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**REPORT**

# EVALUATION OF THE HARPETH RIVER WATER QUALITY RESTORATION AND PROTECTION EFFORTS: 1999 - 2015

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**RE: HARPETH RIVER WATERSHED ASSOCIATION v. CITY OF FRANKLIN (M.D. TENN.)**

## INTRODUCTION AND BACKGROUND

This Report is the product of a one year investigation and evaluation (May, 2014 through April, 2015) by the Water Pollution Control Consultant (Consultant) of the documented operations of the sewage treatment plant owned and operated by the City of Franklin (COF) since 2009, the violations of the COF's NPDES Permit to discharge into the Harpeth River (River), the significance of the COF's NPDES permit violations to the health of the Harpeth River, and the significance of the NPDES permit provisions with which the COF did not comply. In order to understand the operations of this STP and the regulatory context in which it is operating, I also reviewed plans developed and programs implemented for the restoration and protect of the water quality in the Harpeth River since the establishment of the Harpeth River Watershed Association (HRWA) in 1999. These plans and programs were developed by the Tennessee Department of the Environment and Conservation (TDEC) through their NPDES Permit Program, the US EPA and their TMDL and NPDES Permit Programs, the City of Franklin, TN (COF), and the Harpeth River Watershed Association (HRWA). The COF plans include upgrades and expansion of the sewage treatment plant owned and operated by COF. This is progressing under the review and oversight of TDEC, with further oversight by US EPA.

The investigation commenced in May, 2014 by a trip by the Consultant to the SELC offices in Nashville, TN, for discussions regarding the River conditions and the goals of the Investigation. The two days of activities included a visit to the HRWA offices in Franklin, TN, for further review of River conditions, including reviews of River water quality data; a comprehensive auto and hiking tour of the Harpeth River from its headwaters near Eagleville, TN, through the center of Franklin, TN, including sites above, below and near the outfall of the COF Sewage Treatment Plant (STP), a visit to the sites of the other two STPs, discharging effluent into the River, *i.e.* the small STPs, Cartwright Creek and Berry's Chapel; and a review of the four sites proposed for gaging, water quality monitoring and sampling of the River.

As previously noted, the initial stage of the evaluation was visual inspection of several sections of the River including the upper reaches of the Watershed where phosphate mining was formerly practiced, through the suburban areas upstream of the City of Franklin, the River as it flows through the urbanized middle of Franklin, past where the effluent from the Franklin Wastewater Treatment Plant (WWTP) discharges into the River, past the two small WWTPs downstream of the Franklin WWTP discharge, and a downstream section of the River below the urban and suburban developments of Franklin. The Watershed, its environs and surrounding terrain, also were studied using recent geological maps and Google Earth satellite images. Further, the water quality in the different sections of the River was evaluated using documents obtained from the Tennessee Department of the Environment and Conservation (TDEC), the US EPA, the Harpeth River Watershed Association (HRWA), the City of Franklin (COF), and the monthly and other NPDES reports from the Wastewater Treatment Plant to TDEC, including Toxicity Biomonitoring Reports and sewer overflow reports.

**SUMMARY OF DOCUMENT REVIEW, RESEARCH, AND INVESTIGATION**

The investigation and evaluation has proceeded since the May, 2014 Site Visit primarily through the review and evaluation of past communications between COF and TDEC that were generated during the NPDES permitting application process and compliance evaluations, inspections of the COF WWTP, water quality and engineering reports, COF design documents, discharge monitoring reports (DMRs) and monthly operating reports (MORs) prepared for the COF WWTP including the results of weekly grab samples from three sites on the River upstream and downstream of the WWTP outfall, and water quality data generated by COF and HRWA. I have not had access to the daily operating data, including logs or process control data, of the COF STP. Rather, I have reviewed the materials that COF has provided to TDEC, as well as materials COF provided in response to public record requests. My opinion may change if I am presented with other information, and I plan to supplement this report on these topics when additional information becomes available. The documents and correspondence reviewed and utilized are listed in **APPENDIX B** attached to this Report. The document attached as **APPENDIX A** to this Report summarizes the qualifications of the Consultant relative to this investigation and lists publications authored within the last 10 years, *i.e.* the Curriculum Vitae of the Consultant. The materials attached as **APPENDIX C** includes a statement of the compensation to be paid for the study and testimony in this case. There have been some recent additions to the water quality data and to the regulatory processes, mostly within the past two years, which I consider to be the most pertinent to the current condition of the River.

This summary will primarily present and discuss the information in these more recent documents. These documents and data are listed as follows:

1. **Existing NPDES Permit for existing STP**

2. **COF MORs:** City STP Staff collected River samples each week from May through October at three locations for the Monthly Operating Reports to TDEC in compliance with the STP's NPDES Permit (with the exceptions noted in my report, below). Samples were collected nearby above the STP, in the vicinity of the STP Outfall, and a short distance downstream from the STP Outfall. These samples were analyzed for carbonaceous biochemical oxygen demand (CBOD), dissolved oxygen (DO), Total Nitrogen (Total N) and Total Phosphorus (Total P). River flow and STP effluent flow were recorded at the same time. The results were used to calculate the phosphorus loads for each day of sampling, and then the results were averaged and used to calculate the mass of phosphorus discharged to the River by the STP during the May through October growing season, and compared to the quantities of phosphorus measured in the River both upstream and downstream of the STP Outfall. The samples were collected every week beginning with 5/4/2011 and continuing through 8/26/2014. An entire data set was available for the years of 2011, 2012, and 2013, but data for 2014 was available only for the period from 5/6/2014 through 8/26/2014.

3. **A Report of Water Quality Monitoring results** obtained during the spring and summer months of 2014, at the four US Geological Survey Gaging Stations located along the Harpeth River at the following four locations:

   - Site 1: Headwaters in Eagleville at McDaniel Bridge (USGS 03432100)
   - Site 2: Franklin–96E bridge crossing near Pinkerton Park (USGS 03432350)
   - Site 3: Harpeth River, Hillsboro Rd., just downstream of COF's STP (USGS 03432350)
   - Site 4: Harpeth River, Moran Road, just downstream of all 3 STPs (USGS 03432800)

4. **An October 6, 2014 Memo from Dorie Bolze, HRWA**, containing photos taken October 2-4, 2014, of algae growing in the Harpeth River at three locations: a short distance upstream of the COF STP outfall, a short distance downstream of the COF STP outfall, and a short distance near USGS Site 3-Hillsboro Road. This information provided the basis for the decision to undertake a full study; I plan to review the results of the study recently undertaken by other retained experts in this case of the nutrient sourcing (cause and contribution) as well as algal production at sites along the Harpeth River to determine the species successions in the dominant algal populations, *i.e.* taxa/biovolumes, throughout the 2015 Tennessee growing season; if necessary, I will update my report.

5. **2013 Proposed NPDES Permit**

6. **September 14, 2014: City of Franklin's new permit application to expand its wastewater treatment facility** from a 12 mgd facility to a 16 mgd facility with no increase in the mass loadings of BOD, TSS, nitrogen and phosphorus that can be discharged to the Harpeth River.

**7. January 14, 2014 CDM Smith Preliminary Design Report** for the proposed upgrading and expansion of the 12 mgd Franklin STP to a 16 mgd Wastewater Reclamation Facility (WRF). This Report was submitted to the City of Franklin's City Council. **The Design Report recommends the following improvements to the STP to transform it into a WRF.**

a. Construction of a new headworks structure with improved screening of the raw wastewater.
b. Improved grit removal through use of four 20 mgd vortex concrete grit removal structures with telescoping values to handle the discharged grit.
c. Construction of a 10 million gallon (MG) equalization to receive all influent flows greater than 33 mgd with gravity drainage of the excess flow back to the headworks for processing when the influent flow is less than the design flow of 16 mgd.
d. Construction of a new Biological Nutrient Removal (BNR) splitter box to reroute all four of the new 42 inch influent lines to the new BNR Anaerobic Zone. The return activated sludge (RAS) from the bottom of the Final Clarifiers will recycle back to this splitter for distribution to the Anaerobic Zone. The purpose of the Anaerobic Zone is to initial the first stage of biological phosphorus removal (BPR).
e. Conversion of a portion of the existing BNR basin volume to a fermentation zone to enhance BPR, followed by an anoxic volume for denitrification (biological removal of nitrate nitrogen). Each fermentation zone will be baffled into three cells in series and mixers will be installed.
f. An increase in the number of aeration blowers so that it will be possible to increase the DO concentrations to a high concentration than is now possible. With the increase in blowers, there will be a total of three blowers operating at all times with one blower in reserve, for a total of four blowers.
g. Replacement of the piping between BNR Basins 1 & 2 with a single 48 inch diameter pipe.
h. Installation of internal launders in the clarifier distribution box that feed each of the existing sumps. The launders will double the effective length of the existing weirs in the distribution box.
i. Replace the existing 24 inch diameter pipes feeding the clarifiers with 30 inch diameter pipes to reduce head loss.
j. Replacement of the settled water junction box with hard piping to reduce headloss.
k. Construction of a new UV disinfection system consisting of two channels.
l. Construction of an alum storage and feed system for simultaneous orthophosphorus removal for effluent polishing following BPR. The alum will be added into the final clarifiers for removal with the settled and wasted activated sludge.

m. Construction of a fats, oil and grease receiving, storage and blending system to mix the fats, etc. with the waste sludges and feed then to the anaerobic digester to improve biogas production.

