Cleveland County Water
Flocculation and Sedimentation Improvements
Preliminary Evaluation

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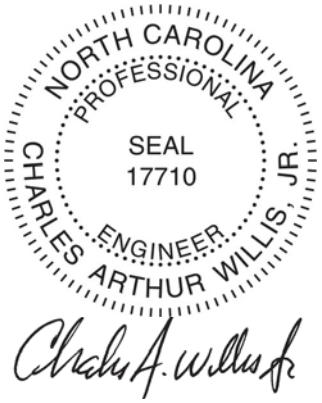

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1. Background

Cleveland County Water (CCW) owns and operates an 8.0 million gallon per day (MGD) Water Treatment Plant (Plant) located on the First Broad River north of Lawndale, North Carolina. The Plant currently produces 4.0 to 5.0 MGD, providing water service to approximately 25,000 residential and commercial connections.

Raw water is pumped from the First Broad River and one of its tributaries, Knob Creek, to a large on-site reservoir. From there it is repumped into the Plant for treatment. The Plant is equipped with one rapid mix basin and four flocculation basins which provide an opportunity for suspended material in the chemically treated water to agglomerate (flocculate), allowing for easier settling. The original Plant, constructed in the 1980s, included the rapid mix basin and Flocculators 1 and 2. A Plant expansion project in the 1990s added two more flocculators, Flocculators 3 and 4, which are slightly larger in size.

Following flocculation, the Plant utilizes six parallel sedimentation basins that provide quiescent conditions for flocculated solids to settle. The sedimentation basins were constructed in several phases over the years. The original Plant had two 90-foot-long sedimentation basins, Basins 1 and 2. A Plant expansion in the 1990s constructed Basins 3 and 4 and extended the length of the original

two basins. In 2016, an expansion project increased the Plant's capacity by constructing Basins 5 and 6, each approximately 140 feet in length.

CCW Plant Operators have reported several concerns with the flocculation and sedimentation facilities. Notably, the rapid mixer and flocculators have a lack of process redundancy and Operators have no way to isolate a single flocculator in the system. The equipment is also showing significant signs of age. Sedimentation Basins 1 through 4 are showing signs of significant concrete degradation. These older four sedimentation basins lack full coverage of the vacuum sludge collection systems needed for removal of settled solids. Additionally, the older basins have poor hydraulic characteristics created by the intermediate walls.

In 2019, a Water Treatment Plant Condition Assessment was undertaken by Willis Engineers to identify deficiencies throughout the Plant. As part of this Condition Assessment, the flocculation and sedimentation facilities were evaluated in their current condition. Willis Engineers visited the Plant on multiple occasions to visually inspect the treatment components and interview the Plant Operators. The evaluation consisted of structural and process-related analyses. The evaluation suggested that CCW should undertake a renovation project to renew the life cycle of these treatment components. The details of these findings and the scope of the renovation project are discussed herein.

2. Evaluation of Rapid Mix and Flocculators

Although the rapid mixer and flocculators appear to be in sufficient working order, some of the equipment is nearing the end of its useful life and will eventually need to be replaced. Unfortunately, there is no way to isolate the rapid mix basin or a single flocculator in the system for repairs or cleaning. Water travels through the rapid mix basin into each of the first two flocculation basins, then through a flume, and then into the final two flocculation basins. Any maintenance or cleaning within the mixing and flocculation systems requires temporarily shutting down the Plant. Implementing new isolation techniques into the existing rapid mixer or flocculation basins does not appear possible.

In addition to the lack of redundancy and isolation, the sequential arrangement of the basins and the flume located between the pairs of flocculators produces some adverse hydraulic conditions. The flume creates turbulence as it conveys water from Flocculator 2, through multiple bends, and into Flocculator 3. The turbulent flow shears flocculated solids formed by Flocculators 1 and 2. Subsequently, Flocculators 3 and 4 must reagglomerate the suspended material before it reaches the sedimentation basins.

One solution would be to construct additional rapid mix and flocculation basins, creating parallel process trains. The new basins should be configured with proper isolation valving, allowing Operators to provide maintenance or cleaning while the Plant remains in service.

3. Evaluation of Sedimentation Basins

To better assess the sedimentation basins, Willis Engineers retained TGS Engineers to evaluate the structural integrity of the older basins and provide structural renovation guidance. Basins 1 through 4 were each drained to allow TGS Engineers to physically examine the structural integrity of each basin.

Structural spalling was discovered across walkways and decking surrounding the older sedimentation basins. These areas are frequently wet and experience freeze/thaw cycles that degrade the surface concrete over time. Severe degradation of the surface concrete could eventually threaten the integrity of the structure. It was noted that CCW had made minor improvements by repairing and caulking the more evident spalls and cracks along the decking.

