
4. Cost-effectively provide reclaimed water to the Town's customers.
5. Gain public acceptance for reclaimed water.

RECLAIMED WATER SYSTEM DEVELOPMENT

In 1997, Cary began the implementation of a reclaimed water system centered on the North Cary WWRP. The first step included the completion of a study evaluating the feasibility of this reclaimed water system. The following sections summarize the results of this study.

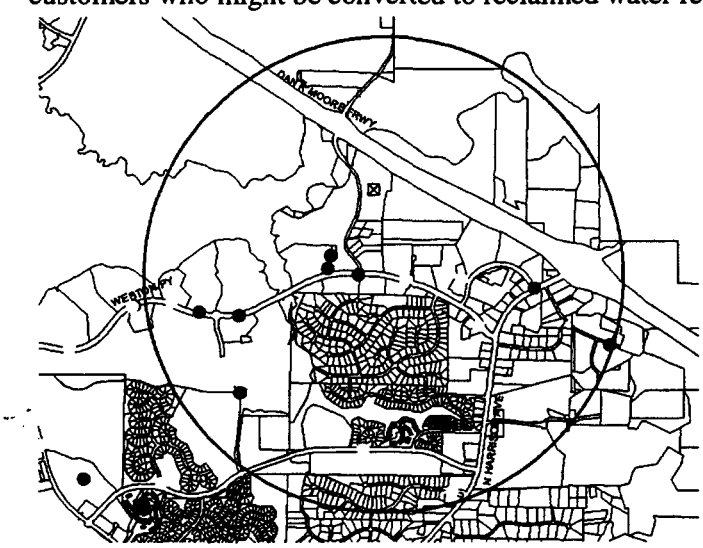
Potential Reclaimed Water System Demand

Once Cary's reclaimed water system goals are established and their water and wastewater systems needs understood, an understanding of the potential reclaimed water system customer base must be established. The Town contains many types of potential customers including large irrigation water users (i.e. golf courses and parks), smaller irrigation water users (i.e. residential and commercial properties), and industrial users. Golf courses have traditionally been an attractive customer base for reclaimed water systems due to their large usage of irrigation water. In fact, previous work done for the Town recommended building a system which primarily served three golf courses, located at the western and southern areas of the Town. This project would involve a long transmission main looping the entire western half of the Town.

This work makes use of Cary's extensive geographic information system (GIS) data to help better define the Town's potential reclaimed water customers. Cary keeps water usage records for all of the water meters served by the Town. Many of Cary's commercial, industrial, and residential customers have dual water meters, one measuring irrigation water use and one measuring all other water use. An analysis of this data gives an indication of who is using potable water for irrigation, how much potable water is being used for irrigation, and where the irrigation water is being applied. From 1994 through 1996, annual use of potable water for irrigation ranged from 159 million gallons (MG) to 211 MG (0.44 to 0.58 mgd). The peaking factor for both seasonal and diurnal variations is 9. Therefore the potential reclaimed water peak demand is currently around 4.5 mgd based on existing irrigation meters. It should be noted that the three golf courses do not use potable water for irrigation. They have their own non-potable water supply.

Almost half of the irrigation demand is attributable to residential meters. These smaller meters do not pose a large individual demand (approximately 160 gpd per meter), but their large numbers attribute greatly to the irrigation demand. The larger meters are owned by larger water users and therefore have a greater demand per meter (up to 5,800 gpd).

The greatest use of the GIS data came from looking at the distribution of irrigation demands. Once the meters were plotted, it became clear where promising reclaimed water customers were located. There are, for example, fifteen relatively large irrigation water users located within a one-mile radius of the North Cary WWRP. This includes the largest potable water for non-potable use customer currently served by the Town. Also, there are a number of clusters of residences using dual meters located relatively close to the North Cary WWRP. These are customers who might be converted to reclaimed water relatively easily (refer to Figure 1).



In order for any customer to convert to reclaimed water for non-potable uses, the customer must see a reason to switch. The greatest benefit to these customers would be a reduction in cost. Cary currently charges approximately $3.23 per 1,000 gallons for potable water. In addition, Cary charges their customers for sewer based on water usage. Many of Cary's customers have lowered their water and sewer bill by putting in dual meters (irrigation water usage is not charged for sewer).

Figure 1 – Non-Potable Water Customers within 1-Mile Radius of North Cary WWRP

If Cary can offer reclaimed water at a rate less than the $3.23 per 1,000 gallons potable water, many of the commercial, industrial, and residential customers may be willing to convert.

Reclaimed Water Supply

The reclaimed water system is to be supplied by the newly constructed North Cary WWRP, which currently treats approximately 4.7 mgd. This facility replaces the old North Cary WWRP which is located at the same site. A water balance model was developed to ensure a reliable reclaimed water source for future customers. The water balance model shows that, once the reclaimed water demand reaches over 25 percent of the average day available supply, seasonal storage will be required (refer to Figure 2). For example, a reuse commitment of 40 percent of the available supply would require 35 days of storage. If the average annual supply is 4.7 mgd, a storage volume of 165 MG would be required. Because of the potential large land requirements and cost for seasonal storage, the Town will initially commit to up to 1.2 mgd of reclaimed water (25 percent of 4.7 mgd).