**<u>Summary and Analysis of the Documents</u>**

**A. The Harpeth River is listed as impaired by both US EPA and TDEC because of low dissolved oxygen concentrations and excessive algae growth, conditions that are driven primarily by the excessive amounts of phosphorus entering the stream from both point and non-point sources of nutrients**

The Harpeth River, though designated as a Scenic River in some segments, is listed as **Impaired** by US EPA and TDEC because of low dissolved oxygen (DO) concentrations in some regions of the stream, particularly the headwaters, and high background concentrations of phosphate concentrations (TP) from the headwaters throughout the length of the River. The phosphorus has also stimulated the growth of phytoplankton (Algae) throughout many reaches of the River. Excessive growth of algae can be very detrimental to a stream, particularly a freshwater river like the Harpeth that experiences very low flows during the latter part of the growing season. During this time, phosphorus concentrations resulting from point source discharges increase dramatically as the point sources dominate the water entering the stream, and as the phosphorus concentrations increase because of the decrease in fresh water inputs. The increase in the phosphorus concentrations, assuming no other conditions are limiting growth, can cause rapid growth of algae, called blooms, and unsightly and detrimental conditions can develop in the River. Examples of unsightly conditions are first the development of a green color in the River, the appearance of algae growth along the shallow reaches of the shore of the stream, the development of floating algal mats on the surface of the water, and the development of filamentous algal forms attached to the rocks in free-flowing sections of the river. The photos taken during October of 2014, Item 3 (above), illustrate that these conditions are developing in the Harpeth during the Fall of the Year, at a minimum, and more likely are present during the Summers as well.

1. Algae growth is a primary cause of poor water quality in the Harpeth River and the growth of algae is limited by the amounts of phosphorus available to the algae.

Blooms of algae also cause other conditions in the water body that further worsen water quality. During photosynthesis growth, which occurs when algae are exposed to sunlight and other environmental conditions are not limiting to algae growth, the algae derive sufficient energy from photosynthesis to consume carbonates and bicarbonates in the water and use the carbons atoms as building blocks for organic compounds that can be used to product new algal cells. This will occur if all of the necessary nutrients needed for the construct of cells of that particular species are present, *i.e.* nitrogen, phosphorus, silica, sulfur, magnesium, potassium, etc. The elements needed in the greatest abundance besides carbon, hydrogen, and oxygen, are: first, nitrogen, then phosphorus, then silica, etc. Any one of these elements can be the limiting nutrient that will limit or prevent growth of the species of algae that are capable of dominating an algae bloom. When attempting to control algae blooms in freshwater bodies, *i.e.* rivers, lakes, estuaries or a shore section of coastal waters, it is essential to know which "nutrient" is the one limiting the growth of the nutrient if control of the growth is to be established. It also is important to understand which nutrient cannot be limited in the water body of interest.

2. There are detrimental effects of algal growth in surface waters that impair water quality and are harmful to aquatic life forms.

There are several additional side effects of algae blooms other than the development of unsightly conditions that can occur during photosynthetic growth. During rapid growth the algae consume the alkalinity in the water and increase the pH of the water to values as high as between 11 and 13. At the same time, they produce DO as a waste product and the DO concentrations in the water can become supersaturated, even to concentrations as high as 20 to 30 mg/L, two to three times greater than concentrations in equilibrium with the oxygen content of the atmosphere. Both of these conditions can be detrimental to fish and other aquatic animals, and even cause death. A chemical effect that can occur simultaneously is that the high pH values can solubilize the aluminum-bound phosphates attached or incorporated into the bottom sediments and the released phosphates will increase the supply of phosphorus available and further fuel the algae bloom. Further, when the sun goes down, the supersaturated DO starts dissipating in the absence of further generation by algae and the algae switch from producing DO to consuming DO for heterotrophic metabolism. During massive algae blooms, the DO can decrease to concentrations that will no longer support aerobic life forms. This can result in massive fish kills and detrimental effects to other life forms. This is most likely to occur in the early hours of the morning before the sunrise, when DO concentrations in the water will decrease to their lowest diurnal value. Therefore, the monitoring of DO during algal blooms can be highly misleading unless measurements are made before but near to sunrise.

3. The death of algae cells causes chemical changes in the water that further impair water quality.

Eventually the algae die and settle to the bottom of the water body and begin undergoing decomposition by aerobic organisms first, which consume DO and lower the DO concentrations, then by anoxic organisms using oxidized nitrogen ($NO_x$) as the electron acceptor in place of DO but maintain positive redox conditions in the water. After the $NO_x$ is fully consumed, redox potentials typical of anaerobic conditions prevail and the iron-bound phosphates in the bottom sediments become solubilized as ferric iron changes to ferrous iron, and additional phosphorus becomes available to fuel algae blooms.

4. Algae use photosynthesis for energy and inorganic elements as nutrients to product organic compounds that increase the biological oxygen demand (BOD) and chemical oxygen demand (COD) in the water, i.e. they produce greater amounts of oxygen demanding chemicals that can be used by microorganisms to consume the DO, and the

amount generated can exceed the amounts that are contained in raw sewage. Phosphorus has a considerably greater potential than nitrogen to stimulate algae growth

It is important to remember that algae create organic compounds out of inorganic elements during photosynthesis. In terms of water quality effects, when the needed nutrient(s), typically nitrogen (N) and phosphorus (P), are discharged into a water body that contains little or no organic matter (BOD), each pound of N and P has a specific potential to cause the production of BOD up to their stoichiometric equilibrium. Thus, each pound of the limiting nutrient for algae growth has the potential to produce biomass in accordance with its fraction of the chemical formula for algae. Because Nitrogen and Phosphorus are the nutrients needed in the most abundant amounts, it is important to know the chemical formula for algae. The ratios of carbon to nitrogen to phosphorus needed for the construction of an algae cell was first investigated by Alfred C. Redfield and his results first reported in a paper he published in 1934 in the James Johnstone Memorial Volume (Ed. R.J. Daniel), published by the University Press of Liverpool, England, pp. 177-192. Redfield gathered samples of algae from many parts of the World and determined the quantities of carbon (C), N and P they contained, and found that the ratios were essentially the same no matter where the algae were collected. He concluded from his initial effort that the molar ratio N to P was 20:1, but he continued to gather data and 22 years later he published a paper which corrected the ratio to 16:1, known as “The Redfield Ratio.” It is more completely expressed as 106:16:1, C:N:P. Because both hydrogen and oxygen are required for the formation of cellular biomass, the complete molecular formula for algae can be balanced accordingly and written in terms of phosphorus as:

$$\mathbf{C_{106}H_{263}O_{110}N_{16}P}$$

Because the other elements needed for algae growth are needed only as a fraction of one in this formula, they are not included in the molecular formula most of the time and are known as trace elements. They are rarely limiting for algae growth in most environments, and therefore, the primary limiting nutrients are N and P, and either N or P is normally the limiting nutrient for algal growth.  But, as you can see from the formula, P has a much greater potential to be the limiting nutrient rather than N, and most fresh water algal control efforts are directed toward the control of P. Estuaries and coastal waters may be an exception to this because such water bodies contain large deposits of sediment, and P is a very surface active substance, and sediments are likely to contain large amounts of P. This is not a problem in most cases if the water above the sediments contains either DO or $NO_x$, or both, but that is not typical of water bodies with large deposits of sediment and P is commonly recycled between soluble and insoluble states, and its abundance in the water column drives the growth system towards being nitrogen limited, particularly during warm weather when microbial activity is at its highest level.

The molecular weight for an algal cell, as shown by the Redfield formula, can be calculated from the formula above by using the molecular weights of the elements contained in the formula.

There weights are as follows: C = 12, H = 1, O = 16, N = 14 and P = 31. Multiplying by the number of each unit of element required yields:

C: 12 x 106 = 1,272 moles
H: 1 x 263 = 263 moles
O: 16 x 110 = 1,760 moles
N: 14 x 16 = 224 moles
P: 31 x 1 = 31 moles
Total Mole Wt. = 3,550 moles

Thus, one pound of P has the potential to produce 3,550 ÷ 31 = 114.5 pounds of algae.

By comparison, one pound of N has the potential to produce 3,550 ÷ 224 = 15.85 pounds of algae, only 13.84 % as much as one pound of P.

It can also be shown that it will take 142.75 moles of Oxygen to oxidize a pound of algae to $CO_2$, $H_2O$, $NO_3$ and $PO_4$. Thus, one pound of P has the potential to growth algae biomass with a total chemical oxygen demand (COD) of 142.75 pounds. COD is equivalent to BOD ultimate ($BOD_u$) when all of the organic matter present is biodegradable. This can be expressed in terms of mg/L if the water receiving the discharge has the same volume as the amount discharged. Thus, 5 mg/L of P discharged by a STP into a river or other water body has the potential to grow 5 x 114.5 mg/L = 572.5 mg/L of algae biomass, which would have a COD equivalence of 5 x 142.75 = 713.75 mg COD/L. That is more COD than municipal raw wastewater typically contains before treatment in a sewage treatment plant. In fact, the projected influent $BOD_5$ concentration for the proposed WRF is 212 mg/L, and this would be estimated as equivalent to about 425 mg/L COD by the BioWin Modeling Program. Now note that 5 mg/L is the summer time P discharge limit for the COF STP in the current NPDES Permit, and there is no limit during the winter time. Further, note that the proposed NPDES Permit for the upgraded and expanded WRF preliminarily designed by CDM Smith Consulting Engineers has a summer time P limit of 3.0 mg/L and no limit for winter discharges. Thus, the proposed permit authorizes the discharge of: 3.0 mg/L x 142.75 mg/L COD = 428.25 mg/L COD, which is nearly identical to the COD concentration that would be discharged to the Harpeth River by the COF if the raw wastewater received no treatment at all.

