WATER QUALITY ANALYSIS

HARPETH RIVER
BETWEEN FRANKLIN AND KINGSTON SPRINGS
TENNESSEE

FOR:

HARPETH RIVER WATERSHED ASSOCIATION
FRANKLIN, TENNESSEE

PREPARED BY:

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SEPTEMBER 2006

INTRODUCTION

AquAeTer, Inc. (**AquAeTer**) is pleased to present our findings from our review of available data and reports for the Harpeth River water quality issues and how they relate to water withdrawal scenarios proposed for drinking water and for the three sewage treatment plants whose permits are up for renewal this fall for the first time since the United States Environmental Protection Agency (USEPA) Total Maximum Daily Load (TMDL) was finalized in 2004.

AquAeTer was first charged with determining the effect of water withdrawal at different flow schemes on the Harpeth River. As part of the total water balance in the basin, which has to be looked at as part of the water available for water supply, we also looked at the effects of water withdrawals on wastewater assimilative capacity. In doing this, we reviewed the WASP model results from the USEPA TMDL and in the TMDL report. We reviewed available dissolved oxygen (DO) and flow data for the Harpeth River that had been most recently collected by the USEPA, the Tennessee Department of Environment and Conservation (TDEC), and the Harpeth River Watershed Association (HRWA) and historically by Sulkin.

SUMMARY OF FINDINGS

The field DO data that have been collected demonstrate that the Harpeth River has been in violation of the DO standard of 5 mg/L at various times, specifically during low-flow warm summer months. At the time of these water quality violations, point source dischargers were discharging to the Harpeth River within their current permit limits. The Clean Water Act does not allow point source dischargers to degrade the water quality of a stream below the accepted water quality standard(s) nor are they allowed to further degrade the water quality in a stream that is not meeting water quality standards.

The USEPA model has shown that the water quality standard is not being met even when the flow in the river coming to the Franklin Publicly Owned Treatment Works (POTW) is 17 cfs, which is two orders of magnitude higher than the 7Q10 low flow of 0.3 cfs at which the standards must be met.

The sediment oxygen demand (SOD) rates measured by the USEPA are in line with rates that one would expect on a river like the Harpeth River. They are not extraordinarily high. The SOD did not cause the diurnal swings in the data measured by the USEPA and TDEC, nor was it the main reason the DO dropped below 5 mg/L.

Although non-point sources, such as runoff from over-fertilized yards or failing septic systems, should be controlled, they do not cause large drops in DO during low flow events when non-point sources are not likely affecting the River.

It is noted that the Franklin POTW is producing a high quality effluent that has been shown to meet lower effluent concentrations than its current permit limits (USEPA, September 2004). Effluents from POTWs typically cause a DO sag in the receiving body of water in the immediate area of their effluent discharge. However, since the Franklin POTW is meeting such high treatment standards, the area of its effect is extended downstream. The USEPA and TDEC data show the effects of the Franklin POTW and the two sewage treatment plants, Lynwood and Cartwright Creek, extending past Harpeth River Mile (HRM) 45. The USEPA model has confirmed this.

Any water withdrawal management plan must take into account its effect on the assimilative capacity of the Harpeth River. The summer months when low flow and higher temperatures occur are critical conditions. If water is removed for the drinking water plant during these critical conditions, then the assimilative capacity of the river is also lowered, and therefore, the three sewage treatment plants must also remove loadings to the river or meet much more stringent effluent standards, or cease discharge to the River at current effluent loadings and flows.

FIELD DATA REVIEW

Harpeth River Flow as a Percentage of Effluent

During critical low flow events, a high percentage of the flow in the Harpeth River is effluent from the Franklin Publicly Owned Treatment Works (POTW) and the two sewage treatment plants (STP) not too far downstream in the Grassland area of Williamson County. A good rule of thumb when choosing a body of water for receiving treated effluent is to ensure that the effluent flow is less than 10% of the total flow in the receiving stream. Estimations of the percentage of flow that is effluent can be made using the available flow data from USGS gages in the area, specifically: **1)** USGS gage #03432350 Harpeth River at Franklin; **2)** USGS gage #03432390 on Spencer Creek at Franklin; and **3)** USGS gage #03432400 Harpeth River below (downstream from) Franklin. By subtracting the flows at the first two gages from the flow at the third gage, an estimation of the effluent flow from the Franklin POTW can be made. This method gives fairly reliable results when the Harpeth River flow is low, but should not be relied on for all situations. The period from July 25, 2002 through September 8, 2002 was analyzed to overlap the time period when the TDEC diurnal studies for August and September 2002 occurred. The average percentage of effluent for this time period was 28.9% and during these time periods, the DO standard was consistently violated. A graph of these data is presented in Figure 1. The percentage of effluent would be dramatically higher if Franklin had been discharging at its current permitted flow of 12 mgd, for an average of 69% effluent in the River downstream from the Franklin POTW during the same period. If the Franklin POTW were to discharge 6 mgd at the 7Q10 low flow condition of 0.3 cfs, the Harpeth River would be 97% effluent following the discharge. At the full permitted flow of 12 mgd, the Harpeth River would be 98% + at the 7Q10 low flow condition. The Harpeth River is an effluent dominated stream.

The USEPA has collected data which basically confirms this. In their April 2001 study results presented in Table 5 of the TMDL report (USEPA, Sept 2004), they provide flow data in April showing that the Franklin POTW contributes 6.18 cubic feet per second (cfs) to the total flow measured downstream at HRM 84.4 of 213 cfs, or 2.9%. In contrast, in the August 2000 study results presented in Table 4 of the TMDL report (USEPA, Sept 2004), they show that the Franklin POTW flow was 4.96 cfs and the flow at the downstream station at HRM 84.4 was 9.0 cfs. This means that during their August 2000 field study, the Harpeth River at HRM 84.4 was 55% effluent. A similar calculation shows that the River was still 40% effluent downstream from Lynwood STP at HRM 76.0. These calculations are presented in Attachment 1.

<u>Harpeth River Dissolved Oxygen</u>

The USEPA, the Tennessee Department of Environment and Conservation (TDEC), and the Harpeth River Watershed Association (HRWA) have collected dissolved oxygen data on the Harpeth River at various locations. Each field study conducted in August or September shows that the Harpeth River is a water-quality impaired stream.

The TDEC study in August 2003 showed an extremely severe violation when the DO measured at HRM 84.4 as previously presented in Figure 1, downstream from the Franklin POTW was less than 5.0 mg/L for 11 days and less than 0.5 mg/L for 5 days. The DO is shown to never rise above the DO water quality standard of 5 mg/L during this time frame. It is noted that DO concentrations less than 1 mg/L should be considered estimates since sulfide (created under anaerobic or anoxic stream conditions) causes a positive interference. That is, sulfide will record as a DO concentration. When the DO in a stream is kept at a DO concentration of less than 2.0 mg/L, the stream can start becoming anaerobic followed by anoxic or aseptic. Under these conditions, human health may be at risk for a stream designated as a recreational water body and fish kills are possible for a stream designated as aquatic use habitat.

Aside from water quality violations downstream, the data collected by the USEPA (TMDL, Sept. 2004) and the TDEC show that water quality is not consistently being met on the Harpeth River coming to the Franklin POTW. Under these conditions, the Franklin POTW should not be discharging to the Harpeth River, even if they are meeting and/or exceeding their NPDES permit requirements. The same is true for both Lynwood STP and Cartwright Creek Utility STP. If the water quality is not meeting the dissolved oxygen standard upstream from each discharger, then that discharger should not discharge to the Harpeth River.

The antidegradation rule in the Clean Water Act (40CFR131.12) specifically states the following: “Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.” Therefore, none of the point source dischargers is allowed to cause the stream to either fall below water quality standards or cause it to be further degraded when it is already below water quality standards. The federal antidegradation rule is provided in Attachment 2. Tennessee's antidegradation rule is provided as standard boilerplate in permits along with the permittee's liability. Both are provided in Attachment 2.