When reviewing the overall structural integrity of each basin, TGS Engineers found the basins to be sound and appear to meet their designed functionality. Although, during their evaluations, TGS Engineers observed multiple leaks along the basin walls. One notable leak formed where the original weir from Flocculator 1 discharged into Basin 1. It appeared the weir opening was grouted during an expansion project and deteriorated over time. Additionally, a leak was present along the sidewall separating Basin 1 and Basin 2. The leaks between basins are not currently harmful to the overall integrity and function; however, the leaks may become a larger issue if not properly addressed. It was also noted that the brick baffle walls are in poor condition. The mortar between the bricks is degraded and may soon fail.

The intermediate walls significantly affect the hydraulics of the basins by forcing water and flocculated solids in an upward direction, thus reducing settling efficiency. An analysis by TGS Engineers included the possibility of removing the intermediate walls within Basins 1 through 4. Summarized in the attached *Sedimentation Basin Repairs* letter, TGS Engineers concluded that these intermediate walls can be removed. However, to maintain structural integrity, it was recommended that structural supports be installed between the walls.

The Plant Operators have expressed difficulty with alum sludge removal in the four older basins. The vacuum sludge collection systems in these basins only extend to the intermediate walls, providing coverage for the first 35 feet of the basin. The recently constructed Basins 5 and 6 have sludge collection systems with complete floor coverage. Our evaluation found higher amounts of settled alum sludge in the four older basins compared to the newer Basins 5 and 6. The lack of sludge collection systems in Basins 1 through 4 causes increased maintenance and basin washdown time during routine cleaning procedures.

Another problem noted by the Plant Operators are the worn shear gates controlling flow at the influent pipes in each sedimentation basin. Each of the older basins contains three shear gates, which are original to the Plant construction. The operators have difficulty isolating the influent flow when emptying the basins for maintenance and even greater difficulty reopening the gates to return the basins to service. CCW should consider replacing the shear gates to increase future reliability.

4. Recommendations

The flocculation and sedimentation facilities were found to have multiple structural and process-related deficiencies. We recommend CCW undertake a renovation project to provide redundant flash mix basins, replace portions of the flocculation system, improve basin hydraulics and restore the existing facilities to a like-new condition. While we recommend the following renovations be completed as one project, the scope of work is subdivided by treatment system below. The proposed improvements will correct some existing deficiencies and restore aging equipment but will not expand the Plant's overall capacity.

CCW should consider undertaking the following renovations to the mixing and flocculation systems.

1. The current rapid mix and flocculator configuration offers no opportunity for isolation or redundancy in the system. It is recommended that CCW construct two new rapid mixers and two new flocculators. The new facilities would be arranged into parallel process trains. The new rapid mix and flocculation basins will replace the existing rapid mixer and Flocculators 1 and 2 and eliminate the flume between Flocculator 2 and 3.

2. Flocculators 3 and 4 have been servicing the Plant for more than twenty years without any structural or mechanical improvements. While these flocculators are in sufficient working order, they are showing signs of age. It is recommended that Flocculators 3 and 4 be enhanced to a like-new condition. Work would likely include repairing and recoating the internal concrete walls and replacing the mechanical equipment.

3. With the construction of the new rapid mixers located near the head of the sedimentation basins, raw water must be conveyed to the new influent location from the raw water pumping station and raw water reservoir. Additionally, chemical feed lines must be extended to the new rapid mix basins. A new metering vault will be necessary for metering the raw water inflow. Further work may be necessary to relocate existing yard piping around the sedimentation basins.

CCW should consider undertaking the following improvements to extend the useful life of the four older sedimentation basins.

1. The concrete decking and walkways are vital to access and provide maintenance around the sedimentation basins and nearby flocculators. It is recommended that the degraded decking and walkways across the older sedimentation basins and all flocculators be repaired and recoated. The work would likely include an application of cementitious repair mortar, where needed, and additional concrete coating across the entire decking and walkways.

2. The intermediate walls in Basins 1 thorough 4 significantly impact settling hydraulics. It is recommended that the intermediate walls be removed from each of the four older basins. With the wall removal, TGS Engineers recommended installing a steel strut to add support.

This strut would be constructed at approximately two-thirds of the wall height from the floor. Additionally, major leaks discovered in the basin walls will be repaired.

3. The brick baffle walls in Basins 1 through 4 should be removed and replaced. CCW Operators would prefer to replicate the concrete wall baffles utilized in Basins 5 and 6.

4. To improve sludge collection in the older basins, it is recommended that additional vacuum sludge collection systems be installed on the remainder of the basin floors. The footings of the intermediate walls prohibit the extension of the existing sludge collection tracks to the full length of the basins; however, supplemental sludge collection systems will allow for more complete coverage of the basins. The new sludge collection systems will require additional independent control panels and new connections to the existing basin drain lines.