**B. The Tennessee Department of Environment and Conservation's Permit terms related to nutrient reduction and instream investigations are critical because the prior strategy for the restoration and protection of water quality in the Harpeth River were ineffective and insufficient.**

The phosphate mineral deposits in the upper reaches of the Harpeth Watershed contribute higher background concentrations of phosphate to the downstream sections of the River than is generically normal for free-flowing non-eutrophic streams. This is particularly noticeable during and after major storms that cause very high stormwater runoff events. For example, a major storm event occurred on May 4, 2011, which resulted in River flow in excess of 1600 mgd before it reached the COF STP outfall, and the total P loading carried by the flow was estimated to be slightly less than 8,600 lbs/d of P from a sample taken immediately upstream of the STP outfall. However, the P concentration measured in the grab sample taken at STP Sample Site #1 that day was only 0.63 mg/L. Two lesser storms that same summer resulted in TP concentrations of 1.3 and 1.2 mg/L measured at the same site. Nonetheless, long term monitoring by grab samples indicates that the background soluble P concentrations in the headwaters during dry weather flow is on the order of only 0.15 mg/L, much less than the concentrations entering the stream from both point and non-point sources of P. Although it is a maxim that PO4-P concentrations in the water column of free-flowing rivers should be kept below 0.1 mg/L TP to protect against phytoplankton (algae) blooms, it is just as certain than the amounts of TP from stormwater runoff and the effluent of the COF STP will be much more detrimental to the Harpeth water quality than the natural background concentrations, and do not justify attempts to control algae blooms by reducing nitrogen concentrations. Unfortunately, when the water quality strategy for the Harpeth River was developed by US EPA and TDEC, the NPDES Permit limits for N and P made it tempting to use N control strategy to control algal growth, and this strategy has been pursued by COF during the past design and operation of the STP. This strategy was continued in part by CDM Smith during the development of a preliminary design for the upgrades and expansion of the STP to transform it to a WRF. However, the new design does include changes designed to incorporate biological phosphorus removal (BPR) into the activated sludge treatment process, which is a significant change. But, as the proposed new NPDES Permit shows, the emphasis is still on the control of nitrogen discharges instead of phosphorus discharges. As a general rule, algae blooms in freshwater systems are controlled by limiting P inputs, rather than N inputs. Exceptions based on scientific analysis rarely occur and clearly are not applicable to the Harpeth River.

The Nutrient Management Plan (NMP) permit provision instructed COF to reduce both total P and total N inputs into the Harpeth. In response the COF provided a copy of parts of its Integrated Water Management Plan (IWMP or IWRP) Draft 2012, which, to my understanding, COF believes fulfills the intent of the NMP. However, I have reviewed many aspects of the IWMP and have not been able to identify any actions planned or undertaken since 2009 that are designed to reduce—or did reduce—the total P discharged to the Harpeth River. Instead, it appears that COF decided to follow a plan that was based on controlling algae growth in the Harpeth by controlling the TN inputs into the River. This plan was enabled by the TN and TP effluent limits in the existing NPDES Permit for the COF STP. The Permit has stringent TN and ammonia-N summer time limits of 5.0 mg/L TN and O.4 mg/L $NH_3$-N, whereas the summertime limit for TP is also 5.0 mg/L, even though algae require more than three times as much N than P to grow. It also is clear that the biological treatment process of the COF STP was designed and configured to reduce TN to low levels, but no provision was made for TP removal, even though it could have been easily accomplished by the by the addition of phosphorus precipitating chemicals, a very well-known wastewater treatment technology. The existing permit also limits only ammonia-N during the winter time, and requires no removal of either N or P during the winter months.

1. The decision to use an N control strategy to control algae blooms in the Harpeth has two major flaws that worsened water quality conditions in River rather than improved water quality.

Prior to the NMP permit provision, which is focused on both N and P, the decision to address the River's impairment by reducing N discharges from the STP was unfortunate because the strategy has two major flaws. The first is that, as previously discussed, P discharges have a larger potential for stimulating algal growth than N discharges, and this is true even if the differences in the concentrations typical of N and P in treatment plant discharges without nutrient removal are considered. For example, a discharge of 20 mg/L N has the potential to grow an algal biomass of 317 mg/L, whereas a P discharge of 5 mg/L has the potential to grow 572.5 mg/L of algal biomass. The second reason is that reducing N concentrations without reducing P concentrations commensurately can result in an imbalance in N and P concentrations that shifts the types of algae growing in the water body from non-toxic green algae to toxic cyanobacters, also known as "blue-green algae." This occurs because the blue-green algae are capable of fixing N directly from the atmosphere, which makes their growth independent of N concentrations in the water, and primarily dependent upon the P concentrations in the water. Because of the ability of the blue-green algae to obtain N directly from the atmosphere, they cannot be controlled by N removal, even to very low concentrations. However, there are two ways to limit their growth. One is to remove P concentrations to low levels, and the second is to make sure that the N to P ratio in the water body does not drop below the Redfield Ratio of 16 N to 1 P. The latter strategy assures that the desirable green algae have a chance to compete with and outgrow the undesirable blue-green algae. Blue-green algae are undesirable because they are not food for fish, they form long, sticky strands, and some produce highly toxic compounds that can kill animals such as dogs, foxes and cows that drink from the stream. They can also kill humans. Green algae also can occur in nuisance blooms, but are suitable for food for aquatic animals and do not form toxic compounds, so reasonable amounts (sub-blooms) of green algae are desirable rather than onerous.

There are already signs of the shift from green to blue-green algae in the Harpeth River in the vicinity of Franklin and the COF STP. The algal growths shown in the photos of Item 2, above, are characteristic of blue-green algae, and a sample from those growths sent to JoAnn Burkholder at North Carolina State was found to contain a blue-green called *Nostoc*. *Nostoc* forms a mildly toxic compound, but it indicates that current conditions in the Harpeth favor blue-green growth, and there is the potential for the growth of much more toxic forms to grow such as *Microsystis*, the most common filamentous form of high toxicity, *Selenastrum*, and *Anabaena*, the most toxic form.

While the Instream Monitoring provision of COF's NPDES permit was not specific to the issue of algae, the information TDEC directed COF to gather each year would have provided critical information to TDEC as it evaluated the proper effluent limits to comply with water quality standards.

2. The MOR data collected by the STP staff indicate that the STP effluent contributes a high percentage of the phosphorus entering the Harpeth through the growing season, and dominates the phosphorus sources during the low flow late summer and early fall and must be reduced to low concentrations such as 0.15 mg/L to improve water quality in the Harpeth.

The MOR data collected by the STP staff from May through October during the years of 2011 through 2014 indicate that during the growing season, the STP accounts for around 40 to 45% of the P transported down the Harpeth River past the site of the STP outfall. However, the STP discharges dominate the P entering the River during dry weather periods whereas most of the quantities of P from non-point sources is transported by a small number of high flow events that occur each year during the growing season. For example, based on the weekly MOR data collected in 2011, three storms transported 85% of the P past the STP outfall and on downstream. Those three storms were of such a magnitude that they surely attained scour velocity for most of the sediment collected on the bottom of the River and possibly on to some location far downstream, even as far as the Cumberland River. On the other hand, except for the loads transported by those three storms, the STP discharges accounted for nearly 45% of the P loads entering the River below the STP outfall during the entire growing season, based on the MOR data. It can be said that the STP truly dominates the P concentrations in the River during the Fall of the year when flows are low. For example, during October 1 & 2, 2014, the River flows measured at USGS monitoring station 03432350, located upstream of the STP at Franklin, averaged 3.4 cfs until a rainfall event early on October 3 and increased it briefly to 16.0 cfs followed by a steep decreasing slope until the flow had decreased to only 4 cfs the morning of the 5$^{th}$. It seems obvious that if the TP concentrations in the Harpeth are to be reduced sufficiently to control algae growth and the accumulation of organic matter in the Harpeth, then the P quantities discharged by the STP will have to be reduced substantially. Further, the operating procedures need to be modified to emphasize the removal of P instead of N. So, in addition to increasing the removal of P, the STP may need to remove less N, but they do need to accomplish complete nitrification so that the STP discharges oxidized N (nitrate) rather than ammonia. Note that adding nitrates adds oxygen equivalent resources to the water body whereas adding ammonia adds another oxygen consuming chemical to the water.

3. The existing STP operated by COF it could have been operated to discharge P concentrations lower than 0.3 mg/L by the addition of P precipitating chemicals such as ferric chloride and alum. Further, the operation of the denitrification filter with addition of an organic chemical has been detrimental to water quality in the Harpeth. It is useful for operation for the removal of effluent suspended solids but should be used as a filter only for future application.

The current biological process at the COF STP is an aerated oxidation ditch flow pattern type, preceded by an anoxic zone (contains nitrates, but is not aerated) that receives activated sludge recycle from the oxidation ditch to return nitrates back to the anoxic zone to accomplish denitrification using the BOD in the influent wastewater as the carbon source. The resulting configuration is defined as a Modified Ludzack Ettinger (MLE) biological nitrogen removal process. It is designed to remove nitrogen from the influent wastewater to concentrations less than 8 mg/L while taking advantage of energy savings through utilization of nitrates as an electron acceptor instead of DO, and through restoring alkalinity to the flow because of denitrification. The use of nitrate for BOD removal instead of DO also decreases the amount of waste activated sludge that has to be processed for disposal. While the MLE process is typically designed to removal nitrogen in the process effluent to concentrations less than 8 mg/L when treating municipal wastewaters, because the aerated process has an oxidation ditch type of flow pattern and utilizes surface aerators placed along the flow length, it also can be operated to remove substantial amounts of N within the aerobic zone and discharge N concentrations on an annual basis that average less than 4 mg/L, if desired. In addition to the MLE-oxidation ditch system, the final biological process in the treatment train is a denitrification filter for further removal of oxidized nitrogen ($NO_x$-N) using a carbon source such as methanol before disinfection and discharge to the River. This type of treatment train is appropriate for discharging effluents with very low N concentrations. However, the use of the treatment train to remove N to very low concentrations is detrimental to the water quality in a freshwater, free-flowing stream like the Harpeth River, particularly if P is not also removed to very low concentrations, as previously discussed. Apparently, the process has been operated in this manner for several years, *i.e.* more than a decade, at this point in time.