Tennessee water quality regulations call for a strict standard of 5.0 mg/L of DO at any time in the water. It should be noted that other states do allow for a diurnal swing that drops to a daily minimum of 4 mg/L for a specified time during the day. However, no state regulations allow the DO concentration to remain close to 0 mg/L for days in streams designated as a recreational and aquatic use habitat such as the Harpeth River.

REVIEW OF USEPA "FINAL ORGANIC ENRICHMENT/LOW DISSOLVED OXYGEN TOTAL MAXIMUM DAILY LOAD (TMDL) FOR WATERS IN THE HARPETH RIVER WATERSHED" DOCUMENT

The USEPA has developed a water quality model for the Harpeth River between HRM 88.1 (in Franklin) and HRM 32.1 (in Kingston Springs) as part of its effort to determine the total maximum daily load of the Harpeth River. The model is a hydrodynamic water quality model, meaning that varying hourly flows and conditions were input into the model.

Critical Flow Condition

When the model was calibrated, the USEPA reviewed the results and determined that the critical time period in the model was August 24, 2000 at 16:00 or 4:00 PM CDT. They then ran the model using various loadings to determine how the river could meet the water quality standards at the critical condition. It should be noted that water quality standards must be met in Tennessee at a flow equal to or greater than the 7-day, 10-year statistical low flow (7Q10) event upstream from the discharge point. The 7Q10 for the Harpeth River coming to the Franklin POTW is 0.3 cfs, as reported by the USGS. For the critical condition that the USEPA used, the flow coming to the Franklin POTW was 17 cfs.

Analysis of Loadings

Presented below is Figure 16 from the TMDL report for the Harpeth River (USEPA, 2004). The USEPA looked at several cases in this graph. If one looks at the case labeled "Current Conditions" and the case labeled "Current Conditions No Franklin", the Franklin POTW is shown to cause a maximum DO drop of approximately 2.2 mg/L, even at 17 cfs background river flow (calculations presented in Attachment 1). The model is showing that the Franklin POTW has a large impact on the Harpeth River on the entire stretch of the river downstream from their discharge, not just in the immediate vicinity. In the model during this critical condition, Franklin was discharging a maximum loading of 225 pounds per day (lb/day) of ultimate biochemical oxygen demand (BOD_u). This is equivalent to a 5-day biochemical oxygen demand (BOD_5) loading of 42.4 lbs/day. The current Franklin permit is for 500 lbs/day of BOD_5. Therefore, the model shows the DO drop caused by BOD is at flows higher than the 7Q10 flow and at less than 9% of the Franklin POTW's permitted load. The model shows that the water quality standard for DO cannot be met even when the Franklin POTW is meeting an extremely efficient treatment standard of 1.0 mg/L BOD_5 (determined from Table 4 of USEPA TMDL report). This means that even though the Franklin POTW was achieving better treatment than required by their permit, the water quality standard was not being met in the Harpeth River.

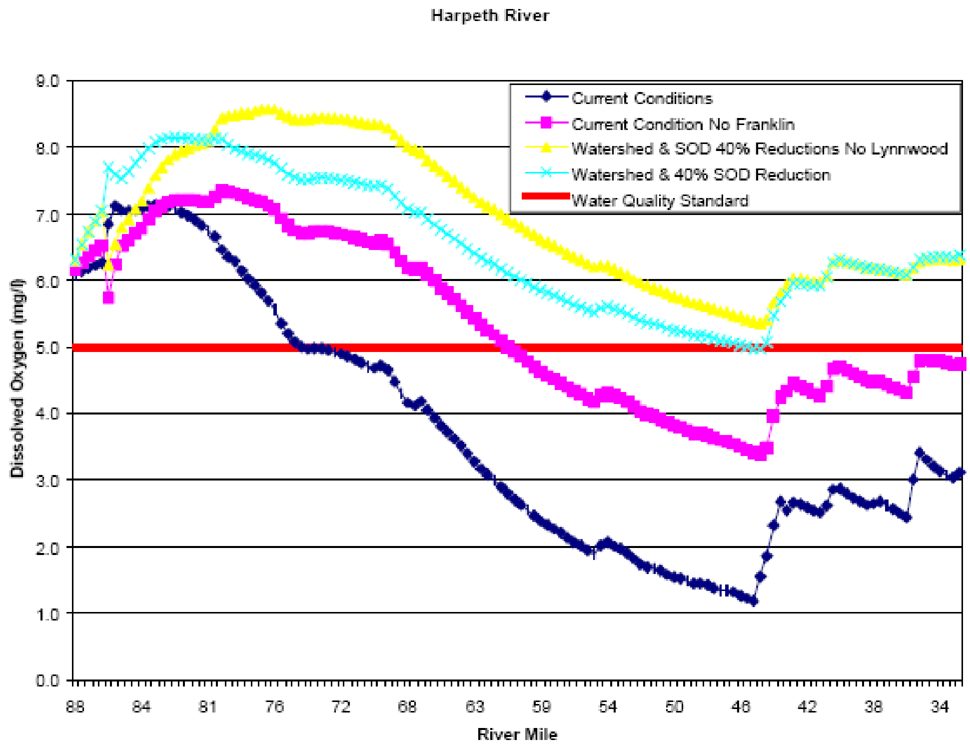


Figure 16 Predicted DO levels versus Pollutant Reduction Scenarios at Critical Conditions

Two additional cases, labeled "Watershed and 40% SOD reduction" and "Watershed & SOD 40% Reductions No Lynnwood" are also presented in Figure 16. From these two curves, one can see that the Lynwood STP causes a maximum reduction of approximately 1.0 mg/L of DO in the Harpeth River. The calculation for this is provided in Attachment 1. It is important to note that these two cases assume no Franklin POTW effluent discharge as well. In other words, in order for the stream to meet water quality standards, the SOD would have to be reduced by 40% and the Franklin POTW would not be able to discharge to the stream. It is noted that there is no practical or economical method to reduce SOD in the Harpeth River. In fact, the SODs measured in the Harpeth River by the USEPA are well within expected parameters and are quite low. It is also noted that SOD impacts to the water column DO concentrations increases as depth decreases. Lynwood and Cartwright Creek substantially add to the severity of the DO sag in an impaired reach of the River. The Tennessee water quality standards do not allow for a DO concentration of less than 5 mg/L at any time. The model shows that the Franklin POTW is not the only point source that has an effect on the water quality in the

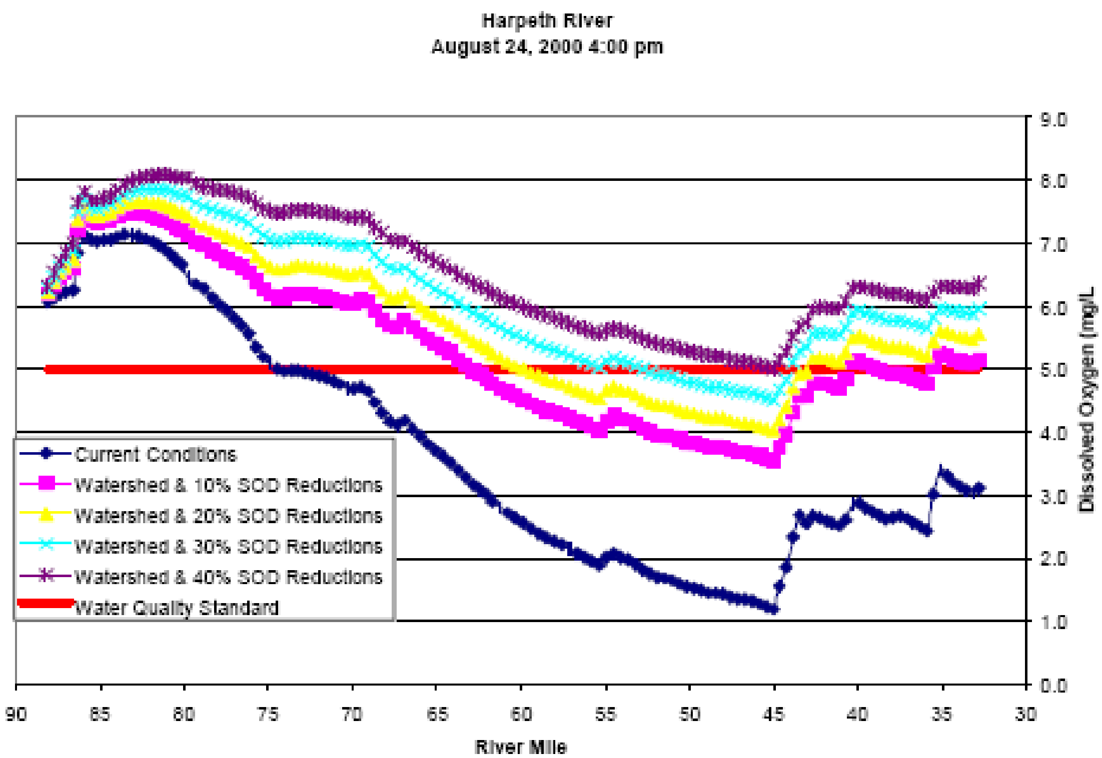
River. Even though the flows from the Lynwood sewage treatment plant (STP) and the Cartwright Creek STP are less than the flows from the Franklin POTW, the model still shows that they each have an impact on the water quality in the River, which is already severely impaired in the area of all three dischargers. Both the data collected and the model show that the effects of these three point sources extend for nearly 50 miles downstream.