5. The shear gates of the older sedimentation basins have reached the end of their useful lives and should be replaced. Due to space limitations, we recommend replacing the existing shear gates with butterfly valves. The butterfly valves can be installed on the outlet section of the pipes utilizing a submerged traveling nut operator. The butterfly valves would be operated via stemmed handwheel, like the current butterfly valves at Basins 5 and 6.

5. Implementation

CCW anticipates operating the Plant for the foreseeable future. We therefore suggest CCW substantially renovate the facilities to ensure their continued reliable service. The recommendations listed herein are not urgent but should be completed within a few years to prevent any further damage to the systems. During the project, portions of the work will require system components to be removed from service for an extended period and will require careful coordination with Plant Operators. The work should be completed by a competent contractor with experience in this type of work.

The estimated cost of these renovations is $2,750,000 as further described on the attached Engineer's Preliminary Opinion of Probable Cost. If CCW desires to complete the improvements as one project, they may wish to pursue low-interest loan funding through the Drinking Water State Revolving Fund (DWSRF) or other loan programs.

Item	Description	Qty.	Unit	Unit Price	Cost
Rapid Mix and Flocculator Improvements					
1	2 Rapid Mixers and 2 Flocculators	1	LS	$495,000	$495,000
2	Influent Flume	90	CY	1,500	135,000
3	Flocculator 3 & 4 Renovations	1	LS	90,000	90,000
4	16-inch Raw Water Line	400	LF	250	100,000
5	Additional Piping, Valves, and Sitework	1	LS	290,000	290,000
6	Demolition & Removal of Old Structures	1	LS	75,000	75,000
7	Electrical	1	LS	50,000	50,000
Sedimentation Basin Improvements					
8	Structural Improvements and Concrete Repairs	1	LS	545,000	$545,000
9	Additional Sludge Collection Systems	4	EA	75,000	300,000
10	16-inch Butterfly Valves	12	EA	10,000	120,000
Subtotal (Items 1-10)					$2,200,000
11	Contingency Allowance (10% of Subtotal)	1	LS	220,000	$220,000
12	Technical Services (15% of Subtotal)	1	LS	330,000	$330,000
Total Estimated Project Cost					**$2,750,000**

This cost estimate is for project planning and budgeting purposes only. The quantities and values stated in this Opinion of Probable Cost are limited to preliminary or conceptual design information, generally classified as an AACE Class 5 Cost Estimate.

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April 15, 2020

Mr. Charles A. Willis, Jr., PE
Willis Engineers
10700 Sikes Place, Suite 115
Charlotte, NC 28277

Project: **Cleveland County Water**
Lawndale, NC

Re: **Sedimentation Basin Repairs**

Dear Mr. Willis,

We are sending this letter in response to your request for Structural Engineering services on the above noted project. Our scope of work included two (2) phases:

- Phase 1: Structural evaluation of existing basins (4 total) for the possible removal of intermediate walls.
- Phase 2: Provide repair/renovation guidelines, recommendations, details and cost estimate to complete the work.

Each of the four (4) basins were drained independently and we were able to physically/visually inspect each basin for any structural defects/distress in the walls and floor. The results of our inspections conclude that the basins are structurally sound and functioning as intended. We have also reviewed the provided construction plans for: the original two (2) basins, extensions of original basins and the addition of two (2) adjacent basins. With the intent of intermediate wall removal, we have investigated various loading conditions on the final basin configuration.

Upon our review and structural evaluation of the basins, we present the following conclusions and recommendations based on removal of the intermediate walls:

- We find that the basins would remain structurally sound under normal earth/water loadings upon having the intermediate walls completely removed.
- Our concern for structural integrity of the basin walls with the intermediate walls removed relates to the Flocculators and their associated loadings/pressures/vibrations.
- With that said, we feel it necessary to install a strut in each of the four (4) basins at the removed intermediate wall location. The struts should be installed in each basin at ⅔ wall height up from the floor.
- We have estimated the construction cost for the repairs of the four (4) basins to be $125,000. This cost includes, as a minimum, the following items:
    - Mobilization
    - Removal of Intermediate Walls

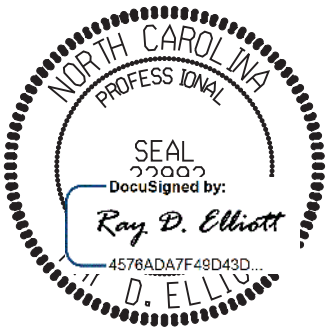
- Temporary Shoring
- Epoxy Grout Repairs along Basins
- Installation of Struts
- Construction Debris Removal & Disposal
- Miscellaneous Basin Repairs

If you have any questions or need further information, please call.

Best Regards,

Ray D. Elliott

Ray D. Elliott, PE
Design Engineer



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