An appropriate recommendation is that the denitrification filter no longer be used for further removal of $NO_{\mathbf{x}}$, and that it be used for filtration only to accomplish removal of effluent suspended solids. A further recommendation is that the oxidation ditch portion of the MLE process be kept as aerobic as feasible to minimize denitrification in the aerated section.

It should be noted that if the objective had been to remove effluent phosphorus to low concentrations, such as below 0.5 mg/L TP, that could have been easily accomplished with the existing facility ever since the denitrification filter has been on-line and would remove suspended solids by filtration. In other words, the COF could have complied with its NMP Permit requirement in a number of ways that did not require capital investments and upgrades. For example, a P precipitating chemical such as ferric chloride or aluminum sulfate (alum) could have been added to the treatment flow immediately upstream of the final clarifiers and settled with the activated sludge. The waste activated sludge (WAS) could then be wasted from the return activated sludge (RAS) line to remove the phosphorus from the treated flow and send it to appropriate processing and final disposal.

The primary recommendation for current operation that could allow COF to comply with the NMP permit requirement in the short-term, and which should be implemented as the annual low flow period for the river is set to begin, is that a phosphorus precipitating chemical such as ferric chloride or alum can be added directly to the influent of the final clarifiers to reduce the discharged TP concentrations to less than 0.5 mg/L, and the STP can be operated in this manner until the upgraded and expanded modifications are completed and the proposed WRF is ready to come on-line. Addition of an appropriate polymer following addition of the precipitating chemical may be necessary for improved flocculation and settling of fines in the clarifiers prior to sending the flow to the denitrification filter. The denitrification filter should no longer be operated for removal of N, but should be operated simply to remove suspended solids from the effluent flow.

It also is recommended that, because the COF STP was operated for years without reducing the TP discharges, the COF STP's operation should be modified **as soon as possible** to mitigate the negative effects of this activity. It is further recommended that the COF adopt a 12 month a year effluent TP requirement of less than 0.5 mg/L. This is a reasonable action given that chemical phosphorus reactions are not significantly affected by low temperatures, and phosphorus can attach to sediment and accumulate in the bottom sediments all year long. If sediment accumulation is permitted to happen, the soluble phosphorus in equilibrium with the phosphorus attached or incorporated into the sediments can be sufficient to fuel massive algae growth at the beginning of the growing season when nitrogen is most abundant in the stream due to high stormwater runoff and low microbial activity during the winter months.

4. The Design of the Upgraded and Expanded COF WRF has the potential to be operated in a manner that will partially offset the past harm caused to the Harpeth River from COF's failure to control TP discharges in compliance with the Nutrient Management Plan and the Instream Monitoring Provisions, but it must be operated knowledgably and aggressively to achieve the desired results, and the performance should be verifiable.

The consulting engineering firm of CDM Smith, with offices located in Franklin, TN, has submitted a Preliminary Design Report dated January, 2014, to the COF. This Report recommends that the existing STP be modified for operation as a WRF, that the flow capacity be expanded from 12 to 16 mgd, and that the activated sludge process be modified from an MLE configuration to an A2/O configuration. The A2/O configuration will require the addition of an anaerobic zone (no DO and no $NO_x$) to each of the treatment trains for the purposes of accomplishing enhanced biological phosphorus removal (EBPR). It should be possible to operate the resulting treatment trains and obtain biological removal of both N and P in all trains. Each train will have separate basins for the implementation of both N and P in each treatment train so that treatment trains can be put into service or taken out of service depending upon the loading conditions. Biological Nutrient Removal processes operate best when loaded to near design conditions, so having the flexibility to take trains on and off line is valuable. Each train also will be equipped for feeding of a P precipitating chemical to the influent of the clarifiers to accomplish simultaneous precipitation of P in the MLSS, if needed to supplement EBPR. The A2/O BNR configuration, as designed by CDM Smith, should be able to product effluent concentrations of less than 8 mg/L TN and less than 1.0 mg/L TP using BNR processes only, *i.e.* without chemical addition to biological nutrient removal (BNR) to produce appropriate effluent concentrations. The denitrification filter should be retained to remove the TSS in the effluent to very low concentrations (less than 5 mg/L) to assure the projected effluent concentrations.

The CDM Smith design engineers used the proprietary BioWin Computer Design Program developed and sold by EnviroSim Associates, Ltd, Hamilton, Ontario, Canada, to assist with the selection, sizing and configuring of the WRF biological treatment system presented in the Preliminary Design Report entitled, "Franklin Wastewater Reclamation Facility Expansion," submitted to the City of Franklin, TN, January, 2014. This is a state-of-the-art Computer Design Program specifically developed for the design of biological processes for application to North American municipal wastewaters, but also capable of being adjusted for the specific characteristics of a known wastewater through determination of pertinent wastewater fractions. The design developed for the WRF should be very capable of meeting monthly average effluent concentrations of TN and TP less than 5.0 and 0.3 mg/L, respectively, if properly constructed and operated. With chemical addition for P removal, it should be capable of achieving effluent TN and TP values less than 3.0 and 0.15 mg/L, respectively, as an annual average, if operated knowledgably and aggressively.

The CDM Smith engineers used the BioWin BNR Computer Program to design the A2/O process for the proposed WRF, so the consultant investigated the proposed WRF design using BioWin version 4.1 to confirm the sizing of the reactors and then performed simulation to check the validity of the design. The simulations indicated that the A2/O process as designed should be able to achieve a TP concentration of less than 1.0 mg/L using EBPR, *i.e.* without addition of P precipitating chemicals, if appropriately constructed and operated. With chemical addition following full BNR operation and effluent filtration, it should easily achieve effluent concentrations of less than 0.3 mg/L TP, as an annual average, if operated knowledgably and aggressively.

I recommend that this configuration be operated with the denitrification filter used only for effluent filtration to remove suspended solids, and that the N removal process be operated to discharge at least 5 mg/L N in the effluent, and as much as 8 mg/L TN would be preferable, but the ammonia-N limits in the current permit not be increased. I further recommend that the EBPR process be operated to minimize the effluent TP, which should at least be less than 1.0 mg/L TP in the biological process effluent, and that chemical then be added as needed to achieve an effluent TP concentration of less than 0.3 mg/L as a yearly average. As a professional judgment, it should be potentially possible to operate this treatment system to achieve an effluent TP concentration as low as 0.1 mg/L. I further recommend that whether or not the COF's future NPDES Permit is revised to contain lower TP effluent limits, COF should adopt a twelve month a year effluent TP requirement of no more than 0.3 mg/ with a target of 0.15 mg/L as an annual average. This latter concentration is approximately the same as the dry weather TP concentrations in the headwater of the Harpeth River and will be essential for the control of algae blooms in the Harpeth.

There are several locations in the USA where effluent requirements lower than 0.3 mg/L TP have been mandated. This includes all of the plants located on both sides of the Potomac River in the vicinity of Washington, D.C., the plant serving Roanoke, VA, and several plants in the vicinity of Atlanta, GA. The most pertinent to the Harpeth River is a relatively new plant in Forsyth County, GA, immediately north of Atlanta. I recently participated in a court case where the court mandated an annual average effluent concentration less than 0.08 mg/L TP. A concentrated this low was mandated because it had been established that another Forsyth plant with the exact same technology had already established that it could maintain a monthly average of less than 0.08 mg/L over an extended period of time. There are many other plants in the USA in areas such as near Denver, Colorado, and along the Neuse River in North Carolina where concentrations less than 0.3 mg/L have been included in the NPDES permits.

When setting an effluent requirement for treatment plants discharging to the Harpeth, it should be remembered that phosphorus is a conservative element, *i.e.* it does not have a gaseous phase, plus it is very surface active, which means it readily attaches to sediment particles and settles to the bottom of quiescent zones in the stream, and remains there until it is scoured by high flows or the environmental conditions change to either high pH or anaerobic conditions. When this occurs the P becomes solubilized and is once again available for microbial metabolism, such as algae growth. Then, if the algae die while still in the stream they will settle to the bottom and increase the sediment oxygen demand (SOD). Microorganisms in the sediment layer will consume the biodegradable portions of the algal cells and consume the oxygen in the stream while doing so. This can result in anaerobic conditions in the bottom layers of the water column as well as the sediments, and result in very detrimental conditions in the River or other receiving water body.

The MORs filed by COF indicate that the effluent TP loads discharged by the STP have increased sharply during the past four years. For example, the average effluent TP load recorded in the MORs for the past four years are as shown in the following table:

| YEAR | Avg. pounds TP per Observation | % increase compared to 2011 |
|---|---|---|
| 2011 | 54.35 | = |
| 2012 | 56.39 | 3.75 % |
| 2013 | 106.62 | 96.2 |
| 2014 | 85.67 | 57.6 |

The comparison indicates that there was a large increase in the pounds per day of TP discharged during the growing season, as indicated by the MOR samples.  This is a matter of great concern. The results need to be checked for the entire year of all four years to see if it is verified. If it is, then it is obvious that COF made no effort to improve P removal at the STP at all during the past two years, which is not acceptable given the clear instructions by the NPDES Permit's Nutrient Management Plan.

Based on the results and discussion already presented, it is assumed that in an extra effort will be made by COF to comply with the NPDES Permit's Nutrient Management Plan, given the damage that has already been done. The COF should implement as quickly as possible the methods of improving the performance of the existing STP for P removal, that have already been mentioned in preceding passages, during this interim period before the WRF is ready to go on-line. COF also should seek for additional methods of restoring the balance between N and P in the Harpeth to avoid even worst conditions from developing before the WRF is ready to go online. For example, the monitoring equipment and SCADA systems being used should be reviewed by a knowledgeable consultant to see if updates are available that could be used to improve operation and performance.

