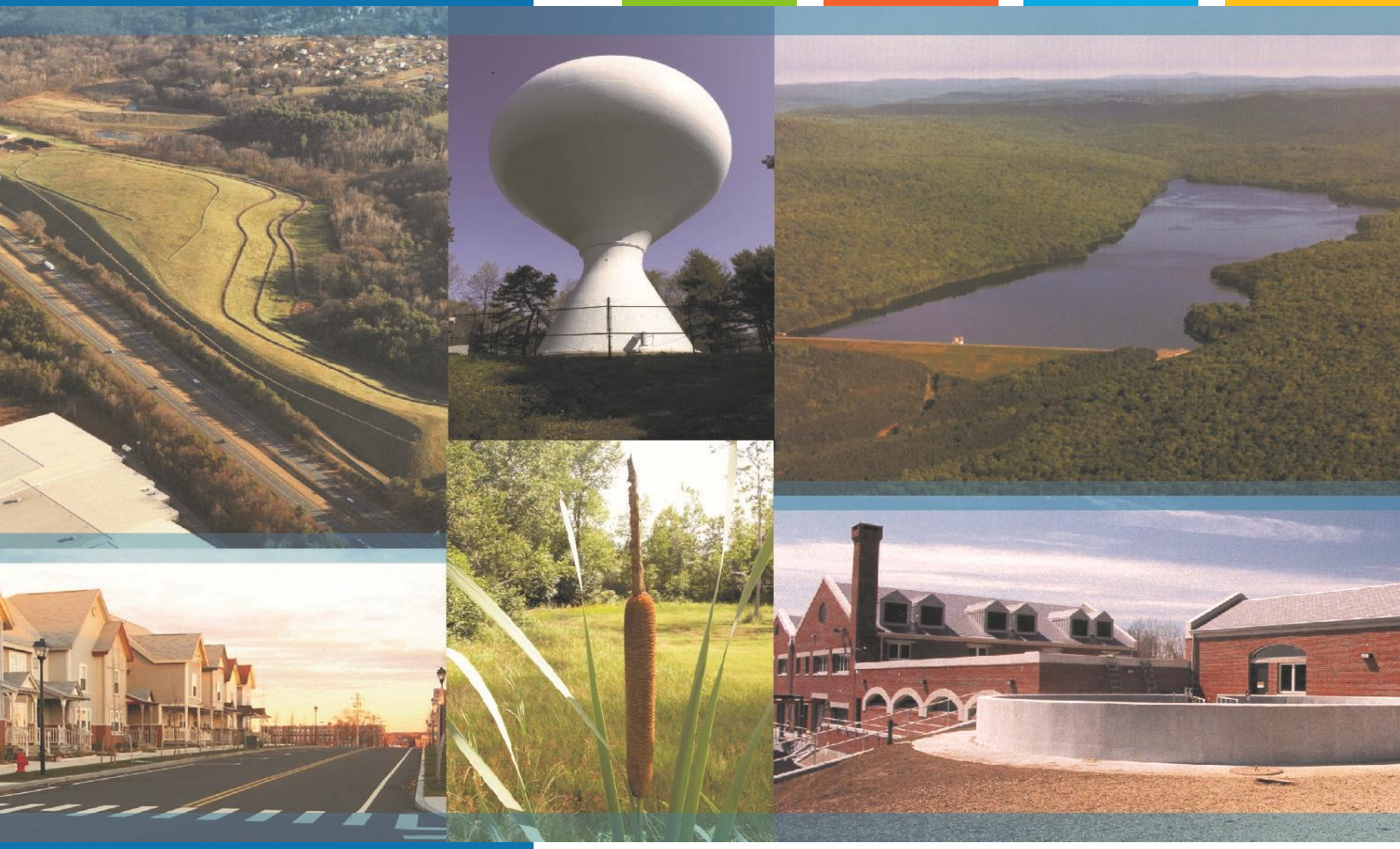

South Windsor Water Pollution Control Facility
1 Vibert Road, South Windsor, CT

ODOR CONTROL STUDY

Town of South Windsor

March 4, 2022

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Town of South Windsor WPCF Odor Control Study

TO: Town of South Windsor: Jeff LeMay

FROM: Tighe & Bond: Alan J. Wells, P.E.

COPY: Tighe & Bond: Ryan Palzere, Zhijian (Jason) Tang

DATE: March 4, 2022

Tighe & Bond is pleased to submit this Technical Memorandum summarizing the results of an Odor Control Study we conducted for the Town of South Windsor Water Pollution Control Facility (WPCF). Tighe & Bond was retained by the Town to conduct this Odor Control Study to identify potential odors and sources at the WPCF and surrounding areas, evaluate the performance of the WPCF's existing odor control system, and develop recommendations for odor control measures. The details of the findings and recommendations are summarized in this Technical Memorandum.

Tighe & Bond, along with our subconsultant Odor Science & Engineering (OS&E) of Bloomfield, CT, provided the following Scope of Services as part of this Odor Control Study:

1. Scope of Services

1. Kick-off Meeting – Tighe & Bond and OS&E attended a kick-off meeting on May 26th, 2021 with the Town of South Windsor at the WPCF for the purpose of reviewing the scope of services and schedule, and coordinating the data collection effort. Odor sampling dates and locations were identified at the kick-off meeting.

2. Data Collection – Tighe & Bond and OS&E collected data relative to odors. Two types of odor data collection were conducted, **odor emissions** and **odor surveys**. **Odor emissions** sampling consisted of hydrogen sulfide and air flow measurements of odor sources at the WPCF (including those sources currently connected to the existing odorous air collection system and other suspect sources such as the primary effluent channel). Measurements were made with portable hand-held meters by Tighe & Bond personnel. Additionally, OS&E collected a total of sixteen (16) samples at the WPCF for off-site qualitative analysis by an odor panel including odor intensity, concentration, and character. **Odor emissions** data collection occurred on June 29th, 2021 and July 28th, 2021.

   Additionally, six (6) off-site **odor surveys** were conducted by OS&E. The off-site odor surveys were conducted in the vicinity of the WPCF (within an approximate 1-mile radius) by slowly driving and/or walking in the areas surrounding the WPCF. The locations of any odors observed during the surveys were recorded on a map of the area. Odor intensity, concentration, character, and the likely source of the odors were recorded. **Odor surveys** data collection occurred on June 29th, July 28th, August 20th, and August 25th, 2021.

3. Summary of Results and Development of Alternatives – A summary of the **odor emission** sampling results from the WPCF campus and ranking of the odor sources was provided based on their odor emission rates (odor concentration x flow rate). In addition, a summary of the off-site **odor surveys** was provided showing the extent of any WPCF related odor impacts as well as the impact from any other sources detected in the study area. Based on these results, odor control alternatives were developed. Odor Control

alternatives include modifications to the existing odorous air collection system, collection of odors from sources not currently being collected (such as the primary effluent channel), alternative odor treatment technologies (in lieu of the existing biofilter) with a specific focus on carbon media systems. Alternatives were not developed for odor sources identified outside and/or unrelated to the WPCF campus.

4. Evaluation of Alternatives – Alternatives were screened based on criteria including estimated effectiveness, estimated opinions of life cycle costs, and operation and maintenance considerations.

5. Recommendations – For those alternative(s) considered to be most viable, recommendations were developed including descriptions, conceptual sketches, estimated capital costs, estimated operation and maintenance costs, and an implementation schedule. Recommendations were documented in a technical memorandum. A draft of the technical memorandum was provided to the Town for review and comment on November 16th, 2021. A virtual review meeting was conducted on January 21st, 2022. Tighe & Bond addressed the review comments from the Town and prepared the final technical memorandum.

2. Meetings and Deliverables

1. One (1) on-site Kick-off Meeting – completed May 26th, 2021.

2. Two (2) on-site odor emission data collection days – completed June 29th, 2021 and July 28th, 2021.

3. Three (3) off-site odor survey data collection days – completed June 29th, July 28th, August 20th, and August 25th, 2021.

4. One (1) Draft and one (1) Final Technical Memorandum.

5. One (1) on-site or virtual review meeting, to discuss the findings and recommendations contained in the Technical Memorandum – completed January 21st, 2022.

3. Introduction

The Town of South Windsor WPCF is located at 1 Vibert Road in South Windsor, CT. On May 4th, 2021, Tighe & Bond submitted a proposal to the Town of South Windsor WPCF to provide engineering services in support of an Odor Control Study for the WPCF. The objective of this Study was to identify potential odors and sources at the WPCF and surrounding areas, evaluate the performance of the WPCF's existing odor control system and develop recommendations for odor control measures.

Prior to the current Tighe & Bond Odor Control Study, the Town retained OS&E and CDM Smith of East Hartford, CT to conduct biofilter performance sampling and odor panel analyses for the WPCF, and the results were documented in a report dated June 17th, 2013. In that study, a total of eight (8) odor emission samples were analyzed for hydrogen sulfide, dimethyl sulfide, and mercaptans. These samples were also returned to OS&E's olfactory laboratory for same-day analysis by eight (8) trained odor panelists. OS&E concluded that odor removal efficiencies for the north and south sides of the biofilter were 99.9% and 99.7%, respectively. Hydrogen sulfide removal efficiencies were determined to be 100% for both the north and south sides, while the dimethyl sulfide and mercaptan concentrations for all samples were below the detection limit.

Since the 2013 study, it is our understanding that the biofilter media was changed by the Town, but the media specifications were thought to be different from the original media. Furthermore, the Town suspects the biofilter media is no longer performing effectively and odorous air may be short circuiting through the media untreated. In addition, the Town has received odor complaints from residents abutting the WPCF, from Main Street and east of the WPCF. For these reasons, the Town retained Tighe & Bond to perform the current Odor Control Study.

4. Data Collection

As part of the current Odor Control Study, a sampling plan was developed to collect data from the WPCF over two (2) non-consecutive days. Tighe & Bond and OS&E staff mobilized onsite to perform sampling activities on June 29th, 2021 and July 28th, 2021. The methods of data collection are described in Section 1. Data are presented in Tables 4-1 through 4-3 included at the end of this section. Figures 1 through 8 and Tables 1 and 2 of the OS&E Report included in Appendix A also present the data collected from this study. A summary of results is provided in Section 5 of this report.

4.1 Odor Emissions

Odor emissions sampling consisted of hydrogen sulfide and air flow measurements from the existing odor control duct for odor sources at the WPCF. A diagram noting the locations of where these measurements were taken is included in Appendix B. Measurements were made with portable hand-held meters by Tighe & Bond personnel. The results of this odor emissions sampling are summarized in Tables 4-1 and 4-2.

Additionally, OS&E collected a total of sixteen (16) samples at the WPCF for off-site qualitative analysis by an odor panel including odor intensity, concentration, and character. The results of this analysis are included in Table 1 and Table 2 in the OS&E report in Appendix A.

4.2 Odor Surveys

OS&E performed a total of six (6) odor surveys in the areas surrounding the WPCF. Two (2) odor surveys took place on June 29th, 2021: one in the morning and one in the afternoon. Similarly, two (2) odor surveys took place on July 28th, 2021: one in the morning and one in the afternoon. The remaining odor surveys occurred on August 20th, 2021, and August 25th, 2021.

The goal of these surveys was to identify the extent and character of any odors off-site from WPCF emission sources. Additionally, these surveys were used to identify other odor emission sources that may be causing complaints from residents. A summary of the off-site odor surveys that resulted in potentially WPCF-sourced odor emissions is presented in Table 4-3.

The odor surveys also found several extraneous odors that weren't believed to have originated from the WPCF. Nearby farmer's barns and fields produced "swampy", "muddy", "earthy", "manure", and "wet vegetation" odors. Other odors that were recorded were that of "stagnant water" due to flooded lawns, "musty/mulch/wood chips" due to home landscaping, "burnt rubber" due to a tire retreading business, and "food cooking" from a local restaurant.

TABLE 4-1
Data Collected from Sampling Event on June 29th, 2021

Sampling Port Location Number (see Appendix B)	Sampling Location Description	Velocity (ft/min)	Pipe Diameter (ft)	Theoretical Flow Rate (CFM)	H_2S Concentration (ppm)	Odor Load (CFM x ppm, rounded to nearest 100)
1	Headworks Building	900	2	2,827	0	0
2	Influent Pump Wet Well/GBT	900	2	2,827	0	0
3	Gravity Thickener	1,100	0.5	216	6.3	1,400
4	Gravity Thickener	1,450	0.5	285	0	0
5	Sludge Holding Tank[1]	1,200	0.83	655	> 100	65,500
6	Influent Pump Wet Well/GBT	1,800	2	5,655	1.6	9,000
7	Odor Control Duct	1,800	2	5,655	24.3	137,400
8	Odor Control Duct (Fan # 1)[2]	210	2	660	13.5	8,900
9	Odor Control Duct (Fan #1)[2]	200	2	628	20	12,600
10	Odor Control Duct	2,000	2	6,283	25.1	157,700

Note:
1. Measured concentration exceeded 100 ppm (the upper limit of the meter). 100 ppm was used to calculate the odor load.
2. Fan #1 was off in first sampling event on June 29th, 2021.

