Presentation to

MONTGOMERY BELL STATE PARK

DISSOLVED OXYGEN IN THE HARPETH RIVER:

CONNECTING POINT SOURCE, NON-POINT SOURCE, AND WATER WITHDRAWALS

Prepared by HRWA/**AquAeTer, Inc.**

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HARPETH RIVER WATERSHED

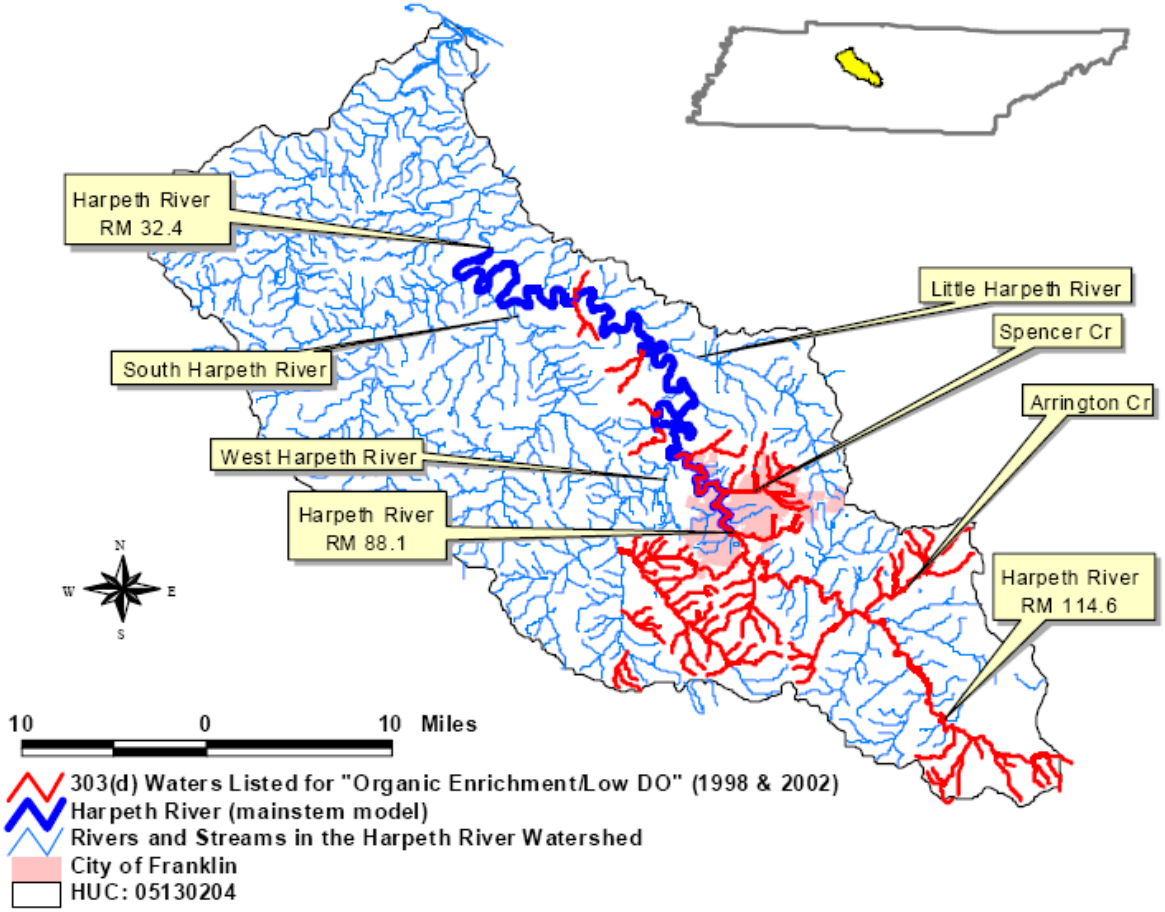
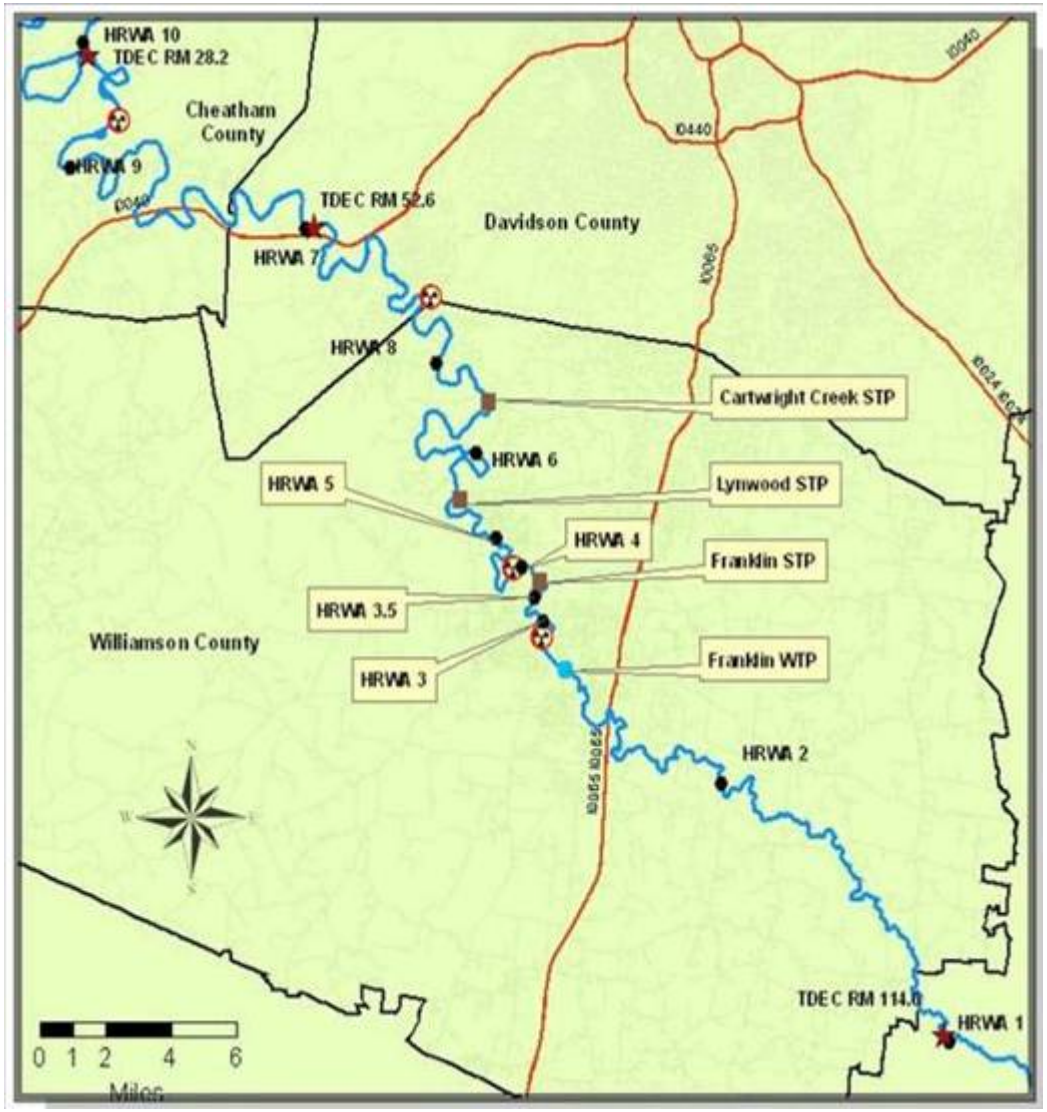