5. Inaccurate Flow Metering and Questionable Data must be avoided to properly operate the treatment plant and have sufficient information to make operating decisions.

The Franklin STP has not been able to accurately measure its flow, according to TDEC's records and COF's written responses to compliance inspections. Based on my experience and education, it is my opinion COF STP's MORs and DMRs contain inaccurate calculations of the pollutant loads discharged into the Harpeth River.

It is my understanding that problems with the flow meters and sampling devices have been experienced at the STP, such as inaccurate influent and effluent flow measurements and inaccurate sampling of the influent wastewater. Such problems can prevent the COF from having sufficient information to make informed decisions regarding accurate performance of the STP's processes, and decisions about management of discharges. Accurate data is essential when making efforts to improve and protect the water quality of a receiving body of water. The data routinely collected should be sufficient for the development of accurate mass balances.

Referring now to the WRF proposal, a better description of sludge processing methods is needed for a firm understanding of the impacts of recycle flows on the performance of the biological and filtration processes. The current impact of the recycles should be investigated to see what might be done to improve STP overall performance and minimization of phosphorus inputs to the River. A study of the potential impacts of sludge hydrolysis, mentioned in the Preliminary Design Report, on the performance of the proposed WRF should be investigated, at least on a lab-scale basis, before it is installed and goes online.

Regardless, STPs should have accurate inflow and effluent meterings. Although STPs used to rely on flumes, there are now a variety of electronic detection methods, including measuring water surface flowing over a weir or through a pipe. According to TDEC's letters, COF has been measuring at the wrong spot in the plant for years. COF has a recycled flow, which affects all of its influent measurements and calculations. In other words, it is not that the monitor is broken, it is that it is placed at the wrong spot. Recommendations could include putting in a staff gage, which is extremely simple to do. In order to accurately place it you must do a survey, but this could have easily been done years ago.

On a related point, for some data that has been submitted, it is not always evident that it is complete. For example, I reviewed the materials COF sent to TDEC in February 2014 when COF reported that it "had 1 bypass of treatment in our old filters and 1 wet weather overflow in our settled water junction box." The report form indicated that the cause of the estimated 348,000 gallon bypass was "excessive flow caused blinding of denite filters" and the comment stated, "The denite filters blinded due to pin floc release from clarifiers and the tertiary filters too on too much flow." A separate report from the same day explained that the estimated 300,000 gallon overflow at the settled water junction box was caused by "excessive flow caused blinding of denite filters downstream of the settled water junction box." The February 2014 DMR showed no exceedances. When a bypass happens, one would expect to see elevated levels of suspended solids and coliforms in the effluent. It is possible that based on the time and location of the evaluations, actual pollutant exceedances in the discharges were not captured by COF and reported to TDEC.

6. Sewer Overflows must be avoided to avoid further deterioration of the Harpeth water quality. Remediation approaches should be defined and utilized as soon as possible.

Sewer Overflows must be controlled if the water quality in the Harpeth is to be restored and protected. The COF has experienced problems with the control of sewer overflows in recent years. These overflows are indicative of problems in the collection system, such as pipes that are inadequately sized for the flows they must transport, and pipes that have been broken or have collapsed structurally. A thorough inspection of the collection system should be performed by an outside organization skilled in collection system surveys, inspections and repairs. Then the recommendations resulting from the survey should be followed. Undersized and collapsed pipes that are detected should be replaced with larger and sound pipes and other repairs made as indicated by the results of the thorough survey. Smoke detection should be performed on the collection system to ensure that problem areas have not been missed.

I have reviewed the maps prepared by HRWA that summarize the overflows that have taken place in COF's collection system since 2009. Based on my experience, an accurate number of overflows that actually occurred during this time period cannot be determined when the system relies in large part on public reporting.

Based on the information made available to me, COF has considered upgrading its facility to include a 10 MGD equalization basin, which may minimize their overflows in the future, but this will depend in part on how well it is integrated it into their system. It should add capacity during stormwater events to capture the flow from the sewage collection system, store it, and then feed it back through the plant. However, to the extent that the COF is having and continues to have problems at the extreme ends of its collection system, this is likely a problem of insufficient planning and not putting in large enough pipes.

I reviewed EPA's Section 308 Report to COF, which states that COF was not properly keeping up with its records. It is important to maintain accurate records, both of overflow incidents and measures taken in response; I believe that these reports should be filed with a regulatory agency to ensure that the permittee is taking preventive and corrective measures to eliminate overflows from its system. Part of what should be known (but is not yet known about COF's system) is the actual quantification of the system's overflows and how much additional pollutant load such overflows are adding to the Harpeth River and its tributaries. If the overflows are quantified, it is possible that TDEC and EPA would discover that the pollutant load from the overflows is at or above the levels of the STP effluent. One way to properly quantify a system's overflows is to monitor the stream itself with a hydrograph. In the Occoquan River watershed, we monitor and sample the hydrograph of every storm that occurs and also take weekly samples to measure background concentrations between storms. Also, there are automatic monitoring stations at various locations in watershed which transmit the flow data back to the linked computer at the Lab. As soon as it starts raining, the automatic collection system starts collecting samples and compositing them. We monitor every stream and have hydrographs and loads across the hydrograph. It is also possible to place flow measuring devices (e.g., an "H flume") within a gravity sewer system in the effluent end of the storm sewers, which makes flow measurements by recorded changes in the water surface as the flow passes through the flume, so one knows how much flow went out of sewer.

Accurate measurements about pollutant loadings from overflows is a critical consideration when determining the impact on a waterbody, because simply looking at average numbers of overflows or similarly-sized systems does not address the potential damage to the particular stream affected by the overflows. I endorse the programs EPA recommended to COF for implementation in its Section 308 Report, but have concluded that it is not enough that COF establish the protocols. In order to prevent future overflows, they must invest in and make collection system upgrades, properly plan for future growth, implement the EPA-recommended programs, and demonstrate that they have achieved results.

7. <u>Instream Monitoring</u>

The failure to conduct sufficient continuous instream monitoring is exacerbated by the inadequate locations and timing where COF collects grab samples. First, taking samples during the daytime has the potential to record falsely high dissolved oxygen levels, because oxygen is being added by the algae present in the water, and such sampling will not capture the true daily swings and likely much lower levels that occur in the last hour or two before sunrise. Second, only looking 500 feet or meters downstream means one is unlikely to detect excessive algal blooms that are a result of the STP's effluent. In that short distance, you are unlikely to see the true disturbances to dissolved oxygen levels or the true impact of nutrients, because they do not have an impact until you get much further downstream and algae growth has peaked.

8. <u>Effluent Limit Exceedances (Ammonia and Toxicity)</u>

I reviewed COF's records reporting periodic ammonia exceedances and their statements that the causes of such exceedances have not been determined. I question whether something happened to the nitrifiers (*i.e.*, autotrophic bacteria, very slow growers and the smallest population in the activated sludge) but would need to see the STP's operating data to determine what happened, such as ineffectively controlling the biosolids residence time or encountering a dissolved oxygen problem. One of the quickest ways to stop or hinder nitrifiers is to deprive them of oxygen. Here, it appears that COF runs their carousel oxidation ditch system at 1 mg/l whereas most others run at a minimum of 2 mg/l. Another way to kill off nitrifiers is to introduce some toxic chemical into the system, though this is relatively rare. In the United States, we have been controlling what industries can discharge since the late 1970s. However, there are ways in which work in one part of the system can contribute to malfunctions in another. For example, if COF was killing roots in the sewers using a toxic chemical and used too much, it could inhibit or wipe out nitrifiers; if COF let the alkalinity (*i.e.*, food for the nitrifiers) get low, then nitrification quits, and if you run out of alkalinity, pH drops. The ammonia violations could also be related to COF's decision to use less than all of its oxidation basins. It is my opinion that if you do not know the cause of a problem, which appears to be true for both the ammonia and toxicity violations, you do not know what you are doing wrong, and you cannot fix or prevent it from recurring.

**C. Conclusions and Recommendations**

1. The decision to pursue the strategy of controlling algal blooms in the Harpeth River by reducing nitrogen inputs without reducing phosphorus inputs was a major mistake, and it indicates a gross misunderstanding of the respective abilities of nitrogen and phosphorus to stimulate algal biomass production, and of the dynamics of the of the nutrient requirements and growth interactions of green algae and cyanobacters (blue-green algae). The reduction of nitrogen without a commensurate removal of phosphorus has shifted the Redfield Ratio for nitrogen and phosphorus in favor of the growth of toxic blue-green algae in the Harpeth River.
2. The growth of blue-green algae in the reaches of the Harpeth downstream of the COF STP outfall has been confirmed both photographically and by genera typing.
3. The existing wastewater treatment facility serving the City of Franklin, TN, has an exceptional ability to remove nitrogen from municipal wastewaters, and it has been operated accordingly for the past few years. Unfortunately, the removal of nitrogen to low levels in the absence of commensurate phosphorus removal has been detrimental to the water quality in the Harpeth River.
4. The decision to install a denitrification filter in the treatment train of the COF STP was an unnecessary and self-defeating decision. The removal of nitrogen in the filter by the addition of an organic carbon source made it more expensive to operate, removed a nutrient that would have been helpful to the River as long as it was in nitrate form, and worsened the suspended solids removal by the filter because of the growth in the filter. The operation of the filters for denitrification should cease immediately, and the discharge of nitrates by the STP should be increased to a concentration of about 8 mg/L as a target, immediately.
5. It would have been both simple and easy to operate the system for phosphorus removal using the addition of phosphorus precipitating chemicals for addition of chemicals

directly into the activated sludge shortly before it enters the final clarifiers, but this was not done. It should be implemented immediately.

