SANFORD LAW OFFICE, PLLC
Jo Anne Sanford, Attorney at Law

August 7, 2015

Ms. Gail L. Mount, Chief Clerk
North Carolina Utilities Commission
4325 Mail Service Center
Raleigh, North Carolina 27699-4325

Via Electronic Filing

Re: Docket No. W-354, Sub 344 - Carolina Water Service, Inc. of North Carolina
Report on Customer Service Quality Issues from Public Hearing in Currituck, North Carolina

Dear Ms. Mount:

Please accept for filing on behalf of Carolina Water Service, Inc. of North Carolina the attached Report on Customer Service Quality Issues from Public Hearing in Currituck, North Carolina.

As always, thank you and your staff for your assistance; please feel free to contact me if there are questions or suggestions.

Sincerely,

Electronically Submitted
***/s/*Jo Anne Sanford**
State Bar # 6831
Attorney for Carolina Water Service, Inc. of North Carolina

c: Parties of Record

STATE OF NORTH CAROLINA
UTILITIES COMMISSION
RALEIGH

DOCKET NO. W-354, SUB 344

In the Matter of Carolina Water Service, Inc. of North Carolina, 2335 Sanders Road, Northbrook, Illinois 60062, for Authority to Adjust and Increase Rates for Water and Sewer Utility Service in All of Its Service Areas in North Carolina	)	**REPORT ON CUSTOMER SERVICE QUALITY ISSUES FROM PUBLIC HEARING IN CURRITUCK, NORTH CAROLINA**

NOW COMES Carolina Water Service, Inc. of North Carolina ("CWSNC" or "Company") and files this report regarding any customer service quality issues raised at the Currituck, North Carolina public hearing.

Specifically, a public hearing was held beginning at 7:00 p.m., on June 24, 2015, in Currituck, North Carolina at the Currituck County Courthouse. Commissioner Don M. Bailey, who served as the Presiding Commissioner, was joined by Commissioner Jerry C. Dockham. Staff Attorney William E. Grantmyre appeared for the Public Staff on behalf of the using and consuming public, accompanied by Public Staff Water Engineer Gina Casselberry. Robert H. Bennink, Jr., of the Bennink Law Office, appeared on behalf of CWSNC, accompanied by Martin J. Lashua, the Company's Vice President of Operations. Britton H. Allen and Brady Allen, of the Allen Law Offices, PLLC, appeared on behalf of the Corolla Light Community Association, Inc. ("CLCA"). CLCA is an intervenor in this proceeding.

A total of ten witnesses testified at the Currituck public hearing. Five of those witnesses voiced service quality complaints.

Corolla Light and Monteray Shores Service Area

Six of the ten witnesses who testified at the Currituck public hearing are CWSNC sewer utility customers who reside in the Company's Monteray Shores/Corolla Light service area in Currituck County. Those six witnesses (Teresa Blaxton, Hugh McCain, Lynn Hoffman, Karen Galganski, Don Cheek, and Dave Phillips) testified primarily in opposition to the proposed rate increase. They generally voiced no service quality complaints. The one exception was witness Galganski, who testified regarding her perceptions of the Company's reputation for customer service.[1] Otherwise, the customers from the Company's Corolla Light/Monteray Shores service area primarily testified about their objections and opposition to the magnitude of CWSNC's proposed rate increase;[2] testified that they had observed only minimal, if any, investment by CWSNC to maintain or

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[1] Witness Galganski testified, in pertinent part, that CWSNC:

> "…has an unhealthy reputation for not answering their telephone, replying to telephone messages, or providing useful information when called upon to answer questions. I know this, as I served as President of Monteray Shores PUD for 8 years and have served as General Manager for the last 6 years. In both positions, I have fielded many phone calls from contractors and homeowners requesting an insight as to how to get Carolina Water to assist them in sewer taps or adding or repairing lines. I myself have had two occasions that applicant proved more than frustrating when called upon to deal with customer service issues."

[2] Witness Blaxton read into the record and introduced in evidence a Resolution adopted by the Board of Directors of the Corolla Light Community Association, Inc. on June 12, 2015, in opposition to CWSNC's proposed sewer rate increase. Witness Blaxton is a member of the CLCA Board. Witness McCain, who is the President of the Monteray Shores Homeowners Association ("MS HOA"), read into the record and introduced in evidence a letter submitted by the MS HOA in opposition to the proposed rate increase.

improve their sewer system; objected to paying for sewage treatment for water used for purposes such as washing cars, watering lawns, etc. which, when used, does not enter the sewer system; asserted that they had not been given timely notice of the hearing; and objected to the location of the public hearing. For instance, witness Blaxton testified that customers received the notice of hearing only about two weeks before the hearing was held on June 24, 2015, which made it impossible for many customers to attend the hearing. Witness McCain questioned why the hearing was scheduled on the mainland of Currituck County rather than on the Northern Outer Banks (in Corolla, for instance), which would have been much more convenient for affected customers.

CWSNC RESPONSE: Only one of the six customers from the Company's Corolla Light/Monteray Shores service area voiced any service quality complaints. Not surprisingly, customer testimony focused primarily on opposition to CWSNC's proposed rate increase, which is one of the primary issues to be decided by the Commission based upon careful consideration of all the evidence, including customer testimony, offered in this proceeding. As to allegations that customers failed to receive timely notice of the June 24th public hearing and their stated objections to the location of the hearing, CWSNC notes that the Company provided public notice in compliance with the directives of the Commission as to the date, time, and location.

In specific reference to the testimony offered by customer Galganski, the Company reviewed her customer service account and found no recent communications of record; the last notation of person-to-person contact by witness Galganski with CWSNC's Customer Service was in 2010. CWSNC's Regional Operations Manager, Danny Lassiter, recently left a voice message with customer Galganski to be sure that she has his personal contact information and to encourage her to contact him directly if there are any situations in the future that the Company needs to address in a timely fashion.

Nags Head Service Area

Three of the ten witnesses who testified at the Currituck public hearing are CWSNC sewer utility customers who reside in the Company's Nags Head service area in Dare County. The fourth Nags Head area witness who testified is not a CWSNC customer, but serves as the Town Manager for the Town of Nags Head. These four witnesses (Barbara Gernat, Meade Gwinn, John Ratzenberger, and Cliff Ogburn[3]) testified regarding customer service quality complaints experienced primarily during peak tourist season months related to (1) sewer system odor problems and (2) perceived wastewater treatment plant ("WWTP") capacity issues. They also testified in opposition to the proposed rate increase and expressed a concern or observation that the flat rate charged by CWSNC may be inequitable

[3] Witness Ogburn is the Town Manager for the Town of Nags Head. The Town has a fire station in the Village of Nags Head service area which is located immediately adjacent to the wastewater treatment plant site and also is a sewer customer of CWSNC.

because it applies to all customer residences in the service area no matter the size.

CWSNC RESPONSE: On April 21, 2015, CWSNC contracted with an engineering firm, Diehl & Phillips, P.A. of Cary North Carolina, to complete an investigation and evaluation of odor and odor sources at the Village of Nags Head wastewater collection and treatment systems ("Odor Investigation Report"). The consulting engineer was on site May 28, 29 and 30, 2015, and the consultant's Odor Investigation Report is dated June 25, 2015. A copy of the report has been forwarded to Public Staff Engineer Gina Casselberry. Subsequent to the NCUC public hearing, the Company also sent a letter to the Nags Head Town Manager, Cliff Ogburn, dated July 31, 2015 (copy attached hereto as Appendix A), addressing the capacity and odor issues raised by Mr. Ogburn during his testimony at the public hearing. A copy of the full Odor Investigation Report was provided to Mr. Ogburn. The narrative portion of the Report is attached hereto as Appendix B. The Report had a number of large figures that have not been included due to size considerations.

As a matter of follow-up to the public hearing, CWSNC has scheduled a tour of the Nags Head wastewater treatment facility for August 19, 2015. Customers Gernat and Gwinn, who testified at the public hearing, have been invited and will attend the tour, as well as representatives from the Town of Nag Head.

Public Staff Engineer Gina Casselberry toured the Village of Nags Head wastewater facility before the Currituck public hearing on June 24.