TABLE 4-2
Data Collected from Sampling Event on July 28th, 2021

Sampling Port Location Number (see Appendix B)	Sampling Location Description	Velocity (ft/min)	Pipe Diameter (ft)	Theoretical Flow Rate (CFM)	H_2S Concentration (ppm)	Odor Load (CFM x ppm, rounded to nearest 100)
1	Headworks Building	850	2	2,670	0	0
2	Influent Pump Wet Well/GBT	800	2	2,513	0	0
3	Gravity Thickener	1,300	0.5	255	15.5	4,000
4	Gravity Thickener	1,400	0.5	275	0.8	200
5	Sludge Holding Tank	1,200	0.83	655	20	13,100
6	Influent Pump Wet Well/GBT	1,600	2	5,027	0	0
7	Odor Control Duct	1,800	2	5,655	1.9	10,700
8	Odor Control Duct	2,000	2	6,283	1.8	11,300
9	Odor Control Duct	2,000	2	6,283	2.2	13,800
10	Odor Control Duct	2,000	2	6,283	2.3	14,500

TABLE 4-3
Summary of OS&E Odor Surveys that Resulted in Odors Potentially Sourced from the WPCF

Date	Sampling Location Number[1]	Sampling Location Description	Character of Odor	Intensity
June 29th, 2021 (morning)	1	Entrance to the WPCF	Sewage/H_2S	0.5 - 1.0
June 29th, 2021 (afternoon)	1	Entrance to the WPCF	Sewage/H_2S	0.5 - 1.0
June 29th, 2021 (afternoon)	2	Main Street	Sewage/H_2S	0.5
June 29th, 2021 (afternoon)	5	Entrance to the WPCF	Sewage	0.5 - 1.0
August 20th, 2021	3	Entrance to the WPCF	Sewage/H_2S	1.0 – 2.5
August 20th, 2021	7	Intersection of Vibert Road & Main Street	Sewage (puffy)	0.5
August 25th, 2021	7	Vibert Road	Sour Sewage	0.5 – 1.5

Note:
1. Location numbers based off corresponding location numbers in Figure 3 through Figure 8 of the OS&E Report included in Appendix A.

5. Summary of Results

Tables 4-1 and 4-2 contain the data collected from the sampling events on June 29th, 2021 and July 28th, 2021, respectively. Table 4-3 presents a summary of OS&E's odor survey data that resulted in WPCF-sourced odors. Appendix A includes the report prepared by OS&E that summarizes the results of the odor data analysis.

The first sampling event occurred on June 29th, 2021. Weather conditions were clear and humid with an approximate temperature of 93°F. The WPCF reported flows of 2.3 MGD. Sampling began at approximately 11:15 AM. The most significant concentration of hydrogen sulfide was recorded at the sludge holding tank, which exceeded the upper detection limits (100 ppm) of the measuring device. The sludge holding tank is located on the eastern side of the WPCF and is the closest structure in the WPCF to Main Street, where the odor complaints are originating from. Sludge is typically transported off-site of the WPCF by means of a 6,000-gallon tanker truck. Other significant concentrations of hydrogen sulfide were recorded at four (4) points in the duct that combines all flows leading to the biofilter. Minimal hydrogen sulfide concentrations were recorded at gravity thickener #1 and the influent pump wet well duct that combines the air flow. Hydrogen sulfide concentrations were not detected at the headworks building, influent pump wet well, or gravity thickener #2 (which was not in use at the time of sampling).

The second sampling event occurred on July 28th, 2021. Weather conditions were partly cloudy with an approximate temperature of 68°F. The WPCF reported flows of 3.7 MGD. Due to significant rainfall between the two sampling events, the wastewater entering the plant was likely diluted by stormwater, leading to decreased overall odor levels. Sampling began at approximately 9:25 AM. Like the first sampling event, the most significant concentration of hydrogen sulfide was recorded at the sludge holding tank. The level in the tank was approximately 3-feet. Other significant concentrations of hydrogen sulfide were recorded at gravity thickener #1. Minimal hydrogen sulfide concentrations were recorded at gravity thickener #2 and the four (4) points in the duct that combines all flows leading to the biofilter. Hydrogen sulfide concentrations were not detected at the headworks building, influent pump wet well, or combined duct from the influent pump wet well.

The OS&E report included in Appendix A summarizes the data collected from these sampling events as well, in addition to the six off-site odor surveys that OS&E performed. As indicated in the OS&E report, elevated odor levels and higher flow rates were recorded at different locations in the biofilter, suggesting an uneven distribution of air flowing through the biofilter and a reduction in its overall performance. During the June 29th, 2021 data collection, samples were collected at both the inlet to the biofilter and the outlet (the surface of the biofilter). With an inlet odor level of 8,282 dilutions to threshold (D/T), the outlet samples ranged from 23 D/T to 8,313 D/T, indicating a significant yet uneven degradation of the biofilter's performance. Moreover, as seen on Figure 1 of the OS&E report, the air velocities measured on the surface of the biofilter were uneven, ranging from 455 ft/min to 192 ft/min, indicating that the biofilter is short circuiting.

Between the June 29th, 2021 and July 28th, 2021 data collection events, a significant amount of rainfall had been received that diluted flows entering the WPCF, with temperature also dropping considerably from 93°F to 68°F. It is believed that these two factors lowered odor levels in general. The two samples that were collected from the surface of the biofilter on July 28th were 69 D/T and 82 D/T, while the results were previously up to 8,313 D/T on June 29th. Primary clarifier #2 showed an odor level of 35 D/T, while the primary effluent channel showed an odor level of 163 D/T. The 6,000-gallon tanker truck that hauls sludge off-site from the sludge holding tank was found to be an insignificant source of odor emissions.

Additionally, of the six (6) community odor surveys that OS&E performed, four (4) resulted in odors that could potentially be traced to the WPCF. These results are summarized in Table 4-3 of this report. In these four (4) surveys, odors that can be characterized as "sewage" or "hydrogen sulfide" smelling were noted at locations along Vibert Road and at the intersection with Main Street. As determined in the report, however, the intensity of the WPCF-related odors that were noted were not high enough to typically be the cause of odor complaints.

6. Development and Evaluation of Alternatives

Based on the results of the odor emissions and odor surveys, the biofilter is experiencing a significant reduction in its capacity to treat odors collected from the WPCF. The biofilter is short circuiting, resulting in odorous air flowing unevenly through the media and not being effectively treated. Furthermore, it appears the media itself has a reduced ability to treat odors. With the biofilter's treatment capacity reduced and short-circuiting, odors are effectively leaving the WPCF untreated or inadequately treated.

Additionally, the primary tank influent and effluent channels were found to be untreated sources of odor that could also be causing complaints. As noted in Table 2 of the OS&E report, these areas have shown significant D/T values (ranging from 38 D/T to 163 D/T). Since the primary tank influent and effluent channels are uncovered, any odors that are present can freely escape the WPCF.

Tighe & Bond has developed the following alternatives to improve the odor control system at the WPCF. Table 6-1 at the end of this Section 6 summarizes the advantages and disadvantages of each of these alternatives for several different categories, including operation and maintenance (O&M), required infrastructure, capital cost, key equipment, safety, and effectiveness of odor removal. A discussion of each alternative is presented below.

6.1 Rehabilitation and Reuse of Existing Biofilter

One alternative to address the WPCF odor control system would be to rehabilitate the existing biofilter. This option would allow for a rather simple transition for WPCF staff, as the current odor control system would remain relatively unchanged. The existing organic media in the biofilter, which consists of degraded wood chips, mulch, and compost, would be replaced with engineered biofilter media to revitalize the system's odor removal effectiveness. Engineered biofilter media is mineral-based and designed to optimize and sustain surface area for bacteria growth, resulting in a high-performing, energy-efficient biofilter system with a lower residence time than organic media biofilters. The existing biofilter's layout would mostly stay the same with some piping changes likely needed to ensure proper air distribution, hydration, and drainage of the new engineered media. This is a relatively low-cost method that would not require any significant additional land and minimize impacts to WPCF operations.

The main disadvantage of rehabilitating and reusing the existing biofilter is its inability to handle peak odor loads from the WPCF. As seen in Tables 4-1 and 4-2, hydrogen sulfide concentrations are everchanging in terms of location and time of year and vary with weather conditions and the wastewater load at the WPCF. Biofilters depend on odor reducing bacteria which work most effectively with steady conditions in terms of hydrogen sulfide, temperature, and moisture. Based on the data, these conditions at the WPCF are significantly variable, and as a result, the biofilter may not effectively treat the full range of odors. This will likely continue to be a problem even if the existing biofilter is rehabilitated.

6.2 Installation of Chemical Scrubber

A second alternative is to utilize the technology of a chemical wet scrubber, which has proved effective in odor control and removal systems. Chemical scrubbers work by absorbing the targeted pollutant into the scrubbing liquid. Design considerations depend upon the targeted pollutant, ideal removal efficiency, and process conditions including the flow rate, temperature, and concentration. A typical chemical scrubber setup includes a scrubbing vessel, fan, recycle pump, instrumentation and controls, mist eliminator, exhaust stack, ductwork, chemical feed pumps, and chemical storage tanks.

While a chemical scrubber application would achieve a high level of continuous odor removal efficiency and be able to handle peak flows, significant costs, both direct and indirect, would be incurred by the WPCF. Capital cost will include chemical scrubber equipment and accessory systems, as well as a building to host the equipment and store chemicals. Significant O&M costs are required, including manpower to run the system, chemical use, and waste disposal. Additionally, the use of chemicals would require health and safety measures and proper chemical storage and containment.

6.3 Installation of Activated Carbon Filter

The third alternative is the installation of activated carbon filters. Carbon filters work through the process of adsorption, where odorous molecules attach to the active surface areas of carbon media. The greater the surface area of the adsorbent, the greater the removal efficiency. A typical carbon filter setup includes two vessels, fans, fan sound enclosure, exhaust stack, prefilter, ductwork, and carbon media. The service life of the carbon media is typically five (5) years, although this depends on the system's flow rate and concentration.

Similar to a chemical scrubber, carbon filters provide a high level of continuous odor removal efficiency and can handle peak flows experienced by the WPCF. However, unlike a chemical scrubber, carbon filters pose much less of safety risk and require a smaller upfront capital cost. Additionally, the infrastructure and equipment required by carbon filters is less than that of a chemical scrubber; but greater than a biofilter. The maintenance of carbon filters is low, generally consisting of changing air pre-filters, maintaining fans and motors, and changing the carbon media approximately every five (5) years. These maintenance requirements are similar to what the WPCF has been doing for the existing biofilter and odor control fan/duct.

6.4 Installation of Satellite Treatment System at the Sludge Holding Tank

Because the sludge holding tank is the largest contributor of odors at the WPCF, as well as being one of the closer odor sources to abutters residing on Main Street, the installation of a satellite odor treatment system at the tank might be effective in reducing odors. This alternative would best be applied in conjunction with one of the alternatives outlined above. The satellite system would treat odorous air associated with the sludge holding tank, significantly reducing the odor load directed to the centralized odor treatment system and thereby improving its performance and longevity, especially for a biofilter system.

Like the technology described in Section 6.3, smaller carbon filters exist in cannister/drum form that are designed to treat odors at the source, as opposed to larger carbon filter that treats odorous air collected from across the entire WPCF. However, because of the high concentrations experienced at the sludge holding tank, carbon filter cannisters would not be the appropriate technology for this application. The carbon media has a greater likelihood of being overwhelmed at the sludge holding tank, resulting in a greater frequency of changing out the filter media and/or inadequate treatment of odor.

Instead of carbon filter cannisters, the sludge holding tank may benefit from the installation of a Vapex™ odor control system. The technology combines ozone, water, and air to create hydroxyl radicals that can oxidize odor compounds. The system has a small footprint, requires no chemicals or biosolutions, and can be tailored to meet the WPCF's needs. In addition to odor control, Vapex™ units are capable of remediating fats, oils, and grease, as well as decreasing rates of corrosion.

The disadvantage of satellite system is that it only treats odor locally, and the other odor sources in the WPCF will remain untreated by the system. However, the satellite system can reduce odor load to the centralized odor treatment system, attenuate peak concentration, and consequently improve the performance of the centralized system.

TABLE 6-1
Evaluation of Odor Treatment Alternatives

	Rehabilitation and Reuse of Existing Biofilter	Installation of Chemical Scrubber	Installation of Activated Carbon Filter	Installation of Satellite Vapex™ System at Sludge Holding Tank
O&M	Low	High	Moderate	Low
Required Infrastructure	Low	High	Moderate	Low
Capital Cost	Low	High	Moderate	Low
Key Equipment	Low	High	Moderate	Low
Safety Risk	Low	High	Low	Low
Effectiveness of Odor Removal	Moderate	High	High	Moderate

7. Recommendations

Based on the evaluation of these alternatives and discussions with the WPCF staff, Tighe & Bond recommends a phased approach for improving odor control at the WPCF. Initially, it is recommended that the WPCF rehabilitate their existing organic media biofilter utilizing engineered biofilter media.

Rehabilitating the existing biofilter with permanent engineered media would provide a higher efficiency for odor removal than the existing organic media and be able to handle the average odor concentrations experienced at the WPCF. The capital cost and required infrastructure necessitated by the rehabilitation of the biofilter is less than that of constructing either a chemical scrubber or activated carbon filter. The application of engineered biofilter media at the WPCF is the least costly alternative that will improve the effectiveness of the current odor control system.

For reference, Table 7-1 lists BIOREM® engineered biofilter installations in the region. Of note is the Westerly, RI Wastewater Treatment Facility (WWTF), where the existing organic media biofilter was rehabilitated with Biosorbens® engineered media. A technical cut sheet of the media can be found in Appendix C.

Table 7-2 presents an Opinion of Probable Construction Cost (OPCC) for the rehabilitation of the existing biofilter. Upon removal of the existing organic media, piping within the biofilter

may need to be modified to ensure proper air distribution, hydration, and drainage of the engineered biofilter media. It should be noted that the engineered biofilter media does not require as long of a contact time as organic media does, so the biofilter volume can be reduced. The total construction and engineering cost is estimated to be approximately $460,000.

TABLE 7-1
Regional Installations of BIOREM® Engineered Biofilter Media

Location	Description
Westerly, RI WWTF	Rehabilitated existing organic media biofilter with 5600 ft^3 Biosorbens® engineered media
New Milford, CT WPCF	Systemwide, large in-ground Biofiltair™ Biofilter
Newport, RI WWTF	Systemwide, large Biofiltair™ Biofilter
Rumford, RI	Two above-ground, two-stage, Basys™ Biofilters
East Providence, RI WTF & Pump Station	Mytilus® Biotrickling Filter installed at both the influent building and at a pump station

TABLE 7-2
Biofilter Rehabilitation OPCC and Engineering Estimate

Demolition and Modification of Existing Biofilter[1]	$50,000
Supply and Delivery of Engineered Biofilter Media[2]	$126,500
Installation of Engineered Biofilter Media	$60,000
Subtotal Construction	**$236,500**
Construction Contingency @20%	$47,300
Total Estimated Construction	**$283,800**
Contractor OH&P @40%	$113,520
Estimated Engineering @20%	$56,760
Total Estimated Construction and Engineering	**$454,080**
Rounded[3]	**$460,000**

1. One of the existing biofilter cells to be demolished and backfilled, the other is to be rehabilitated.
2. Price includes SCH 80 PVC manifold, Engineering Submittal packages, O&M manuals, and field services.
3. Cost estimate is a rough order of magnitude, estimated prior to any design efforts.