6. The phosphorus in the effluent of the COF STP is a major fraction of the phosphorus entering the Harpeth River during the summer growing season, and it thoroughly dominates the mass of phosphorus entering the River during the very low background flows that typically occur in the late summer and early fall of each year. It is crucially important that the STP effluent phosphorus be reduced to very low concentration (less than 0.15 mg/L) during that period of time. Virtually all of the phosphorus that enters the River during the low flow periods will be used primarily to support algae growth, except in wetland areas.
7. It appears that there has been reluctance at the COF STP to make modifications and purchase equipment that would have improved the data acquired through monitoring of flows.
8. There appears to be a considerable amounts of nutrients contributed to the Harpeth upstream of the STP outfall by soil erosion, sewer overflows and stormwater runoff flows. Very high loads can be transported downstream during heavy rainstorm events. These sources need attention and remediation efforts. If they have not already done so, the COF should develop a comprehensive non-point source control plan, and if they have, it should be implemented in the very near future.
9. The planned monitoring program that has been established by the Harpeth River Watershed Association is much needed and should contribute a great deal towards definition of the water quality problems in the Harpeth and information that can be used to develop and implement solutions. However, the results of the monitoring effort could be substantially enhanced by the installation and operation of flow monitoring equipment at all four stations rather than just two.
10. Because COF STP has not been accurately monitoring of flows in the plant, COF STP's MORs and DMRs contain inaccurate calculations of the pollutant loads discharged into the Harpeth River. COF STP could have easily—and should have—ensured accurate inflow and effluent meterings since TDEC first identified the issue.
11. An accurate accounting of overflow events from the COF STP collection system during the last five years cannot be determined because the system relies in large part on public reporting.
12. There are many possible explanations for the recurring ammonia exceedances and whole effluent toxicity test violations, but if you do not know the cause of a problem, you do not know what you are doing wrong, and you cannot fix or prevent it from recurring.
13. Accurate measurements about pollutant loadings from overflows is a critical consideration when determining the impact on a waterbody, because simply looking at average numbers of overflows or similarly-sized systems does not address the potential damage to the particular stream affected by the overflows. I endorse the programs EPA recommended to COF for implementation in its Section 308 Report, but have concluded that it is not enough that COF establish the protocols. In order to prevent future overflows, they must invest in and make collection system upgrades, properly plan for

future growth, implement the EPA-recommended programs, and demonstrate that they have achieved results.

Signed this 15th Day of May 2015,

*CWRandall*

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CLIFFORD W. RANDALL

**CASES IN WHICH I HAVE TESTIFIED DURING THE LAST 4 YEARS**

I have participated in two mediation sessions in the last 4 years, but have not yet testified in court. [redacted]

[redacted]

[redacted]

# APPENDIX A

## CURRICULUM VITAE

**CLIFFORD WENDELL RANDALL, PhD, DIST.M. ASCE, HON.M. AAEES**
**The C.P. Lunsford Emeritus Professor**
**Department of Civil and Environmental Engineering**
**Virginia Tech University (VPI&SU)**

**DATE OF BIRTH**: [redacted]    **NATIONALITY:** USA

**EDUCATION**:

| *Name of Institute* | *Year* | *Degree/Diploma* |
|---|---|---|
| University of Texas | January 1966 | Ph.D. (Environmental Health Engr.) |
| University of Kentucky | December 1963 | M.S.C.E (Sanitary Engineering) |
| University of Kentucky | June 1959 | B.S Civil Engineering |

## EMPLOYMENT HISTORY

__Academic And Professional Experience__

**Free-Lance Water Pollution Control Engineer Consultant**, with specialties in Municipal Wastewater Treatment, Biological Nutrient Removal Wastewater Treatment, Integrated Fixed-Film Activated Sludge (IFAS) Processes, Industrial Wastewater Treatment, Non-Point Source Pollution Control and Watershed Management
*2001-Present*

**The C. P. Lunsford Professor Emeritus**
*2001-Present*

**The Charles P. Lunsford Professor of Civil Engr.**, Virginia Tech
*1981-2001*

**Chair**, Environmental Sciences and Engineering Program, Virginia Tech
*Sept. 1979-1997*

**Division Leader**, Environmental Engineering Program, Virginia Tech
*Sept. 1979-1997*

**Founder and Director**, Occoquan Watershed Monitoring Program, Virginia Tech
*July 1972-2001*

**Professor**, Virginia Tech

*Sept. 1972-March 1981*

**Associate Professor**, Virginia Tech
*Sept. 1969-Aug. 1972*

**Assistant Professor**, Virginia Tech
*Feb.1968-Sept. 1969*

**Assistant Professor**, The University of Texas, Arlington
*Sept. 1965-Jan. 1968*

**Commissioned Officer**, U. S. Coast & Geodetic Survey (now Commissioned Corps of NOAA, Dept. of Commerce), Ensign 1959-61, LT(j.g.) 1961-62, Lieutenant 1962
*June 1959-Aug. 1962*

**Laboratory Technician**, Sewage Treatment Plant, City of Lexington, Ky.
*Jan. 1957-May 1959*

**SHORT-TERM POSITIONS**

Technical Lecture Tour, Costa Rica, Central America, Southern Baptist International Mission Board
*May, 1998*

Water Quality Evaluation Consultant, Zimbabwe, Africa, So'ern Bap. Intern. Mission Board
*May-June, 1996*

Water Treatment Plant Construction Director, Iringa, Tanzania, So'ern Bap. Intern. Mission Board *June, 1991*

Waterborne Disease Consultant, Tanzania and Kenya, So'ern Bap. Intern. Mission Board
*Nov.-Dec., 1990*

Lecturer, Shanghai College of Architectural and Municipal Engineering, and
*April-May 1987*

Wuhan University of Technology, Peoples Republic of China

Short-Term Consultant, World Health Organization, Geneva, Switzerland *Dec. 1983-Jan. 1984*

Assignment as Lecturer to the National Environmental Engineering Research Institute of India
Nagpur HQ, Hyderabad, Madras, Cochin & Bombay Regional Offices

Visiting Professor, Department of Civil Engr., University of Cape Town, S.A. *March-June 1983*

Water Supply Development Consultant to Kenya, Africa. So'ern Bap. Intern. Mission Board
*February-March 1983*

Project Director, Sludge Disposal Research, San Antonio River Authority, Texas
*June-Sept. 1967*

Aerobiology Research Specialist, U. of Texas Southwestern Medical School, Dallas, Texas
*June-Sept. 1966*

## PROFESSIONAL ASSOCIATION MEMBERSHIPS

**Distinguished Member**, American Society of Civil Engineers (ASCE)

**Honorary Member**, American Association of Environmental Engineers & Scientists (AAEES)

**Life Member**, Water Environment Federation (WEF), formerly Water Pollution Control Federation

**Emeritus Member**, International Water Assoc. (IWA), formerly Intern. Assoc. on Water Qual. (IAWQ)

**Emeritus Member**, Association of Environmental Engineering and Science Professors (AEESP)

**Life Member**, American Water Works Association (AWWA)

**Member**, Sigma Xi Research Honor Society

**Member**, Chi Epsilon Honor Society

**Member**, Phi Kappa Phi Honor Society

## HONORS, AWARDS AND RECOGNITIONS

- Hall of Distinction, College of Engineering, Univ. of Kentucky 2011
- Joan Hodges Queneau Palladium Award, Amer. Assoc. Engr. Soc. & Audubon Soc. 2010
- WEF/AEESP Lecturer, Water Envir. Federation Conference, Orlando, FL Oct. 2009
- Founders Award for Lifetime Achievements, Assoc. of Envir. Engr. & Science Professors 2008
- Distinguished Member, American Society of Civil Engineers 2007
- Leadership Award, Virginia Water Research Center 2006 Lifetime Achievement Award, Virginia Water Environment Association 2001
- Gordon Maskew Fair Medal for Achievements in Engr. Educ., Wat. Envir. Fed. 1998
- Deans Award for Excellence in Public Service, College of Engineering, Virginia Tec 1997

- Distinguished Service Award, Association of Environmental. Engr. Professors 1997
- Mathias Medal for Scientific Excellence, Chesapeake Research Consortium and the Sea Grant Programs of Maryland & Virginia (award was one of four given between 1985-2003) 1996
- Alumni Award for Excellence in Public Service, Virginia Tech 1996
- Salute to Excellence, Governor of Maryland 1994
- Research Achievement Award, Water Pollution Control Federation (now Wat. Envir. Fed.) 1991
- Academic Achievement Award, American Water Works Association 1980 & 1989
- Distinguished Service Award, USA National Committee, IAWQ (now Intern. Wat. Assoc.) 1988
- Citation for Contributions to the Construction Industry, Engineering News Record 1986
- Conservationist of the Year 1986, Chesapeake Bay Foundation 1986
- Service Award, Water Environment Federation 1985
- Arthur Sydney Bedell Award for Meritorious Contributions, Water Envir. Fed. 1984
- Phillip F. Morgan Cert. of Merit for Large-Scale WWTP Research, Water Envir. Fed 1982
- Recognition of Contributions to Envir. Engr, Educ., Assoc. of Envir. Engr. Prof. 1981
- Service Award, Association of Environmental Engineering Professors 1981
- Service Awards, Environmental Engineering Division, ASCE 1980 & 1981
- Past President's Award, Virginia Association, Water Pollution Control Federation 1977
- Meritorious Technical Paper Award, ASCE Nat. Conf. on Envir. Engr., Dallas, Texas 1969
- Ford Foundation Fellowship, Univ. of Texas, Austin 1964-65
- US Atomic Energy Com. Graduate Training Fellowship, Univ. of Texas, Austin 1963-65
- Phi Kappa Phi 1964
- Chi Epsilon 1964

**PROFESSIONAL SERVICE**

**President**, Association of Environmental Engineering & Science Professors 1995-96 Past-President, 1996-97; Vice-President, 1994-95; Secretary-Treasurer, 1979-80 (2 years) Board of Directors, 1978-80 & 1994-97; Newsletter Co-Editor, 1972-74

