DATE ISSUED: May 28, 2025

CAPE FEAR PUBLIC UTILITY AUTHORITY

REQUEST QUALIFICATIONS FOR:

RICHARDSON WATER TREATMENT PLANT RAW WATER BIO-GROWTH ELIMINATION

Time and Date of Pre-Submittal Conference	**June 10, 2025, 9:00 AM**
Deadline for Inquiries	**June 24, 2025, 2:00 PM**
Time and Date Set for Submittal	**July 8, 2025, 2:00 PM**

REQUEST FOR QUALIFICATIONS (RFQs)
FOR
DESIGN-BUILD SERVICES

RICHARDSON WATER TREATMENT PLANT RAW WATER BIO-GROWTH ELIMINATION
INFORMATION AND INSTRUCTIONS TO DESIGN-BUILDERS

1 GENERAL INFORMATION

1.1 Cape Fear Public Utility Authority (CFPUA) intends to procure a qualified Design-Builder (DB) to provide design and construction services for the study, elimination process and elimination work of irradicating bio-growth in the Pee Dee Raw Water Line.

1.2 Statement of Qualifications (SOQ) must be submitted in .pdf format to bids@cfpua.org no later than 2:00 PM on July 8, 2025.

1.3 Questions pertaining to the selection process should be directed to Procurement Manager at bids@cfpua.org no later than 2:00 PM on June 24, 2025.

1.4 CFPUA shall not be held responsible for any oral instructions. Any changes to this Request for Qualifications (RFQ) will be in the form of an addendum, which will be furnished to all registered RFQ holders. Please register by email at bids@cfpua.org and provide company name and contact information.

1.5 CFPUA reserves the right to reject any SOQs to waive any informality or irregularity in any SOQ received, and to be the sole judge of the merits of the respective SOQ received.

1.6 A pre-submittal conference for the Project will be held June 10, 2025, at 9:00 AM local time in the Training Room at Richardson Water Treatment Plant, 633 Groundwater Way, Wilmington, NC 28411 staff will discuss the scope of work, general contract issues and respond to questions from the attendees. Because staff will not be available to respond to individual inquiries regarding the project scope outside of this pre-submittal conference, attendance at this pre-submittal conference is not required, however, highly recommended.

1.7 Project Description: The Richardson Water Treatment Plant produces an average of 3 million gallons per day. In 2022 bio-growth was observed in the cartridge filters before the reverse osmosis membranes. After the operations staff investigated, the source appeared to be the Pee Dee aquifer. Environmental testing revealed it originated from surficial water sources. The raw water line was partially pigged in 2023, and a selection of wells were cleaned/ chlorinated in 2023. Bio growth has been reduced but continues to foul the cartridge filters. The goal of the project will be to determine the root cause of the bio-growth, develop options for eradication, remove bio growth from Pee Dee raw water line and develop a maintenance plan and schedule to prevent or reduce bio growth in the future.

Total Estimated Design-Build Project Budget: $5,000,000

Project funding is contingent upon CFPUA Board approval of Fiscal Year 26 Budget. Funds available July 1, 2025.

The project's anticipated schedule is to be **substantially completed in April 2026**

1.8 The DB will be selected based on qualifications as outlined in Section 3 of this RFQ.

1.9 The Design Build services will be performed using the Design Build Institute of America (DBIA) contract documents with one entity identified as the DB. Services will include all necessary activities to design and construct the project.

1.10 The DB will be an integral member of the Project Team, consisting of the DB, representatives from CFPUA, and other consultants required. It will be the responsibility of the DB to integrate the design and construction phases, utilizing skills and knowledge of design and general contracting, to provide design, code analysis, value engineering and constructability reviews, develop schedules, prepare detailed project construction estimates, study labor conditions, and, in any other way deemed necessary, to contribute to the development of the Project during the pre-construction/design phase. Planning to maintain existing system operations during construction shall be a critical portion of the pre-construction/design phase.

1.11 The DB assumes design and construction risk and has direct authority over the sub-consultants and subcontractors. The DB will act as the CFPUA's fiduciary and have a relationship of trust and confidence between itself and CFPUA. CFPUA intends to enter into a Preliminary Design-Build Agreement with the selected Design-Build firm utilizing standard DBIA contract documents. Upon completion of the preliminary design-build scope of work, the DB firm will provide a lump sum.

1.12 Please see http://www.cfpua.org/DocumentCenter/Home/View/370 for CFPUA's MWBE Outreach Plan for project goals.

2- ANTICIPATED SCOPE OF WORK

2.1 The scope of work will be generally delivered in a two-phased DB approach as described below.

- Phase 1 – Design and Pre-Construction Services: It is anticipated that the scope of services for Phase 1 will be negotiated on a lump sum basis and will require approval by CFPUA. During this phase, the scope of services will include overall project scoping, design workshops, development of an initial opinion of cost, design services through a 30% submittal package (with cost opinion update), and design completion to 60% or greater (with cost opinion update), and with the preparation and delivery of a lump sum price and schedule for Phase 2.

  In addition, the CFPUA will work with the Design-Builder to finalize the terms of the Design-Builder Agreement for Phase 2. If the parties can negotiate the Agreement for Phase 2 including, but not limited to: scope, schedule, contract terms, and lump sum then the Design-Builder will be authorized to proceed with Phase 2. It should be noted that the CFPUA must be able to demonstrate that execution of the Phase 2 work is cost-effective, allows for local sub-contractor competition, achieves schedule milestones, and meets the needs of the CFPUA. If a Phase 2 Agreement is not reached, then CFPUA will have no further contractual responsibility to the Design-Builder and may seek alternatives to project completion.

- Phase 2 – Design-Build Services Agreement: Phase 2 Design-Build work will include completion of design services, construction, testing and final project completion as outlined in the Design-Build Agreement.

2.2 In general, the project scope of work includes design and construction for the following key elements:

- Review existing information provided by Water Systems, Inc. regarding characterization of bio-growth, extent of growth and work done to date by CFPUA to mitigate.
- Determine root cause of biological growth
- Provide CFPUA with recommendations for corrective actions, preventative measures, operation and maintenance procedures and schedule for performing such measures for both raw waterline and inside Richardson Water Treatment Plant and cost estimates for each recommendation.
- Sustainability solutions - Provide sustainable solutions with a balance of cost and benefit, determining best-fit solutions were feasible.
- Experience with bio-growth, super chlorination, pigging, water treatment plant operations is highly recommended.

2.3 After being selected, the DB will execute a contract with CFPUA to provide design and construction services for the project including, but not limited to:

- Project management and administration through project leadership and overall team coordination.
- Implement a job specific safety plan for design and construction related activities.
- Perform corrective actions such as, but not limited to:
    - i. Conventional pigging and preparing raw waterlines to accept a conventional pig
    - ii. Cleaning of affected infrastructure inside water treatment plant
    - iii. Disinfecting raw water line, prefilters and appurtenances
    - iv. Properly dispose of any discharge from above listed actions.
    - v. Installation of any appurtenances to mitigate or prevent bio-growth
    - vi. Perform corrective actions during off-peak demand season- October 2025 to April 2026.
- Review and confirm CFPUA's as-built records for Pee Dee raw waterline and make corrections if applicable.
- Provide a comprehensive operations and maintenance guide with recommended actions and detailed scheduled for maintenance.
- Develop a cost estimate for work to be performed by the Design-Build Team and cost estimate for recommended operations and maintenance techniques to prevent future bio-growth.

- Develop an initial opinion of cost and then update that cost opinion during design development with submittals at the 30% design stage, and 60% design stage. An updated cost opinion should be maintained throughout Phase 1 effort. Develop construction cost models, estimates based on marketplace conditions, and cash flow analyses.
- Complete all surveying, SUE, and geotechnical engineering required for successful design and construction and development of construction pricing.
- Provide interdisciplinary coordination, review codes and standards, perform value engineering, offer cost savings suggestions, and best value recommendations.
- Perform constructability review, construction sequence planning and scheduling.
- Obtain permits required for project construction if applicable.
- Provide quality assurance and quality control plan for both design and construction.
- Provide engineering services during construction to include RFIs, shop drawing reviews, contractor change order requests, preparation of record drawings, and project management support.
- Provide all construction management services related to the DB's scope of work.
- Complete project close-out activities including final punch-lists, project certifications, documentation for asset management, and warranty efforts, if applicable.
- Provide conformed record drawings if changes are made to Pee Dee Raw Waterline as-builts, test results and operation and maintenance recommendations and schedule.
- The DB will assume the risk of delivering the Project and will be responsible for construction means and methods.
- Anticipated project schedule:

Item	Task	Anticipated Date
1	Advertise Design-Build RFQ	May 28, 2025
2	SOQ's Due	July 8, 2025
3	Firms notified of shortlist	July 15, 2025
4	Final selection	July 22, 2025
5	Execute Preliminary Design Build Agreement	August 2025
6	Design Team develops 60% drawings	November 2025
7	Execute Construction Contract	December 2025

3 - STATEMENT OF QUALIFICATIONS SELECTION CRITERIA

3.1 Firms interested in providing design build services must submit a Statement of Qualifications (SOQ) that addresses the following evaluation criteria. Applicants are encouraged to organize their submissions in such a way as to follow the general evaluation criteria listed below. Information included within the SOQ may be used to evaluate your firm as part of any criteria regardless of where that information is found within the SOQ. Information obtained from the SOQ and from any other relevant source may be used in the evaluation and selection process.