The measurements collected by the USEPA and the Tennessee Department of Environment and Conservation (TDEC) show a maximum diurnal DO swing during the August and September studies of 6 mg/L, as presented in Figures 2 to 4. The time period shown in the above figure is representative of the time in the day when the diurnal cycle is nearing or at its peak DO level. In other words, based upon the predictions in Figure 16 and the measured diurnal cycle, the water quality standard would still be violated. It is very important to note that the actual DO measurements made by the USEPA and the TDEC and confirmed by HRWA clearly demonstrate that the three effluent discharges result in violations of the DO water quality standard in the Harpeth River for at least 50 miles.

Sediment Oxygen Demand

The USEPA has stated that: "A 10 percent reduction achieves the greatest incremental improvement in water quality". Attached below is Figure 17 from the TMDL report. The USEPA is trying to imply in the above statement is that a 10% reduction in SOD would result in an increase in DO of nearly 2.5 mg/L of DO. However, what is not mentioned is the fact that the Franklin POTW effluent was not included in any of the model runs except the current conditions. This is confirmed by Figure 16, presented above. As one can see, the magnitude of removing the Franklin POTW's effluent from the river is approximately 2.2 mg/L. Thus, the "10% SOD reduction" only provides a DO increase of approximately 0.3 mg/L. This 0.3 mg/L is on the same order of magnitude as the additional runs with further SOD reductions. Therefore, this graph shows that the Franklin POTW's discharge must be removed in addition to reducing non-point source impacts just to get the water quality standard to 5.0 mg/L. This would also mean that the other two STPs would not be able to discharge, since their effluents would further reduce the DO to less than 5.0 mg/L. Again, USEPA presents model results for 4:00 PM in the afternoon, which is typically a time considered to be at or approaching the maximum DO concentration on a diurnal curve. Thus, if the DO predicted at 4:00 PM is at a maximum DO concentration of 5 mg/L, the DO concentration would be expected to be less than 5 mg/L when the diurnal cycle is less than the maximum.

The SOD rates measured by the USEPA during their field studies are not high and are certainly in the expected range for rivers such as the Harpeth. The simple reality of the situation is that during critical low flow conditions when the DO water quality standard has been violated, the Harpeth River is an effluent-dominated stream.



The sensitivity of the Harpeth River to SOD reductions is illustrated in Figure 17. A 10 percent reduction achieves the greatest incremental improvement in water quality but it does take the 40 percent reduction to fully achieve water quality standards under these critical conditions. It is interesting to note that the removal of the Franklin STP discharge is roughly equilavent to a 10 percent reduction in SOD. As discussed in the headwaters of the Harpeth River section, there is a relationship between the control of polluted runoff from a watershed and the expected relative reduction in the SOD in the receiving stream. EPA believes that there is a reasonable expectation that the nutrient reduction targets for the subwatersheds will require the

WATER WITHDRAWAL FOR PROPOSED DRINKING WATER PLANT EXPANSION

The City of Franklin operates a water intake structure at Harpeth River Mile (HRM) 89.32. During certain flow and water quality conditions on the Harpeth River, the withdrawal of water from the Harpeth River upstream from the Franklin publicly owned treatment works (POTW) must be balanced with the addition of effluent at the Franklin POTW. The exact amount of background river flow required for assimilating the effluent discharges needs to be confirmed as this was not the intent of this review. A general rule of thumb for adding effluent to a receiving stream is to ensure that the effluent flow is not more than 10% of the total flow in the receiving body of water during critical low-flow high-temperature periods that can occur from June through October. The Franklin POTW is currently permitted at a flow of 12 million gallons per day (mgd) or 18.56 cubic feet per second (cfs), but is actually discharging at present about 6 mgd. Using the general rule of thumb, the flow in the Harpeth River coming to the Franklin POTW would need to be around 100 cfs at current conditions or 185.6 cfs at full permitted flows to assimilate all effluent discharges to the Harpeth River and to meet the DO standard. This "rule of thumb" was confirmed during the TDEC's August 2003 diurnal DO study when the river flow coming to the Franklin POTW was 20 cfs and the DO in the river at HRM 84.4 dropped to nearly 0 mg/L DO for about 5 days. The DO did not rise again until the flow in the river at HRM 84.4 approached 100 cfs, as presented in Figure 5.

In reviewing the United States Geological Survey (USGS) flow records from the gage at Franklin at HRM 88.1 for the period from October 1, 1974 to August 24, 2006, the flow is only above a daily average flow of 185 cfs about 35% of the time and above a daily average flow of 100 cfs about 48% of the year and during the summer months, the flow upstream from the POTW is above 100 cfs only about 13% of the June through October period.

The river is not meeting the water quality standard for dissolved oxygen of 5 mg/L during the critical summer months, primarily because the River does not have enough natural flow to assimilate the treated effluent. During summer months when low flows and high temperatures occur (typically June-October), any withdrawal from the Harpeth River can result in worsening the water quality violations downstream from the Franklin POTW, Lynwood STP, or Cartwright Creek STP. This is in clear violation of the antidegradation requirements of both the Federal Clean Water Act and the State's antidegradation regulations. During other months from November through April when temperatures are lower, the river has not been shown to be water quality limited. For non-summer seasons, another method to determine at what point the river is negatively affected by water withdrawal must be used. Unless all current effluent dischargers are removed from the River during water-quality impaired periods that can occur from June through October, no water withdrawals should occur from the Harpeth River when flows drop below about 100 cfs (Note: exact flows need to be confirmed).

RECOMMENDATIONS FOR FUTURE WORK

1. Prepare 7-day 10-year low flow (7Q10) analyses for each month in the period of record for the USGS gage in Franklin at HRM 88.1. Also prepare monthly 7Q10 analyses for the previous 10 years and the previous 5 years. This may show a trend of increased runoff due to development in and around Franklin. Note that the flows will have to be adjusted using water withdrawal data from the Franklin Water Treatment Plant.

   The 7Q10 low flow represents the flow in the river where water quality standards must be met. Any water quality model that is used to predict the effects of effluent and non-point source loadings on the river must prove that the river meets the water quality standards at this flow condition.

2. Prepare 7Q10 monthly low flows for each of the Harpeth River tributaries. The USGS may have data on these tributaries. The normal process of estimating flows based on drainage area may not be completely applicable, since many of these streams are fed by spring flows which flow more or less at a constant flow rate during dry conditions.

These tributary flows should be used in future models to predict flow increases in the Harpeth River going downstream.