With regard to the odor complaints addressed at the public hearing, CWSNC notes that the Village of Nags Head wastewater treatment site is located in close proximity to homes and businesses in a very confined area on a barrier island. WWTP odors are challenging under the best of circumstances and can be difficult to address and resolve, but CWSNC will continue to explore any and all reasonable, prudent, and cost-effective options to minimize potentially objectionable odors. Odors can often be fleeting and brief and individually subjective. That is why CWSNC considers the use of analytical equipment to be extremely important in assessing the nature, severity and origin of odor complaints.[4] This is not said to in any way minimize or denigrate odor complaints, but merely to add context to the difficult situation CWSNC faces in identifying and confirming a source to take appropriate action.

As recommended by the Company's consulting engineer, CWSNC will proceed with a period of additional sampling to investigate and better understand odor issues using a stationary gas monitoring data logger. The Company will also implement the other recommendations made by the consulting engineer in an attempt to mitigate potentially objectionable odors. The Company has already relocated one chemical dispersion fan as recommended and purchased and installed a fourth fan unit. CWSNC is also adding a chemical product at all lift

[4] For instance, CWSNC's consulting engineer was on site May 28-30, 2015, but sampling did not confirm the severity of the odor issues about which customer Gernat testified during the investigation period.

stations to help with any problems of odors as they reach the facility. CWSNC is taking these actions in a good faith attempt to further investigate, address, and mitigate potentially objectionable WWTP odor issues.

In summary, CWSNC is fully committed to being responsible and attentive to odor complaints and other concerns expressed by its customers and the Town of Nags Head. The Company sincerely values these relationships and will continue to work closely with customers and the Town to resolve any such issues.

ADDITIONAL CWSNC RESPONSE: CWSNC appreciates and takes seriously this opportunity to respond to the complaints and concerns expressed by the Company's customers. While some customers from the Company's Corolla Light/Monteray Shores service area testified that they had not seen visible signs of any improvements or repairs being made to their sewer system, CWSNC notes that investments made by the Company in the various systems are not always obvious to customers, given the nature of some of the work. Additionally, should there be a need for major investment for upgrades or repairs—as there will inevitably be for every system—CWSNC has an obligation arising from its status as a regulated public utility to make necessary capital investments to ensure that consumers receive reliable and adequate utility service.

Furthermore, objections to the proposed rate increase request and rate design matters (flat rate versus metered rate, charging for sewage treatment of water which does not enter the sewer system, etc.) raised by some customers involve complex issues to be decided by the Commission based upon careful consideration of all the evidence, including customer testimony, offered in this proceeding.

Respectfully submitted, this the 7th day of August, 2015.

SANFORD LAW OFFICE, PLLC

Electronically Submitted
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ATTORNEYS FOR CAROLINA WATER SERVICE, INC. OF NORTH CAROLINA

APPENDIX A

Utilities, Inc.

July 31, 2015

Mr. Cliff Ogburn, Town Manager
Town of Nags Head
5401 S. Croatan Hwy.
Nags Head, North Carolina 27959

Re: Village of Nags Head Wastewater Treatment System

Dear Mr. Ogburn,

It was a pleasure to see you again on June 24, 2015, at the Currituck evening public hearing conducted by the North Carolina Utilities Commission ("NCUC") to consider the general rate case filed by Carolina Water Service, Inc. of North Carolina ("CWSNC").

Town of Nags Head Commissioner John Ratzenberger and you, in your capacity as Town Manager, both attended the NCUC public hearing and testified with regard to certain matters of concern to the Town. On behalf of CWSNC, I want to take this opportunity to address the concerns expressed on behalf of the Town.

First, let me clarify the issue of capacity of the Village of Nags Head wastewater treatment plant ("WWTP") or facility. The official State environmental permit for the facility establishes a capacity for the WWTP of an average of 400,000 gallons per day ("GPD"). I am attaching a flow tracking spreadsheet showing the average daily and peak daily flows from the facility for January 2013 through June 2015. At no time during that period did the average flow exceed the permit limit of 400,000 GPD. We are confident that the WWTP is capable of handling the current and any proposed connections in CWSNC's Village of Nags Head service area.

The permitted capacity of the Village of Nags Head wastewater treatment system was, prior to December 11, 2009, set at 500,000 GPD, and consisted of five (5) parallel treatment units of 100,000 gallons each. At that time, the WWTP had proprietary AeroMod brand treatment equipment installed that was not capable of providing reliable treatment at the flow rate the manufacturer originally specified. Thus, the State "de-rated" each of the five units from 100,000 GPD to 75,000 GPD. In one unit, we removed the AeroMod modules and installed another type of treatment equipment rated at 100,000 GPD, taking the capacity of the total plant to 400,000 GPD [(4 x 75,000) + (100,000)] as set forth in a permit issued December 11, 2009. After CWSNC completed substantial improvements at the plant, including investment of over $500,000, the wastewater treatment facility was successfully restored to full compliance and a moratorium on new connections was lifted by the State on October 1, 2010. I am pleased to report that the facility has been in substantial compliance since that time with only two exceptions because of flooding during Tropical Storm Beryl in late May 2012.

Since 2010, CWSNC has continued to invest heavily, both financially and through operational commitment at the facility, to ensure proper operation of the Village of Nags Head wastewater treatment system. The original design AeroMod modules design were inadequate and had reached the end of their usable life with heavy corrosion from the salt air environment, CWSNC has now replaced all of the original AeroMod units with new low maintenance, revised

P.O. Box 240908 • Charlotte, NC 28224 • P: 704-525-7990 • F: 704-525-8174
5701 Westpark Dr., Suite 101 • Charlotte, NC 28217 • www.uiwater.com

design units that are performing very well. As CWSNC continues to demonstrate a strong environmental and operational compliance history to the State environmental regulatory agency, the Company may, after further evaluation, request that the capacity rating of the wastewater treatment facility be restored to 500,000 GPD by the State.

In addition to the new AeroMod modules, CWSNC is adding new effluent filters to the facility that will provide a greater level of reliable and consistent polishing treatment at the facility before disposal.

CWSNC has made approximately $1,500,000 in major capital improvements to the Village of Nags Head WWTP since 2008, which are detailed in the following chart:

Project Description	**Cost**	**Status**
WWTP Modifications and Improvements	$591,154	Complete 2010
WWTP Aeromod Replacement of trains #3 and #4	$204,435	Complete 2014/2015
WWTP Aeromod Replacement of trains #1 and #2	$297,850	Complete 2015
Replace Standby Power Generator L.S. #7	$50,000	9/15/2015 est. complete
WWTP New Effluent Filter Installation	$300,000	9/15/2015 est. complete
Total	**$1,443,439**	

In regards to the odor complaints, as you of course can appreciate, this wastewater treatment site is located in close proximity to homes and businesses in a very confined area on a barrier island. WWTP odors are challenging under the best of circumstances and can be difficult to address and resolve, but CWSNC will continue to explore any and all options to minimize potentially objectionable odors.

CWSNC has retained an independent engineering consultant to conduct a third-party investigation and the consultant's final report is enclosed for your information and review. The report is very comprehensive, but CWSNC acknowledges that the sampling was only done for a 3-day period from May 28 through May 30, 2015. At the time of this investigation, the consulting engineer found no odors off-site and with lack of findings, his recommendations were limited. However, we will conduct additional monitoring.

As you may remember, one of CWSNC's customers testified at the NCUC public hearing regarding significant, objectionable odors which she said had been "very bad" and "nauseating" since May 22. CWSNC's consultant was on site May 28-30, but sampling did not confirm the customer's experience during the investigation period. Odors can often be fleeting and brief and individually subjective. That is why CWSNC considers the use of analytical equipment to be extremely important in assessing the nature, severity and origin of odor complaints. This is not said in any way to minimize or denigrate odor complaints, but merely to add context to the difficult situation identifying and confirming a source to take appropriate action.

