901 Glencastle Way
Raleigh, NC 27606
7 December 2016

Mr. James M. Redwine
Director, Water Quality Protection
and Sustainability Program
Harpeth River Watershed Association
PO Box 1127
Franklin, Tennessee 37065

Dear Mr. Redwine,

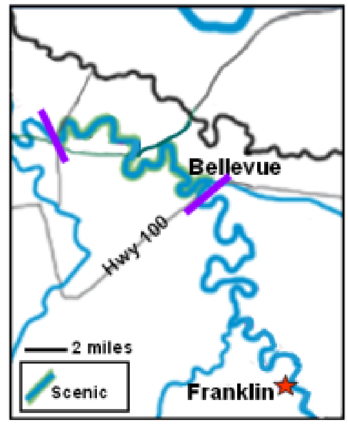
As you know, I submitted an assessment of the draft permit for the City of Franklin water reclamation facility (Franklin WRF) on the 21st of November. The assessment addressed three basic points: (i) the nitrogen and phosphorus pollutant levels allowed in the draft permit, which were not developed from technology-based effluent limitations or from water quality-based effluent limitations (WQBELs); (ii) the need to develop WQBELs for nitrogen (specifically for nitrate+nitrite, hereafter referred to as nitrate or NOx since nitrite is generally negligible in comparison to nitrate) and total phosphorus (TP) for the discharge from this WRF, considering both the pollutant concentrations and the pollutant (nitrogen-to-phosphorus) supply ratios; and (iii) the technology that is already available at the WRF, or could be installed with minimal modifications, which could significantly reduce the NOx and TP in the treated effluent to levels that met the WQBELs. Although I was asked by the Harpeth River Watershed Association to focus on the N and P levels in the draft permit as indicated above, I wanted to bring another issue of concern to your attention, namely, the impacts from the draft permit for the Franklin WRF on downstream Scenic River waters.

Only 13 rivers or river segments are included in the Tennessee Scenic Rivers Program, directed by the Tennessee Department of Environment and Conservation (TDEC) in cooperation with the Tennessee Wildlife Resources Agency (TWRA). This program is supposed to preserve and protect "unpolluted and outstanding scenic, recreational…values of these waters. The Harpeth Scenic River Complex, as a Tennessee Exceptional Water, is supposed to be afforded special protection under the *Rules of the TDEC* (Chapter 0400-40-03 – General Water Quality Criteria) which state:

> …new or increased discharges that would cause degradation of any available parameter above the level of de minimis and discharges of domestic wastewater will only be authorized if the applicant has demonstrated to the Department that reasonable alternatives to degradation are not feasible and the degradation is necessary to accommodate important economic or social development in the area and will not violate the water quality criteria for uses existing in the receiving waters. At the time of permit renewal, previously authorized discharges, including upstream discharges, which presently degrade Exceptional Tennessee Waters above a de minimis level, will be subject to a review of updated alternatives analysis information provided by the applicant….In waters identified as Exceptional Tennessee Waters, an activity that would cause degradation of habitat above the level of

de minimis will only be authorized if the applicant has demonstrated to the Department [TDEC] that reasonable alternatives to degradation are not feasible…."

The Harpeth Scenic River Complex begins only about 22 river miles downstream from the Franklin WRF at the Highway 100 bridge (see map at right). There is no question but that the Franklin WRF, under its present permit, is degrading the water quality and aquatic habitat of the Harpeth Scenic River Complex, considering these points:



- *Nitrate is at high levels in the treated effluent* (1,320 micrograms per liter [µg/L], averaged during 2009-2015), relative to natural background (reference) levels according to the U.S. EPA (2000; 610 µg NOx/L).