3. Perform an assimilative capacity study on the Harpeth River. There are many items that should be measured in order to accurately predict conditions using a water quality model. These include the following: **1)** reaeration rate; **2)** the in-stream ultimate carbonaceous biochemical oxygen demand ($CBOD_u$) rate; **3)** the in-stream decay/removal rates for each of the nitrogen series, which includes ammonia, organic nitrogen, and nitrite+nitrate; **4)** the primary algal productivity, which includes a measure of total chlorophyll (a, b, and c) to biomass, algal productivity and respiration (USEPA states that light and dark bottle analyses were performed, but did not provide this data in the final report), and diurnal DO; **5)** additional locations for SOD rates, the USEPA did not use the SOD rates they measured during field studies in the model because there were only three locations measured; and **6)** flows in the river.

   It is important to determine the in-stream rates so that one can accurately model the river and then use the model to project impacts at various water withdrawal and effluent discharge scenarios. Aside from SOD, algal productivity and respiration, and diurnal DO, it does not appear that any of these items have been measured with time of travel for any of the studies we have reviewed.

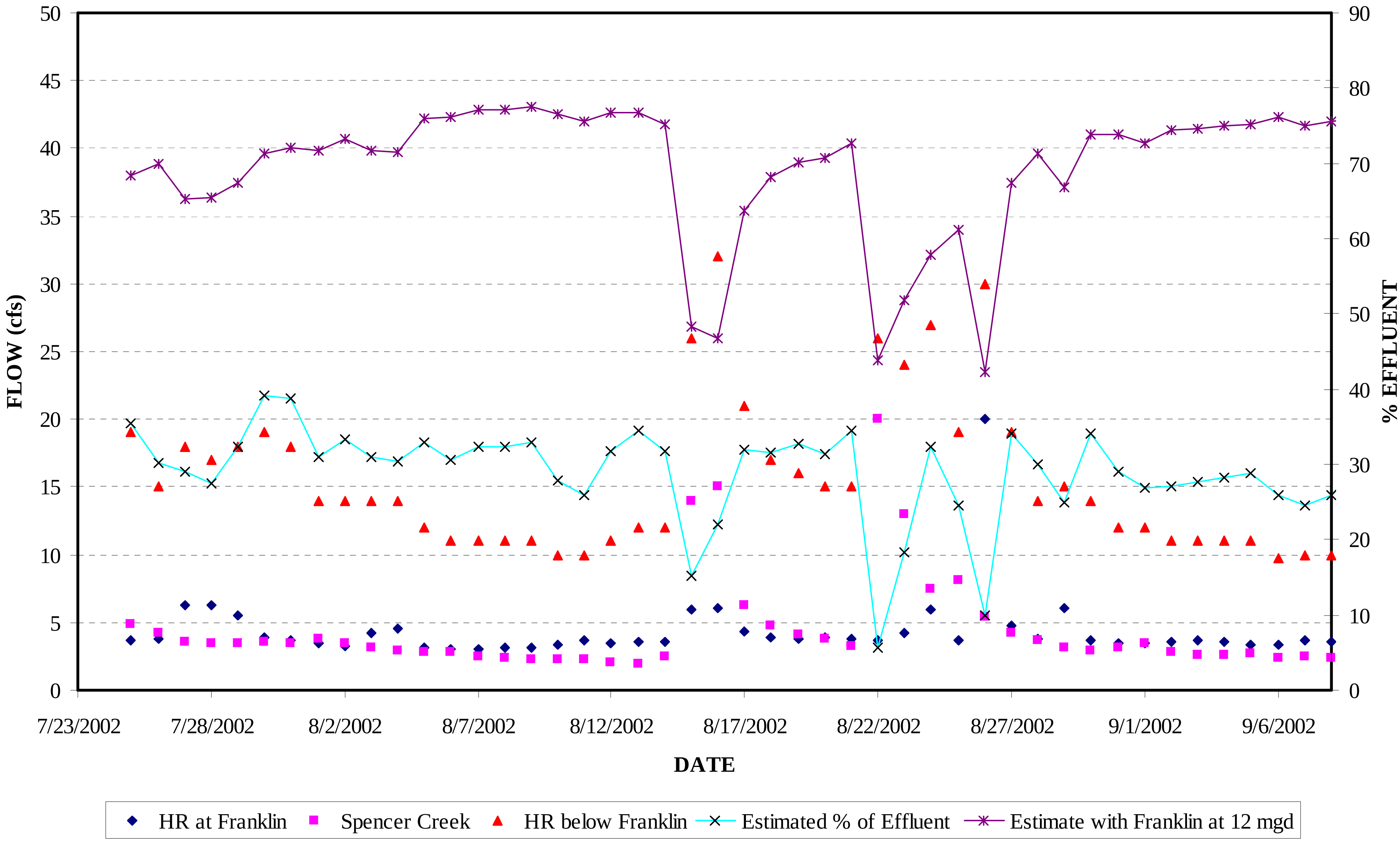
   Measuring the reaeration rate on the river is important, since this is typically the single largest source of DO to the river.

   The in-stream $CBOD_u$, organic nitrogen, and ammonia decay rates are important to determine. One measures this by collecting samples from the same slug of water as it moves downstream. Individual bottle rates should not be used as the river rate.

As part of this study, bottle rates for the Franklin POTW, Lynwood STP, and Cartwright Creek STP would be determined. These rates would show the level of recalcitrant nitrogen in each of the effluents. This recalcitrant nitrogen would actually not contribute to any DO sag or algal productivity and should therefore not be modeled as such.

4. A more robust sampling scheme for DO in the river should also be conducted. The field studies conducted by the USEPA and TDEC in 2000, 2002, and 2003 did not determine the exact location of the sag point in the river downstream from the Franklin POTW, Lynwood STP, or Cartwright Creek STP. Indications are that the DO sag below 5 mg/L continues to at least Kingston Springs, a distance of about 50 miles. The USEPA model is predicting a DO recovery downstream from HRM 45, so data should be collected downstream from the USGS Bellevue gage until the DO is shown to recover.

ESTIMATION OF PERCENTAGE OF EFFLUENT IN THE HARPETH RIVER DOWNSTREAM FROM THE FRANKLIN POTW USING USGS FLOW GAGE DATA



CLIENT: Harpeth River Watershed Association
LOCATION: Franklin, Tennessee
PROJECT/FILE: 061512