3.2 Cover Letter (1-page) containing at a minimum:

Company name, contact name, address, fax number, and email address

3.3 Qualifications Criteria

For the development of a shortlist, a rating system will be utilized by CFPUA to score and rank each proposal. Proposers are encouraged to keep their proposals concise and to include a minimum of marketing materials. At a minimum, each proposal must address the following criteria:

Item	Evaluation Criteria	Maximum Points
1	General Information	5
2	Relevant Firm Experience and References	25
3	Project Team Qualifications and Availability of Resources	20
4	Project Understanding and Implementation	25
5	Innovative Ideas	20
6	Other Factors	5
7	Financial & Legal	Pass/Fail
	Total Possible Points	**100**

*Interviews are optional. If interviews are conducted, both the SOQ and interview will be considered in the final score for each criterion.

Evaluation Criteria 1 - General Information

a. Description of firm/team
b. Legal company organization; organizational chart with names. The organizational chart shall also include major subcontractors.
c. Identify the Project Manager for the DB firm who will be assigned to this project.
d. Each Proposer shall submit in its response to this RFQ an explanation of its project team selection consisting of either of the following team selection options:

   a. A list of the licensed contractors, licensed subcontractors, and design professionals whom the design-builder proposes to use for the project's design and construction. If this project team selection option is used, the design-builder may self-perform some or all of the work with employees of the design-builder and, without bidding, also enter into negotiated subcontracts to perform some or all of the work with subcontractors, including, but not exclusively with, those identified in the list. In submitting its list, the design-builder may, but is not required to, include one or more unlicensed subcontractors the design-builder proposes to use. If this project team selection option is used, the design-builder may, at its election and with or without the use of negotiated subcontracts, accept bids for the selection of one or more of its first-tier subcontractors.

   b. A list of the licensed contractors and design professionals whom the design-builder proposes to use for the project's design and construction and an outline of the strategy the design-builder plans to use for open subcontractor selection based upon the provisions of Article 8 of Chapter 143 of the General Statutes. If this project team selection option is used, the design-builder may also self-perform some of the work with employees of the design-builder, but shall not enter into negotiated contracts with first-tier subcontractors.

Evaluation Criteria 2 - Relevant Firm Experience and References

a. Applicant's service capabilities and quality as it relates to this project.
b. List and briefly describe two comparable projects completed by your firm or currently in progress; include your firm's role, and discuss contract amendment history, if applicable. For each project, include contract value and construction value (original value plus contract amendments, if applicable), project owner, project location, contact name and title, address, current and accurate telephone number, and email address (if available).
c. A minimum of two referrals and references from other agencies and owners. If possible, references should be from the projects listed above.
d. Type and amount of total self-performed work that was completed (for completed projects) or is anticipated (for on-going projects).

Evaluation Criteria 3 - Project Team Qualifications and Availability of Resources

a. Provide an overall organizational chart (showing Team Members, Key Team Members, and their firm affiliation) for all phases of the Project from design through final acceptance and warranty maintenance period with names, including subcontractors.
b. Briefly describe each team member's role on this project.
c. Provide "team" experience working together on similar projects.
d. Explain your understanding of, and experience with, the Progressive Design-Build Delivery Method.
e. Provide information regarding teaming history and working relationship between the DB and the DB's consulting engineering firm(s).
f. Provide information regarding teaming history and working relationship between the DB and any proposed major construction subcontractor(s).
g. Explain the DB team’s current workload and ability to proceed promptly with the project. Provide a statement regarding your assurance that your team has the necessary resources available to complete this project within the schedule provided in this RFQ.

Evaluation Criteria 4 - Project Understanding and Implementation

a. Describe your understanding of the project.
b. Methodology and approach to the design, permitting, and construction services including creative alternatives that could be proposed to add value or cost saving measures.
c. Identify and discuss any potential risk during design and construction and possible mitigation measures.
d. Provide an anticipated project schedule with ideas to accelerate the overall duration.

Evaluation Criteria 5 – Innovative Ideas

a. Describe any innovative ideas, alternative design and/or construction concepts that will provide CFPUA added value. For each proposed idea, provide adequate information, concepts, estimated cost information, and schedule impacts, if any, in sufficient detail to allow CFPUA to determine whether the proposed idea is in CFPUA's best interest.

Evaluation Criteria 6 – Other Factors

a. Provide statement regarding your willingness to abide by CFPUA's standard form Agreements with few or no objections or changes. CFPUA accepts the latest version of DBIA Standard Documents with appropriate modifications agreed upon by both parties.
b. Provide a statement regarding your assurance that this engagement will not result in a conflict of interest.
c. Describe relevant factors impacting the quality and value of work.

Evaluation Criteria 7 – Financial & Legal

No points will be allocated for Evaluation Criteria No. 7; Proposers will be rated as acceptable (pass) or unacceptable (fail). Will not be included in page count

a. The selected DB firm will be required to provide a Performance and Payment Bond in the full amount of the contract. For this submittal, proposers shall provide evidence of their ability to provide and maintain the following:
   i. A Performance and Payment Bond in the amount of at least $3M
   II. General Liability Insurance at $3M per occurrence and $5M aggregate
   III. Umbrella Liability Insurance at $5M per occurrence.
   Iv. Workman's Compensation $500,000 Each Accident, $500,000 Disease-Each Employee, $500,000 Disease-Policy Limit
   V. Professional Liability at $2M per occurrence.

b. List and describe any litigation; arbitration; claims filed by your firm against any project owner as a result of a contract dispute; any claim filed against your firm; termination from a project.

c. Any firm wishing to be considered must be properly registered with the Office of the Secretary of State.

4 - SUBMITTAL REQUIREMENTS

4.1 The SOQ shall include a one-page cover letter plus a maximum of thirty-five (35) pages to address the SOQ criteria specified in Section 3 (excluding Resumes and Sub-consultant/Subcontractor Selection Plan). Table of Contents and section divider pages do not count toward the total page count. Resumes for each key team member shall be limited to no more than two pages. Resumes and Sub-consultant/Subcontractor Selection Plan shall be attached as Appendix A.

4.2 Firms shall submit their Statement of Qualifications and Appendix for consideration in .pdf format to bids@cfpua.org no later than 2:00 PM local time on July 8, 2025. Maximum file size for .pdf submission is 25MB. A reply will be sent to the email address submitting the statement of qualifications to confirm receipt. It is the submitting firms' responsibility to confirm that CFPUA has received statement of qualifications via email. If email reply is not received from bids@cfpua.org, please call 910-332-6472 or 910-332-6651 before deadline for submission.

4.3 Failure to comply with the following criteria may be grounds for disqualifications:

a. Receipt of submittal by the specified cut-off date and time.
b. Adherence to maximum page requirements. Adherence to the maximum page criteria is critical; each page side (maximum 81/2" x 11") with criteria information will be counted. Pages that have photos, charts and graphs will be counted toward the maximum number of pages.

4.4 Information submitted shall be in compliance with N.C.G.S. 143-64.31 through 64.34 (aka Mini Brooks Act).

5- SELECTION PROCESS AND SCHEDULE

5.1 A Project Evaluation Team (PET) will evaluate each Statement of Qualifications (SOQ) according to the above criteria. No oral interviews are planned in the first step of the selection process. Following a review of the submittals, PET will select DB and post results. Those firms not selected for further consideration will be notified.