**President**, Virginia Water Environment Association, 1976-77; Vice-President, 1975-76; Board of Directors, 1971-77 & 1981-84; Federation Director, 1981-84

**Board of Control**, Water Environment Federation 1981-84

**Chair**, USA National Committee (USANC) for Representation to the Intern. Water Assoc. (IWA) 1986-88

**Senior Delegate to USANC**, 1980-88; Junior Delegate, 1978-80

**Governing Board**, International Water Association 1986-88

**USA Member**, Scientific and Technical Committee, IWA (one representative per member country) 1994-98

**Chair**, Nutrient Removal Specialty Group, IWA, 1992-96, Member, Management Committee 1988-98

**Chair**, Arrangements Committee, 16th Biennial Conference, IWA & Vice-Chair, Planning Com. 1986-92

**Editor**, Biennial Conference Report to US EPA: Proceedings of 13th & 14th IWA Conferences 1986 & 88

**Vice-Chair**, Water Pollution Engineering Committee, American Society of Civil Engineers 1992-98

**Thrust Area 3 Panel**, National Civil Engr. Res. Needs Forum, CERF, Wash., D.C., January 28-30, 1991

**Organizer and Chair**, Session 3.3, National Civil Engr. Research Needs Forum, Civil Engr. Research Foundation, Washington, D.C., January 28-30, 1991

**Chair**, Environmental Engineering Research Council, American Society of Civil Engineers 1989-90
*Past Chair,* 1990-93, *Vice-Chair*, 1988-89; *Control Group Member*, 1983-2000

**Session Organizer**, UPADI '90, XXI Convention, Pan American Federation of Engineering Societies 1990

**ASCE Delegate** to the USA National Committee (USANC) for representation to IWA 1978-88

**Chair**, Water Supply & Resources Management Committee, Envir. Engr. Division, ASCE 1977-78
*Vice-Chair*, 1976-77; *Control Group Member*, 1975-78

**Faculty Advisor**, ASCE Student Chapter, University of Texas, Arlington 1967

**APPOINTED POSITIONS AND PUBLIC SERVICE**

**Founder and Director,** Occoquan Watershed Monitoring Program & Occoquan Water Quality Laboratory. Appointed as Chair of the Occoquan Watershed Monitoring Program Subcommittee of the State Water Control Board of Virginia, effective July 1, 1972. Served until April 30, 2015. Currently serving as a member of the Subcommittee.

**Member, Scientific and Technical Advisory Committee (STAC) to the Executive Council Chesapeake Bay Restoration Project,** 1985-2006

Appointed by Governor of Virginia, 1984, 1986, 1988, 1990 & 1992

Initial Chair Elected by Committee Members, 1993-97
Chair, Available Technology Committee, 1985-2006
Chairman, Nutrient Limitations Committee, 1984-85
Member, Nutrient Reevaluation Strategy Work Group 1989-2006

**Member,** Nitrogen Removal Technical Advisory Committee, DC WASA, Blue Plains WWTP 2007-2008

**Member**, Science Advisory Committee of the Virginia Water Control Board 1991-Present

**Member**, Virginia/Israel Water Resources Conference Advisory Group 1988-1992

Appointed by Governor's office, 1988.
Virginia/Israel Water Resources Workshop, Jerusalem, Israel, 1989

**Member, Nitrogen Committee (1 of 10)**, New York City Department of Public Works, 1983-2003.

Oversee and review implementation of Nitrogen Removal at 6 WWTPs in Jamacia Bay and East River operated by New York City, Appointed by District Court. Task completed in 2003.

**Member, Blue Ribbon Panel (1 of 4)** for full BNR Implementation at the 80 MGD RM Clayton, 40 MGD South River and 30 MGD Utoy Creek WWTPs, Atlanta, GA, 1997- 2001.

Appt. by Mayor of Atlanta. Task completed in 2001.

**Member**, Tech. Advisory Committee for the Development of Nutrient Control Standards in VA

Appointed by State Water Control Board of Virginia 1987

**Member**, James River Water Quality Management Advisory Committee 1983-1988

Appointed by State Water Control Board of Virginia, 1983

**Member**, James River Water Quality Monitoring Committee 1983-1988

Appointed by State Water Control Board of Virginia, 1983.

**Member**, Virginia-North Carolina Technical Advisory Committee for the Chowan River Basin. Appointed by Virginia Secretary of Commerce, 1979 Served 1979-1983

**Member**, Virginia Chowan River Technical Liaison Committee 1979-1983

Appointed by Virginia Secretary of Commerce, 1979

**Member**, Virginia Board of Certification of Water and Wastewater Works Operators. 1979-86

Appointed by Governor of Virginia. 1979 & 1983

**Member**, USEPA Chesapeake Bay Pollution Abatement Committee 1977-78

**Member**, USEPA Training Grant and Research Fellowship Committee 1970-71

## SELECTED REPRESENTATIVE PUBLICATIONS

**Books**

***Biological Process Design for Wastewater Treatment*** (w. L. D. Benefield), Prentice-Hall, Inc.1980

***Stormwater Management in Urbanizing Areas*** **(**w. W. Whipple, et al.) Prentice-Hall, Inc. 1983

***Design and Retrofit of Wastewater Treatment Plants for Biological Nutrient Removal*** (Chief Editor & Co-author w/J. L. Barnard, and H. D. Stensel) Technomic Publishing Co. 1992

***USEPA Biological Nutrient Removal Manual, 2010 Edition*** w/ J. L. Barnard & H. D. Stensel Published by Cadmus Group, Inc., Vienna, Virginia (2010)

**White** Papers**, Chapters & Special Reports**

**White Paper (1975)**. Whipple, W., Jr., Berger, B. B., Gates, G. D., Ragan, R. M. and Randall, C. W., "The Impacts of Non-Point Pollution on Water Quality", Distributed by the Rutgers University Water Center and Published in Urbanization and Water Quality Control, edited by William Whipple, Jr., Proceedings No. 20, American Water Resources Association, June 1975. **Stimulated: (1) Modification of 208 Water Center funding to include nonpoint pollution, and (2) Development of the National Urban Runoff Program**.

**Position Report (1986)**. "Nutrient Control in the Chesapeake Bay," Authored and Edited by the Ad-Hoc Working Group on Nutrients, C. W. Randall, Chair and Editor. Endorsed and published by the Scientific and Technical Advisory Committee (STAC) of the Chesapeake Bay Program, 1986. 24 pages plus two appendices authored by C. W. Randall. **Established nitrogen as the primary limiting nutrient in the Chesapeake Bay Estuary, and introduced biological nutrient removal for point source controls in the Bay Watershed.**

***Chapter 8****, "Design of Biological Phosphorus Removal Processes" in Biological and Chemical Systems for Nutrient Removal*, **Special Publication, WEF, 1998**

***Final Report, WERF Project 96-CTS-4***. Sen, D, R. Copithorn, C. W. Randall and R. Jones (**1998**). Investigation of Integrated Fixed Film Activated Sludge (IFAS)/Hybrid Systems for Enhanced Nutrient Removal. Water Environment Research Foundation, December 16, 1998.

***Chapter 8****, "Technological Solutions" in* *CHESAPEAKE FUTURES: Choices for the 21st Century*, Edited by D.F. Boesch and J. Greer. **An Independent Report of the Scientific and Technical Advisory Committee (STAC) of the Chesapeake Bay Program, January, 2003**

**Total Publications of approximately 250 in Journals, Conference Proceedings, Project Reports and Journal Discussions. Approximately 140 Referred Publications.**

**PUBLICATIONS 2005 – 2014**

**1.** Sen, D., R. R. Copithorn and C. W. Randall (2005). "Operating Thresholds for Single Stage Nitrification in Municipal IFAS and MBBR Systems as Measured in Terms of Minimum Hydraulic Retention Times and Mixed Liquor MCRT." Proceedings, WEF Conf., Wash., D.C., Oct. 31 – Nov. 2, 2005.

**2.** Sen, D. and C. W. Randall (2005). "United Computational Model for Activated Sludge, IFAS and MBBR Systems." Proc.WEF Conf.,Wash.D.C, Oct.31-Nov.2 2005.

**3.** Randall, C.W. (2005). "Fundamentals and economics of biological nutrient removal wastewater treatment", Proc. 2006th Annual Meeting, Industrial Microbiology and Biotechnology (SIM), Session 5: Wastewater Technology: Nutrient-removing activities of bacteria and new discoveries. Baltimore, MD July 30 – August 3, 2005

**4.** Punrattanasin, W., A.A.Randall, and C.W. Randall (2006) "Aerobic production of activated sludge polyhydroxyalkanoates from nutrient deficient wastewaters", Wat. Sci. Tech. Vol.54, No. 8, pp.1-8, IWA Publishing

**5.** Randall, C.W. (2006) "Changing needs for appropriate excreta disposal and small wastewater treatment methodologies or the future technology of small wastewater treatment systems", Proc. Small Water and Wastewater Treatment Systems, pp. 1-6, (Wat. Sci. Tech., Vol. 48, no. 11-12)

**6.** Yagci, N., E.U. Cokgor, N. Artan, C.W. Randall and D. Orhon (2006). "The Effect of Substrate on the Composition of Polyhydroxyalkanoates in Enhanced Biological Phosphorus Removal", Environmental Engineering Department, Maslak, TR-34469, Istanbul, Turkey, 33 pages

**7.** Sen, D., C. Randall, W. Brink, G. Farren, D. Pehrson, W. Flournoy and R. Copithorn (2007). "Understanding the Importance of Aerobic Mixing Biofilm Thickness Control and Modeling on the Success or Failure of IFAS Systems for Biological Nutrient Removal", Proc., Nutrient Removal 2007, Session 11E on CD, WEF/IWA Speciality Conf.; Nutrient Removal: The State of the Art, Baltimore, MD, March 4-7, 2007.