As part of the biofilter rehabilitation, the WPCF should consider installation of a satellite odor treatment technology at the sludge holding tank. The sludge holding tank is the largest source of odor loads at the WPCF. Treating this odor source separately will lessen the load on the biofilter, reducing its size and likely improving its performance and longevity. As discussed in Section 6.4, a Vapex™ unit may prove effective in reducing odors at the sludge holding tank, ultimately reducing downstream concentrations to lessen the load on the biofilter. Appendix D contains the cut sheets of a Vapex™ system. Recently, a Vapex™ system was installed at the Southington, CT WPCF for odor control of the sludge holding tank and the system is capable of treating peak H_2S concentrations greater than 1,000 ppm.

Table 7-3 presents an OPCC for the installation of a Vapex™ treatment system at the sludge holding tank. With no treatment chemicals needed, the system can begin treating odors at the sludge holding tank once the proper water and electrical connections are made. One unit

equipped with four nozzles should be sufficient to treat odorous compounds within the sludge holding tank. It should be noted that adding a satellite treatment system to the sludge holding tank will lessen the load on the biofilter, allowing the biofilter to potentially decrease in physical size and thus making it less expensive. The total construction and engineering cost is estimated to be approximately $380,000.

TABLE 7-3
Sludge Holding Tank Satellite Treatment OPCC and Engineering Estimate

Supply and Delivery of Vapex System[1]	$137,713
Installation of Vapex System	$60,000
Subtotal Construction	**$197,713**
Construction Contingency @20%	$39,543
Total Estimated Construction	**$237,255**
Contractor OH&P @40%	$94,902
Estimated Engineering @20%	$47,451
Total Estimated Construction and Engineering	**$379,608**
Rounded[2]	**$380,000**

1. Price includes Engineering Submittal packages, O&M manuals, spare parts, field services, and training.

2. Cost estimate is a rough order of magnitude, estimated prior to any design efforts.

As part of the WPCF odor control system upgrade, Tighe & Bond also recommends covering the primary tank influent and effluent channels. As noted in Table 2 of the OS&E report, these areas have shown significant D/T values that could be contributing to odor complaints. Covering the primary tank influent and effluent channels will help contain odors at the WPCF and ensure that they are properly routed to the WPCF's odor control system. During the design phase, it should be confirmed that the rehabilitated biofilter is properly sized for the additional air flow from these areas. Table 7-4 includes an Engineering Cost Estimate for covering the primary tank influent and effluent channels as well as the installation of any required air ducts.

Ultimately, the WPCF may decide to move away from biofilters for odor control. The biological processes within a biofilter can be challenging for reliable odor control, especially with variable factors such as odor loads, temperature, and moisture. Many wastewater facilities find carbon filters to be the easiest and most effective means of treating odors. The activated carbon media can also be engineered to have an affinity for a specific compound, such as hydrogen sulfide. While they have higher upfront capital costs as compared to biofilters, Tighe & Bond believes they provide the best reliability and ease of operation in the long term for controlling odors. For this reason, we recommend the installation of carbon filters for a long-term odor control solution at the WPCF.

Table 7-4 presents an OPCC and Engineering Cost estimate for the installation of an activated carbon filter odor control system. Appendix E contains a conceptual design layout for the proposed carbon filter odor control system. In the concept, we propose installing the carbon filters in the same location as the existing biofilter. It is presumed that the existing biofilters would be demolished. A carbon filter package for the odor control system at the WPCF would include two insulated fiber-reinforced plastic (FRP) vessels, exhaust stacks, new fans with sound enclosure, prefilter differential pressure gauges, carbon media, and a simple control panel with motor starter. The OPCC also includes work for covering the primary tank influent and effluent channels as well as all associated ductwork needed to fully integrate the carbon

filter. The total construction and engineering cost is estimated to be approximately $1,200,000.

TABLE 7-4
Carbon Filter OPCC and Engineering Estimate

Demolition of Existing Biofilter	$50,000
Backfill and Filter Pad	$50,000
Carbon Filter & Installation	$600,000
Electrical Works	$70,000
Cover Primary Tank Influent/Effluent Channels/Air Ducts	$50,000
Subtotal Construction	$820,000
Construction Contingency @20%	$164,000
Total OPCC	**$984,000**
Total Estimated Engineering @20%	**$196,800**
Total Estimated Construction and Engineering	**$1,180,800**
Rounded	**$1,200,000**

1. Cost estimate is a rough order of magnitude, estimated prior to any design efforts.
2. Assumed the existing biofilters will be demolished and backfilled, and new carbon filter will be installed at the same location.
3. Assumed two units at 6,000 cfm/unit. One duty unit and one standby unit.

APPENDIX A

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September 1, 2021

Alan Wells
Sr. Project Manager
Tighe & Bond
213 Court Street
Middletown, CT 06457

RE: Assessment of odors associated with the South Windsor Water Pollution Control Facility
OS&E Project No. 2252-M-00

Dear Alan:

This letter report summarizes the results of Odor Science & Engineering, Inc. (OS&E's) tasks associated with Tighe & Bond (T&B's) Odor Control Study at the South Windsor Water Pollution Control Facility (WPCF). The facility is located at 1 Vibert Road in South Windsor, CT. The objective of the T&B Odor Control Study was to address the potential source(s) of odor causing complaints from a few residents located nearby Main Street. OS&E's tasks consisted of the following:

- Participation in the project's Kick-off meeting,
- Collection and analysis of odor emission samples from plant sources and
- Conducting ambient odor surveys in the areas surrounding the WPCF

The project kick-off meeting was held at the WPCF on May 26th, 2021. Following the meeting, OS&E together with T&B conducted a plant walk through to identify potential sources of odor emission. A sampling plan was developed which involved collecting a total of 16 samples from plant sources over 2 non-consecutive days. The first round of sampling was conducted on June 29th followed by a second round of sampling on July 28th, 2021. Each day the samples were returned to OS&E's Olfactory Laboratory in Bloomfield, CT for quantification and characterization within 24 hours.

Odor Sample Analysis

The samples were analyzed by dynamic dilution olfactometry using a trained and screened odor panel. The odor panelists are chosen from OS&E's pool of panelists from the Greater Hartford area who actively participate in ongoing olfactory research and represent an average to above average sensitivity when compared to a large population. The samples were quantified in terms of dilution-to-threshold (D/T) ratio in accordance with ASTM Method E-679-04. The odor panelists were also asked to describe the odor character of the samples at varying dilution levels. The sampling and odor measurement methodology is further described in Attachment A.

The odor panel results are summarized in Tables 1 and 2. Table 1 summarizes the results for the samples collected on June 29th, 2021. Emissions from several of the facility's strongest odor sources are collected and ducted to the biofilter for odor control. Samples were collected at the inlet to the biofilter and the outlet (surface) of the biofilter at 4 locations. With an inlet odor level of 8,282 D/T, the outlet samples ranged from 23 D/T to 8,313 D/T. Elevated odor levels at outlet locations 1 and 2 indicate short circuiting and uneven distribution of the air going into the biofilter. The biofilter sampling locations are shown in Figure 1. The flow rate was measured from a stack on the sampling hood during sample collection with an anemometer recording the velocity in feet/minute (fpm). Higher flow rates were measured at locations 1 and 2 (averaging 400 fpm) compared to locations 3 and 4 (averaging 221 fpm).

Three samples were also collected from aeration basin #2. The odor level of the sample collected 2" above the turbulent water surface at the influent channel was 75 D/T. The odor level collected from the quiescent surface at the center of the tank using a floating sampling hood was 19 D/T while the odor level of the sample collected 2" above the water at the effluent channel was 15 D/T.

Table 2 summarizes the results for the samples collected on July 28th, 2021. A significant amount of rain had been received between the June and July sampling events. With a much higher flow rate into the plant diluted by stormwater, odor levels in general were lower. A sample was collected from the water surface of the SW aeration anoxic zone tank using a floating sampling hood. The odor level was found to be 38 D/T. Two sample were again collected from the surface of the biofilter. The odor levels were considerably lower (69 D/T and 82 D/T) than those collected in June. The biofilter sampling locations are shown in Figure 2. H_2S measurements made by T&B at the inlet to the biofilter recorded ~20 ppm in June and ~1.6 ppm during the July sampling. The remaining samples were collected from the primary tanks. Odor levels ranged from 35 D/T from the quiescent surface of primary tank No.2 to 163 D/T in the primary effluent weir channel. OS&E also observed the sludge unloading operation that took place on July 28th and found it to be insignificant in terms of odor emissions. It is essentially a closed loop system with a direct attachment from the sludge tank into a 6000 gallon tanker truck that hauls off site. The sludge transfer area was found to be kept very clean.

Ambient Odor Monitoring

In conjunction with the June and July emission sampling events and on two additional days in August 2021, OS&E conducted a total of 6 individual odor surveys in the areas surrounding the WPCF. The odor surveys were conducted to document the extent and character of any off-site impact from WPCF emission sources as well as the impact from other odor sources in the area which could potentially cause odor complaints from nearby residents.

Community surveillance was accomplished by slowly driving or walking downwind of the WPCF. Each survey included the areas of concern along Main Street where odor complaints have been received from. The odor monitoring was conducted specifically looking for WPCF-related odors and, if found, to document the extent of their impact. Odors from odor sources in the area were also noted. When an odor was perceived, the location, aerial extent, weather, time, wind speed, wind direction, temperature, odor character, odor concentration (D/T ratio) and odor intensity were recorded.

Odor concentration was measured using a Scentometer. Odor intensity was measured using the 8-point butanol odor intensity scale. These ambient odor measurement methods are further described in Attachment B.

The individual surveys are shown in Figures 3 through 8. The shaded area on each figure represents the boundary of the areas investigated during the survey. The locations of the individual zones of odors detected are shown in red, numbered in the order in which the observations were made. Any WPCF-

related odor observations are highlighted in yellow. The numbers correspond to the entries in the table on each figure which provide the details of each odor observance. The tabular inserts in Figures 3 through 8 show the intensity of the odors on the n-butanol scale, odor concentration (in terms of "dilutions to threshold", D/T), the character and the likely source of the odor.

Summary of off-site Surveys

Survey No. 1 began early on the morning of June 29th, 20 21. Winds were from the S-SW at 2-4 mph, gusting to 6 mph. Skies were mostly sunny with an ambient temperature of 85^0F. The only WPCF-related odors detected were at the entrance to rear gate. The "sewage/H_2S" was very light (odor intensity 0.5-1.0). Other odors detected during this survey included a "swampy/muddy" odor (intensity 1.0) coming from the wet marshy area just after the WPCF on Vibert Rd, Further down on Vibert Rd. an "earthy/dirt" odor (intensity 0.5) was noted coming from the open fields. Heading north on Main Street a "manure/barnyard" odor (intensity 0.5) was detected coming from a local home with a small farm on the property. On Strong Rd. and again on Pleasant Valley Rd. an "earthy/dirt/vegetation" odor was observed (intensity 0.5) coming from the open fields.

Survey No. 2 was conducted following sample collection on the afternoon of June 29th, 2021. Winds were west to W-SW shifting to W-NW by the end of the survey. Skies were sunny with an ambient temperature of 97^0F. WPCF-related odors were detected at the plant entrance (intensity 0.5-1.0, locations 1 and 5) and again immediately northeast of the plant entrance on Main Street (location 2). Other odors detected during this survey were "food cooking" odors (intensity 1.0-1.5) from a local restaurant on Route 5 and "sour vegetation" odor (intensity 0.5-1.0) on Chapel Rd.

Survey No. 3 was conducted during the early morning on Wednesday, July 28th, 2021. Skies were mostly cloudy, with winds from the N shifting toward S at 1-5 mph with gusts up to 8 mph. The ambient temperature was 68^0F. No WPCF odors were detected during this survey. "Wet grass" odors (intensity 1.0-2.0) were detected along Brook Street from a localized small flooded area of wet grass. Just south of the Bissell Bridge "earthy/dirt/manure" odors (intensity 1.0-1.5) were found to be coming from a local farm. A light "manure" odor (intensity 1.0) coming from another small local farm was detected along Newberry Road.

A fourth survey was conducted later that afternoon, Winds were from the N-NNE blowing at 2-4 mph gusting to 6 mph. Skies were mostly sunny with an ambient temperature of 81^0F. Again, no wastewater treatment plant odors were detected during this survey. The only odor detected during this survey was a "stagnant/muddy water" odor (intensity 1.0-1.5) found west of the treatment plant on Vibert Rd. coming from wet areas on the access road.

Survey No. 5 was conducted on Friday morning, August 20, 2021. The temperature was 73^0F with a very light S-SW-W at 0-1 mph and mostly cloudy skies. WPCF-related odors were again only found in close proximity to the plant. "Sewage/H2S" odors (intensity 1.0-2.0) were detected at the entrance to the plant on Vibert Rd and light puffs of "sewage" (intensity 0.5) were detectable at the intersection of Vibert Rd & Main St. Other odors detected were attributable to local vegetation as well as a "burnt rubber" odor (intensity 1.0-2.0) at the intersection of Route 5 and Governors Hwy from a local tire company.

The final survey was conducted on the evening of August 25th, 2021. Winds were calm with an ambient temperature of 82^oF. The only WPCP-related odor detected during this survey was a "sour sewage" odor (intensity 0.5-1.5) located immediately north of the plant on Vibert Rd. (location 7). All other odors

detected were related to local farms/fields, woodburning and a sewer drain located near the intersection of Route 5 and Glendale Rd.