5.2 The following tentative schedule has been prepared for this project. Firms interested in this project must be available on the interview meeting date.

a. SOQ's due:	July 8, 2025
b. Firms notified of Short List:	July 15, 2025,
c. Interview date:	TBD if requested
d. Final Selection	July 22,2025

5.3 CFPUA will enter into negotiations with the selected Offeror using CFPUA's standard form Design-Build Contract (DBIA Standard Documents with appropriate modifications agreed upon both parties). If the Offeror is unwilling to execute CFPUA's standard form Design-Build Contract and/or the selected firm fails to execute CFPUA's standard form Agreement within two weeks of notification of the highest rated team, CFPUA may then negotiate with the second or third highest ranked firm until a contract is executed, or CFPUA, in its sole discretion, may decide to terminate the selection process. If CFPUA is unsuccessful in receiving an acceptable price proposal for Phase 1 services, CFPUA may decide to terminate the selection process.

6-REFERENCE DOCUMENTS

6.1 Analysis of bio growth

6.2 Site layout for well

6.3 Site map of wells

Date: November 8, 2022

Lab Report No. 22569

Allan Upham
Cape Fear Public Utility Authority
637 Ground Water Way
Wilmington, NC 28411

Project Description: RWTP – Pee Dee Aquifer; Sample dated: 10/05/2022
Deposit Analysis (1)

Test Description:

The deposit analysis is designed to assess the chemical, biological, and mechanical components of a given sample. Deposits are initially measured, photographed, and evaluated both macro and microscopically. Following initial evaluation, a pre-measured amount of sample is digested with acid and the solution is analyzed chemically for mineral analysis. A unique biological and gravimetric analysis is used to determine the organic portion and biological presence. Biological testing is performed in an effort to quantify the total bacterial population, assess anaerobic conditions, and identify the presence of iron related bacteria or sulfate reducing organisms. Following analysis, a dissolution test may be conducted to evaluate cleaning techniques.

Testing Procedures:

All laboratory testing procedures are performed according to the guidelines set forth in *Standard Methods for the Examination of Water and Wastewater* as established by the American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF). Corrosion analyses are performed in accordance with the guidelines as set forth by the National Association of Corrosion Engineers (NACE). In general, these methods are approved by both the Environmental Protection Agency (EPA) and AWWA for the reporting of water and/or wastewater data.

Sample collection and shipment is the responsibility of the customer, performed according to protocol and procedures defined by the laboratory in advance of the sampling event with regards to the specific project and nature of the problem.

Disclaimer:

The data and interpretations presented are based on an evaluation of the samples and submitted data. Conclusions reached in this report are based upon the data available at the time of submittal and the accuracy of the report depends upon the validity of information submitted. Any recommendations presented are based on laboratory and field evaluations of similar fouling occurrences within potable water systems. Further investigative efforts, such as efficiency testing, site inspection, video survey, or other evaluation methods may offer additional insight into the system's condition and the degree of fouling present.

Client: Cape Fear Public Utility Authority
Date: November 8, 2022
Lab Report No. 22569

Re: RWTP – Pee Dee Aquifer; Sample dated: 10/05/2022
Deposit Analysis (1)

Photographs of RWTP-Pee Dee Slime:

Figure 1: Slime sample, as received.

Figure 2: Macro of raw slime sample.

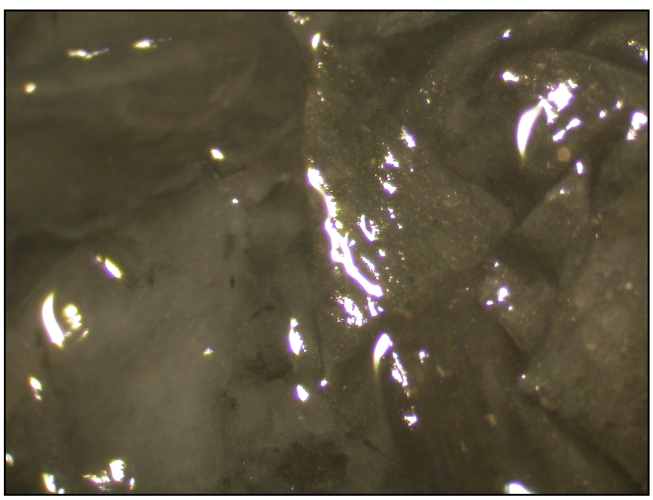


Figure 3: Slime sample, at 15x magnification.

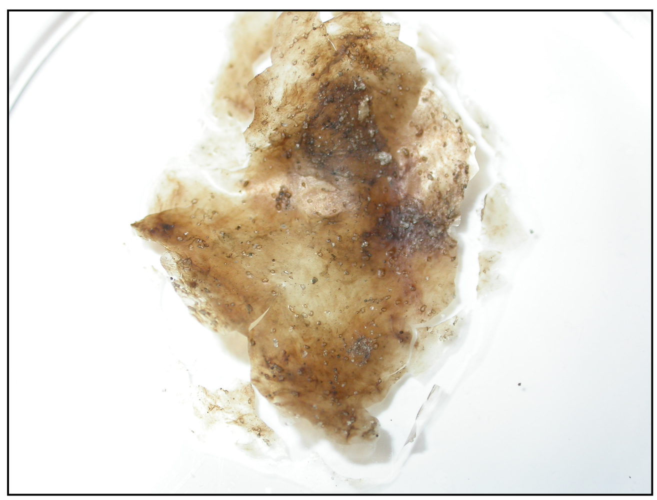


Figure 4: Macro of slime sample, after 24-hours of air-drying.

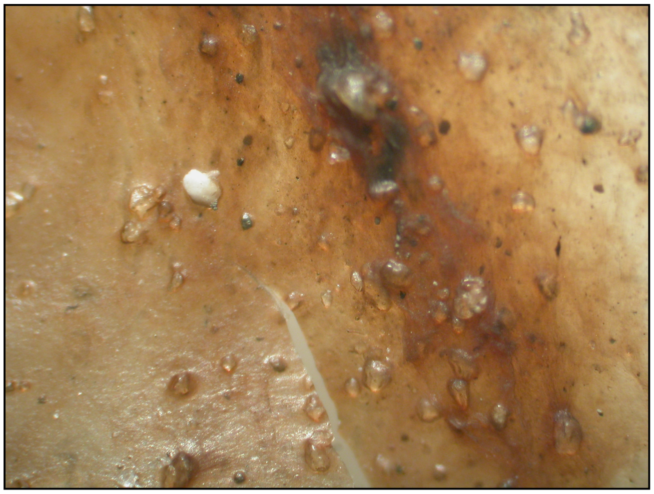


Figure 5: Air-dried slime sample, at 15x magnification.

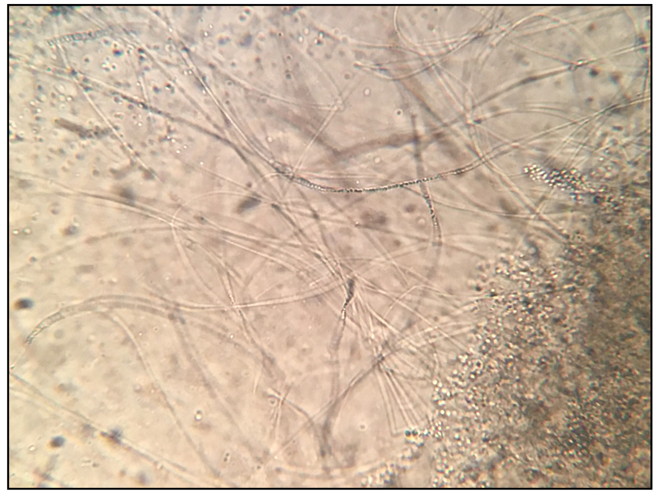


Figure 6: Wet mount of slime sample, at 200x magnification, with large numbers of *Crenothrix* visible.

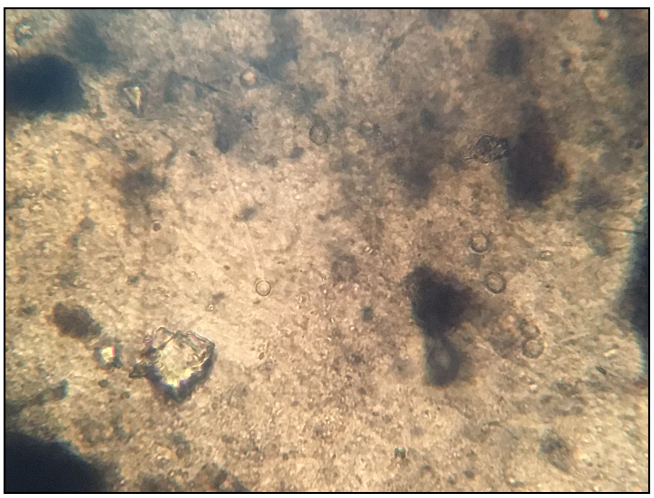


Figure 7: Heavy iron oxide entrained biomass with crystals and sporadic microbial cysts visible.