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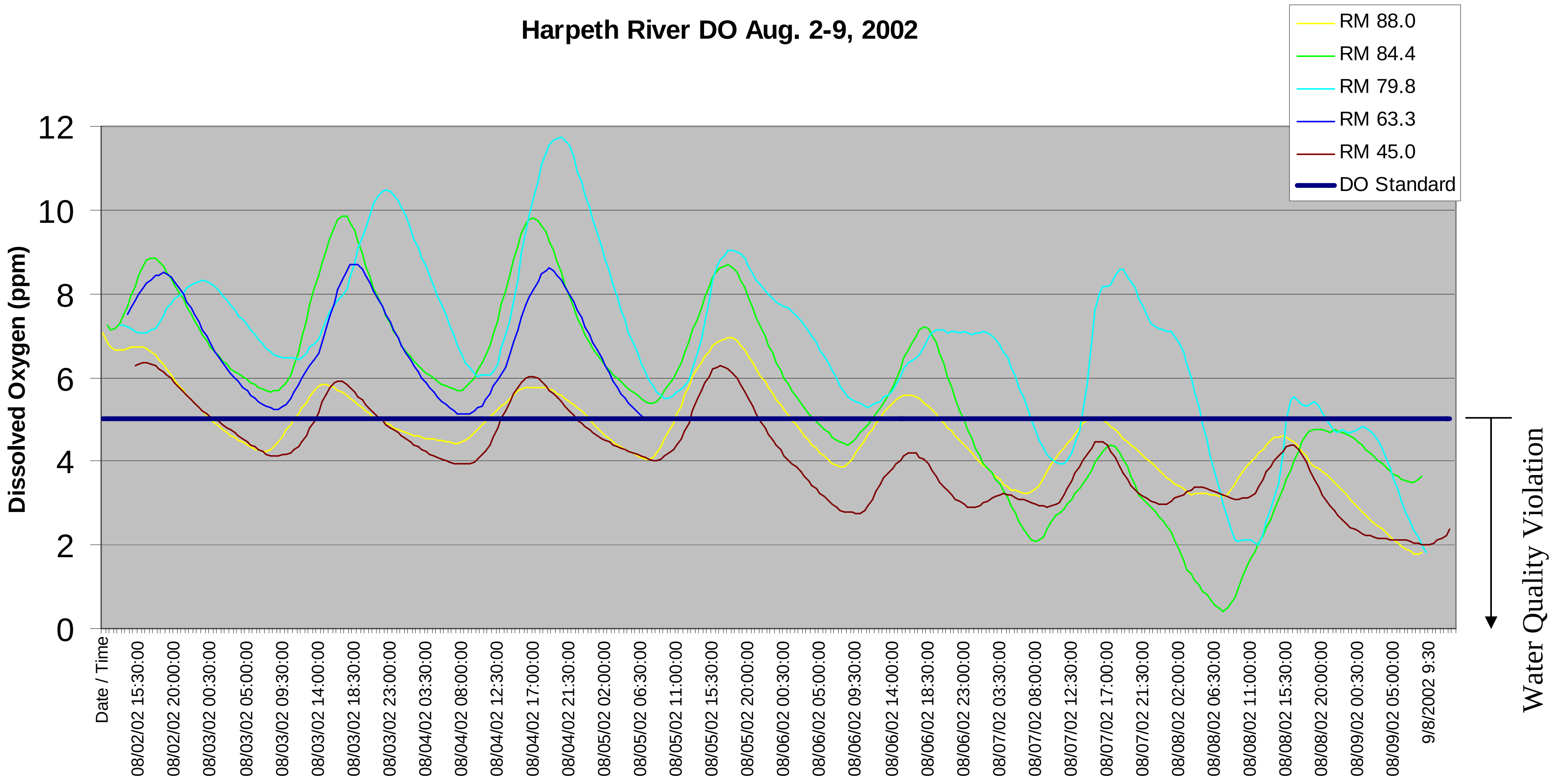
FIGURE 1 ESTIMATION OF EFFLUENT PERCENTAGE

TDEC DIURNAL DO STUDY RESULTS



CLIENT: Harpeth River Watershed Association
LOCATION: Franklin, Tennessee
PROJECT/FILE: 061512

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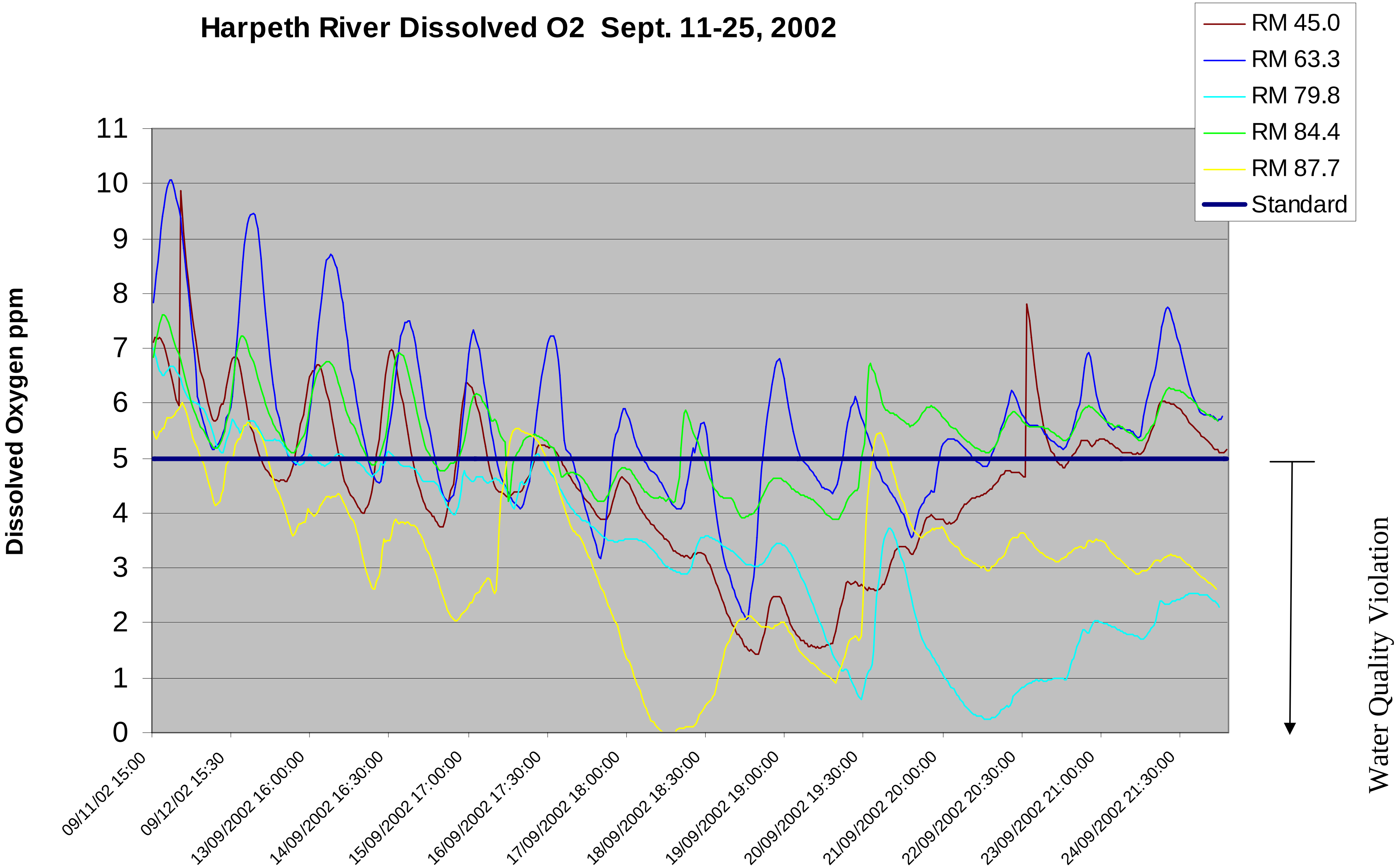
FIGURE 2 TDEC DIURNAL STUDY AUGUST 2002

TDEC DIURNAL DO STUDY RESULTS



AquAeTer

CLIENT: Harpeth River Watershed Association
LOCATION: Franklin, Tennessee
PROJECT/FILE: 061512

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FIGURE 3 TDEC DIURNAL STUDY SEPTEMBER 2002