Summary June/July/August Odor Surveys
In summary, when specifically looking to detect SWWPCF-related odors, light "sewage" odors were sometimes detected, but were found to be localized to the immediate area around the plant on Vibert Rd. and at the intersection of Vibert Rd. and Main St. The intensity of plant-related odors ranged from 0.5 to a maximum of 2.0.

Odors at these intensity levels would be characterized as:

n-butanol intensity level (0-8) ASTM E544-18	description of perceived odor
0.5 – 1	**Very Faint:** An odor that would ordinarily not be noticed by the average person and but could be detected by the experienced inspector or a hypersensitive individual.
1-2	**Faint:** An odor so weak that the average person might detect if his attentions are called to it, but that would not otherwise attract his attention.

Odors of such intensity level would not typically be the cause of odor complaints. Odor complaints are usually initiated at an odor intensity value of 3.0 or greater on the 8-point n-butanol intensity scale. This has been verified in many of our field studies across the country for a wide variety of industries and their neighboring communities. Only when a community has become "sensitized" (developed a disproportionate lack of tolerance for certain odors) is the objectionability level significantly below 3.0.

We appreciate the opportunity to work with T&B on this project. Please feel free to call me if you have any comments or questions concerning this report.

Sincerely,
ODOR SCIENCE & ENGINEERING, INC.

Martha O'Brien
Principal

Table 1. Results of dynamic dilution olfactometry analysis – June 30th, 2021
Tighe & Bond - South Windsor WPCF Source Sampling Test Results
OS&E Project No. 2252-M-00

Sample				Odor Conc. D/T[1]	Stevens' Law Constants[2]		Odor Character[3]
Date	Time	Location	Sampling Method		a	b	
06/29/21	10:38	Biofilter Inlet	From inlet duct	8,282	.60	.75	sour, H_2S, sewage, rotten eggs, sulfur, rotten meat/feces
06/29/21	10:10	Biofilter Outlet Loc. #1	Sampling Hood	4,071	.55	.91	sour, sewage, H_2S, rotten eggs, rotten sulfur, rotten meat, feces
06/29/21	10:28	Biofilter Outlet Loc. #2	Sampling Hood	8,313	.52	.91	sour, sewage, H_2S, rotten eggs, sulfur, rotten, feces, garbage
06/29/21	10:49	Biofilter Outlet Loc. #3	Sampling Hood	539	.64	.80	sour, sewage, H_2S, rotten eggs, sulfur, feces
06/29/21	11:09	Biofilter Outlet Loc. #4	Sampling Hood	23	.68	.73	sour, earthy, musty, wood chips, sewage, mercaptan, feces, plastic
06/29/21	11:44	Aeration Tank #2 Influent Channel Box	2" above water level	75	.59	.82	sour, sewage, rotten sludge, rotten meat, putrid, garbage, sulfur, H_2S, rotten potatoes, rotten onions, rotten cabbage
06/29/21	11:57	Aeration Tank #2 Effluent Channel Box	2" above water level	15	.54	.95	sour, sewage, sulfur, dirty water, rubber, plastic, exhaust
06/29/21	12:18	Aeration Tank #2 - Center of Tank	Floating Sampling hood	19	.64	.79	sour, dirty water, musty, earthy, sewage, mercaptan, onions, plastic, exhaust

1. D/T = dilutions-to-threshold
2. Stevens' Law correlates odor concentration (C) and odor intensity (I): $I = aC^b$. The constants a and b were determined by regression analysis based on the intensity ratings of the odor panel at varying dilution levels. I = 0-8 (based on the n-butanol intensity scale), C = odor concentration (D/T) typical of ambient odor levels.
3. Summary of all odor character descriptors used by the odor panelists at varying dilution levels.

Odor Sampling of SWWPCF Biofilter

Date 06/29/2021 Time: 10:10-11:10

Temp. 91^{0}F Barometric Pressure 29.98 Wind Speed 2-4 Dir. S-SSW

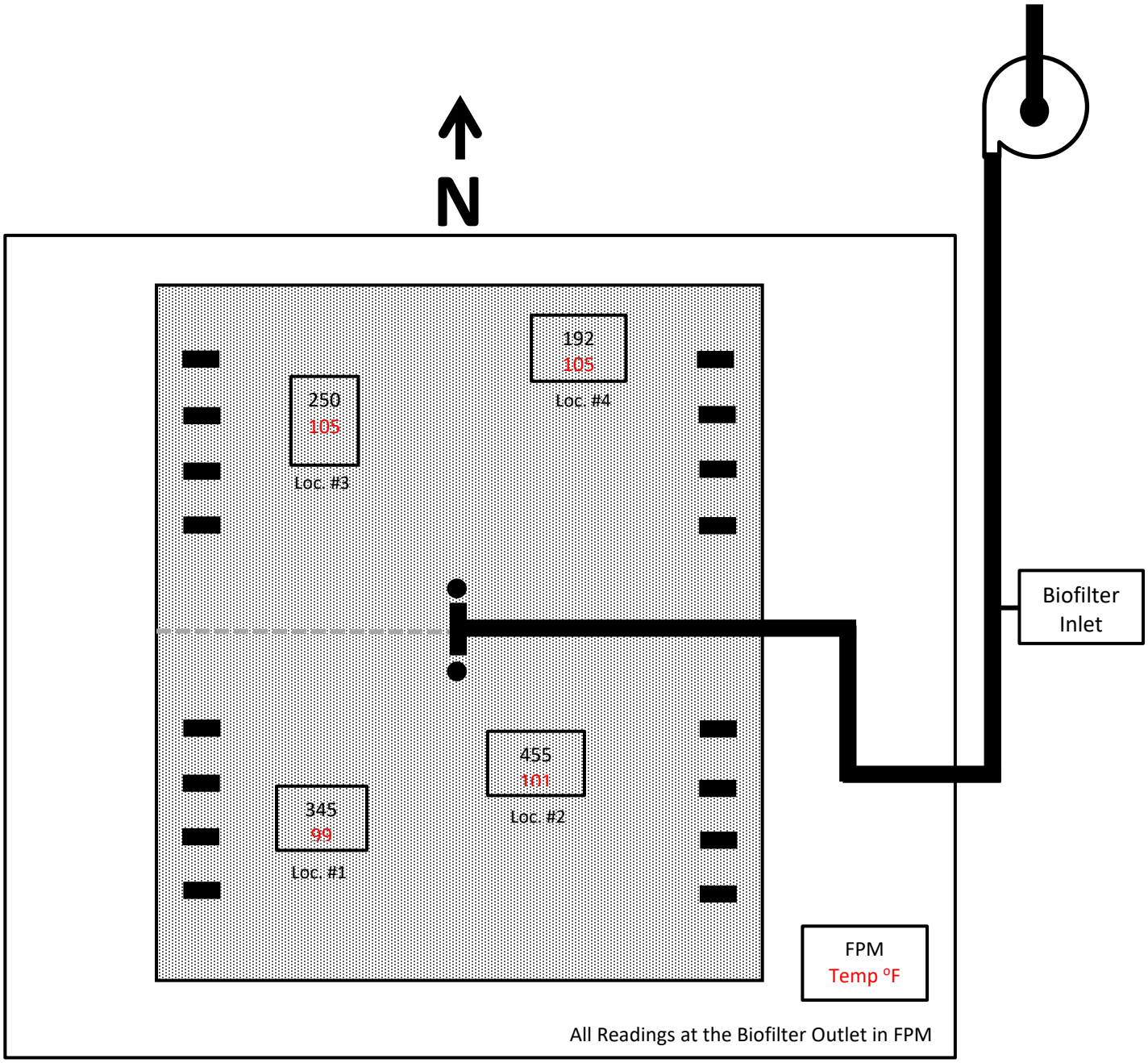


Figure 1. Air flow and Temperature Measurements During Sample Collection

Table 2. Results of dynamic dilution olfactometry analysis – July 29th, 2021
Tighe & Bond - South Windsor WPCF Source Sampling Test Results
OS&E Project No. 2252-M-00

Sample				Odor Conc. D/T[1]	Stevens' Law Constants[2]		Odor Character[3]
Date	Time	Location	Sampling Method		a	b	
07/28/21	10:42	Biofilter Outlet South Center of Bed	Sampling Hood	69	.52	.71	sour, rotten sewage, H_2S, rotten cabbage, earthy, wet dirt, rotten composted leaves
07/28/21	11:03	Biofilter Outlet North Center of Bed	Sampling Hood	82	.66	.76	sour, rotten sewage, rotten cabbage/vegetables, sulfur, swampy, urine, outhouse
07/28/21	11:34	Primary Influent Channel Splitter Box	2" above water level	38	.56	.79	sour, sewage, rotten cabbage, urine, garbage
07/28/21	11:52	Primary Clarifier No. 2 Quiescent	Floating Sampling hood - flux	35	.58	.74	sour, sewage, sulfur, urine, burnt, smoky, plastic, exhaust
07/28/21	12:08	Primary Clarifier No. 2 Weir	Floating Sampling hood - flux	89	.56	.72	sour, sewage, sulfur, H_2S, rotten eggs, rotten greens
07/28/21	12:23	Primary Clarifier No. 2 Effluent Weir Channel	Floating Sampling hood - flux	163	.59	.72	sour, sewage, sulfur, H_2S, rotten eggs, feces
07/28/21	12:55	Primary Effluent Channel Box	2" above water level	49	.66	.72	sour, sewage, sulfur, swampy, rotten cabbage/vegetation, musty
07/28/21	13:17	Anoxic Zone SW Tank Center of Tank	Floating Sampling hood – Flux	38	.45	.74	sewage, earthy, dirt, musty cellar, stagnant water, swampy

1. D/T = dilutions-to-threshold
2. Stevens' Law correlates odor concentration (C) and odor intensity (I): $I = aC^b$. The constants a and b were determined by regression analysis based on the intensity ratings of the odor panel at varying dilution levels. I = 0-8 (based on the n-butanol intensity scale), C = odor concentration (D/T) typical of ambient odor levels.
3. Summary of all odor character descriptors used by the odor panelists at varying dilution levels.