<u>Microscopic Evaluation:</u>

Slime Sample: Excessive visible bacterial activity, low crystalline debris, moderate number of protozoa, low amounts of iron oxide and excessive iron oxide entrained biomass with large numbers of *Crenothrix*.

Biological Analysis:

	RWTP-Pee Dee Slime	Detection Limits
Plate Count (CFU/ml)	231	NA
Sulfate Reducing Bacteria	Positive	NA
Anaerobic Growth (%)	50	NA
SRB Occurrence	*Excessive*	NA
Fe / Mn Oxidizing Bacteria	Positive	NA
ATP (cells per ml)	718,000	NA
Total Coliform (presence/absence)	Positive	NA
Bacterial Identification	*Enterobacter cloacae ss dissolvens*	NA
Bacterial Identification	*Enterobacter specie*	NA
Bacterial Identification	*Crenothrix*	NA

Chemical Analysis:

Component	Percent of Total Mass
Organic biomass, moisture	98.3 %
Insoluble material	1.3 %
Dissolvable mass	0.4 %
Total	100 %

Component	Percent by Weight of Dissolvable Mass
Calcium carbonate	33.5 %
Iron oxide	19.6 %
Silica	22.6 %
Phosphate compounds	18.6 %
Sulfide	1.4 %
Aluminum hydroxide	4.3 %
Total	100.0%

Observations:

A largely organic sample collected from a raw water source transmission line was submitted for evaluation. The sample was assessed as a deposit with the organic portion extracted and evaluated separately.

Dissolution and analysis of the deposit identified a primary composition of organic biomass. A minor concentration of dissolvable material was present comprised mainly of calcium carbonate, silica, iron oxide, and phosphate compounds. The insoluble portion appeared to consist of silica crystals and polymer remnants.

Heterotrophic plate growth of the aerobic population reported a low to moderate level of colony forming units. This data was inconsistent with the level of visible microbial activity noted during microscopic evaluation. Adenosine triphosphate (ATP) testing, a means of quantifying the total bacterial population which is not growth agar dependent yielded a very high level of bacteria present. As a point of reference, potable groundwater sources typically exhibit a background ATP range of 10,000 to 70,000 cells per milliliter (cpm). ATP levels greater than 100,000 cpm are of concern for biofouling potential. Although deposits of this nature will exhibit an increase in the typical population ranges due to the concentrating of cells, the observed level is considered excessive.

Anaerobic growth, reported as a percentage of the total population, were present at a high level of fifty percent. Anaerobic bacteria include many nuisance and pathogenic bacteria. Testing for the presence of sulfate reducing bacteria, a nuisance anaerobe associated with hydrogen sulfide (H2S) generation, were present in the sample with an excessive rate of occurrence noted.

Testing for the presence of iron bacteria was positive with a large occurrence of the iron and manganese bacteria Crenothrix noted.

Identification of the dominant microbial species within the sample included the iron and manganese bacteria *Crenothrix* as well as the coliform *Enterobacter cloacae ss dissolvens* as well as a general *Enterobacter species.* Background on the identified bacteria is presented below, in alphabetical order.

Crenothrix are a genus of sheathed bacteria that oxidize iron and manganese. *Crenothrix* cells are non-motile and can generally be found in a variety of aquatic environments with sufficient organic matter present. Oxidation, resulting from aeration including cascading water or rapid recharge, can stimulate the growth and activity of these bacteria. *Crenothrix* are commonly found associated with other iron and manganese oxidizing bacteria such as Gallionella and Leptothrix. As a result of the oxidation of both iron and manganese, *Crenothrix* sheaths are encrusted with iron and manganese oxides, resulting in a very effective fouling mechanism.

Enterobacter cloacae is a gram-negative, facultative-anaerobe, rod-shaped bacterium. *E. cloacae* are widely dispersed in the environment, found in water and soil, but also in sewage and dairy products. *E. cloacae* are considered nosocomial (opportunistic) pathogens, responsible for a number of infections such as bacteremia, lower respiratory tract infections, urinary tract infections, and septic arthritis when immuno-compromised patients have direct contact with the bacteria. The subspecies/substrain *dissolvens* is an aerobe, mesophilic human pathogen isolated from maize and similar agricultural foodstocks.

Enterobacter is a gram-negative, facultative-anaerobe, rod-shaped genus of bacteria. *Enterobacter* are widely dispersed in the environment, found in water and soil, but also in sewage and dairy products. They are considered nosocomial (opportunistic) pathogens, responsible for a number of infections such as bacteremia, lower respiratory tract infections, and urinary tract infections.

Microscopic evaluation noted a moderate occurrence of Protozoa within the sample. Protozoa are single-celled eukaryotic organisms present in water. Protozoa are most often associated with surface water bodies, indicating large, diverse, and mature microbiological communities. Protozoa occurrence is a concern as some are parasitic and some, like Giardia and Cryptosporidium, are pathogenic. The identification of Protozoa within a water sample is dependent on microscopic evaluation, with neither heterotrophic plate tests nor total coliform tests indicating their presence.

When subjected to drying and evaluation, the deposit exhibited a polymer like occurrence. Although this type of behavior is not uncommon in dense biomass, some polymer presence within the sample is suspected. While polymer breakthrough does occur in water treatment systems, it is typically observed post-settling basins at the treatment facility.

Interpretations:

In general, the sample was identified as a dense agglomeration of biomass and sediment, presenting a significant fouling potential for the transmission line. While it is not uncommon to identify Protozoa, coliforms, or even large accumulations of biomass in raw water lines (from a surface water unit), the sample exhibits a level of concentrating and anaerobic activity that suggests fouling within the line is occurring. If the raw water source is groundwater in origin, one or more of the supporting well systems may be experiencing heavy fouling or even a breach of the surface seal and subsequent surface influence.

Mechanical cleaning and heavy flushing of the transmission line is advised. Biomass accumulations can easily build-up, reducing flow and increasing the maturity among resident microbial populations leading to more advanced biofouling. In addition to increased impacts on flow, as the microbial community matures, water quality degrades requiring more advanced water treatment efforts to meet potable water treatment goals.

If you have any questions regarding the report or require additional information, please contact our office.

Michael Schnieders, PG, PH-GW
Hydrogeologist

Date: December 18, 2023

Lab Report No. 22865

Allan Upham
Cape Fear PUA
235 Government Center Drive
Wilmington, NC 28403

Project Description: Cape Fear Public Utility Authority; Wells G, H, I and J
Samples dated 09/13/2023; Deposit Analysis (4); PO# 240473

Test Description:

The deposit analysis is designed to assess the chemical, biological, and mechanical components of a given sample. Deposits are initially measured, photographed, and evaluated both macro and microscopically. Following initial evaluation, a pre-measured amount of sample is digested with acid and the solution is analyzed chemically for mineral analysis. A unique biological and gravimetric analysis is used to determine the organic portion and biological presence. Biological testing is performed in an effort to quantify the total bacterial population, assess anaerobic conditions, and identify the presence of iron related bacteria or sulfate reducing organisms. Following analysis, a dissolution test may be conducted to evaluate cleaning techniques.

Testing Procedures:

All laboratory testing procedures are performed according to the guidelines set forth in *Standard Methods for the Examination of Water and Wastewater* as established by the American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF). Corrosion analyses are performed in accordance with the guidelines as set forth by the National Association of Corrosion Engineers (NACE). In general, these methods are approved by both the Environmental Protection Agency (EPA) and AWWA for the reporting of water and/or wastewater data.

Sample collection and shipment is the responsibility of the customer, performed according to protocol and procedures defined by the laboratory in advance of the sampling event with regards to the specific project and nature of the problem.

Disclaimer:

The data and interpretations presented are based on an evaluation of the samples and submitted data. Conclusions reached in this report are based upon the data available at the time of submittal and the accuracy of the report depends upon the validity of information submitted. Any recommendations presented are based on laboratory and field evaluations of similar fouling occurrences within potable water systems. Further investigative efforts, such as efficiency testing, site inspection, video survey, or other evaluation methods may offer additional insight into the system's condition and the degree of fouling present.