TDEC DIURNAL DO STUDY RESULTS

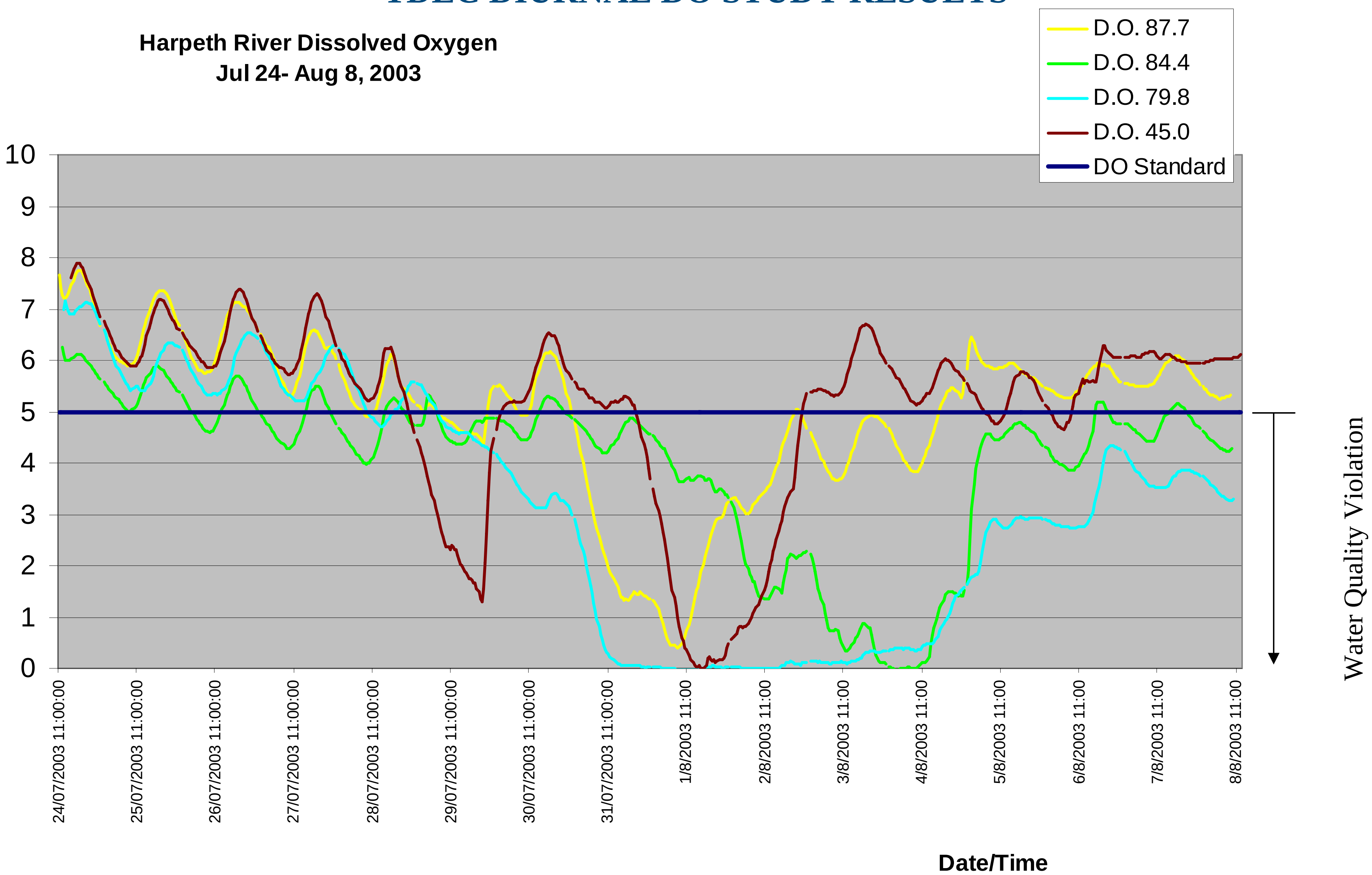

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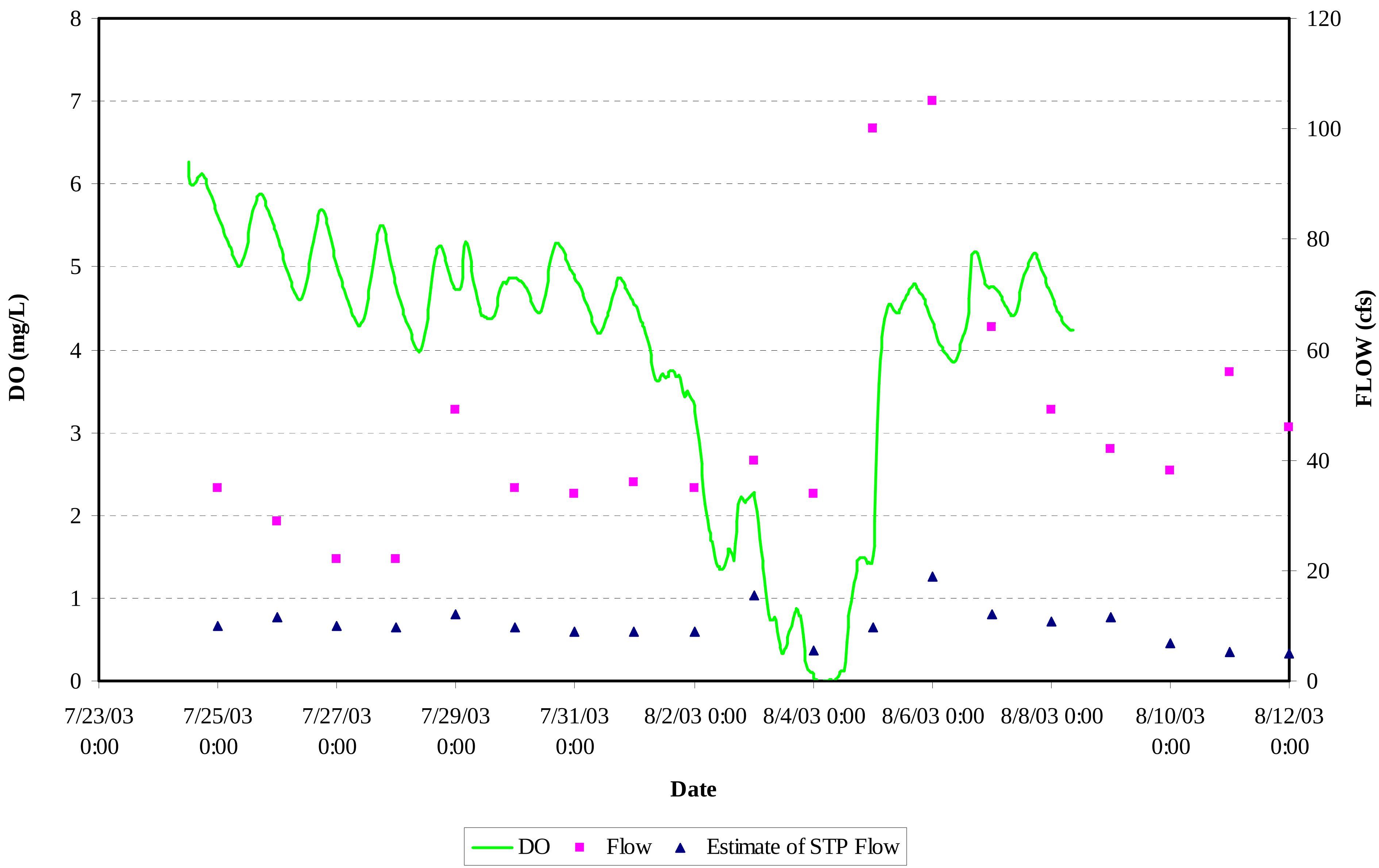
FIGURE 4 TDEC DIURNAL STUDY AUGUST 2003

COMPARISON OF FLOW DURING DO STUDY AT HRM 84.4



CLIENT: Harpeth River Watershed Association
LOCATION: Franklin, Tennessee
PROJECT/FILE: 061512

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FIGURE 5 HARPETH RIVER AUGUST 2002

ATTACHMENT 1

BASIS FOR CALCULATIONS

CALCULATION OF PERCENT EFFLUENT BASED UPON USEPA FIELD DATA

Table 5 Water quality data collected in April 2001

Station	Flow (cfs)	UltimateC BOD (mg/l)	NH_3-N (mg/l)	NO_2/NO_3 (mg/l)	TKN (mg/l)	Total N (mg/l)	Total P (mg/l)	Chl a (ug/l)
RM114.6	24.4	5.25	< 0.05	0.71	0.25	0.96	0.06	0.47
Arrington C	17.5	2.15	< 0.05	0.65	0.15	0.80	0.30	1.43
RM103.1	109	2.64	< 0.05	0.64	0.21	0.85	0.19	0.96
Starnes Cr	5.7	4.46	< 0.05	0.76	0.21	0.97	0.28	0.90
RM97.5	139	4.92	< 0.05	0.70	0.18	0.88	0.20	0.7
5mile Cr	10.4	2.75	< 0.05	1.30	0.2	1.50	0.40	1.73
Watson Br	4.9	3.81	< 0.05	0.79	0.225	1.01	0.34	2.06
RM88.1	178	4.08	< 0.05	0.83	0.23	1.06	0.25	1.48
Spencer C	7.2	3.93	< 0.05	1.10	0.20	1.30	0.27	2.37
RM84.4	213	3.43	< 0.05	1.00	0.24	1.24	0.29	1.28
W. Harp R	130	2.26	< 0.05	0.88	0.15	1.03	0.18	1.26
RM76.0	369	3.04	< 0.05	0.99	0.25	1.24	0.25	0.89
L. Harp R	39.3	3.31	< 0.05	1.20	0.16	1.36	0.22	0.78
RM62.4	503	2.84	< 0.05	0.95	0.27	1.22	0.26	1.24
Franklin STP	6.18	11.94	< 0.05	2.70	0.94	3.64	0.70	-
Lynnwood STP	0.21	13.07	0.051	4.50	0.83	5.33	1.1	-
Cartwright Cr STP	0.52	8.2	< 0.05	9.20	0.67	9.87	1.5	-