As recommended by our consultant, CWSNC will proceed with a period of additional sampling to investigate and better understand odor issues using a stationary gas monitoring data logger. The Company will also implement the other recommendations made by the consulting engineer in an attempt to mitigate potentially objectionable odors. The Company has already relocated one chemical dispersion fan as recommended and purchased and installed a 4th fan unit. CWSNC is also adding a chemical product at all lift stations to help with any problems of odors as they reach the facility. CWSNC is taking these actions in a good faith attempt to further investigate, address, and mitigate potentially objectionable WWTP odor issues.

CWSNC is fully committed to being responsible and attentive to odor complaints and other concerns expressed by its customers and the Town of Nags Head and we hope that you find the information set forth in this letter and the attached engineering consultant's report to be responsive.

The Company sincerely values these relationships and will continue to work closely with customers and the Town to resolve any such issues.

If you have any questions or need any additional information, please give me a call. Thank you for your attention.

Sincerely,

Martin Lashua
Vice President of Operations

Cc: Danny Lassiter
Gina Casselberry, Engineer, North Carolina Public Staff

Village of Nags Head Permit WQ0000910 Expiration 7/31/2020 flow measured continuous Units = Million Gallons Per Day

Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	ANNUAL AVERAGE
0.081	0.062	0.073	0.083	0.120	0.207	0.264	0.254	0.152	0.105	0.087	0.081	0.131

Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	ANNUAL AVERAGE
0.073	0.067	0.077	0.104	0.141	0.190	0.247	0.231	0.153	0.093	0.080	0.083	0.128

Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	ANNUAL AVERAGE
0.080	0.098	0.081	0.090	0.162	0.298							0.135

APPENDIX B

APPENDIX B

EVALUATION OF ODORS AND ODOR SOURCES

IN THE

VILLAGE AT NAGS HEAD

WASTEWATER COLLECTION AND TREATMENT SYSTEMS

PREPARED FOR:

CAROLINA WATER SERVICE, INC. OF NORTH CAROLINA

Prepared By:

Diehl & Phillips, P.A.

1500 Piney Plains Road, Suite 200

Cary, NC 27518

Firm License No. C-0465

EVALUATION OF ODORS AND ODOR SOURCES IN THE VILLAGE AT NAGS HEAD WASTEWATER COLLECTION AND TREATMENT SYSTEMS

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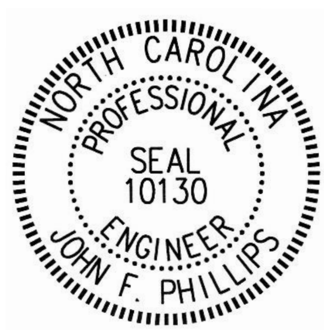
CERTIFICATION

I hereby certify that this report was prepared by me and by others under my direct supervision.

Signed, Sealed, and Dated this 25th day of June, 2015



John F. Phillips, P.E.
Diehl & Phillips, P.A.

EVALUATION OF ODORS AND ODOR SOURCES IN THE VILLAGE AT NAGS HEAD WASTEWATER COLLECTION AND TREATMENT SYSTEMS

I. INTRODUCTION

The Village at Nags Head wastewater system is owned and operated by Carolina Water Service, Inc. of North Carolina ("CWS"), and is operated under NC Division of Water Resources Permit No. WQ0000910 for treatment and Permit No. WQCS00285 for collections. The wastewater system serves approximately 604 residential customers, 35 non-residential customers that include the Nags Head Golf Links Clubhouse, the Village Beach Club, the Outer Banks Mall, the Outer Banks Hospital, and the Town of Nags Head Fire Station 16 and Planning Offices. The wastewater collection system consists of approximately 34,500 linear feet (LF) of 8-inch gravity sewer lines, eight wastewater pump stations, approximately 6,840 LF, 6,125 LF, and 1,350 LF of 6-inch, 4-inch, and 3-inch force mains respectively (force mains being the pipes that carry the pumped wastewater to a point where the wastewater is discharged into another pump station, a gravity sewer line, or the treatment plant). The wastewater from the collection system is discharged into the Village at Nags Head Wastewater Treatment Plant, where the wastewater is biologically treated, filtered, disinfected, and ultimately disposed of in either a 50,000 square foot high rate infiltration spray bed (rated for 10 gallons per day per square foot application rate), or in an 41,000 square foot infiltration pond (rated for 334,889 gallons per day) located on Hole No. 12 of the golf course. See Figure 1 for a map of the collection system and service area.

Diehl & Phillips, P.A. was retained by CWS to examine the Village at Nags Head wastewater system, to quantify any odors produced, and to document the location of the detected odors. We were also directed to make recommendations regarding possible methods to reduce or eliminate odors as might be detected by the system examination. Before the presentation of our findings from the examination, the process of odor formation in wastewater systems will be reviewed.

II. ODORS IN WASTEWATER SYSTEMS

Most odor producing compounds found in domestic wastewater and the solids removed from the wastewater result from anaerobic (without oxygen) biological activity that consumes organic matter, sulfur, and nitrogen normally found in domestic wastewater. Odor producing compounds include inorganic and organic molecules. The major inorganic molecules are hydrogen sulfide and ammonia. Organic matter that decomposes can form malodorous compounds such as mercaptans, amines, skatoles, and indoles.

Hydrogen sulfide is the most prevalent odor in domestic wastewater collection and treatment systems, and can have the characteristic "rotten egg" smell at certain concentrations. It is typically the odor that is first detected, as it can be detected at extremely low concentrations by the human sense of smell. Hydrogen sulfide is usually the gas that is examined in wastewater odor studies because it is the most common and predominant objectionable odor, and because it is one of the few specific gases for which portable instruments have been developed to measure its concentration in the atmosphere.

Hydrogen sulfide is produced in wastewater collection systems by sulfate reducing bacteria that live in the thin slime layer coating the pipe interiors and within solids deposits that may occur in the pipes. These naturally occurring bacteria live in an environment that is devoid of dissolved oxygen and nitrates (these bacteria live in the human mouth and intestinal tract as well, producing the hydrogen sulfide components of halitosis and flatulence). These bacteria are also naturally occurring in swamps, salt marshes, and tidal marshes, where the production of hydrogen sulfide gas in those environments has been documented.

These bacteria reduce sulfate, one of the most common anions in wastewater, to sulfide, effectively "removing" the oxygen portion of the sulfate anion. The resulting sulfide combines with hydrogen ions to form hydrogen sulfide. Depending on the pH of the wastewater, the hydrogen sulfide dissociates to dissolved hydrogen sulfide gas (H_2S), hydrosulfide ion (HS^-), and sulfide ion (S^{2-}). At neutral pH of 7, the distribution is approximately 50% dissolved hydrogen sulfide (H_2S) and 50% hydrosulfide ion (HS^-). At pH 6, the distribution is approximately 90% H_2S and 10% HS^-, while at pH 8, the distribution shifts to approximately 90% hydrosulfide ion.

The rate at which sulfide is produced by the sulfate reducing bacteria in the slime layer depends on the following environmental conditions:

- Sulfate concentration (typically not a limiting factor in domestic wastewater)
- Concentration of organic matter and nutrients in the wastewater
- The dissolved oxygen (DO) concentration in the wastewater
- The pH of the wastewater
- The temperature of the wastewater
- The velocity of the wastewater moving through the pipe
- The detention time of the wastewater in the collection system

These environmental factors combine to produce differing concentrations of dissolved hydrogen sulfide in the wastewater throughout the year. If the organic matter concentration is relatively high in the wastewater, the DO will be more rapidly depleted, promoting anaerobic conditions in the pipelines. The reduction of sulfates to sulfides is not an instantaneous occurrence, so the sooner anaerobic conditions are achieved, the more time that will be available for the bacteria to produce sulfides. The wastewater temperature is also a key component; the rate of sulfide production can double for every 10º C increase in temperature, due to the increased biological reaction rates at warmer temperatures. A sluggish velocity of the wastewater through the pipelines can lead to a thicker slime coating, which can increase the amount of sulfides produced. One of the key factors in sulfide generation has been demonstrated to be directly proportional to the detention time of the wastewater in the collection system.