Odor Sampling of SWWPCF Biofilter

Date 07/28/2021 Time: 10:30-11:03

Temp. 67^{0}F Barometric Pressure 30.01 Wind Speed 2-8 mph Dir. North

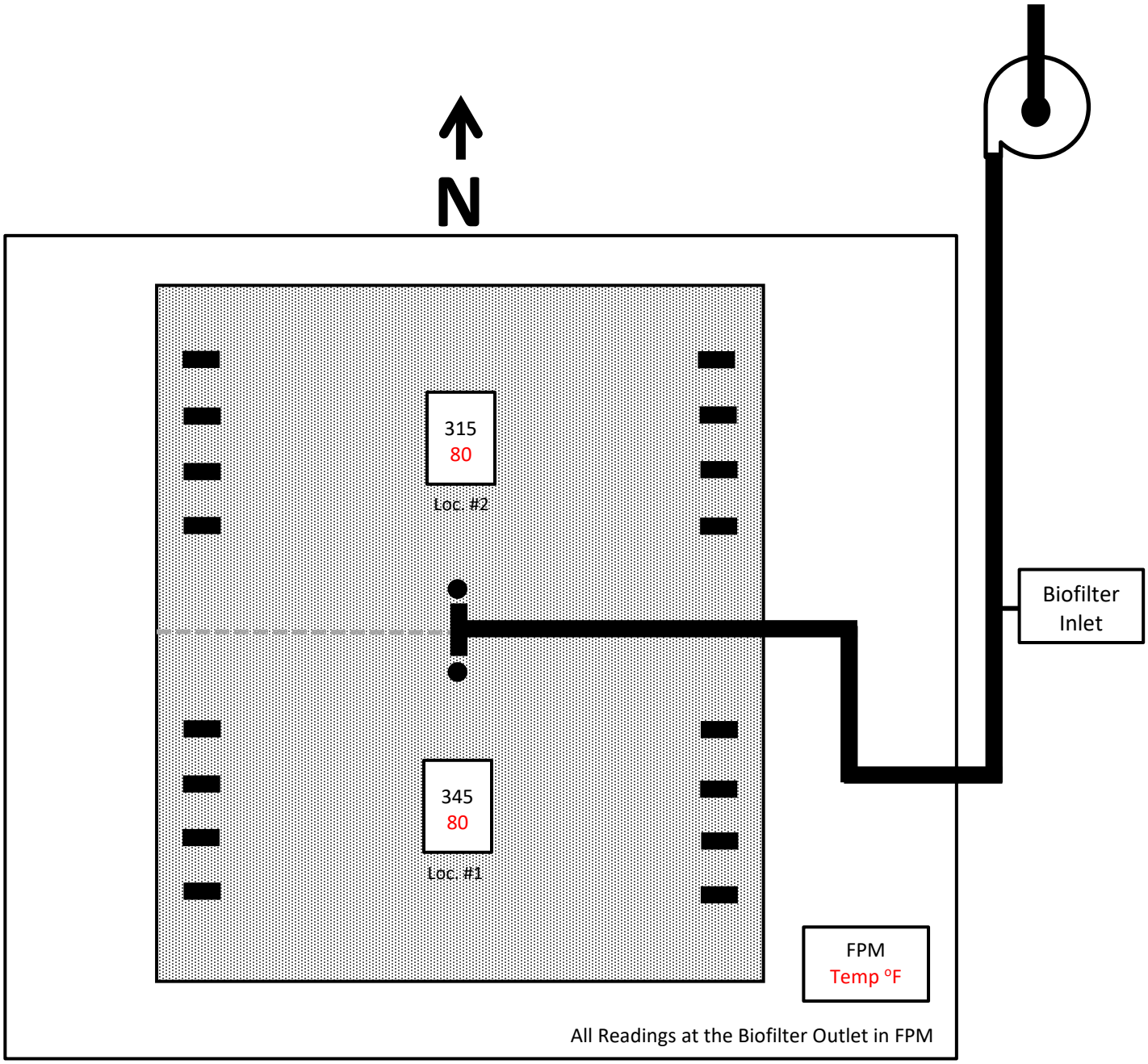
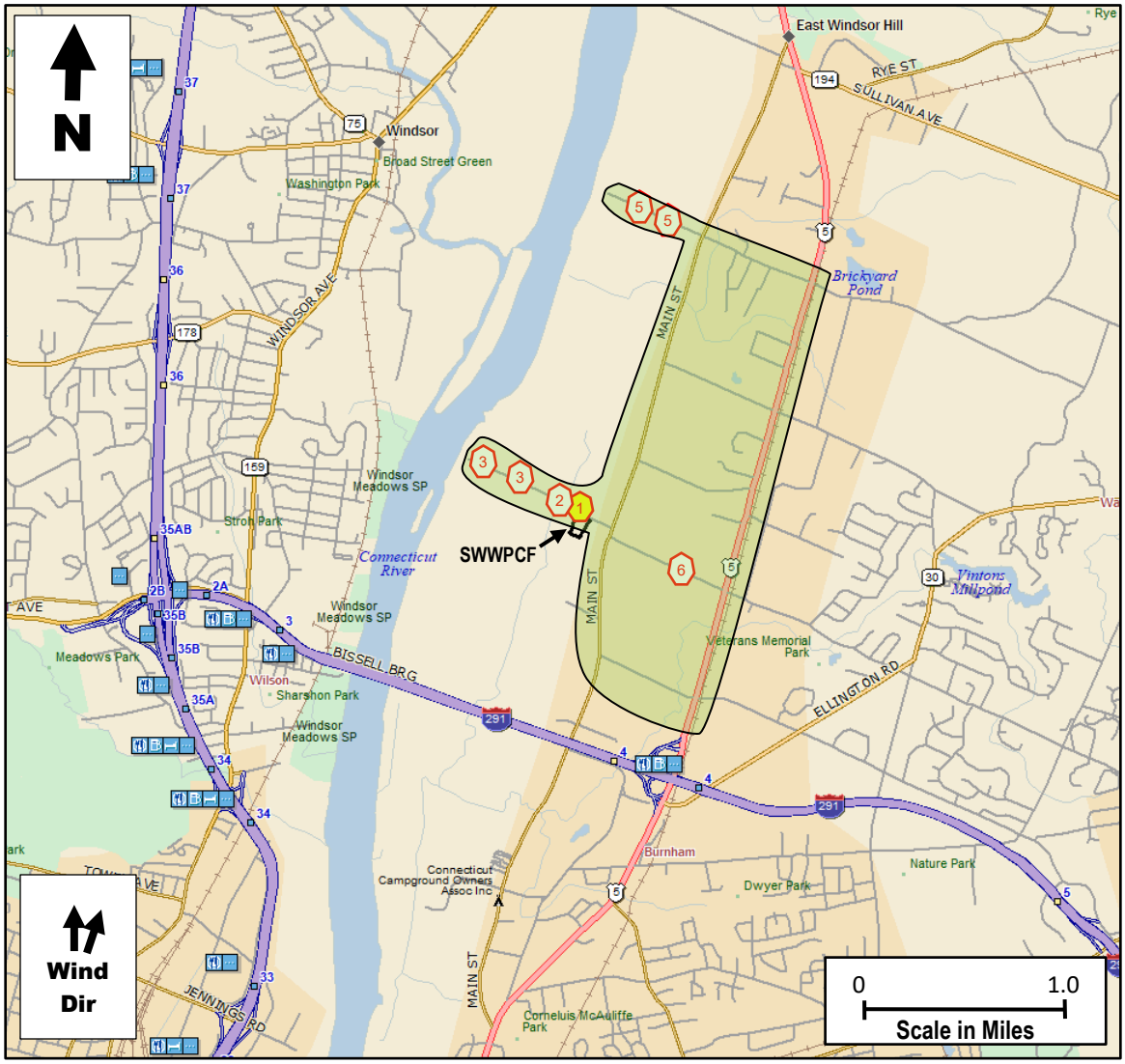
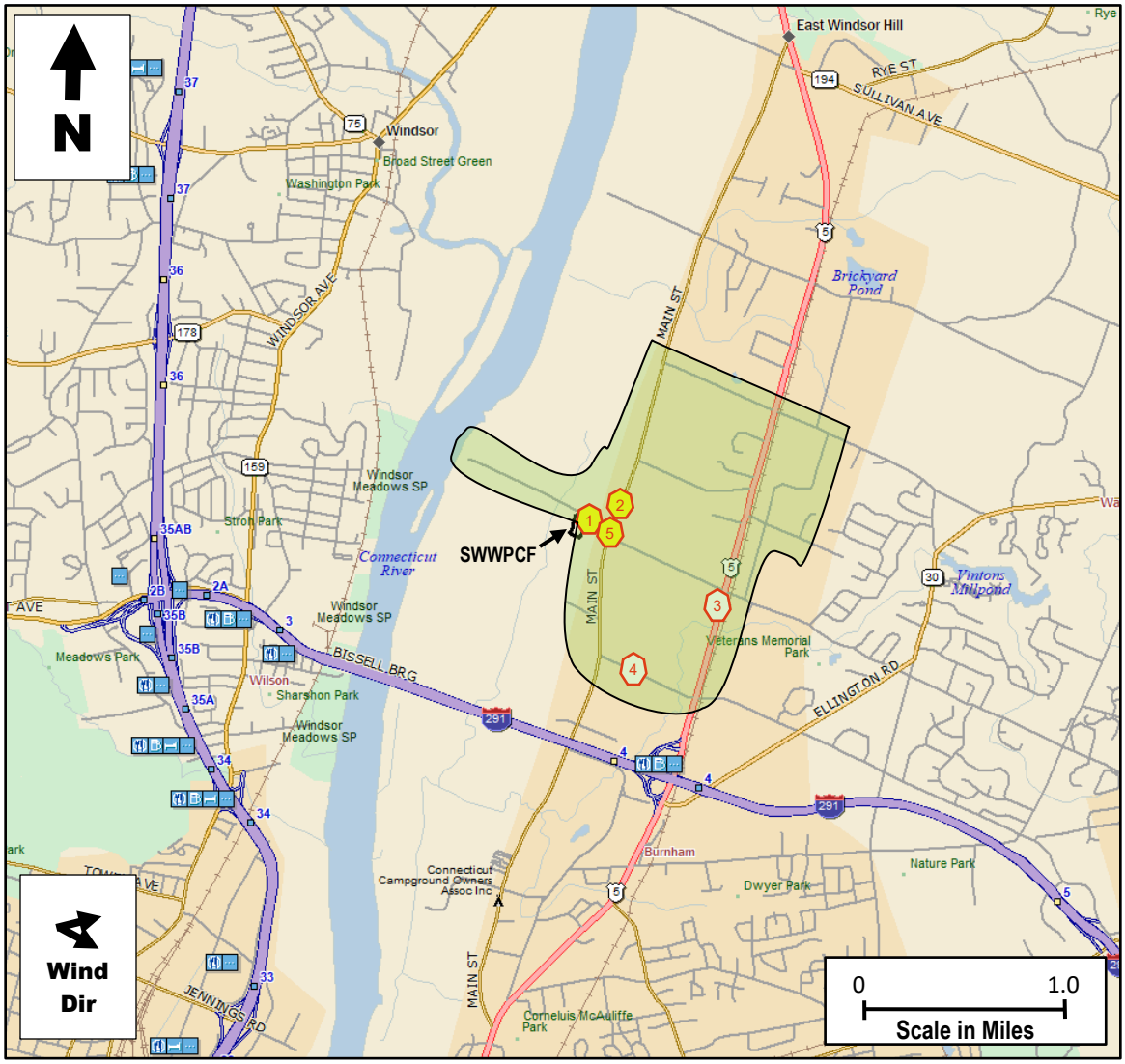


Figure 2. Air flow and Temperature Measurements During Sample Collection



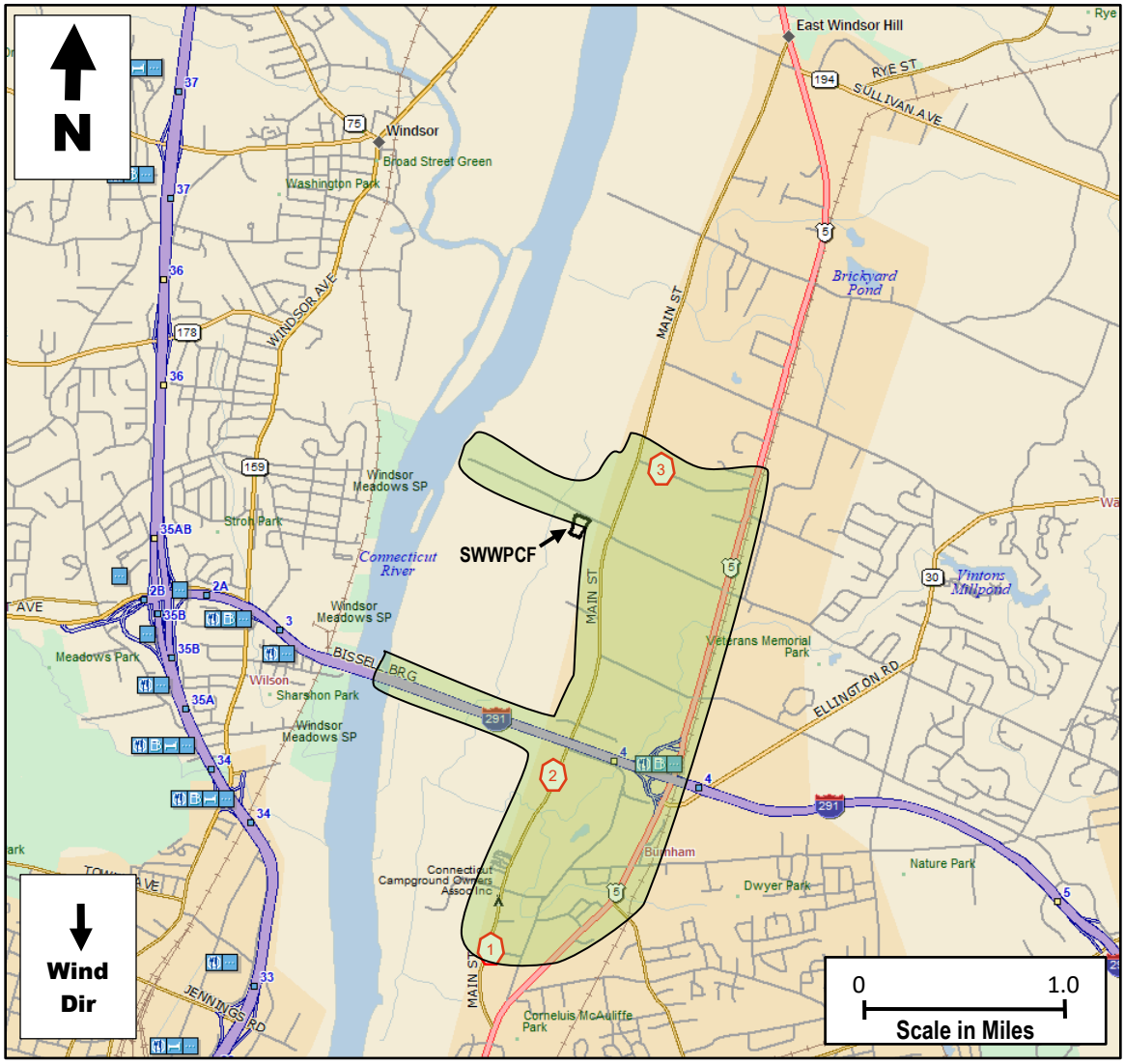
loc. #	int.	D/T	character	potential source
1	0.5-1.0	0.5	sewage/H_2S	SWWPCF
2	1.0	0.5	swampy, muddy	roadside ditch
3	0.5	0.5	earthy/dirt	farmer's fields
4	0.5	0.5	manure/barnyard	local farmer's barn
5	0.5	0.5	earthy/dirt/vegetation	famer's fields
6	0.5	0.5	earthy/dirt/vegetation	famer's fields
meteorological conditions: wind: S-SSW, 2-4 mph, gusts to 6 mph, 85^{0}F, sunny, 10% cloud cover				

Figure 3. Community Odor Survey No. 1 (06/29/2021 08:00-09:20)