Percent Effluent at HRM 84.4 (downstream from Franklin POTW)

$$\% effluent = \frac{Effluent\ Flow}{Total\ Flow} * 100$$

$$\% effluent = \frac{Franklin\ POTW}{Harpeth\ River\ Flow\ at\ HRM\ 84.4} * 100$$

$$\% effluent = \frac{6.18}{213} * 100$$

$$\% effluent = 2.9\%$$

Note that the Franklin STP was not discharging at its full permitted flow of 5.5 mgd (8.5 cfs). If they had been, the % effluent would have been 3.9%.

Table 4 Water quality data collected in August 2000

Station	Flow(cfs)	UltimateC BOD (mg/l)	NH_3-N(mg/l)	NO_2/NO_3 (mg/l)	TKN (mg/l)	Total N (mg/l)	Total P (mg/l)	Chl a (ug/l)
RM114.6	0.02	7.13	0.06	0.05	0.84	0.89	0.09	5
RM106.5	0.03	5.61	0.08	0.19	0.64	0.83	0.25	-
RM97.5	0.03	3.56	0.03	0.05	0.54	0.59	0.26	-
RM88.1	2.6	0.98	0.09	0.29	0.42	0.71	0.28	0.64
Spencer C	1.9	2.72	0.05	0.29	0.47	0.76	0.36	2.75
RM84.4	9.0	3.78	0.09	1.20	0.70	0.77	1.30	1.28
W. Harp R	0.5	2.36	0.07	0.05	0.24	0.29	0.24	2
RM76.0	12.8	3.5	0.04	0.57	0.37	0.94	0.67	2.6
RM66.0	10.9	3.62	0.06	0.36	0.48	0.84	0.43	-
L. Harp R	0.03	1.73	0.05	0.13	0.50	0.63	0.31	6.4
RM62.4	12.0	1.78	0.07	0.31	0.39	0.70	0.46	3.8
Franklin STP	4.96	5.53	0.06	1.90	1.0	2.90	1.8	-
Lynnwood STP	0.24	16.96	0.11	10.0	1.4	11.4	4.0	-

Percent Effluent at HRM 84.4 (downstream from Franklin POTW)

$$\% \, effluent = \frac{Effluent\ Flow}{Total\ Flow} * 100$$

$$\% \, effluent = \frac{Franklin\ POTW}{Harpeth\ River\ Flow\ at\ HRM\ 84.4} * 100$$

$$\% \, effluent = \frac{4.96}{9.0} * 100$$

$$\% \, effluent = 55\%$$

Note that the Franklin STP was not discharging at its full permitted flow of 5.5 mgd (8.5 cfs). If they had been, the % effluent would have been 67%.

Percent Effluent at HRM 76 (downstream from Lynwood STP)

$$\% \, effluent = \frac{Effluent\ Flow}{Total\ Flow} * 100$$

$$\% \, effluent = \frac{Franklin\ POTW + Lynwood\ STP}{Harpeth\ River\ Flow\ at\ HRM\ 76.0} * 100$$

$$\% \, effluent = \frac{4.96 + 0.24}{12.8} * 100$$

$$\% \, effluent = 40.6\%$$

Calculation of Franklin POTW effect on the River

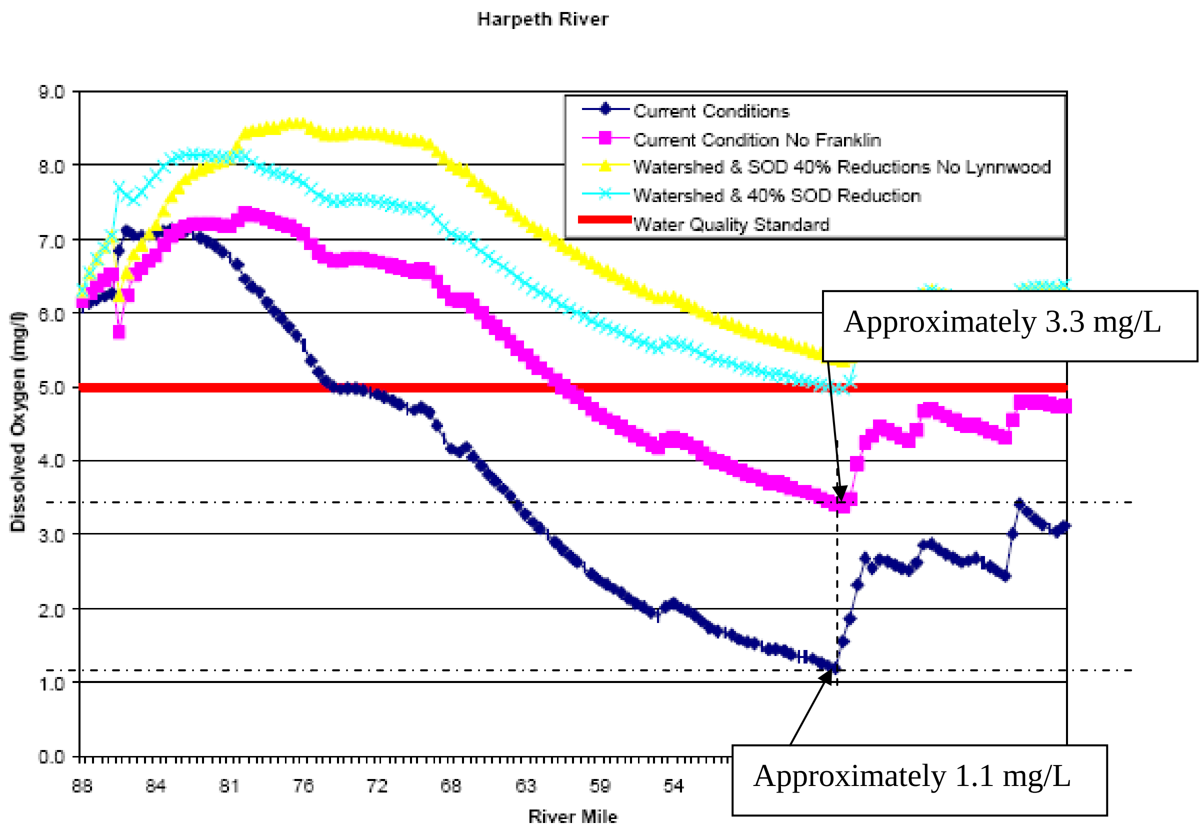

Figure 16 Predicted DO levels versus Pollutant Reduction Scenarios at Critical Conditions

This figure shows an influence of approximately 3.3 – 1.1 = 2.2 mg/L of DO caused by the Franklin POTW.