In the specific cases of the Village at Nags Head (and other coastal resort communities), the effects of some of these factors are mitigated by others. The wastewater flows are typically lower in the winter months, leading to the longest detention times in the collection system. The potential for sulfide production due to the longer detention times is reduced because the lower wastewater temperature slows the biological reaction rates. The ability of oxygen to be dissolved in the wastewater also increases as the water temperature decreases, which would also slow the production of sulfides.

During the warmer months the wastewater temperature increases, causing an increase in the activity of the bacteria and decreasing the solubility of oxygen in the wastewater. Partially offsetting these potential increases in sulfide production is the increased flowrates experienced by the system, which reduces the travel time of the wastewater in the collection system. In the gravity sewer lines the increased flow rates also increase the liquid velocity in the pipes, which can shear and reduce the slime layer thickness.

Dissolved hydrogen sulfide gas is the only form of dissolved sulfide which can be released from the wastewater to the atmosphere, which can then lead to the "rotten egg" odors. The release of H_2S from the aqueous, or liquid phase, is typically accelerated by turbulent conditions in the wastewater collection system (wastewater exiting a pipe and "free falling" in a manhole or into a pump station wet well). In the specific case of the Village at Nags Head, the gravity wastewater collection system piping is generally installed on relatively flat slopes, with little or no "free fall" discharges into manholes. There are some "free fall" discharges of the gravity sewer lines into the eight remote wastewater pumping stations located throughout the system, but these do not appear to be sources of odors, as will be discussed in greater detail later.

The discharges from the eight remote pump stations come together at the head of the Village at Nags Head wastewater treatment plant, and discharge into a manually cleaned bar rack. Coarse solids (rags, poorly degraded wipes, etc.) are retained on the bar rack, and the wastewater free falls through the rack to the water surface of the flow equalization basin. This location is a potential release point of hydrogen sulfide gas for three reasons: (1) the discharged wastewater will have spent the maximum time possible in the collection system, thus maximizing the possible dissolved hydrogen sulfide production, (2) a portion of the dissolved hydrogen sulfide will readily come out of solution when it exits the confines of the force main and is exposed to air, due to the vapor-liquid equilibrium properties of hydrogen sulfide, and (3) the significant free fall distance into the flow equalization basin and the diffused aeration system in the equalization basin both promote the release of hydrogen sulfide gas. The hydrogen sulfide measurements made at the influent bar rack will be further discussed later in this report.

III. QUANTIFICATION OF LIQUID PHASE AND VAPOR PHASE HYDROGEN SULFIDE IN THE VILLAGE AT NAGS HEAD WASTEWATER SYSTEM

Before discussing the quantification of the various forms of hydrogen sulfide, the following question must be addressed: "What is an acceptable level of hydrogen sulfide gas from the Village at Nags Head wastewater system?" If the answer is when an objectionable "rotten egg" odor is detected and recognized outside of the treatment plant site, then how is that answer to be standardized, or translated into a measureable quantity?

The quantification of odors is difficult, for several reasons. The ability of humans to perceive odors varies widely among individuals. A thousand-fold difference in olfactory acuity has been observed between the least and most sensitive individuals. Nonsmoking adults show greater acuity than smokers, and females have been shown to have a keener sense of smell than males in studies. Age is also a variable, as olfactory sensory nerves atrophy with age. At age 20 there is an average 18% loss of the original acuity; at age 60 the loss is 62%; and at age 80 the loss is 72%.

The minimum concentration of hydrogen sulfide gas in the atmosphere that can be detected by humans is therefore a variable number. It is further complicated by the differences in detection and recognition thresholds. A very low concentration of an odorous substance can produce an odor sensation indicating to a person the presence of odor vapors. At this level, the brain may not recognize the odor, but it does detect the odor's presence, and is therefore termed the "detection threshold". At higher concentrations the odor becomes recognizable, and that concentration is termed the "recognition threshold". The difference between detection and recognition threshold concentrations can vary by factors between 2 and 10, depending on the specific odor.

In order to have some standardization in the measurement of odors, the American Society for Testing and Materials (ASTM) and various European counterparts developed devices and methods to uniformly expose a panel of human "assessors" to gas samples of varying concentrations. The consensus of these controlled tests have established threshold and recognition concentrations for various odorous substances, including hydrogen sulfide. While there is still some variation in the published literature, the hydrogen sulfide gas threshold concentrations that are generally accepted are:

> Detection Threshold (the concentration at which 50 percent of a human panel can identify the presence of an odor, but cannot characterize the stimulus):
>
> 0.00047 parts per million (by volume)

Recognition Threshold (the concentration at which 50 percent of a human panel can identify the odor):

0.0047 parts per million (by volume)

These values are found in numerous odor-related technical documents and literature, although it appears these references all originate from a 1969 study "Odor Threshold Determinations of 53 Odorant Chemicals" (Leonardos, Kendall, and Barnard).

In 2001 the Secretary's (Secretary of the NC Division of Environment and Natural Resources) Scientific Advisory Board on Toxic Air Pollutants prepared a toxicity assessment of hydrogen sulfide in response to a request by DENR. In that document they cited a scientific study prepared for the California Air Resources Board and the California Office of Environmental Health Hazard Assessment as estimating that 50 percent of humans could detect the odor of hydrogen sulfide at 0.008 parts per million, while over 90% could detect the odor at 0.05 parts per million. They also estimated that exposures to concentrations as low as 0.0005 parts per million might be detectable by a limited number of people.

The Public Health Statement published by the US Department of Health and Human Services in October 2014 states that "People can usually smell hydrogen sulfide at low concentrations in air, ranging from 0.0005 to 0.3 parts per million".

While there is no single "right" answer, the consensus of multiple technical studies and articles indicate a hydrogen sulfide gas concentration of approximately 0.005 parts per million (by volume) will be recognized by approximately half of the population. 0.005 parts per million (equivalent to 5 parts per billion) in the atmosphere may be difficult to visualize; 5 parts per billion on a linear scale is equivalent to one inch in 3,156 miles.

Based on the consensus of the technical literature, the goal for the operations of the Wastewater System for the Village at Nags Head should be to not exceed 0.005 parts per million of hydrogen sulfide in the atmosphere of the collection system service area and the areas outside of the treatment plant and high rate infiltration sites.

IV. DATA COLLECTION AT VILLAGE AT NAGS HEAD

The hydrogen sulfide gas concentration in air was measured using a Jerome 631X Hydrogen Sulfide analyzer that had its calibration verified prior to its use at the Village at Nags Head. Ambient air was sampled at each of the eight remote wastewater pump station sites in the collection system, and at approximately 22 other data collection points located outside of the wastewater treatment plant site fence, but within a range of 20 feet to 2,300 linear feet of the treatment plant site fence. Additionally, there were approximately 40 data collection points distributed around and on the wastewater treatment plant and around the high rate infiltration spray bed. The data collection was performed on Thursday, Friday, and Saturday, May 28 to 30, 2015.

The concentration of hydrogen sulfide gas measured at each sample location, along with the time of day, date, wind direction, and wind speed for each data point, is presented in Figures 3 through 7. Figure 2 is a key map that identifies the location in the wastewater system of each of the subsequent Figures.

The hydrogen sulfide gas measurements in the collection system area (outside of the wastewater treatment plant and high rate infiltration site) can be summarized as follows:

> Thursday, May 28 – Thirty-eight (38) measurements ranging from 0.000 to 0.003 parts per million
>
> Friday, May 29 – Thirty (30) measurements ranging from 0.000 to 0.003 parts per million

These values were all below the goal value of 0.005 parts per million; no odors were detected by the personnel making the measurements at each site.