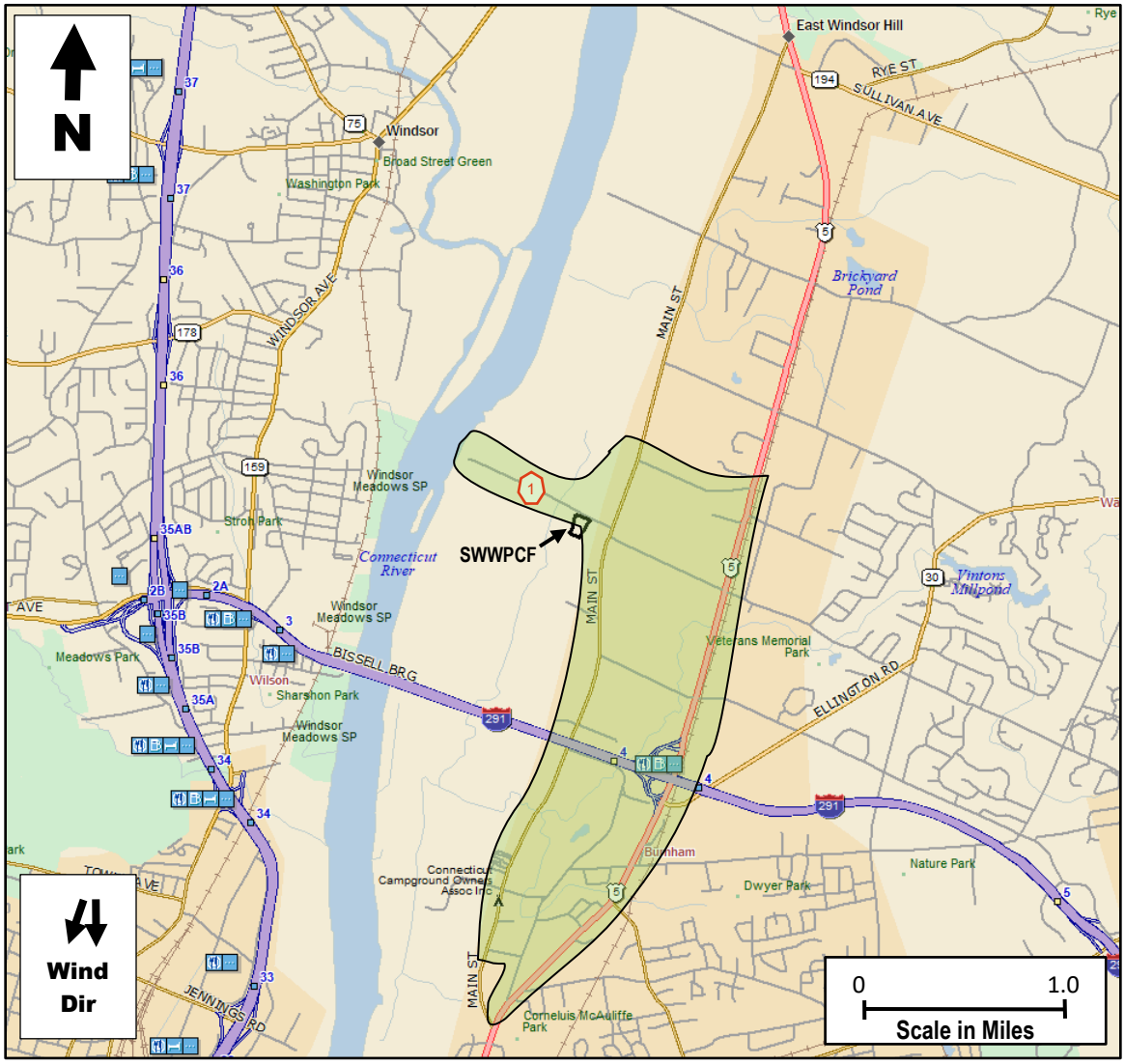
loc. #	int.	D/T	Character	potential source
1	0.5-1.0	<2	sewage, H_2S	SWWPCF
2	0.5	<2	sewage, H_2S	SWWPCF
3	1.0-1.5	<2-2	food cooking	local restaurant
4	0.5-1.0	<2	sour vegetation	local home yards
5	0.5-1.0	<2	Sewage	SWWPCF
meteorological conditions: wind: WSW-WNW, 1-4 mph, gusts to 6 mph, 97^{0}F, mostly sunny, 25% cloud cover				

Figure 4. Community Odor Survey No. 2 (06/29/2021 12:55-13:55)



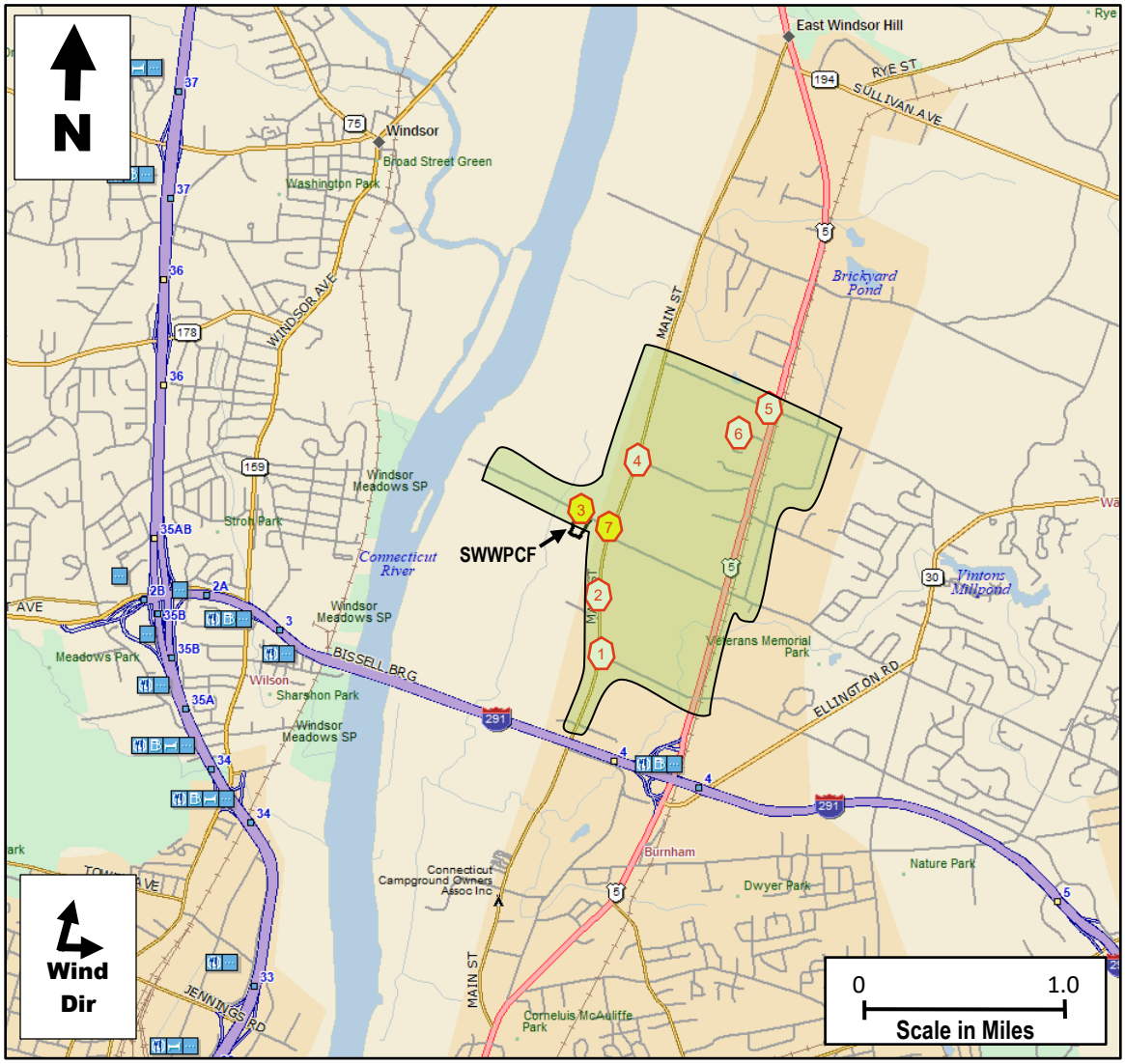
loc. #	int.	D/T	Character	potential source
1	1.0-2.0	2-<7	sour wet grass	lawn mowing
2	1.0-1.5	<2	earthy/dirt/manure	local farm
3	1.0	<2	Manure	local farm
meteorological conditions: wind: N, 1-5 mph, gusts to 8 mph, 68^{0}F, mostly cloudy, 75% cloud cover				

Figure 5. Community Odor Survey No. 3 (07/28/2021 08:00-09:22)



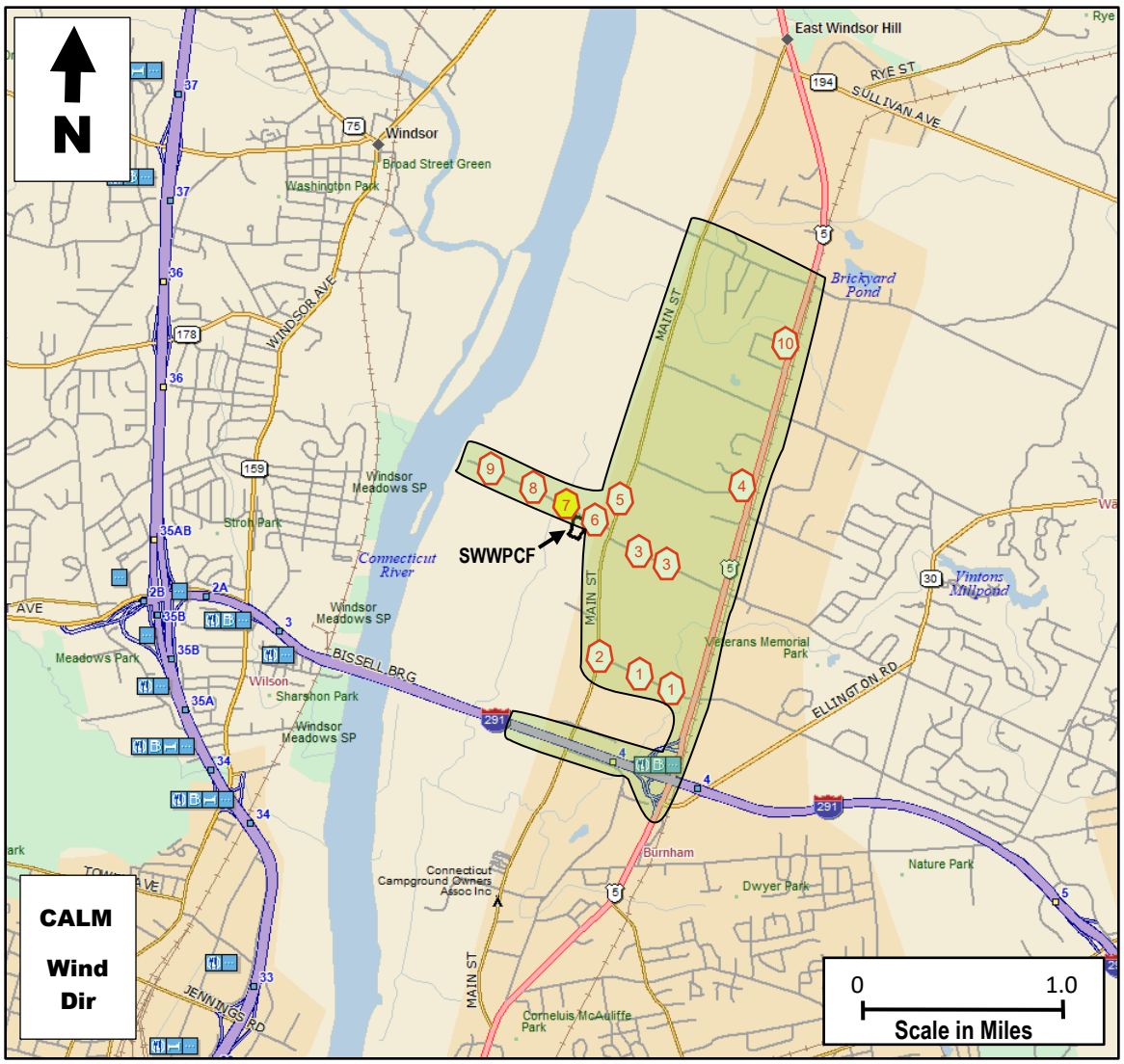
loc. #	int.	D/T	Character	potential source
1	1.0-1.5	<2	stagnant, muddy water	roadside ditch
meteorological conditions: wind: N-NNE, 2-4 mph, gusts to 6 mph, 81^{0}F, mostly sunny, 40% cloud cover				

Figure 6. Community Odor Survey No. 4 (07/28/2021 13:40-14:50)



loc. #	int.	D/T	Character	potential source
1	0.5-1.0	<2	stagnant water	flooded lawns
2	1.0-1.5	<2-2	musty/mulch/wood chips	local home landscaping
3	1.0-2.5	2-7	sewage/H_2S	SWWPCF
4	1.0-1.5	<2-2	manure/mulch	local home/farm
5	1.0-2.0	2-7	burnt rubber	Commercial Tire retreading
6	1.0-1.5	<2-2	sour garbage	?
7	0.5	<2	sewage (puffy)	SWWPCF
meteorological conditions: wind: SSW-W, 0-1 mph, 85^{0}F, mostly cloudy, 90% cloud cover				

Figure 7. Community Odor Survey No. 5 (08/20/2021 06:39-08:15)