Calculation of Lynwood POTW effect on the River

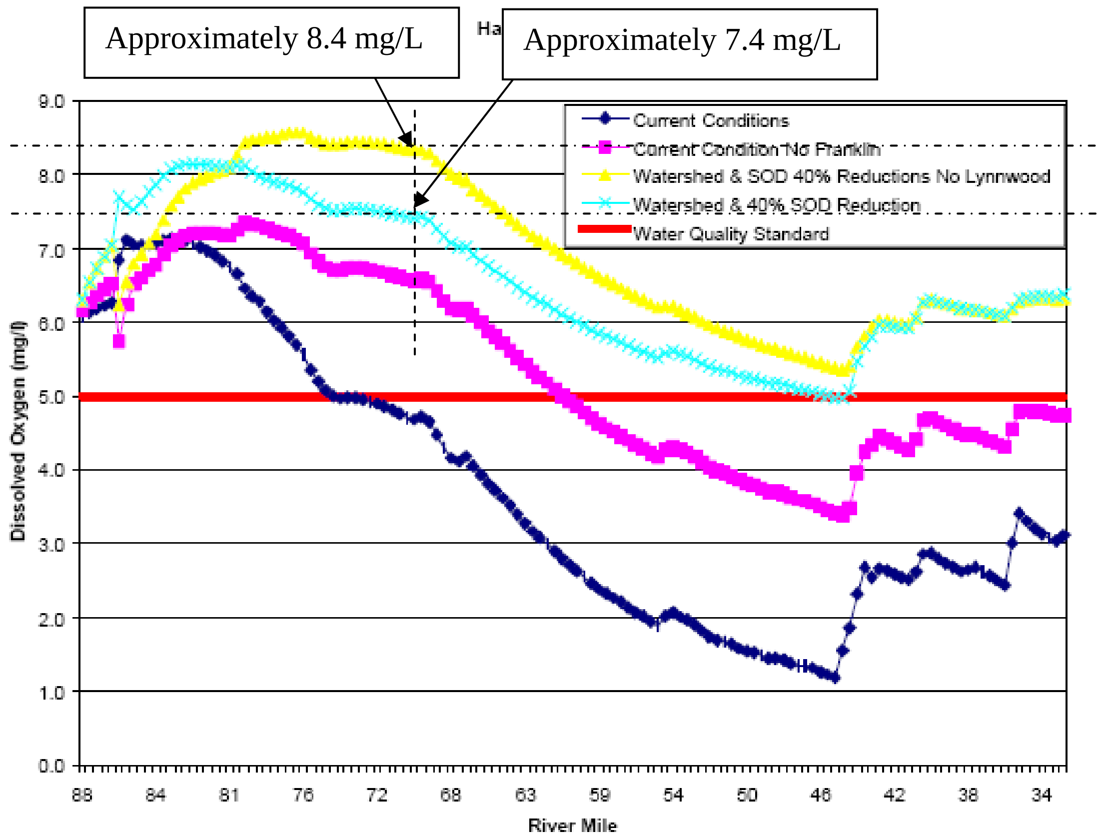

Figure 16 Predicted DO levels versus Pollutant Reduction Scenarios at Critical Conditions

This figure shows an influence from the Lynwood STP of approximately 1.0 mg/L of DO. In other words, removing the Lynwood STP effluent from the stream would raise the DO in the River.

ATTACHMENT 2

REGULATIONS

This is the antidegradation clause in the Clean Water Act (40CFR131.12(a)(1):

(1) Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

This is the State's antidegradation policy as described in section I of the NPDES permits for all three point source dischargers (Franklin POTW, Lynwood STP, and Cartwright Creek STP)

I. ANTIDEGRADATION

Pursuant to the Rules of the Tennessee Department of Environment and Conservation, Chapter 1200-4-3-.06, titled "Tennessee Antidegradation Statement," and in consideration of the Department's directive in attaining the greatest degree of effluent reduction achievable in municipal, industrial, and other wastes, the permittee shall further be required, pursuant to the terms and conditions of this permit, to comply with the effluent limitations and schedules of compliance required to implement applicable water quality standards, to comply with a State

Water Quality Plan or other State or Federal laws or regulations, or where practicable, to comply with a standard permitting no discharge of pollutants.

This is section D from the NPDES permits for all three point source dischargers (Franklin POTW, Lynwood STP, and Cartwright Creek STP).

D. LIABILITIES

1. Civil and Criminal Liability

Except as provided in permit conditions for "***Bypassing,***" "***Overflow,***" "***Upset,***" "***Diversion,***" and "***Treatment Facility Failures,***" nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance. Notwithstanding this permit, the permittee shall remain liable for any damages sustained by the State of Tennessee, including but not limited to fish kills and losses of aquatic life and/or wildlife, as a result of the discharge of wastewater to any surface or subsurface waters. Additionally, notwithstanding this Permit, it shall be the responsibility of the permittee to conduct its wastewater treatment and/or discharge activities in a manner such that public or private nuisances or health hazards will not be created.

AquAeTer, Inc. Profile

Rev. (04/06)

AquAeTer, Inc. (AquAeTer) is a multi-disciplinary, environmental consulting firm dedicated to providing environmental engineering and science services to help our clients comply with federal, state, and local environmental regulations. Simply put, we find practical, cost-effective solutions to environmental problems.

From offices in Tennessee, Colorado, and Pennsylvania, we are responsive to our clients' needs, while providing high-quality work that meets their objectives. AquAeTer's team of 30 professionals includes professional geologists and engineers, environmental scientists, highly trained technicians and administrative personnel.

AquAeTer was founded in August 1992; the firm's name was derived as follows:

Aqua **(water) + *Aer* (air) + *Terra* (earth) = AquAeTer**

AREAS OF EXPERTISE

ENVIRONMENTAL ASSESSMENTS & DUE DILIGENCE
- Asbestos, Lead-based Paint and Radon Sampling
- Cost Analysis for Current/Future Liabilities
- Compliance Cost Forecasting
- Desktop Reviews
- Due-Diligence and Compliance Review Audits
- NEPA Environmental Screening
- Peer Review
- Phase I and II Site Assessments - "All Appropriate Inquiries"

ENVIRONMENTAL FORENSICS
- Cost Recovery/Allocation or Liability Determination
- Forensic Claim Assistance
- Litigation Support, Export Testimony and Reports

ENVIRONMENTAL STUDIES
- Air Emission Inventories
- Ambient Air Testing and Monitoring
- Aquatic Toxicity Testing & Analysis
- Bench and Pilot Scale Studies
- Contaminant Fate and Transport Modeling
- Database Management and Presentation
- Mixing Zone Delineation and Assessment
- Soil and Groundwater Investigations
- Stormwater Management Implementation
- Total Maximum Daily Load (TMDL) Determination
- Use Attainability Analysis
- Vadose Zone Investigations
- Water Quality Analysis and Studies

MINE & MILL ENVIRONMENTAL SERVICES
- Baseline Environmental Investigation
- Facility and Infrastructure Siting
- Hazardous Materials Management
- Permitting and Regulatory Compliance
- Property Closure
- Reclamation Plan Design
- Water Treatment System Design and Evaluation
- Water Use Plan Development

PERMITTING & COMPLIANCE ASSISTANCE
- Air, Water and Landfill Permitting:
  – Minor Source, NSR/PSD and Title V
  – NPDES, Stormwater & Wetlands
  – Radioactive Waste, Municipal, RCRA and TSCA Landfills
- Best Management, SPCC and SWPP Plans
- Greenfield and Brownfield Siting
- Negotiations and Strategy
- Permit Application Preparation

REMEDIATION SYSTEM DESIGN & IMPLEMENTATION
- Bio-Remediation
- Environmental Media Sampling
- Evaluation and Selection of Remedial Measures
- Facility Remediation Closure or Reuse
- Innovative Technology Applications
- RCRA, SWA, CERCLA and TSCA
- Risk Assessment & Site Investigations/Voluntary Clean-up

SOLID, HAZARDOUS, AND RADIOACTIVE WASTE MANAGEMENT
- Construction Quality Assurance
- Corrective Measures Studies and Implementation
- Design Drawings and Construction Specifications
- Groundwater Bio-Remediation
- Groundwater Flow and Contaminant Transport Modeling
- Hydrogeologic Investigations
- Leachate Analysis
- Management /Analysis of Environmental Monitoring Data

WASTEWATER SYSTEM EVALUATION & OPTIMIZATION
- Biological Treatment Processes Modeling
- Expert Testimony
- Nutrient Removal and Physical/Chemical Treatment Analysis
- Process Evaluation and Design
- Toxicity Reduction Analysis
- Treatment Plant Capacity Analysis
- Treatability Investigations
- Treatment of Volatile Organics
- Wastewater Workshops/Seminars