Client: Cape Fear Public Utility Authority
Date: December 18, 2023
Lab Report No. 22865

Re: Cape Fear Public Utility Authority; Wells G, H, I and J
Samples dated 09/13/2023; Deposit Analysis (4); PO# 240473

Well G-PD – Deposit Material

Photographs of Sample:

Figure 1: Material as received

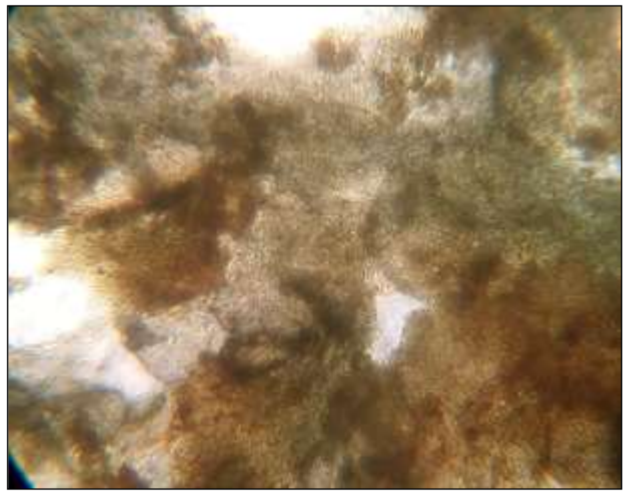


Figure 2: Material after sterile wash at 200x magnification

Microscopic Evaluation:

Excessive visible bacterial activity, very low crystalline debris, low numbers of protozoa, very low iron oxide and excessive iron oxide entrained biomass.

Biological Analysis:

	Well G-PD	Detection Limits
Plate Count (CFU/ml)	127	NA
Sulfate Reducing Bacteria	Negative	NA
Anaerobic Growth (%)	<10	NA
Fe / Mn Oxidizing Bacteria	Negative	NA
ATP (cells per ml)	717,000	NA
Bacterial Identification	*Ralstonia insidiosa*	NA
Bacterial Identification	*Bacillus cereus*	NA
Bacterial Identification	*Bacillus thuringiensis*	NA

Chemical Analysis:

Component	Percent of Total Mass
Organic biomass, moisture	98.4
Dissolvable mass	0.7
Insoluble material	0.9
Total	100 %

Component	Percent by Weight of Dissolvable Mass
Calcium carbonate	81.3
Iron oxide	13.7
Phosphate compounds	3.4
Copper	1.5
Aluminum Hydroxide	0.1
Total	100.0%

Well H-PD – Deposit Material

Photographs of Sample:

Figure 3: Material, as received.

Figure 4: *Thiothrix,* at 200x magnification.

Microscopic Evaluation:

Excessive visible bacterial activity, large amount of multicellular activity, low iron oxide and excessive biomass with moderate numbers of *Gallionella* and large numbers of *Thiothrix.*

Biological Analysis:

	Well H-PD	Detection Limits
Plate Count (CFU/ml)	>1,500	NA
Sulfate Reducing Bacteria	Negative	NA
Anaerobic Growth (%)	<10	NA
Fe / Mn Oxidizing Bacteria	Negative	NA
ATP (cells per ml)	629,000	NA
Bacterial Identification	*Ralstonia insidiosa*	NA
Bacterial Identification	*Bacillus specie*	NA

Chemical Analysis:

Component	Percent of Total Mass
Organic biomass, moisture	98.6
Dissolvable mass	0.5
Insoluble material	0.9
Total	100 %

Component	Percent by Weight of Dissolvable Mass
Calcium carbonate	*Interference*
Iron oxide	89.2
Silica	*Interference*
Phosphate compounds	5.6
Copper	5.2
Total	100.0%

Well I-PD – Deposit Material

Photographs of Sample:

Figure 5: Material, as received.

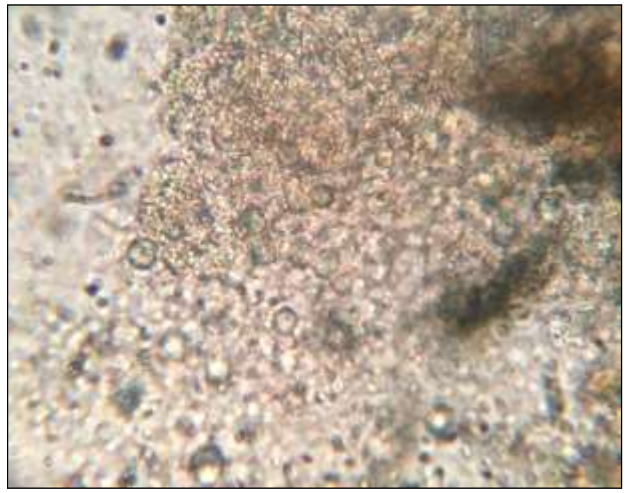


Figure 6: Microbial cysts, at 200x magnification.

Microscopic Evaluation:

Excessive visible bacterial activity, large numbers of protozoa, low iron oxide and excessive biomass with large numbers of *Thiothrix.*

Biological Analysis:

	Well I-PD	Detection Limits
Plate Count (CFU/ml)	>1,500	NA
Sulfate Reducing Bacteria	Negative	NA
Anaerobic Growth (%)	<10	NA
Fe / Mn Oxidizing Bacteria	Negative	NA
ATP (cells per ml)	225,000	NA
Bacterial Identification	*Thiothrix*	NA
Bacterial Identification	*Ralstonia insidiosa*	NA
Bacterial Identification	*Bacillus specie*	NA

Chemical Analysis:

Component	Percent of Total Mass
Organic biomass, moisture	96.5
Dissolvable mass	1.6
Insoluble material	1.9
Total	100.0%

Component	Percent by Weight of Dissolvable Mass
Calcium carbonate	*Interference*
Iron oxide	61.3
Silica	2.9
Phosphate compounds	8.1
Copper	27.5
Aluminum Hydroxide	0.2
Total	100.0%

Well J-PD – Deposit Material

<u>Photographs of Sample</u>:

Figure 7: Material, as received.

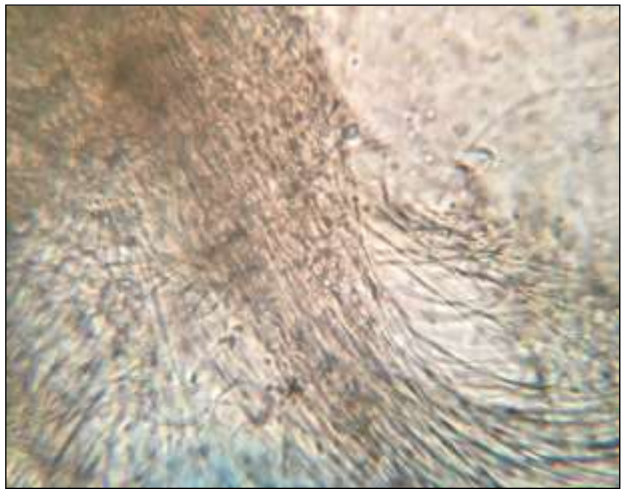


Figure 8: *Thiothrix,* at 200x magnification.

Microscopic Evaluation:

Excessive visible bacterial activity, moderate numbers of protozoa, low iron oxide and excessive iron oxide entrained biomass with excessive numbers of *Thiothrix.*

Biological Analysis:

	Well J-PD	Detection Limits
Plate Count (CFU/ml)	>1,500	NA
Sulfate Reducing Bacteria	Negative	NA
Anaerobic Growth (%)	<10	NA
Fe / Mn Oxidizing Bacteria	Negative	NA
ATP (cells per ml)	583,000	NA
Bacterial Identification	*Thiothrix*	NA
Bacterial Identification	*Ralstonia insidiosa*	NA
Bacterial Identification	*Acidovorax specie*	NA

Chemical Analysis:

Component	Percent of Total Mass
Organic biomass, moisture	97.9
Dissolvable mass	0.7
Insoluble material	1.4
Total	100.0%

Component	Percent by Weight of Dissolvable Mass
Calcium carbonate	56.6
Iron oxide	28.7
Silica	*Interference*
Phosphate compounds	13.1
Copper	1.5
Aluminum Hydroxide	0.1
Total	100.0%

Observations and Interpretations:

Four samples, each representing deposit material collected from production wells G, H, I and J, were submitted to the laboratory for evaluation. Upon arrival at the lab, the samples were physically inspected. Each sample was noted to be comprised of a dark, gelatinous mass, which was suspended in water (Figure 1, 3, 5 and 7). Initial observation of the samples concluded a significant biological influence. A strong, foul odor was associated with the samples.