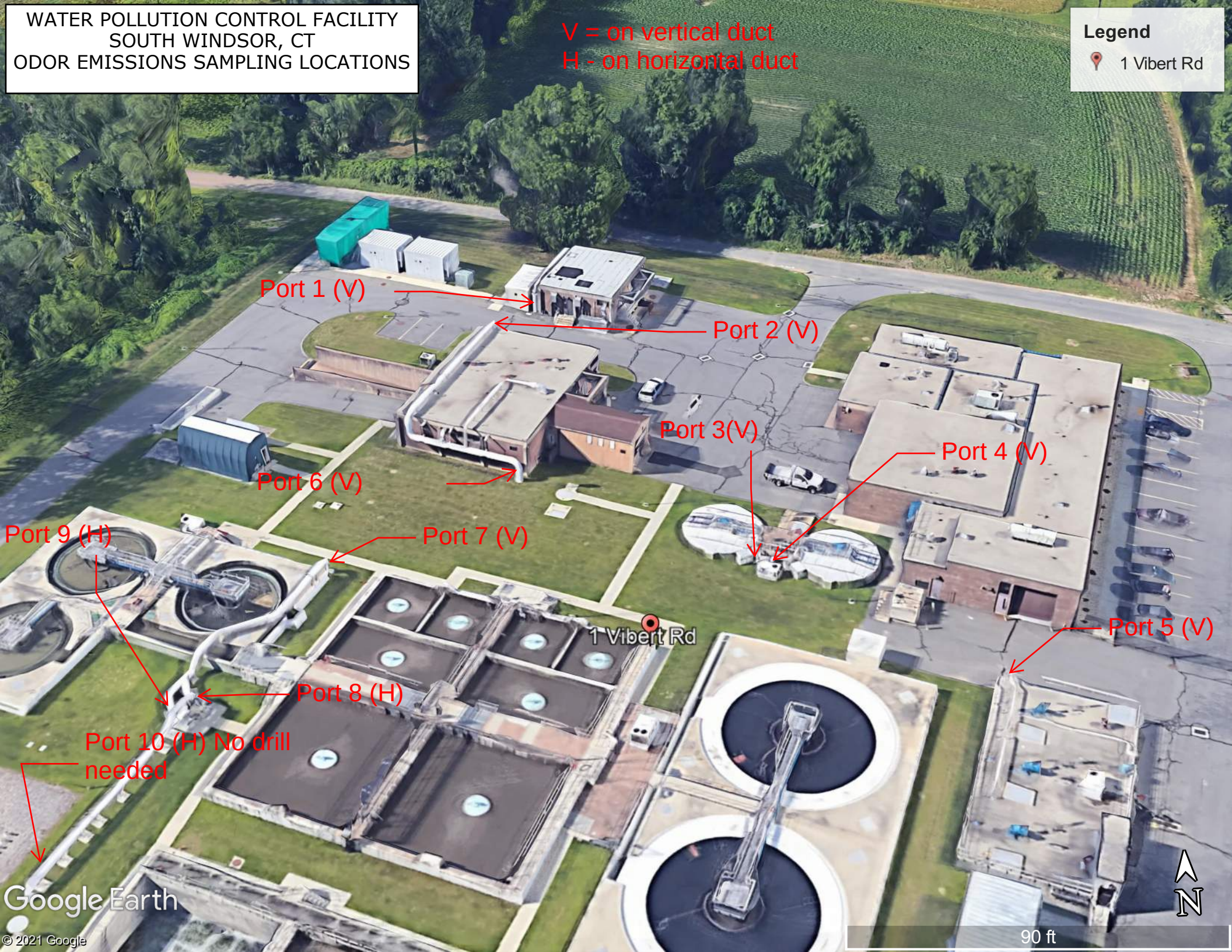
loc. #	int.	D/T	Character	potential source
1	0.5-1.0	<2	wet dirt/vegetation	wet farmland
2	1.0-1.5	<2-2	Woodsmoke	local home
3	0.5-1.0	<2	wet green vegetation/crops	wet fields
4	1.0-1.5	<2-2	food cooking	local restaurant
5	1.0-2.0	2-7	manure/barnyard	local farm
6	0.5-1.0	<2	fresh cut grass/weeds	side road ditches
7	0.5-1.5	<2-2	sour sewage	SWWPCF
8	1.5-3.0	2-15	swampy/stagnant water	swamp lands
9	0.5-1.0	<2	sour corn/vegetation	corn fields
10	0.5-1.5	<2-2	manure-like/rotten sewage	sewer drain/swampy area
meteorological conditions: wind: CALM 0 mph, 82^{0}F, partly cloudy, 45% cloud cover				

Figure 8. Community Odor Survey No. 6 (08/25/2021 19:05-20:30)

APPENDIX B

WATER POLLUTION CONTROL FACILITY
SOUTH WINDSOR, CT
ODOR EMISSIONS SAMPLING LOCATIONS

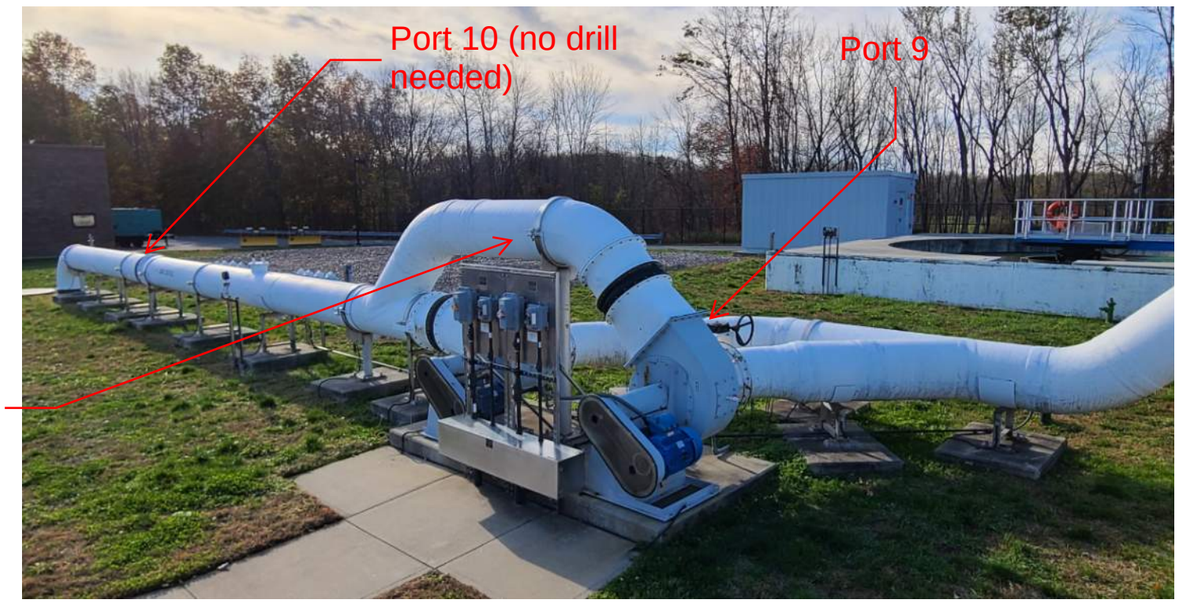
V = on vertical duct
H - on horizontal duct



Headworks Bldg. and Influent Pump Wetwell/GBT Bldg

Gravity Thickners and Influent Pump Wetwell/GBT Bldg

Sludge Holding Tank



Odor Control Exhaust Fans and Duct

APPENDIX C

Permanent Biofilter Media

Engineered Solutions for Total Odor and VOC Control

BIOSORBENS®

BIOSORBENS® is a top performing, engineered inorganic permanent biofilter media which delivers consistent performance over the life of the media. BIOSORBENS® is ideal for applications where total odor removal is required. It is guaranteed to perform and carries a 10 year warranty.

FEATURE	BENEFIT
Engineered	Our media is an engineered media manufactured to exacting specifications; this ensures predictable and consistent removal efficiency. No more guess work at EBRT's.
Low Pressure Drop	Maintains an even flow distribution throughout the biofilter media bed and minimizing power costs.
High Performance	Consistent and stable, readily achieving greater than 90% total odor removal and 99% H2S removal.
Rigidity	Mineral structure provides rigid support to minimize the compaction and consolidation effects.
Hydrophilic	Greater water holding capacity provides superior elimination capacity while resisting degrading, decomposition and compaction of the media bed.
Mineral Structure	Immune to compositing and does not react with acids, bases and solvents.
Low Residence Times	Empty bed residence times as low as 20 seconds.
Warranty	BIOSORBENS® is warranted for 10 years.

BIOREM

BIOREM® is an environmental biotechnology company which manufacturers a comprehensive line of high efficiency, biologically-based, air pollution control systems that are used to eliminate odors, H2S, NH3, TRS, VOCs and other hazardous air pollutants. With more than 500 installed systems worldwide, and over 15 years of experience, BIOREM® not only offers state-of-the-art technology based products but provides engineered solutions for total odor and VOC control.

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Toll Free: 1.800.353.2087 • Tel: 519.767.9100
Fax: 519.767.1824 • Email: info@biorem.biz

UNITED STATES
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Victor, NY, 14564
Toll Free: 1.877.299.2108
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APPENDIX D

VAPEX™
ENVIRONMENTAL TECHNOLOGIES

Radical Odor Control Technology
with Advanced Oxidation Process

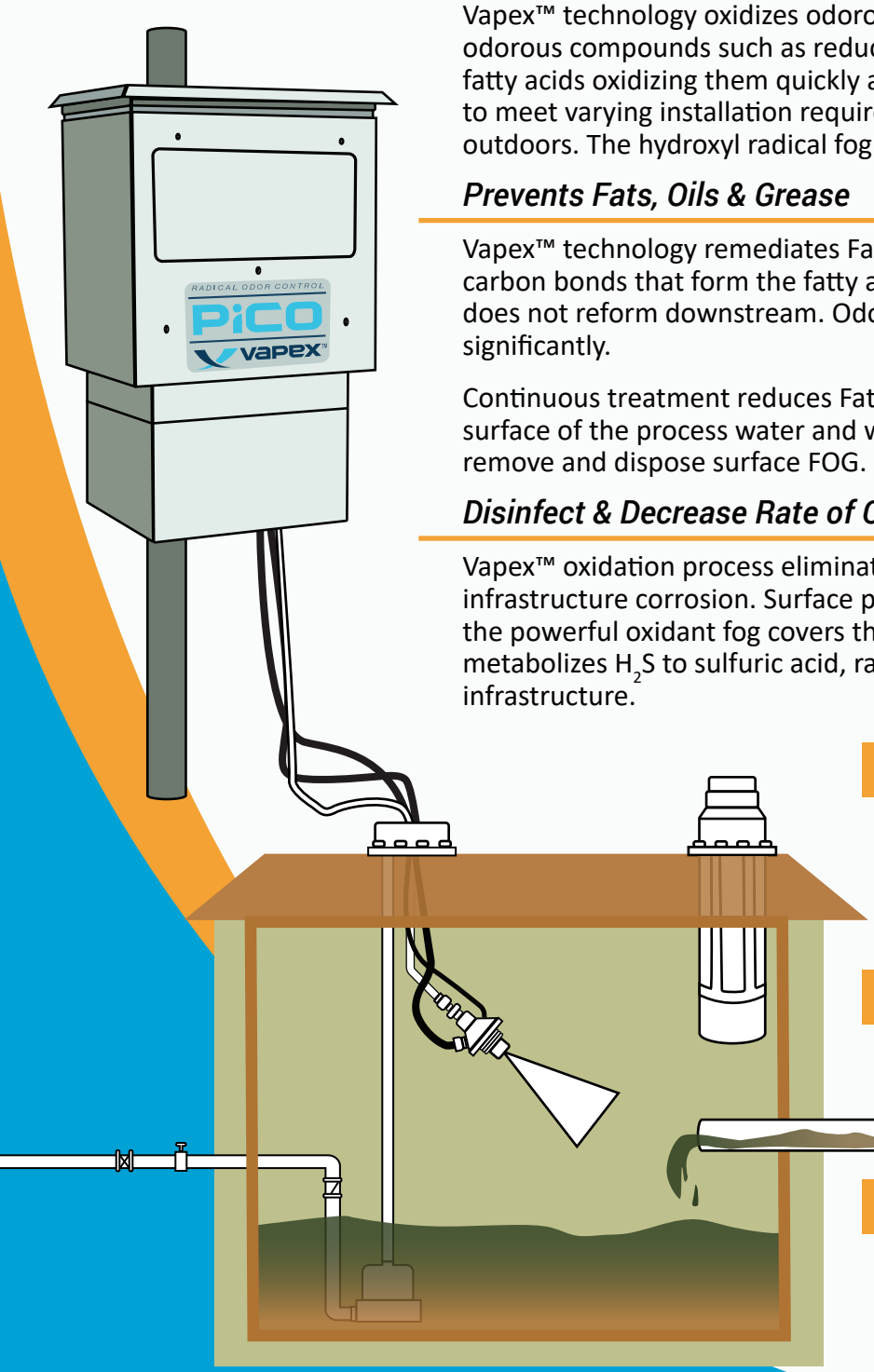
- *Treats Odors, Fats, Oils Grease & Corrosion*
- *Designed for enclosed or partially enclosed areas*
- *No chemicals or biosolutions required*
- *Minimal startup & operation costs*
- *Easy Installation & low maintenance*

Successfully Installed in Hundreds of Locations

The Vapex™ odor control system with its patented air atomizing three-fluid nozzles enhance the Advanced Oxidation Process by creating hydroxyl radicals (•OH), the most potent oxidant used in odor treatment.

Vapex™ combines ozone, water and air to create hydroxyl radical fog that is efficiently dispersed throughout enclosed or partially enclosed spaces, such as lift stations, wet wells, holding tanks, diversion boxes, and headwork channels.

Vapex™ odor control systems treat offensive odors in situ greatly reducing energy costs. Vapex™ units have a small footprint, require minimal water and electricity, and are extremely quiet.



Eliminate Odors

Vapex™ technology oxidizes odorous compounds. Hydroxyl Radicals combine with odorous compounds such as reduced sulfur compounds, amines, and volatile fatty acids oxidizing them quickly and efficiently. This technology is customizable to meet varying installation requirements and can be installed indoors or outdoors. The hydroxyl radical fog results in almost instantaneous odor reduction.

Prevents Fats, Oils & Grease

Vapex™ technology remediates Fats, Oils, & Grease (FOG) by breaking the double carbon bonds that form the fatty acid chain. By breaking the carbon bonds, FOG does not reform downstream. Odors from volatile fatty acids are decreased significantly.

Continuous treatment reduces Fats, Oils, and Grease from collecting on the surface of the process water and walls, reducing or eliminating the need to remove and dispose surface FOG.

Disinfect & Decrease Rate of Corrosion

Vapex™ oxidation process eliminates biofilm on surfaces that lead to costly infrastructure corrosion. Surface pH in wet wells can be as low as 1, however, the powerful oxidant fog covers the entire surface killing the bacteria that metabolizes H_2S to sulfuric acid, raising the pH to above 6 and preserving the infrastructure.

Proven

An independent university study found that hydroxyl radicals are being produced by combining micron-sized water particles and ozone using the patented nozzle from Vapex™.

Accepted

Major engineering firms and a state EPA determined the Vapex™ technology is effective in eliminating odors and remediating FOG.

Established

Over the past 10 years, major municipalities have standardized on Vapex™ technology.