The hydrogen sulfide gas measurements within the treatment plant site fencing can be summarized as follows:

> Thursday, May 28 – Sixteen measurements ranging from 0.000 to 0.004 parts per million, and then multiple measurements at the influent bar rack where the force mains from the various pump stations collectively discharge. The measurements from the influent bar rack area are discussed further below.
>
> Friday, May 29 - Eight measurements ranging from 0.000 to 0.004 parts per million, and then multiple measurements at the influent bar rack area. The measurements from the influent bar rack area are discussed further below.
>
> In addition to the eight measurements taken around the perimeter of the treatment plant on May 29 and summarized above, approximately 29 measurements were made from the walkways on the treatment plant, and along the exterior walls of the plant. Measurements were also made adjacent to the Salsnes primary filter, at the dumpster receiving the bagged, dewatered solids from the Salsnes filter, and at the flow splitter box receiving the filtered effluent from the Salsnes filter. The measured concentrations ranged from 0.001 to 0.005 parts per million (ppm), except for a value of 0.007 ppm measured within the dumpster and a value 0.010 ppm at the northwest corner wall of the treatment plant (there was a force main discharging into the nearby influent bar rack when the 0.010 ppm concentration was measured at the northwest corner of the treatment plant).

Saturday, May 30 – Eighteen measurements ranging from 0.000 to 0.004 parts per million, one measurement of 0.013 parts per million at the northwest corner of the treatment plant (near the influent bar rack), and then multiple measurements at the influent bar rack. Multiple measurements were taken this day at the four corners of the perimeter of the high rate infiltration spray field, during an effluent dosing event. The measured concentration of hydrogen sulfide gas at these points during the dosing event ranged from 0.000 to 0.003 parts per million.

Photo 1 - High Rate Infiltration Spray Beds

The dissolved sulfide concentration in the wastewater (liquid, or aqueous phase) was measured using a Hach Model HS-WR Hydrogen Sulfide Test kit. This test procedure determines the total sulfides in the wastewater (H_2S, HS-, and certain metal sulfides that might be present). As stated previously, the dissolved hydrogen sulfide gas (H_2S) is the only form of dissolved sulfide which can be released from the wastewater into the atmosphere. Whether the dissolved hydrogen sulfide concentration constitutes the majority or the minority of the measured total sulfides is mainly a function of the pH of the wastewater. The influent wastewater pH was generally in the range of 7.0 to 7.2 during the sampling period, indicating approximately half of the measured sulfides would be in the form of dissolved hydrogen sulfide gas and half in the form of hydrosulfide ions (HS^-). In this report the measured liquid phase sulfide concentrations are reported as dissolved hydrogen sulfide, even though some of the measured sulfides are in the hydrosulfide ion form. This is in keeping with Hach's instructions for reporting the test results from their testing equipment, and also to conservatively represent the potential maximum dissolved hydrogen sulfide gas concentration should there be a drop in the wastewater pH.

Although there are eight remote pump stations in the collection system, there are only four force mains that extend to the treatment plant site, and only three force mains that actually discharge into the bar rack and flow equalization basin. The routing of the force main for each pump station is described below – refer to Figure 1 for the collection system mapping.

- Pump Station No. 8 discharges into Pump Station No. 7
- Pump Station No. 7 discharges into a manhole near the intersection of West Seachase Drive and the service driveway to the treatment plant and golf maintenance shop.
- Pump Station No. 2 discharges into a gravity sewer line that flows into the manhole described above (at West Seachase and service driveway).
- The wastewater from the three pump stations above, plus gravity flow from a portion of Links Drive, the hospital, the Outer Banks Mall, and other commercial establishments flows by gravity to Pump Station No. 1.
- Pump Station No. 1 pumps the flow through a 6" force main to the influent bar rack at the flow equalization basin of the treatment plant.
- Pump Station No. 5 pumps into a common 6" force main that is shared with Pump Station No. 6. This force main extends to the influent bar rack at the flow equalization basin of the treatment plant.
- Pump Station No. 4 pumps into a 4" force main that extends to a point approximately five feet from the influent bar rack, where it is joined with the 4" force main from Pump Station No. 3. The combined 4" force main extends to the influent bar rack at the flow equalization basin of the treatment plant.
- Pump Station No. 3 pumps into a 4" force main that connects with the force main from Pump Station No. 4, as described above.

The dissolved sulfide concentrations in the wastewater in the wet wells of the remote pump stations were measured on Thursday, May 28 and Friday, May 29, 2015. The measured concentrations ranged from 0.00 milligrams per liter (mg/l) to 0.10 mg/l. The results of these tests are presented in Table 1 that follows:

TABLE 1 – DISSOLVED HYDROGEN SULFIDE GAS IN REMOTE PUMP STATION WET WELLS			
Pump Station No.	Date	Time	Mg/l of H_2S In Wastewater
1	5/28/15	13:15	0.10
2	5/28/15	17:15	0.00
3	5/28/15	16:45	0.02
4	5/28/15	16:10	0.00
5	5/28/15	15:50	0.00
6	5/28/15	15:25	0.00
7	5/28/15	15:00	0.04
8	5/28/15	13:58	0.00
1	5/29/15	09:40	0.10
2	5/29/15	12:19	0.00
3	5/29/15	11:56	0.00
4	5/29/15	11:35	0.00
5	5/29/15	11:10	0.00
6	5/29/15	10.45	0.02
7	5/29/15	10:28	0.10
8	5/29/15	09:59	0.00

V. MEASURED CONCENTRATIONS OF DISSOLVED AND GASEOUS HYDROGEN SULFIDE AT THE INFLUENT BAR RACK

The dissolved hydrogen sulfide test is used, in this case, to measure the concentration of dissolved hydrogen sulfide in the wastewater discharged from each force main into the flow equalization basin. This information can then be used to determine the relative contribution of each force main to the total hydrogen sulfide discharge into the plant, and can also be used to make a first approximation of the required chemical quantities if odor control chemical feed systems are added in the future. There is not a constant correlation of the measured dissolved hydrogen sulfide concentration in the wastewater to the amount of hydrogen sulfide gas that could potentially be released into the atmosphere, due to the H_2S and HS^- portions varying with the wastewater pH, and the liquid-vapor equilibrium varying with temperature (Henry's Law constant for H_2S changes as the temperature changes).

Repeated dissolved and gaseous hydrogen sulfide measurements were made at the discharge of the force mains into the influent bar rack. Each measurement of the vapor phase hydrogen sulfide concentration taken by the Jerome 631X meter required 15 to 30 seconds. When a force main was discharging, multiple measurements were made of the air directly above the discharging main. Table 2 below presents the average of those measurements, the number of measurements, and the highest measurement in each series.

TABLE 2 – LIQUID AND VAPOR PHASE HYDROGEN SULFIDE MEASUREMENTS MADE AT THE DISCHARGE OF THE FORCE MAINS				
Source - Force Main Discharge from Pump Station(s):	Date	Time	Mg/l of H_2S In Wastewater	Parts per Million H_2S in Air One Foot above Force Main Discharge
3 and 4	5/28/15	18:15	2.40	0.99 PPM (Highest) 0.42 PPM (Ave. of 8)
5 and 6	5/28/15	18:30	2.65	0.99 PPM (Highest) 0.56 PPM (Ave. of 5)
1	5/28/15	18:40	No Measurement	0.80 PPM (Highest) 0.34 PPM (Ave. of 6)
5 and 6	5/29/15	08:15	3.2	1.0 PPM (Highest) 0.43 PPM (Ave. of 4)
5 and 6	5/29/15	08:48	No Measurement	0.32 PPM (Highest) 0.18 PPM (Ave. of 5)
1	5/29/15	08:50	0.6	0.065 PPM (Highest) One measurement
1	5/29/15	09:03	No Measurement	0.050 PPM (Highest) 0.029 PPM (Ave. of 6)
3 and 4	5/29/15	09:10	1.9	0.36 PPM (Highest) 0.28 PPM (Ave. of 6)
3 and 4	5/29/15	14:05	1.7	0.103 PPM (Highest) One Measurement
5 and 6	5/29/15	14:25	2.1	0.12 PPM (Highest) 0.06 PPM (Ave. of 7)
1	5/29/15	14:45	0.36	0.23 PPM (Highest) 0.09 PPM (Ave. of 5)
1	5/29/15	15:14	0.34	0.135 PPM (Highest) 0.05 PPM (Ave. of 6)
5 and 6	5/29/15	15:32	1.8	No Measurement
3 and 4	5/29/15	16:40	1.9	0.133 PPM (Highest) 0.08 PPM (Ave. of 3)
1	5/30/15	08:05	0.4	0.21 PPM (Highest) 0.11 PPM (Ave. of 7)
3 and 4	5/30/15	08:20	1.6	1.20 PPM (Highest) 0.87 PPM (Ave. of 3)
5 and 6	5/30/15	08:33	2.1	1.50 PPM (Highest) 1.03 PPM (Ave. of 5)
5 and 6	5/30/15	08:40	2.1	No Measurement
3 and 4	5/30/15	09:01	1.7	No Measurement
1	5/30/15	09:16	0.24	No Measurement