Representative portions of each sample were subjected to a variety of tests, to include gravimetric analysis. In testing, it was determined that over 96-percent of the raw weight of each sample was attributed to organic biomass or retained moisture content. Exposure of the deposit samples to strong acid resulted in low to moderate dissolution ratios, ranging from 31.0 to 45.6-percent, by weight. This dissolution ratios were noted to remain fairly consistent between the samples, supporting the premise that the samples are of similar, general composition. Based upon the dissolution ratios, it was assessed that roughly 0.9 to 1.9-percent of the raw sample weight represented insoluble material. The remaining 0.5 to 1.6-percent weight within the samples was determined to be dissolvable mineral content, suggesting limited mineral influence within the samples.

Chemical analysis was conducted on acid wash solutions of each sample. During testing, there were instances of chemical interference impeding evaluation of calcium carbonate and silica concentrations within samples associated with Wells H, I and J and the results of these tests were excluded from reporting. It is probable that the occurrence of calcium carbonate and silica in those samples experiencing interference follow a similar trend as those which did not. For example, within Well G and J deposit samples, calcium carbonate compounds were found to be dominant, followed by iron oxides as secondary constituents. As a note, the concentrations of iron with Well I was nearly proportionate to samples from Well G and J. However, iron concentrations within Well H were found to be much higher when compared to the others samples, resulting in a significant mineral weight representation of 89.2-percent of the total mineral compounds evaluated. Each deposit sample was found to contain various concentrations of copper, which were measured in higher levels within the deposits collected from Well H and I. Phosphate compounds were also present in lesser concentrations.

Biological testing was conducted on portions of each sample and identified excessive levels of bacterial activity in all. Adenosine triphosphate (ATP) analysis, a test used to quantify the total population of bacteria within a volume of sample, indicated elevated levels of bacteria within all the samples, with concentrations exceeding 100,000 cells per milliliter (cpm). As a point of reference, potable water samples collected from healthy groundwater wells typically exhibit ATP ranges of 10,000 to 70,000 cpm, with values of 100,000 cpm or above indicating biofouling.

Heterotrophic plate counts (HPC), a method of estimating the number of aerobic and facultatively anaerobic heterotrophs within a volume of sample, returned excessive growth in samples obtained from Wells H, I and J. The plate counts in these samples exceeded 1,500 colony-forming units (CFUs) per milliliter, which surpassed the upper limit of the testing procedure. Curiously, plate growth within Well G was low with 127 CFUs. At times, the ATP concentrations and observable bacterial activity does not necessarily reflect the levels assessed during HPC testing. It is worth noting that only 1-percent of the total bacteria present can be successfully cultured in a laboratory setting.

Testing for anaerobic growth, expressed as a percentage of the total bacterial population, was limited in each sample at less than ten-percent. Surprisingly, given the odor and color exhibited by the samples, sulfate related bacteria (SRBs) were not-detected. SRBs are groups of nuisance anaerobic bacteria known for their influence in corrosion and the production of hydrogen sulfide (H_2S) as a metabolic byproduct.

Iron oxidizing bacteria, organisms associated with microbially induced corrosion (MIC), were also not-detected within the deposit samples.

Microscopic evaluations of portions of the samples confirmed the biological derivation of the deposits, where excessive levels of visible bacterial activity and biomass were observed. Low amounts of iron oxide mineral precipitants were also present with the biomass matrix of each. A very low level of crystalline debris was visible within the Well G sample. Most important to note, the biomass matrices observed within the samples of Wells H, I and J were entrained with large to excessive numbers of the sulfate oxidizing bacteria, *Thiothrix* (Figure 4 and 8). *Thiothrix* is an aerobic, sulfur-oxidizing Gammaproteobacterium. The bacteria are typically larger and filamentous, behaving similar to *Beggiatoa*. *Thiothrix* cells form filaments that cling to each other and secrete an encompassing sheath of mucous film, often resulting in bundles or masses of the bacteria which act as an effective fouling mechanism.

In addition to excessive levels of bacterial activity, the samples also demonstrated variable populations of more complex uni- and multicellular organisms, to include protozoa, amoeba and rotifers. The Well H sample demonstrated the highest degree of variability, the only one of the samples noted to contain each of the forementioned organisms and exhibiting heavy numbers of each. Heavy numbers of flagellated protozoa and microbial cysts were observed within Well I, while Wells G and J contained low to moderate occurrences of both. These organisms serve as indicator organisms in groundwater well testing, as the presence of these organisms can imply that structural issues are present within the well or unrestricted movement of surface water influence into the well column is occurring. A description of these organisms is provided below.

Protozoa are single-celled eukaryotic organisms present in water. Protozoa are most often associated with surface water bodies, indicating large, diverse, and mature microbiological communities. Protozoa occurrence is a concern as some are parasitic and some, like Giardia and Cryptosporidium, are pathogenic. The identification of Protozoa within a water sample is dependent on microscopic evaluation, with neither heterotrophic plate tests nor total coliform tests indicating their presence.

A flagellate (subphylum Mastigophora), is a cell or organism of the group of protozoans, that possess one or more whip-like organelles called flagellum. The flagellum is a hair-like structure that is primarily used for locomotion (movement) as well as sensation.

Microbial cysts are a resting or dormant stage of a microorganism, usually a bacterium or a protist, that helps the organism to survive in unfavorable environmental conditions. It can be thought of as a state of suspended animation in which the metabolic processes of the cell are slowed down and the cell ceases all activities like feeding and locomotion. Encystment also helps the microbe to disperse easily, from one host to another or to a more favorable environment. When the encysted microbe reaches an environment favorable to its growth and survival, the cyst wall breaks down by a process known as excystation.

Amoeba is a genus of Protozoa consisting of shapeless, unicellular organisms. Protozoa and Amoeba specifically, are most often associated with surface water bodies, indicating large, diverse, and mature microbiological communities. Protozoa occurrence is a concern as some are parasitic and some, like Giardia and Cryptosporidium, are pathogenic. The identification of Protozoa within a water sample is dependent on microscopic evaluation, with neither heterotrophic plate tests nor total coliform tests indicating their presence. Amoebas often live in biofilm and other water-soil, water-air, and water-plant interfaces. When confronted with harsh environmental conditions that threaten them, they convert to a form known as a cyst. Amoeba cysts are resistant to chlorination, adverse pH changes, osmotic pressure, and temperature.

Rotifers, also identified in the sample, are a group of larger multi-cellular microbes usually around 0.1–0.5 mm long (although their size can grow to over 2 mm). They get their name from a Latin word meaning "wheel-bearer” due to the corona around the mouth that move in concerted sequential motion resembles a wheel. They are common in freshwater environments throughout the world with some being free swimming and truly planktonic, others moving by inch worming along a substrate, and still other being sessile. Rotifers are an important part of the freshwater zooplankton, with many species contributing to the decomposition of soil organic matter and the digestion of particulate organic detritus, dead bacteria, algae, and protozoans.

If you have any questions regarding the analysis or require additional information, please contact our office.

David Dunn
Environmental Consultant

Michael Schnieders, PG, PH-GW
Hydrogeologist

Date: December 15, 2023

Lab Report No. 22927

Allan Upham
Cape Fear Public Utility Authority
235 Government Center Drive
Wilmington, NC 28403

Project Description: RWTP, PeeDee Wells; Samples dated 11/28/2023
Biogrowth Evaluation (14); PO#240473

Test Description:

The Monitoring Analysis is an abridged series of chemical and biological tests used to identify common fouling issues within potable well systems. The tests include a limited number of chemical parameters such as pH, total dissolved solids/conductivity, and the oxidation reduction potential (ORP). The sample is also evaluated for the presence of chlorine, iron, and manganese. Biological testing is performed in an effort to quantify the total bacterial population, assess anaerobic conditions, and identify the presence of iron related bacteria or sulfate reducing organisms.

Testing Procedures:

All laboratory testing procedures are performed according to the guidelines set forth in *Standard Methods for the Examination of Water and Wastewater* as established by the American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF). Corrosion analyses are performed in accordance with the guidelines as set forth by the National Association of Corrosion Engineers (NACE). In general, these methods are approved by both the Environmental Protection Agency (EPA) and AWWA for the reporting of water and/or wastewater data.

Sample collection and shipment is the responsibility of the customer, performed according to protocol and procedures defined by the laboratory in advance of the sampling event with regards to the specific project and nature of the problem.