**8.** Randall, C.W. (2007). "Development of a Safe Water Supply at Iringa, Tanzania" Session B: POU-Talk 4, Interactions at the Interface-Making the Connections Between Environments, Disciplines and Nations", July 28-August 1, 2007

**9.** Sen, D. and C. W. Randall (2008). "Improved Computational Model (AQUIFAS) for Activated Sludge, Integrated Fixed-Film Activated Sludge, and Moving-Bed Biofilm Reactor Systems, Part I: Semi-Empirical Model Development", Water Environment Research, 80 (4), 439-453.

**10.** Sen, D. and C. W. Randall (2008). "Improved Computational Model (AQUIFAS) for Activated Sludge, Integrated Fixed-Film Activated Sludge, and Moving-Bed Biofilm Reactor Systems, Part II: Multilayer Biofilm Diffusional Model", Water Environment Research, 80 (4), 624-632.

**11.** Sen, D. and C. W. Randall (2008). "Improved Computational Model (AQUIFAS) for Activated Sludge, Integrated Fixed-Film Activated Sludge, and Moving-Bed Biofilm Reactor Systems, Part III: Analysis and Verification", Water Environment Research, 80 (5), 633-645.

**12.** Stinson, B, M.Peric, D.Neupane, M.Laquidara, E.Locke, S.Murthy, W.Baily, S.Kharkar, N.Passarelli, R.DerMinassian, J.Carr, M.Sultan, G.Shih, J.Barnard, G.Daigger, D.Parker, C.Randall & T.Wilson (2009). "Design and Operating Considerations for a Post Denitrification MBBR to Achieve Limit of Technology Effluent NOx<1 mg/L and effluent TP<0.18mg/L", Proc. WEFTEC 2009, Session 69, Orlando, Florida.

**13.** Sun, L.P., Randall, C.W. & Novak, J.T. (2010). "The influence of sludge interchange times on the oxic-settling-anoxic process". Water Environ. Res. 82 (6), 519-520.

**14.** Randall, C.W., J.L. Barnard and H.D. Stensel (2010)**. *USEPA Biological Nutrient Removal Manual, 2010 Edition*,** Cadmus Group, Inc., Vienna, VA

**15.** Yagci, N, J.T.Novak, C.W.Randall, and D.Orhon (submitted 2015). "The effect of iron dosing on reducing waste activated sludge in the oxic-settling-anoxic process". Bioresource Technology, Ref: BITE-D-15-02178R1

## CONSULTING ACTIVITIES

Consultant to more than 100 Industries, Consulting Firms, Authorities & Municipalities 1968-present for water quality control, wastewater & water treatment, pollution abatement projects, etc.

Current Activities and Affiliations

City of Binghamton, NY Since 2014
Southern Environmental Law Center, Nashville, TN Since 2014
Biological Process Design Engineer, Atlatec Engineers, Inc. Monterrey, Mexico Since 2008
Biological Process Design Engr & Analyzer, Underwood Engineers, Inc. Portsmouth, NH Since 2000
Chemical Treatment Biological Effects, Sewer Science, Inc., Syracuse, NY Since 1996

Past Long-Term Clients

Advanced Wastewater Treatment Systems, Jacksonville, FL 2002-2008

| | | |
|---|---|---|
| Technical Consulting Group | San Juan, PR | 2002-2005 |
| Contracted Consultant | City of Atlanta, Georgia | 1997-2001 |
| BNR Consultant | Daewoo Construction Research Institute, Seoul, Korea | 1995-1996 |
| Contracted Consultant | CUNY/New York City Dept of Environmental Prot. | 1993-2003 |
| Contracted Consultant | Harza International, Chicago, IL | 1996-2000 |
| Contracted Consultant | Celanese Acetate, Inc., Narrows, VA | 1980-1998 |
| Process Dev. Consultant | NSW Corp., Nordenham, West Germany | 1987-2001 |
| Process Consultant | Innova-Tech, Inc., Valley Forge, PA | 1982-1990 |
| Treatment Consultant | United Piece Dye Works, Edenton, NC | 1970-1986 |

Selected Past Major Clients:

Black & Veatch, Kansas City, MO
United Water, Harrington, NJ
Dow Environmental Technology Center, Midland, MI
EXPO'98 Lisbon, Portugal
EXXON Corporation, Benicia, CA
Wastewater Technology Centre of Canada, Burlington, Ontario, Canada
R. Stuart Royer & Assoc., Richmond, VA
Eckenfelder, Inc., Nashville, TN
Union Carbide, Inc., Charleston, WV
Lemar S.r.l., Rome, Italy
Dupont de Nemours, Inc., Martinsville, VA
Dupont de Nemours, Inc., Waynesboro, VA
AlliedSignal, Hopewell, VA
Mead Corporation, Chillicothe, OH
American Cyanamid, Damascus, VA
Hercules, Inc., Radford, VA
Fieldcrest Mills, Inc., Eden, NC
Olin Corporation, Stamford, CT
Tennessee Eastman, Kingsport, TN
CH2M Hill, Inc., Corvallis, Oregon
Holly Farms, Inc., Wilkesboro, NC
U. S. Environmental Protection Agency, Training Grants Branch
World Health Organization, Geneva, Switzerland
Maryland Department of the Environment

# ATTACHMENT 2 TO RANDALL REPORT

**EXHIBITS ATTACHED AND REFERENCES TO EXHBIITS ALREADY IN THE RECORD**

A. 2013-12-18 EPA Letter re Overflows in Franklin & Compliance Inspection Report (ATTACHED)
B. 2005-05-24 CSO and SSO Compliance and Enforcement Conference (ATTACHED)
C. 2013-07-09 Franklin Compliance Evaluation Inspection Letter (ATTACHED)
D. 2013-07 Letter re June Selenium-Cyanide Testing (ATTACHED)
E. 2014-02-06 Franklin-Detection Limits Letter (ATTACHED)
F. 2014-04-14 Franklin Open Records Request (ATTACHED)
G. 2012 Franklin's Response to the 308 letter that precipitated the inspection (ATTACHED)
H. 2013 Bioassessment TN0028827 (ATTACHED)
I. Harpeth River BioSurvey Results (ATTACHED)
J. 2014-01-13 Franklin 60-Day Notice re CWA (CM/ECF Doc. 22-1)
K. 2013-07-12 Franklin to TDEC re June Selenium_ Cyanide Testing (ATTACHED)
L. 2014-02-06 TDEC to Franklin re Detection Limits (ATTACHED)
M. 2012-08-20-Energy Assessment (ATTACHED)
N. 2013-7-9 Franklin Compliance Eval Inspection letter (ATTACHED)
O. Integrated Water Management Plan (Draft 2012) (ATTACHED)
P. NPDES Permit - Franklin - February 2011 Modification (CM/ECF Doc. 22-3)
Q. Franklin STP Current Permit (2010), Addendum (CM/ECF Doc. 22-3)
R. Franklin STP Current Permit (2010), Provisions (CM/ECF Doc. 22-3)
S. Franklin STP Current Permit (2010), Rationale (CM/ECF Doc. 22-3)
T. 2013-04-23 Franklin STP Draft Permit (2013) (ATTACHED)
U. 2013-11-13 Franklin STP comments on permit (ATTACHED)
V. 2013-11-13 HRWA Additional comments on Harpeth NPDES draft permits (ATTACHED)
W. 2013-11-13 Liberty Creek Discharge and BOD demand by Global Environmental Nov 2013 (ATTACHED)
X. 2014-02-06 Bypass (ATTACHED)
Y. 2004 - Harpeth River Nutrient & D.O. TMDL (ATTACHED)
Z. Harpeth Dissolved Oxygen Data compilation 2000 to 2011 (ATTACHED)
AA. 2013-02 Biomontoring/Toxicity (2013) (ATTACHED)
BB. Av & Max Influent and Effluent 2013 months, Franklin STP (Excel spreadsheet) (ATTACHED)
CC. New Toilets Plugged to Franklin STP in 2013 o Franklin Wastewater Treatment Plant (ATTACHED)
DD. HRWA Memo on Overflows vs. Sewer Basin (ATTACHED)
EE. Sewer map Franklin pink 2013 overflows (ATTACHED)
FF. 2012-01-05 Email re: CBOD and Total N annual in December DMR (ATTACHED)
GG. An undated evaluation of Franklin's plant focused on its energy use (ATTACHED)
HH. Franklin's new permit application to expand its facility from 12 MGD to 16MGD (September 2014) (ATTACHED)

II. Preliminary Design Report for the Franklin Wastewater Reclamation Facility Expansion Project (January 2014) (ATTACHED)

JJ. Memo (City of Franklin) and Amendment to Franklin Wastewater Reclamation Facility Expansion and Upgrades (May 2014) (ATTACHED)

KK. An Excel spreadsheet (PDF) summarizing the City's Monthly Operating Reports' nutrient grab sampling data since 2011 (ATTACHED)

LL. Spreadsheets (native format) with Franklin nutrient grab data sampling in river and effluent from City's Monthly Operating Reports, as collated by HRWA (ATTACHED)

MM. A spreadsheet with a summary of the permittee's instream biosurvey results (2001-2013) (ATTACHED)

NN. HRWA's nutrient sampling report 2014 (ATTACHED)

OO. An internal memo about possible algae in October 2014 (ATTACHED)

PP. 2015-01-07 Letter from TDEC to City of Franklin (ATTACHED)

QQ. 2014-12-08 Letter from City of Franklin to TDEC (ATTACHED)

RR. Algae Study Protocol Materials (ATTACHED)

SS. 2015 Algae Study Plan (ATTACHED)

# APPENDIX C

## Statement of Compensation

[redacted]