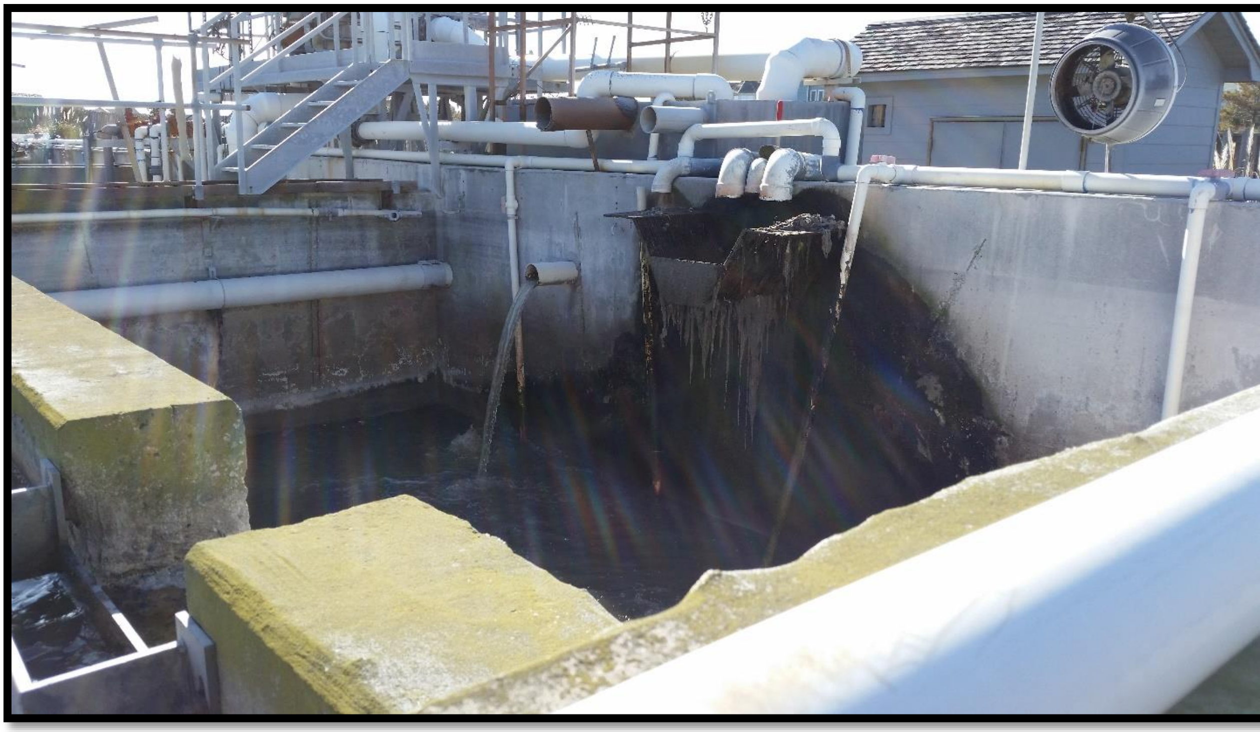


Photo 2 - Manually Cleaned Bar Rack with the Three Force Main Discharges Above and the Flow Equalization Basin Below

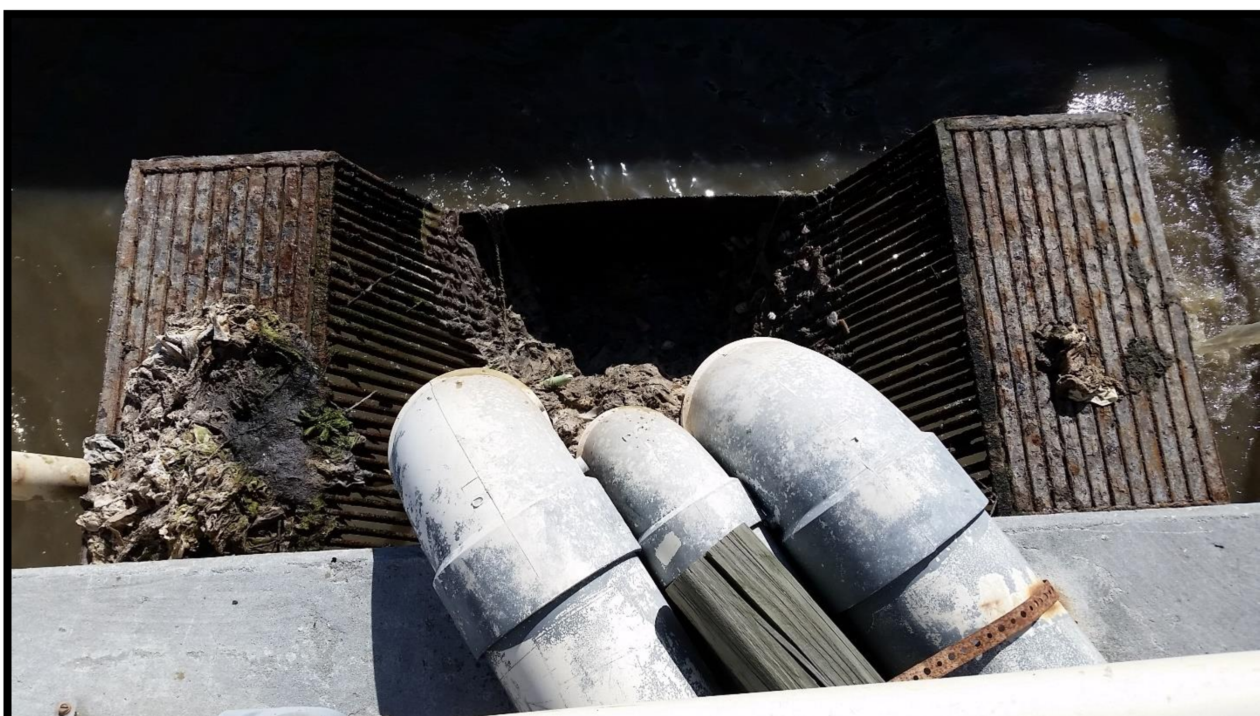


Photo 3 - Discharge Point of Three Force Mains onto Manually Cleaned Bar Rack

VI. INTERPRETATION OF THE COLLECTED DATA

Collection System

There is no standard or single value of dissolved hydrogen sulfide concentration that serves as an indicator that the wastewater will or will not produce detectable odors. There are numerous variables, with wastewater turbulence probably being the most significant, that will affect the amount of dissolved hydrogen sulfide gas that is released into the atmosphere. A wastewater with a dissolved hydrogen sulfide concentration of 0.30 mg/l that has a free fall discharge into a manhole will produce more hydrogen sulfide gas in that manhole than a wastewater with a 3.0 mg/l dissolved hydrogen sulfide concentration that flows quiescently through the manhole with no drop or free fall. Some of the technical literature regarding hydrogen sulfide in wastewater cites a dissolved hydrogen sulfide concentration greater than 1.0 to 1.5 mg/l as having a high probability of creating detectable odors in wastewater systems. There are also other technical sources that cite a more conservative value of 0.50 mg/l of dissolved hydrogen sulfide as a very general indicator that the wastewater is likely to produce detectable odors if it undergoes some turbulence and has an outlet to the atmosphere. Detectable odors were produced at the influent bar rack during every force main discharge, although the odors were relatively mild and weak when the dissolved hydrogen sulfide concentration was in the 0.25 to 0.40 range.