Disclaimer:

The data and interpretations presented are based on an evaluation of the samples and submitted data. Conclusions reached in this report are based upon the data available at the time of submittal and the accuracy of the report depends upon the validity of information submitted. Any recommendations presented are based on laboratory and field evaluations of similar fouling occurrences within potable water systems. Further investigative efforts, such as efficiency testing, site inspection, video survey, or other evaluation methods may offer additional insight into the system’s condition and the degree of fouling present.

Client: Cape Fear Public Utility Authority
Date: December 15, 2023
Lab Report No. 22927

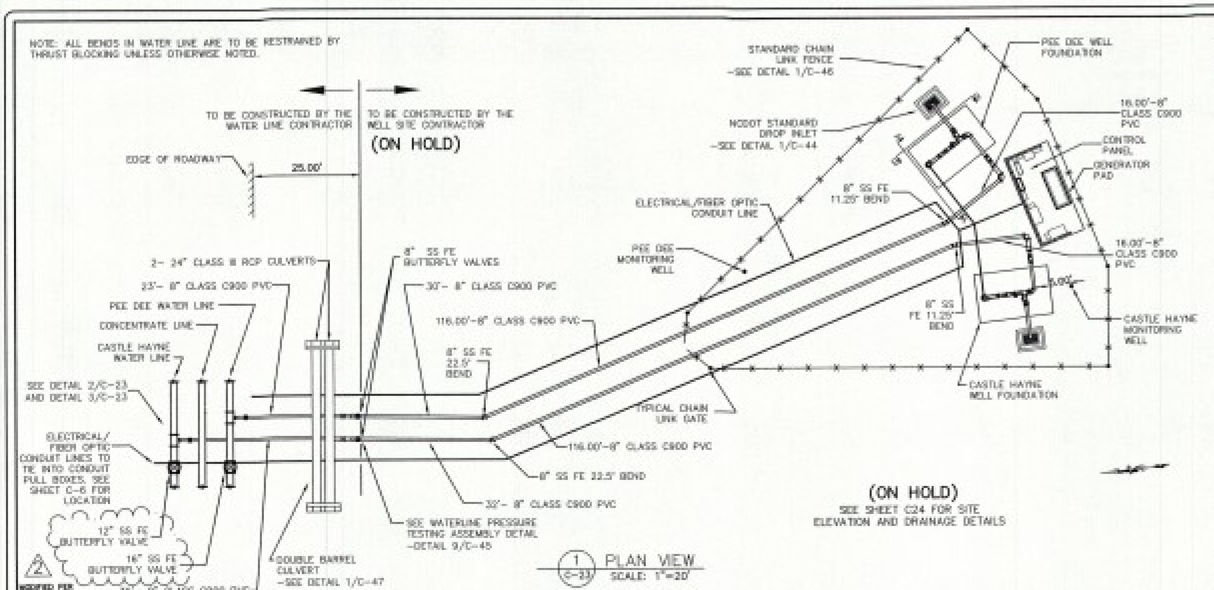
Re: RWTP, PeeDee Wells; Samples dated 11/28/2023
Biogrowth Evaluation (14); PO#240473

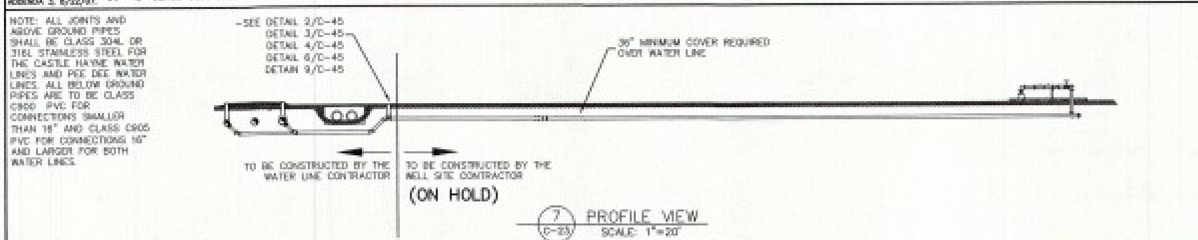
ND - Not Detected NA - Not Applicable	**A1 Initial**	**A2 3 hrs**	**C1 Initial**	**C2 3 hrs**	**Detection Limits**
ATP (cells per ml) Initial	35,000	38,000	43,000	70,000	NA
Anaerobic Growth (%)	10	<10	<10	<10	NA
Sulfate Reducing Bacteria	Negative	Negative	Negative	Negative	NA

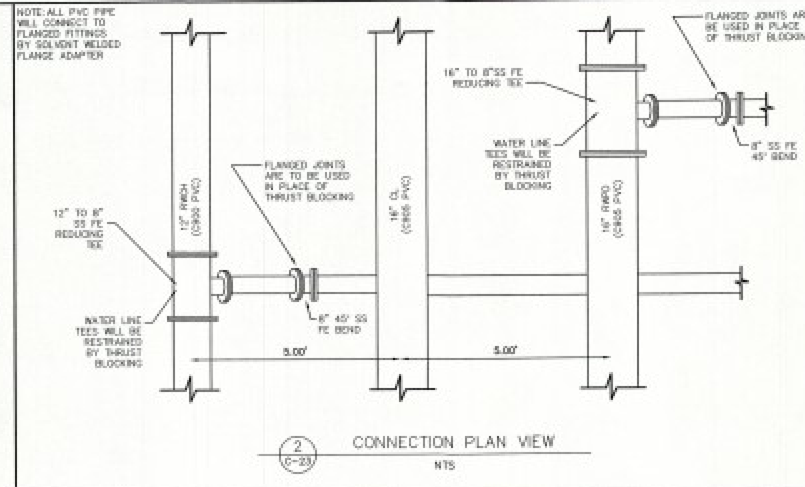
ND - Not Detected NA - Not Applicable	**F1 Initial**	**F2 3 hrs**	**H1 Initial**	**H2 3 hrs**	**Detection Limits**
ATP (cells per ml) Initial	79,000	37,000	33,000	40,000	NA
Anaerobic Growth (%)	<10	<10	50	20	NA
Sulfate Reducing Bacteria	Negative	Negative	Positive	Positive	NA
SRB Occurrence	-	-	Excessive	Low	NA

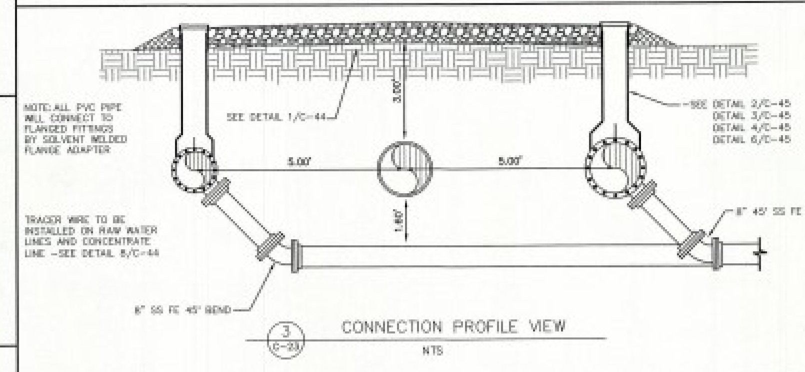
ND - Not Detected NA - Not Applicable	**K1 Initial**	**K2 3 hrs**	**L1 Initial**	**L2 3 hrs**	**Detection Limits**
ATP (cells per ml) Initial	79,000	34,000	46,000	37,000	NA
Anaerobic Growth (%)	<10	<10	<10	<10	NA
Sulfate Reducing Bacteria	Negative	Negative	Negative	Negative	NA

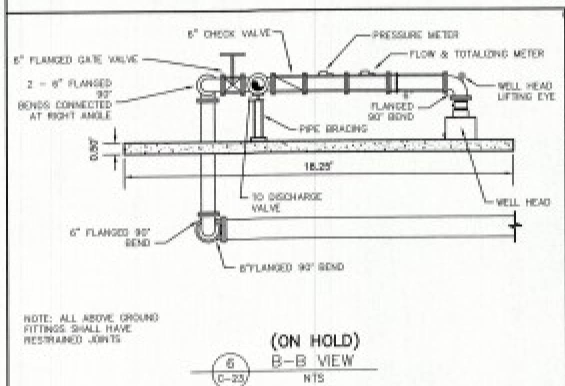
ND - Not Detected NA - Not Applicable	**Q1 Initial**	**Q2 3 hrs**	**Detection Limits**
ATP (cells per ml) Initial	30,000	31,000	NA
Anaerobic Growth (%)	<10	<10	NA
Sulfate Reducing Bacteria	Negative	Negative	NA

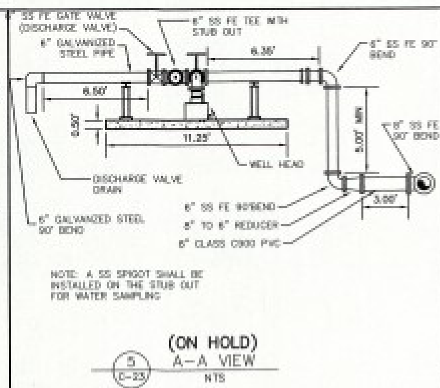












MODIFIED PER ADDENDA 3, 8/22/07.