  Nitrate is a form of nitrogen that is readily available for uptake by algae (Wetzel 2001). Nitrate can stimulate algal blooms when added to surface waters, and it is an excellent metric in predicting nutrient limitation of algae (Morris and Lewis 1988), and an important form of N that supports noxious algal blooms (Ambrose et al. 1988, Biggs 2000). Importantly, nitrate is highly soluble and can travel long distances – hundreds of miles – to stimulate algal blooms in downstream waters (Mallin et al. 1993, Houser and Richardson 2010, Houser et al. 2010). Clearly, the ~22 river miles from Franklin to the Harpeth Scenic River Complex are a small distance for nitrate to travel. *Excessive nitrate from the Franklin WRF is contaminating this Scenic River.*

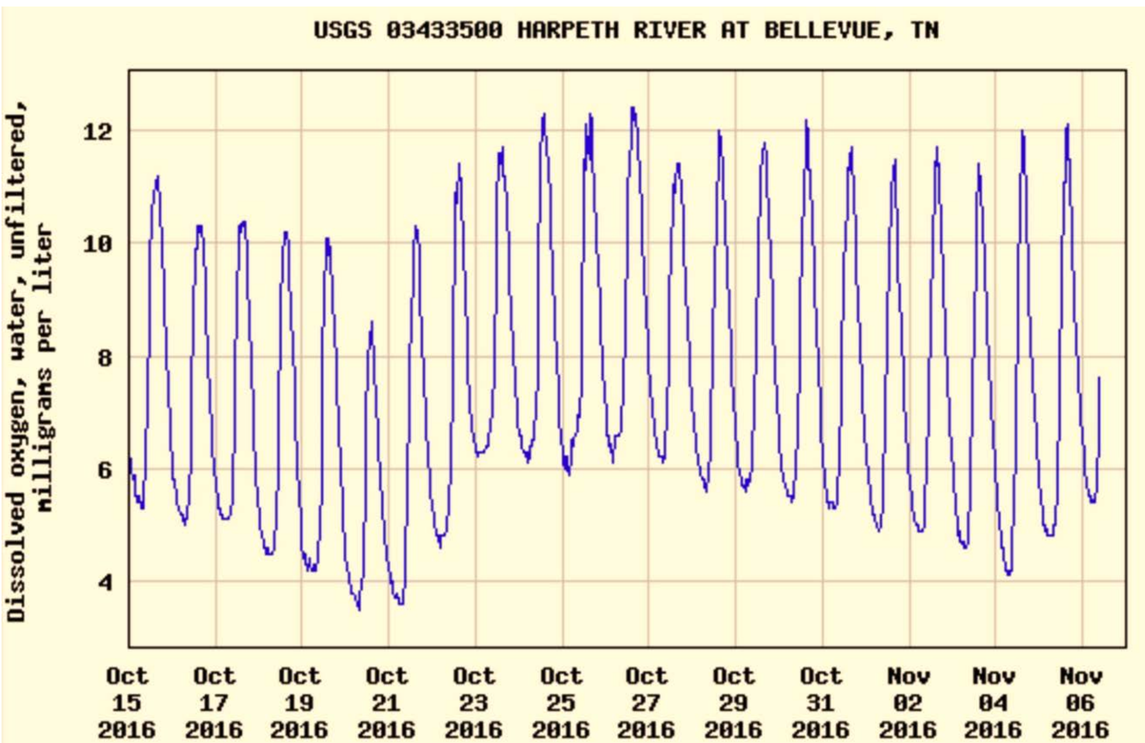
- *Phosphorus is also at high levels in the treated effluent*. While the draft permit would reduce the TP to about 1,300 µg/L, that concentration is still about 7.5 times higher than natural background levels according to my analysis (170 µg/L; Burkholder assessment, 21 Nov. 2016, based partly on TDEC's data) and the U.S. EPA (2000; maximum 160 µg/L). Nearly all of the P in treated effluent is *phosphate*, the form of P that is rapidly available to fuel algal growth (Reynolds and Davies 2001, Wetzel 2001, Peters and Bergmann 2011). Rivers that receive high P enrichment mostly from sewage are much more vulnerable to the adverse impacts of P pollution, because most of the P is highly available phosphate (Young et al. 1982, Ekholm and Krogerus 2003, Millier and Hooda 2011). The P supplies in sewage-affected systems are much more potent in causing adverse impacts (Jarvie et al. 2006).