Based on the May 28 and 29 measured concentrations of aqueous and gaseous hydrogen sulfide at the remote pump stations, and at other locations within the collection system service area, there were no detectable levels of hydrogen sulfide in the atmosphere and apparently a very limited potential for the wastewater in the collection system to produce a detectable level of gaseous hydrogen sulfide in the service area. The concentrations of dissolved hydrogen sulfide in the wastewater in the eight remote pump station wet wells were measured in daily grab samples over a two day period, with the measured range being 0.00 to 0.10 mg/l. Thirteen of the 16 measurements were 0.04 mg/l or less. All vapor phase measurements of hydrogen sulfide were at or below 0.003 parts per million (by volume), which is below the generally accepted recognition threshold of 0.005 parts per million. No hydrogen sulfide or other objectionable odors were detected by the personnel making the measurements throughout the collection system.

Treatment Plant and High Rate Infiltration Sites

Measurements of hydrogen sulfide concentrations in the atmosphere within the treatment plant and high rate infiltration sites were all within the range of 0.000 to 0.005 parts per million (below the generally accepted recognition threshold), except for measurements made within the primary screenings dumpster (0.007 ppm), at the northwest corner wall of the plant (0.010 ppm), and the measurements made at the influent bar rack. The influent bar rack area, where the influent force mains discharge into the flow equalization basin, was the only odor source identified during the May 28-30 sampling period. While hydrogen sulfide gas concentrations ranged up to 1.50 parts per million by volume at the discharge location, the concentrations measured at the treatment plant fence location that was downwind of the discharge location were in the range of 0.001 to 0.005 parts per million (during and after a discharge of the force main serving Pump Stations 5 and 6).

The dissolved hydrogen sulfide created in the force main from Pump Station No. 1 predictably had the lowest measured concentrations (0.24 to 0.60 mg/l), as it is the shortest force main (approximately 250 linear feet) and has the least detention time of the influent force mains. The other influent force main lengths range from 2,000 LF to 4,800 LF, approximately. The measured dissolved hydrogen sulfide concentrations varied, but the force mains serving Pump Stations 5 and 6 typically had the greatest concentrations.

The dissolved hydrogen sulfide concentrations in the discharged wastewater at the bar rack did not produce as much hydrogen sulfide gas in that location as might have been anticipated. Possible explanations for this observance are (1) the bar rack is in an open space exposed, so any released hydrogen sulfide gas is immediately being diluted by the atmosphere and dispersed by any winds, and (2) the turbulence and aeration of the influent wastewater occurs at the water surface in the flow equalization basin, with the majority of the gas possibly being released at that location (which was approximately 6 to 8 feet below the gas measurement point). The hydrogen sulfide gas stripped out by the aeration system in the flow equalization basin would have then been distributed across the surface area of the wastewater in the equalization basin, and would have been diffused and diluted in the atmosphere by the air movement from the aeration system and any wind currents. While there may be other possible explanations, testing confirmed the dissolved hydrogen sulfide in the wastewater exiting the force mains varied as shown in Table 2, but the concentrations measured in the wastewater in the flow equalization tank were 0.10 mg/l or less. Gas measurements above and around the flow equalization basin were all 0.004 ppm or less, except in the immediate vicinity of the force main discharges and influent bar rack. The higher gas concentrations at the influent bar rack were found to have been dissipated and diluted to concentrations below the recognition threshold at the treatment plant perimeter fence.

The conclusion that could be drawn from the data collected May 28-30, 2015 at the Village at Nags Head wastewater collection and treatment systems is that there are no detectable hydrogen sulfide odors outside of the treatment plant site. It is our opinion that this conclusion would probably be flawed, as there are so many variables involved in wastewater odor production and distribution that it is likely that some detectable odors may escape the plant site under certain conditions. It may be that during certain times in the spring or fall the population served and resulting wastewater flows will be relatively small, leading to long detention times in the wastewater collection system and force mains. These conditions, coupled with moderately warm wastewater temperatures, could produce significant dissolved hydrogen sulfide concentrations in the wastewater. If the force mains then discharged into the plant in the early morning, with little or no wind blowing, the hydrogen sulfide concentration in the air could possibly accumulate in areas beyond the treatment plant site. The hydrogen sulfide gas that is produced will eventually be degraded through oxidation, by oxygen in the air, to yield sulfur dioxide and sulfate compounds. The sulfur dioxide and sulfates are removed from the atmosphere by precipitation and by adsorption by plants and soils. The lifetime of the hydrogen sulfide gas can be as short as a few hours on a summer day, or several weeks in the winter, according to various technical investigations. The longevity of hydrogen sulfide gas and the fact that it is heavier than air make it reasonable to assume that detectable concentrations of gas could possibly accumulate in the vicinity of the treatment plant site, but outside of the site fence, under certain conditions.

VII. POSSIBLE MEASURES TO MITIGATE ODOR DETECTION OUTSIDE OF THE TREATMENT PLANT SITE

Hydrogen sulfide odors from wastewater systems are generally attacked using either liquid phase technologies or vapor phase technologies. Liquid phase technologies are further divided between (1) chemical addition to oxidize odorous compounds into more stable, odor-free forms, (2) chemical additions to raise the oxygen levels to prevent anaerobic bacteria from reducing sulfate anions to sulfide, and (3) chemical additions to raise the wastewater pH to keep the sulfides in the HS^- form rather than as hydrogen sulfide. Vapor phase technologies include (1) bio-filtration, (2) odor scrubbers, (3) odor neutralizers, and (4) carbon adsorption systems.

The Village at Nags Head is currently using the following methods to mitigate potentially objectionable odors:

- Feeding Biologic® SR2 at Pump Station No. 1. The manufacturer states that this product provides micronutrients that stimulate the microbial growth and activity in the treatment plant. It is claimed to help reduce odor, reduce sludge volumes, and improve effluent quality. The field testing did indicate the force main from Pump Station No. 1 had the least concentration of dissolved hydrogen sulfide, but it was also noted that the force main from this pump station is very short and provides the least amount of detention time of the influent force mains.

- Adding Ecosorb® odor neutralizing product by pumping a dilute solution through atomizing nozzles, with the atomized mist then distributed into the atmosphere over the treatment plant via oscillating fans. The manufacturer claims that the tiny water droplets created by the nozzles contain a thin oil skin that creates an electrostatic charge. This charge facilitates adsorption of the malodor molecules onto the droplet surface. The gas is absorbed by the droplet and held. This product is not limited to hydrogen sulfide odors; the manufacturer claims it will also work on other odor compounds that might be in the air at the treatment plant. There are four fans located at the four corners of the treatment plant; the two on the west side of the plant were in operation during the May 28-30 testing period.

- Installing odor neutralizing, scented socks that generally produce a pleasant odor intended to overpower any malodors.