LV NOZZLE

HV NOZZLE

RXN VENT

Base Model Features

- Powder Coated Aluminum Cabinet
- Insulated Cabinet
- Patented Nozzles
- HMI/PLC (excluding PICO model)
- Individual Oxidant Control for each nozzle
- SCADA Connection (excluding PICO model)
- Timer Based Oxidant Control
- Auto-Draining Moisture Removal System
- Pressure & Flow Based Oxidant Shut Off
- Small Footprint
- Low Power Usage
- 1- Year Mechanical Warranty
- Modem & Communication Services
- Ergonomically Designed Pedestal Mount

Benefits

- Treats High Concentrations of Hydrogen Sulfide, Mercaptans, and Amines
- Eliminates Odor Complaints
- Reduces Rate of Corrosion in the Infrastructure
- Remediates Fats, Oils, and Grease
- No Chemical Storage or Handling
- Quiet Operation
- Easy Installation
- Straightforward to Operate
- Environmentally Friendly
  - Reacted chemistry condenses safely back into influent stream
  - Small Carbon Footprint
- Low Installation, Maintenance, and Operational Costs

Applications

- Pump Stations/Wet Wells/ Lift Stations
- Junction Boxes & Siphons
- Interceptors
- Manholes
- Sludge Holding Tanks
- Grease and Scum Pits
- Grit Chambers
- Covered Primary Clarifiers
- Holding, Retention & Equalization Tanks
- Headworks Channels
- Rotary Screens

Options

- Extended Mechanical Warranty
- Quarterly Maintenance Program
- RXN Vent

Specifications	PICO	NANO	MICRO	MILLI
Maximum Treatment Volume, ft^3 (m^3)	750 (21)	10,000 (283)	26,000 (736)	42,000 (1,189)
Maximum Number of Nozzles	1	2	4	6
Oxidant Output, g/hr	≤ 10	≤ 20	≤ 50	≤ 60
Average H_2O Usage, gal/h/nozzle (l/h/nozzle)	1.5 (5.7)	8 (30.3)	8 (30.3)	8 (30.3)
Air Output, cfm/nozzle (m^3/hr/nozzle)	1 (1.8)	20 (34)	20 (34)	20 (34)
Material of Construction*	TGIC polyester powder coated aluminum			
Noise Level, dB	< 65	< 70	< 70	< 70
Average System Weight, lbs (kg)	62 (28)	160 (73)	290 (132)	325 (147)
System Dimensions L in (cm) x W in (cm) x H in (cm)	L: 20 (51) W: 17 (43) H: 31 (79)	L: 41 (104) W: 17 (43) H: 47 (119)	L: 48 (122) W: 32 (81) H: 71 (180)	L: 48 (122) W: 32 (81) H: 71 (180)
Power Requirements				
Volts, VAC	110	110 or 220	220	220
Average Current Draw, A, 50 Hz	3.5	10	18	20
Average Current Draw A, 60 Hz	6	17 or 11	19	23

Contact your Vapex™ Sales Representative or call 1-888-907-0004 to determine which Vapex™ unit is best suited to eliminate odors, remediate FOG, and decrease corrosion for your application.

MICRO

A#) 1' #5";) ; A" ; 9DA; 5'B; 5F D1; 9B"

DESCRIPTION

The technology is specifically designed to treat H_2S, mercaptans, amines, and other odorous compounds in enclosed spaces. By combining ozone, water, and air using a patented 3-fluid nozzle to atomize the water molecules to create hydroxyl radicals. Hydroxyl radicals are highly reactive and can quickly and effectively oxidizes odorous compounds.

Additionally, the hydroxyl radical fog remediates most Fats, Oils and Grease by breaking them down into alcohols and acids and protects the infrastructure from microbial induced corrosion by destroying the bacteria causing the corrosion.

MAIN FEATURES

- Eliminates H_2S and other odorous compounds
- Reduce or eliminate some forms of Fats, Oils, and Grease (FOG)
- Reduce or eliminate biofilm or bacterial growth in the treatment area
- Reduce the rate of microbial induced corrosion

APPLICATIONS

- Lift Stations/Pump Stations
- Wet Wells
- Holding Tanks
- Headworks
- Covered Clarifiers
- Junction Boxes
- EQ Tanks
- Influent Channels
- Interceptors

SPECIFICATIONS

System

Oxidant Output: 50 grams per hour max
Number of Nozzles: 1 to 4
Treatment Volume: 26,000 ft^3 max (estimate)

Nozzle Properties

HV Nozzle
Air output per nozzle: 20-30 CFM.
Water Usage per nozzle: 8 gal/hr.
LV Nozzle
Air output per nozzle: 1.5 CFM
Water Usage per nozzle: 1.5 gal/hr.
Max distance between nozzle & unit: 300 ft

Physical

Aluminum Powder Coated with TGIC polyester
Unit Dimensions: 53" L × 32" W × 72"H
Clearance Dimensions: 126" L × 107" W × 50"H
Installation Pad: 72" ×72" (Minimum)
Unit Weight 300-400 lbs.

Operating Temperature

20°F to 100°F

Power supply

208-240 VAC, 30A, 60 Hz, Single Phase

Water supply

Water Quality: Potable Water
Minimum supply water: 10 gal/hr. per nozzle
Minimum water pressure: 25 psi
Maximum water pressure: 75 psi

CONTACT INFORMATION

- Contact your local Vapex rep
- Call Vapex – 407-977-7250
- Email Vapex – sales@vapex.com"

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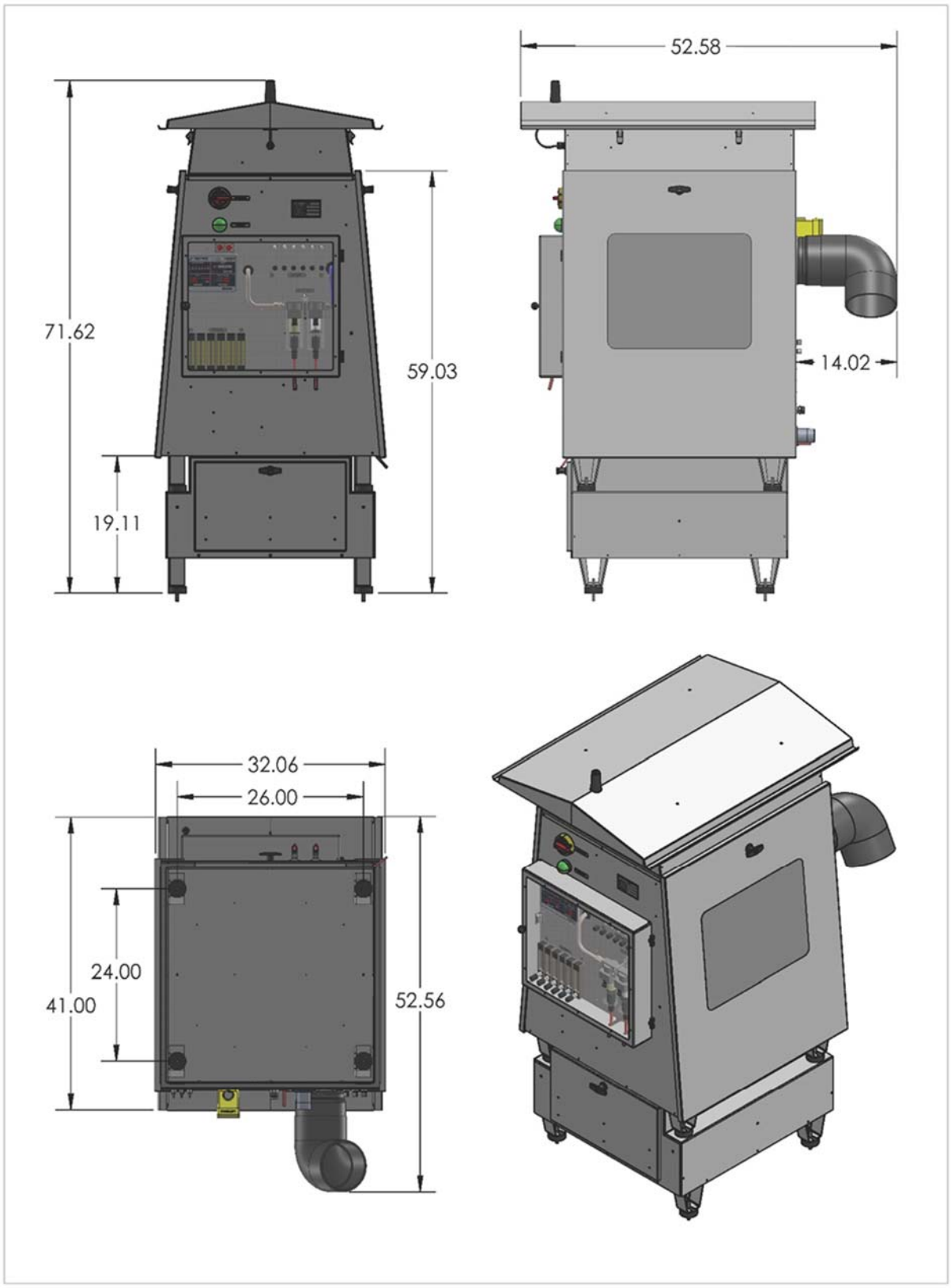
*Picture may contain optional equipment – actual unit configuration may be different

MICRO

A#) 1' #5";) ; A'" ; 9DA; 5'B; 5FD1; 9B"

" "



***Picture may contain optional equipment – actual unit configuration may be different**

Town of Southington, CT Water Pollution Control
999 Meriden Waterbury Turnpike, Plantsville, CT 06479

SUMMARY

- Southington *WPC has four sludge retention tanks but only one was being used. The plant is relatively close to residential areas and the Odors emanating from the tank caused residents to complain. Peak hydrogen sulfide concentrations were greater than 1,000 ppm.*

PROBLEM

- Odor

APPLICATION

Sludge Tank

- 37’ diameter
- 23’ deep

SOLUTION

- One ***(1) MILLI with 6 HV nozzles***

INSTALL DATE

November 2016

CONTACT

Steve Gregory, Foreman
gregorys@southington.org
(860) 628-8530

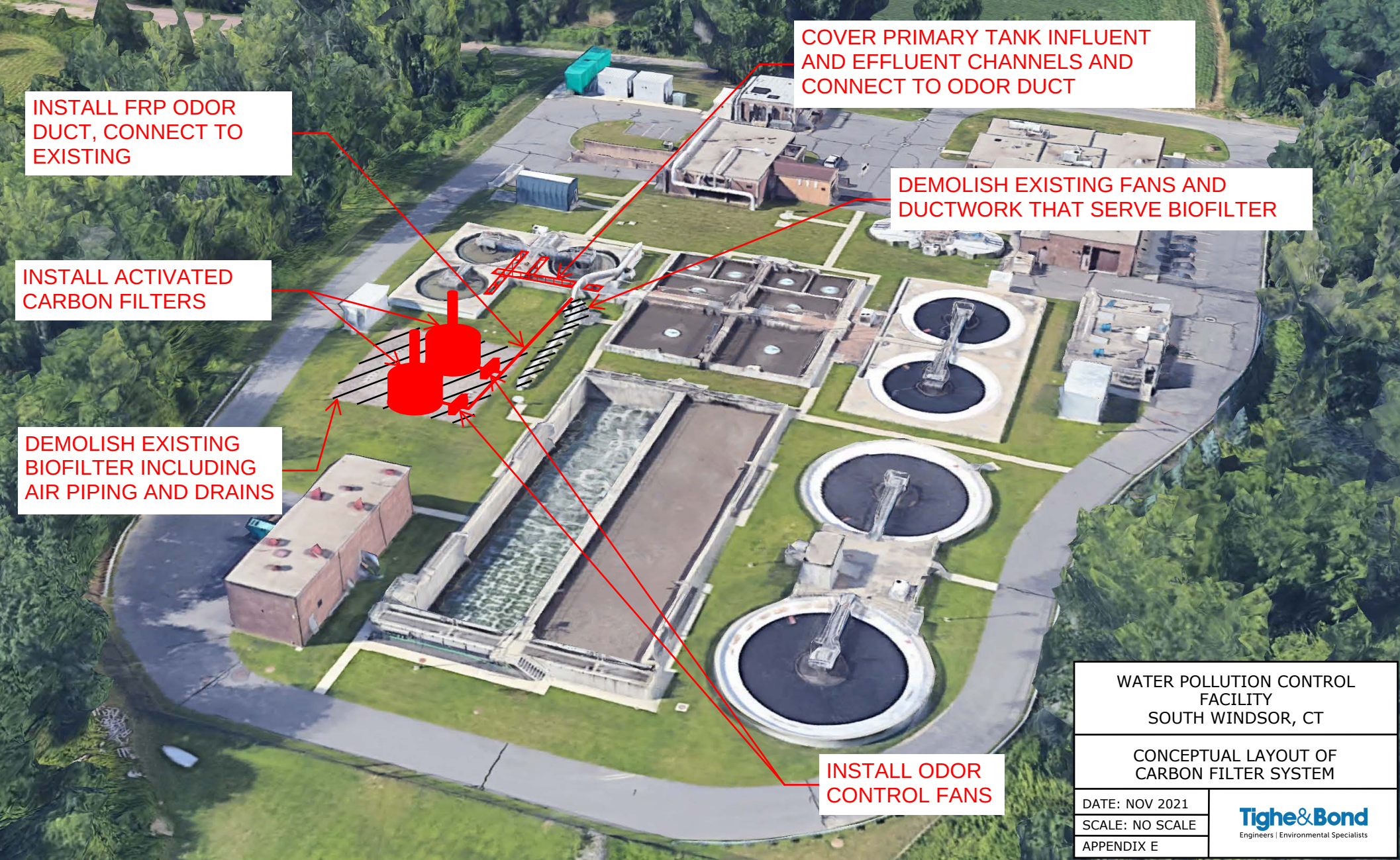
MANUFACTURER’S REPRESENTATIVE

Maher Corporation - (781) 421-2600

vapex ENVIRONMENTAL

Tighe&Bond

APPENDIX E



WATER POLLUTION CONTROL FACILITY
SOUTH WINDSOR, CT

CONCEPTUAL LAYOUT OF CARBON FILTER SYSTEM

DATE: NOV 2021
SCALE: NO SCALE
APPENDIX E

Tighe&Bond
Engineers | Environmental Specialists