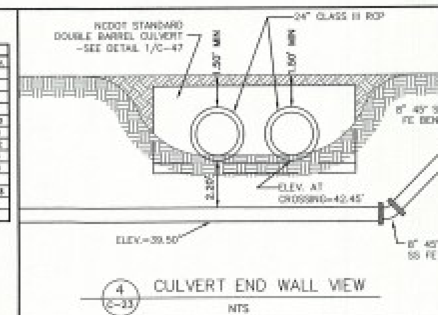
WATER LINES QUANTITY TAKE-OFF		
ITEM	UNIT	QTY.
16" C905 PVC PIPE	LF	40
12" C900 PVC PIPE	LF	20
8" C900 PVC PIPE	LF	78
16" TO 8" SS FE REDUCING TEE	EA	1
12" TO 8" SS FE REDUCING TEE	EA	1
16" SS FE BUTTERFLY VALVE	EA	1
12" SS FE BUTTERFLY VALVE	EA	1
8" SS FE BUTTERFLY VALVE	EA	2
8" SS 45° FLANGED BEND	EA	6
24" CONCRETE CULVERT W/ END WALLS	LS	1
ABC STONE FOR PIPE BEDDING	TON	25
ABC STONE FOR ROADS/DRIVEWAYS	TON	21
2" PVC CONDUIT (BANK)	LF	77

NOTE: QUANTITIES ARE FOR ESTIMATING PURPOSES ONLY AND MAY NOT REPRESENT ALL COMPONENTS NECESSARY FOR COMPLETE INSTALLATION AS SHOWN.

(ON HOLD)

WELL SITE "F" QUANTITY TAKE-OFF					
ITEM	UNIT	QTY.	ITEM	UNIT	QTY.
8" C900 PVC PIPE	LF	336	6" SS FE GATE VALVE	EA	4
6" 304L SS PIPE	LF	23	6" SS CHECK VALVE	EA	2
8" SS PIPE	LF	17	6" SS PRESSURE METER	EA	2
12" CLASS III RCP	LF	50	6" SS FLOW METER	EA	2
20" SS FE TEE	EA	2	CHAIN LINK FENCE	LF	290
6" SS FE TEE	EA	4	6' TALL CONCRETE MASONRY UNIT WALL	LF	30
6" SS 90° BEND	EA	2	ABC STONE FOR ROADS/DRIVEWAYS	TON	272
8" SS 22.5° FE BEND	EA	2	CLASS II RIP RAP	TON	15
8" SS 11.25° FE BEND	EA	2	ABC STONE FOR PIPE BEDDING	TON	25
8" SS 90° FE BEND	EA	6	PRECAST CONCRETE DROP INLET	EA	2
6" GS 90° BEND	EA	2	2" PVC CONDUIT (BANK)	LF	383
8" TO 6" SS REDUCER	EA	2	ELECTRICAL EQUIPMENT	LS	1
6" SS FE GATE VALVE	EA	2	CONCRETE PADS	LS	1

NOTE: QUANTITIES ARE FOR ESTIMATING PURPOSES ONLY AND MAY NOT REPRESENT ALL COMPONENTS NECESSARY FOR COMPLETE INSTALLATION AS SHOWN.



FINAL DRAWINGS-NOT RELEASED FOR CONSTRUCTIO

REV. NO.	DESCRIPTION	DATE
2	REVISIONS DUE TO ADDENDUM DEH PWS COMMENTS AND ADDENDA 3	8/22/07
1	REVISIONS DUE TO 7/25/07 NCDOT COMMENTS	7/13/07
	REVISIONS	

WK DICKSON
community infrastructure consultants
909 MARKET STREET WILMINGTON, NC 28401 (910) 762-4200
Office Locations: North Carolina, South Carolina, Georgia, Florida

RELEASED FOR / DATE: APPROVALS, BIDDING, CONSTRUCTION, RECORD DWG.

9/18/07

NEW HANOVER COUNTY
WATER AND SEWER DISTRICT
WELL FIELD & WATER TREATMENT FACILITY
NEW HANOVER COUNTY, NORTH CAROLINA

SITE "F" WELL PLANS

C2

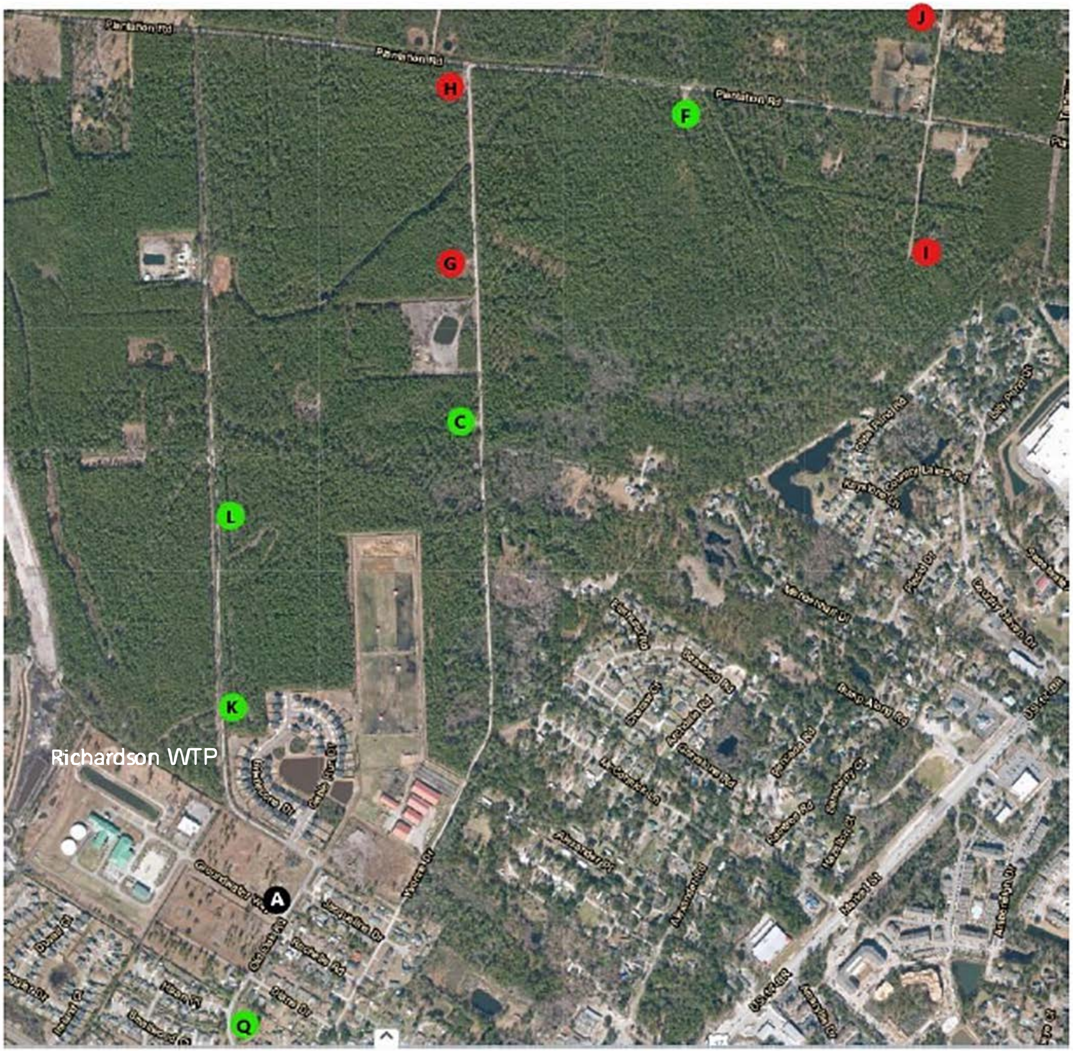


Fig. 1.1 Map showing the area of investigation. Green identifies sites where observations were made, but biological material was not found. Red identifies sites where biological material was found and samples were collected. Black identifies sites that were visited and no observations were made.