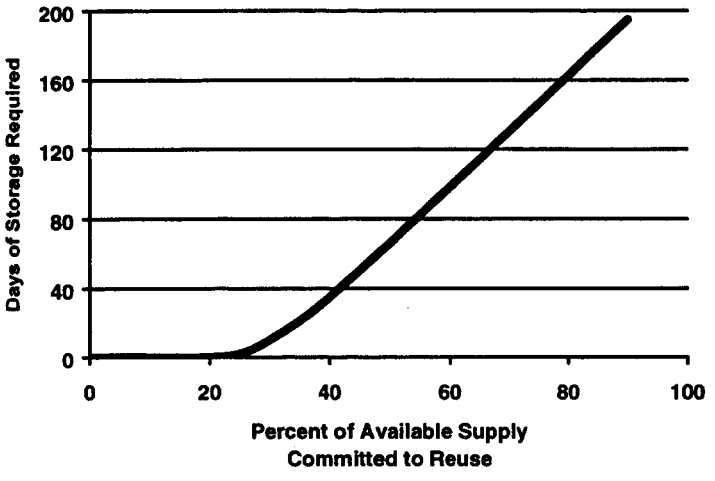


Figure 2 – Required Storage for Reclaimed Water Systems

The North Cary WWRP has been designed with Class I reliability and is subject to surface water discharge limits that are in some ways more stringent than those required for the reclaimed water system. It is expected that the facility will be capable of consistently meeting the requirements for reclaimed water a majority of the time and there will be a limited need to divert reclaimed water away from customers. However, the ability to detect and react to intermittent water quality problems is an important aspect of this project.

The new 10-mgd North Cary WWRP has not generated water quality data for analysis, but should be able to meet the state water quality requirements for reclaimed water without modifications to the treatment train. The existing abandoned chlorine contact basins from the original plant will be used as a reclaimed water wet well and pump station. A splitter box will be added to divert plant effluent (from the plants filter and UV disinfection systems) to the reclaimed water wet well. In order to protect against biological regrowth in the distribution system, a low dose chlorine injection system will be implemented to provide a disinfection residual in the reclaimed water. Turbidity monitoring of the filter effluent will be provided. Sampling and testing for BOD_5, NH_3-N, and fecal coliform levels would be taken at existing sampling locations, downstream of UV disinfection.

It is imperative that any water not meeting the reclaimed water standards be diverted away from the reclaimed water distribution system. An automatic control system will be implemented to respond to either high turbidity or a problem with the chlorine injection system. If the turbidity is high, water will not be allowed to enter the reclaimed water wet well and will continue to the NPDES discharge point. If the chlorination system is upset, the water will not be allowed to enter the reclaimed water distribution system. The "rejected" reclaimed water cannot be

delivered to the NPDES discharge point as it will likely contain chlorine. It will therefore be returned to the head of the plant. In both instances, an alarm will notify the plant operator of a problem so corrective action can be taken.

Reclaimed Water System Implementation

There is little doubt that reclaimed water originating from the North Cary WWRP will be suitable for irrigation or cooling water makeup for the Town of Cary's customers. The major issue influencing the success of this project is public acceptance. For this reason, Cary is proceeding with a demonstration project, the primary purpose of which is to demonstrate to the public that reclaimed water is a valuable water resource. The fifteen irrigation meter customers (all non-residential) located within a one-mile radius of the plant are potential irrigation system customers. These customers include the SAS Institute which uses a large amount of water for cooling water. Also included are the Weston Property Owners/North Hills customers which are located along Weston Road.

It is assumed that these commercial customers located in the vicinity of Weston Parkway will form the reclaimed water system core customers. Three alternatives were developed for expanding the reclaimed water system beyond the demonstration project. Conceptual costs were developed and evaluated for these alternatives, as summarized in Table 4.

Table 4
Conceptual Cost Estimates for an Expanded Reuse Service Area

Alternative	*Average Demand (gpd)*	*Capital Cost*	*Unit Cost per 1,000 gallons*
Service to Weston Parkway and Prestonwood Golf Course Only	520,000	$3,370,000	$2.02
Service to Weston Parkway and Three Golf Courses	960,000	$8,880,000	$2.79
Service to Weston Parkway, Prestonwood Golf Course and Residential Homes	880,000	$8,190,000	$2.80

The average demand for each of the alternatives is within the limit of 1.2 mgd established by the water balance model. Although the unit cost for providing water to the Weston Parkway and Prestonwood Golf Course only is the lowest at $2.02 per 1,000 gallons, it should be noted that the majority of the water will be supplied to the golf course. They currently pay very little for their non-potable water and would therefore not likely be willing to purchase reclaimed water. The same is true for the second alternative, which would supply water to all three golf courses.