- *A major portion of the Harpeth River's flow is Franklin WRF effluent.* According to calculations from USGS's gage 0.9 river miles downstream of the Franklin WRF, in October 2016 approximately 55% of the river's flow is comprised of effluent from the Franklin WRF. Approximately 22.9 river miles downstream, at Bellevue, approximately ~28% of the river flow consists of treated effluent from the Franklin WRF. During low flows, there is little addition to the river's flow, and the river loses flow to shallow groundwater. In October 2016, the river flow below Franklin only doubled, which is a relatively low amount. Accordingly, at the Highway 100 USGS gage site, the Franklin WRF effluent was still approximately 28% of the river's flow.

- *Risks of increased impacts on downstream segments are greater as well*: Large dissolved phosphate loads from treated sewage can saturate stream communities and depress nutrient retention efficiency (Marti et al. 2004). Thus, surface waters dominated by P inputs from point sources have been shown to need strengthened protection because of their enhanced vulnerability to high inputs of bioavailable P (Bowes et al. 2010, Neal et al. 2010).

  Phosphate is not as soluble as nitrate, as it tends to adhere easily to sediments and other particulates (Wetzel 2001). Nevertheless, when "river" flow during low-flow conditions is almost entirely compose of treated sewage, such as the Harpeth River in the vicinity of, and downstream from, the Franklin WRF, substantial phosphate from the discharged sewage can be expected to contaminate downstream segments such as the Harpeth Scenic River Complex (see Houser and Richardson 2010, and references therein).

- *There is compelling evidence that the excessive NOx and phosphate from the Franklin WRF is degrading the Harpeth Scenic River Complex*. During a low-flow period from 15 October



  to 6 November 2016, the USGS gaging station (#03433500 - Bellevue) at the Highway 100 bridge recorded the following dissolved oxygen (DO) conditions.

  The data show extreme diel variations (changes over 24-hour periods), referred to as diel "swings." Such patterns are caused by very high algal photosynthesis during the daytime, when algae produce oxygen. At night, however, algae have to breathe as do other biota; they no longer can produce oxygen without sunlight, and instead they use much of the oxygen in the water for their respiration (Wetzel 2001). They can even drive the DO concentration down to levels that physiologically stress aquatic life. This condition, with DO levels at ~4 milligrams per liter (mg/L) or less, is referred to as hypoxia (Diaz 2001).

Note the conditions during October 20-21 in the above graph, clearly showing hypoxic DO concentrations.

Another stress indicated by the graph is the extent of the diel variations. Diel swings of more than ~3.5-4 mg/L can stress and kill beneficial aquatic life (Heiskary et al. 2010, and references therein). The diel swings affecting the Harpeth Scenic River Complex at the Highway 100 bridge were excessive, as high as 6-8 mg/L. Overall, the data from this graph indicate that the Harpeth Scenic River Complex has been adversely affected by noxious algae which, in turn, have caused extreme diel DO swings and habitat degradation for beneficial aquatic life. Such algal blooms develop when strongly stimulated by nutrient pollution, and a major source of that NOx and phosphate pollution is the Franklin WRF.

- *There is additional evidence that excessive nutrient contamination is already fueling downstream algal overgrowth.* As examples from late October 2016, first, in the Harpeth River just upstream from the Highway 100 bridge where the USGS Bellevue gage is located, filamentous green algae were growing densely in the middle of the river, presumably on a shallow gravel or rock bar, over an estimated distance of 70-120 feet and ranging in width from 5-10 feet. River discharge, as observed at a location ¼ to ½ mile upstream of this location area, was extremely low, with water in only 20-25 feet of the river channel and averaging less than 6 inches deep. Second, at the Highway 70S bridge at Gossett Track section of the Harpeth River State Park, the attached photograph was apparently taken. Filamentous green algae are known responders to nutrient pollution (e.g., Burkholder 2009 and references therein).

Thank you for considering these additional comments about downstream impacts of the treated effluent from the Franklin WRF, and the need for much higher effluent quality (much lower NOx and TP) than would be allowed by the draft permit.

Sincerely,

JoAnn M. Burkholder

JoAnn M. Burkholder, Ph.D.

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