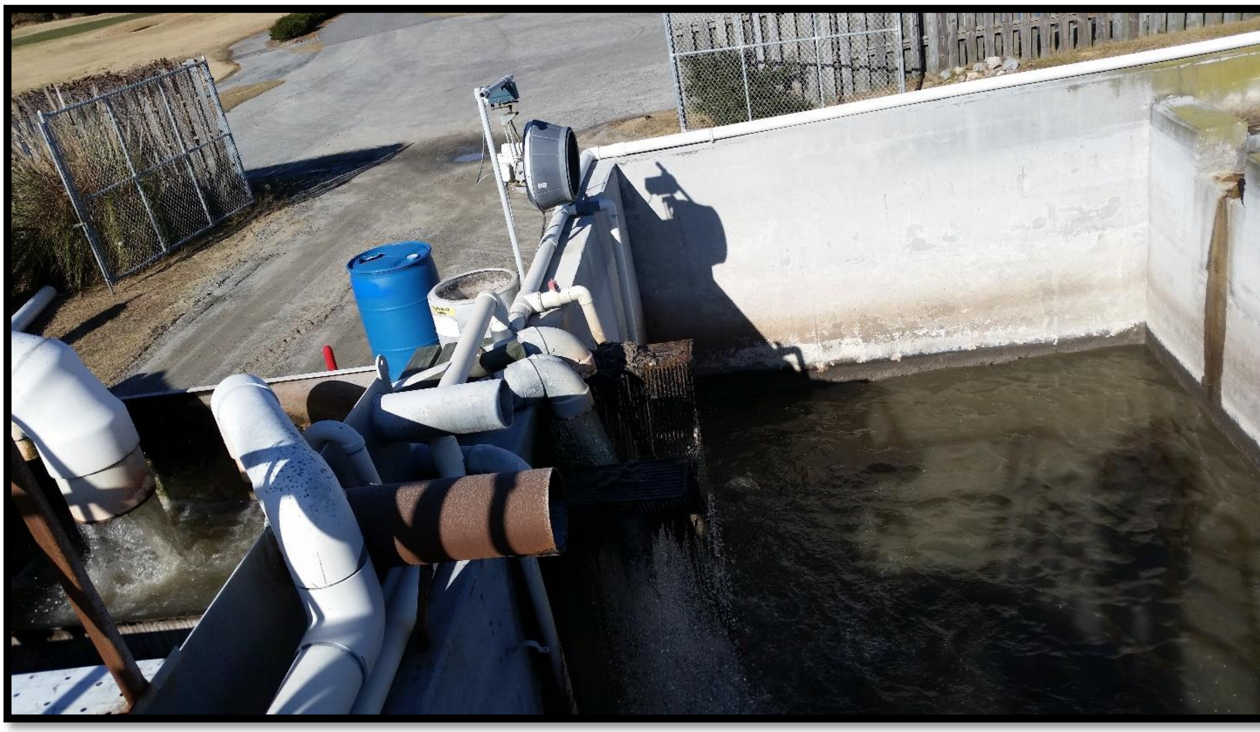


Photo 4 - Force Main from Pump Station 1 Discharging into Bar Rack, Oscillating Ecosorb® Distribution Fan Beyond

VIII. RECOMMENDED ACTIONS

Based only on the data collected on May 28 through May 30, 2015, there was not an off-site odor problem detected during that period. Realizing the various conditions that affect odor production and distribution may vary throughout the year, especially in a setting where the service population and flows have significant seasonal fluctuations, it is our recommendation that Carolina Water Service, Inc. install a gas monitoring data logger near the influent bar rack. This device, such as an OdaLog Logger L2, can monitor H_2S gas concentrations continuously and log the results every minute, for up to 29 days. The manufacturer has proprietary software that can retrieve and then analyze the data. The benefits of installing a data logger would be (1) to get a complete understanding of the variations in the concentrations of the hydrogen sulfide gas released at the influent area of the treatment plant, (2) to determine how the concentrations vary within a day, week, month, and seasonally, and (3) possibly establish predictive correlations of gas concentrations to wastewater flows and ambient temperatures. Once the data established when the peak daily gas concentrations might occur, periodic measurements of the dissolved hydrogen sulfide and pH should be taken for each force main.

The information provided by a long term data logging program would be used to design any future odor control systems that might be indicated. If an odor control system were to be designed without benefit of long term data logging, it appears that vapor phase treatment would be more feasible to implement rather than liquid phase treatment. The measurements made from the force main discharges indicate hydrogen sulfide formation occurs in the force mains from Pump Stations No. 1, 3, 4, 5, and 6. Due to the physical arrangements and interconnections of the force mains, there is currently no way to allocate the amount of hydrogen sulfide produced in the pumped flow of any station except for No. 1. A liquid phase chemical treatment approach would most likely require a feed pump system and chemical storage tank at each of these five pump stations. Some of these pump stations have limited available space for a chemical storage tank, would require fencing to secure the chemical and feed system, and would be difficult access for re-stocking the chemical. Other limitations and negatives of a liquid phase approach would be that it would only target hydrogen sulfide odors, and that the chemical feed rates would require frequent re-adjustment due to changes in service population and flows.

A vapor phase approach would address the hydrogen sulfide gas released at the treatment plant headworks. Based on the testing performed, the potential odor source for the system is confined to the force main discharges into the influent bar rack, and the flow equalization basin near the influent bar rack. One possible solution for this arrangement would be to have a small mechanical screening device installed within an accessible enclosure. The screenings would be bagged and discharged into a waste dumpster, similar to what is currently being done with the filtered materials from the Salsnes primary filter. The flow through the screen would then discharge into the Flow Equalization basin. The screening enclosure would be maintained with a slight negative pressure within the enclosure, created by a blower attached to an activated carbon canister (such as a Carbtrol unit) or a similarly functioning system with a combination of engineered media and activated carbon media (such as a Syneco unit). It may also be beneficial to partition and cover the northwest corner of the flow equalization basin to capture the majority of the hydrogen sulfide gas stripped from the wastewater as it enters the flow equalization basin and is aerated, and have it pulled through the activated carbon canister system. This vapor phase approach for odor control would have the system components in a single location, and it would also provide much more efficient and effective coarse solids removal than the existing manually cleaned bar rack. The life of the canister media is directly related to the amount of hydrogen sulfide removed; if the average gas production is less than anticipated, the media life will be longer than originally assumed (or shorter if the gas production exceeds the estimated quantities). With liquid phase chemical feed systems, overestimating or underestimating the hydrogen sulfide production can lead to overfeeding or underfeeding the chemical, resulting in wasted costs or incomplete odor control. Another benefit of this type of a vapor phase odor control system is that the carbon filters will also effectively remove other odor causing compounds, in addition to hydrogen sulfide (whereas essentially all of the chemical feed options are limited to targeting hydrogen sulfide only).

While it is possible to design either a liquid phase or vapor phase odor control system based on the collected data, it is recommended that more data be collected to determine if there is a need for an odor control, and if so, what the maximum hydrogen sulfide concentrations will be and how they will vary throughout the year. Data logging will allow for a more targeted design if a system is installed, and more accurate estimates of media and chemical consumption.

Other recommendations are:

1. Re-position the Ecosorb® distribution fan that is currently located on the west wall of the equalization basin, just south of the northwest corner of the plant. Due to the oscillation of the fan, it is possible that the fan may be pulling hydrogen sulfide gas from the manual bar rack area and exhausting it in a north to northeast direction. It is suggested that the fan be relocated to the north wall of the equalization basin, within 5 to 10 feet of the northwest corner of the plant, with the fan exhausting to the south. (Note: the fan has been relocated)

2. Perform pump drawdown measurements in each pump station wetwell, to accurately determine the current pump rates. For Pump Stations 5 and 6, which share a common force main, measurements should be made for each pump with no other pump operating, and again for each pump with a pump from the other station operating simultaneously. Accurate pump rates and pump run times will be required if an odor control system is subsequently designed. This action is being recommended because when the current pump rate information available to the plant operator is applied to the Daily Pump Run Time information provided by the Mission monitoring system, the calculated total daily flow is only 60% to 70% of the recorded plant effluent flow (for the two days checked). The difference could also be due to error in the plant effluent flow meter, but since its calibration is checked at least annually, that is less likely to be the explanation for the discrepancy.

Should Carolina Water Service, Inc. wish to proceed with data logging the hydrogen sulfide in the atmosphere at the influent bar rack, Diehl & Phillips, P.A. will be glad to assist in getting a program started. We can also assist in performing the pump rate measurements, if desired.

VERIFICATION

Martin J. Lashua, being duly sworn, deposes and says:

That he is the Vice-President of Operations for Carolina Water Service, Inc. of North Carolina; that he is familiar with the facts set out in the attached **Report On Customer Service Quality Issues from Public Hearing in Currituck, North Carolina** filed in Docket No. W-354, Sub 344; that he has read the foregoing Report and knows the contents thereof; and that the same is true of his knowledge except as to those matters stated therein on information and belief, and as to those he believes them to be true.

Martin J. Lashua

North Carolina

Mecklenburg County

Sworn to and subscribed before me this the 7 day of August, 2015.

Notary Public

Donna Stegall
Printed Name

DONNA STEGALL NOTARY PUBLIC UNION COUNTY, NC My Commission Expires January 8, 2019

My Commission Expires: 01/08/2019
Date

CERTIFICATE OF SERVICE

I hereby certify that on this the 7th day of August, 2015, a copy of the foregoing **Report On Customer Service Quality Issues from Public Hearing in Currituck, North Carolina** has been duly served upon all parties of record by electronic service, as follows:

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