The final alternative would supply reclaimed water to commercial and residential customers located between the North Cary WWRP and the Prestonwood Golf Course (located on the west side of Town). The estimated cost of $2.80 per 1,000 gallons is 58 percent less than what is currently being paid for potable water. Additionally, the system would serve only a planned future portion of the golf course which would use potable water for irrigation. Therefore the cost for service should be attractive for all customers.

Cary has decided to implement the reclaimed water system in seven phases, the first being the demonstration project. Cary has decided to budget $600,000 per year to construction of the reclaimed water system. The remaining phases serve commercial development along Weston Parkway, pockets of residential customers, and a future section of an existing golf course. The seven phases are to be implemented within 16 years.

The Town of Cary could further reduce the cost of reclaimed water to the customer if it elects not to recover all capital and operating costs. For example, if the Town chooses to subsidize all capital costs and recover only operating expenses, the unit cost of service could be as low as $0.20 per 1,000 gallons. This would require the Town to invest more than $8,000,000 to construct the project over a 16-year period. As an alternative, the Town could cap subsidies at $600,000 per year and construct each phase in one year. Any capital cost in excess of $600,000 would be financed and that financed amount recovered from the customers. This would accelerate the implementation of the reuse system from 16 years to 9 years, and reduce user costs to $1.17 per 1,000 gallons. This scenario would require the Town to invest approximately $4,000,000 in the construction of the reuse system.

SUMMARY

The Town of Cary has made at least four important commitments for undertaking its reclaimed water reuse program:

1. The Town of Cary has made an agreement with the Neuse River Foundation to undertake a water reuse program in order to divert a wastewater discharge away from the Neuse River basin.

2. The Town of Cary has made a commitment in its Jordan Lake water allocation increase application that it was undertaking a water reuse program as a part of its water conservation and peak demand management practices.

3. The Town of Cary is making a commitment in its interbasin transfer application that it is undertaking water conservation measures to assure efficient use of the water and avoidance of waste, among them, specifically, its water reuse program.

4. The Town of Cary, as a part of its long-range water demand management plan, desires to divert as much non-potable water use away from its potable water system as possible. This can be best achieved by through a water reuse program.

Cary has also established five goals for the implementation of their reclaimed water program. Cary is well on its way toward meeting these goals. Discussion on each of the goals is presented below:

Goal – Protect the Public Health

The Town's reclaimed water system will draw water from the North Cary WWRP. This facility currently supplies water that meets the major requirements of the state for reclaimed water quality. With the addition of continuous turbidity monitoring, the facility will fully meet the state requirements. Control measures will be put in place to keep substandard water from reaching the reclaimed water distribution system. In addition, a disinfection residual will be introduced into the reclaimed water as it enters the distribution system.

Goal – Provide a Tool for Demand Management of Potable Water

Cary's reclaimed water system will provide an average of approximately 1 mgd of reclaimed water to the Town's customers to be used for non-potable water needs. At this time, the major uses identified are irrigation water for residences, commercial, and industrial property, and cooling water for institutional use. The system will meet seasonal demands of 3 mgd and peak hourly demands of approximately 9 mgd. This will offset potable water demands, particularly in the summer months when the water plant is achieving its highest rate of production.

Goal – Fulfill the Commitments of the Settlement Agreement with the NRF

Cary has agreed to attempt to implement a 2.0-mgd reclaimed water system using water generated by the North Cary WWRP. This project demonstrates that a 2.0-mgd system is not feasible at this time. However Cary has committed to implementing a 1-mgd reclaimed water system to be implemented in phases. This system could grow to 2 mgd as the North Cary WWRP influent flows reach 8 mgd.

Goal – Cost Effectively Provide Reclaimed Water to the Town of Cary's Customers

The costs for constructing, operating, and maintaining the 1-mgd reclaimed water system amounts to approximately $2.80 per 1,000 gallons. This represents 87 percent of the Town's potable water rate of $3.23 per 1,000 gallons. By supplementing some of the capital costs associated with the system, the Town could lower the unit cost of reclaimed water below $2.80 per 1,000 gallons.

Goal – Gain Public Acceptance for Reclaimed Water

Public acceptance for the reclaimed water system will require commitment on a variety of levels. First and foremost, the Town must provide a product that is safe and reliable. The North Cary WWRP has the ability to provide a safe product for non-potable uses. The augmentations recommended as part of this project will protect against sub-standard water entering the system. The system is also sized to provide a reliable supply to Cary's customers.

The customers must also be educated about reclaimed water. The first phase of this project, the demonstration phase, provides a vehicle for showing prospective customers that the system works. After reliably supplying the demonstration project customers' needs, future customers will be more willing to come on line.

Finally, Cary has a number of future challenges as they implement their reclaimed water system. The biggest challenges are summarized below:

1. Financial Decisions – Cary must decide how to fund the capital improvements of this project including distribution lines to the customers' "door".

2. Buy In of Non-Potable Water Customers – Cary needs to gain commitment from an adequate number of reclaimed water customers to justify the investment in the system.

3. Public Policy Development – Cary is now in the first stages of developing their public policy towards their reclaimed water system.