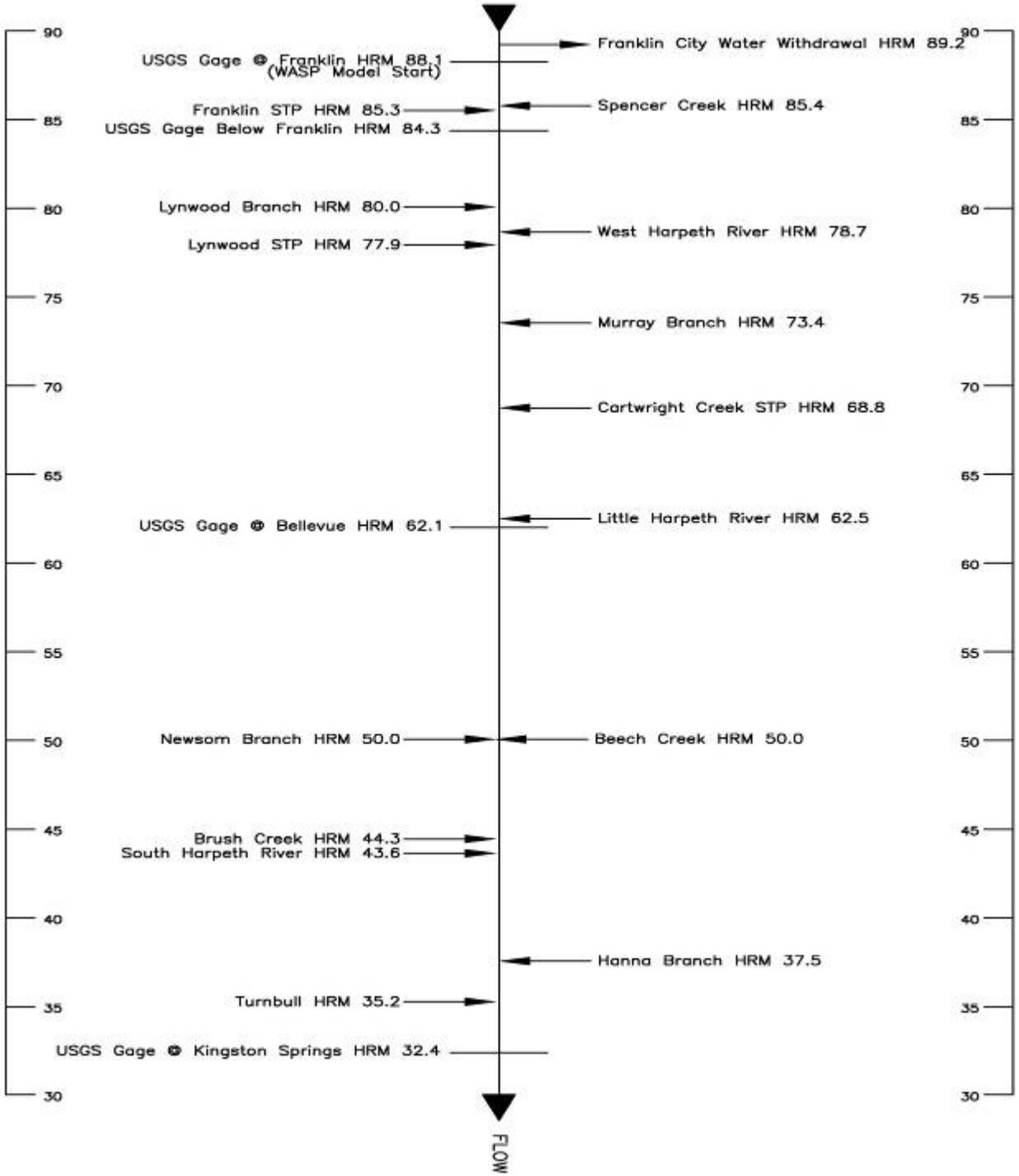


Figure 1 Harpeth River Watershed

HRWA & TDEC DISSOLVED OXYGEN STUDY - AUGUST AND SEPTEMBER 2006




90
85
80
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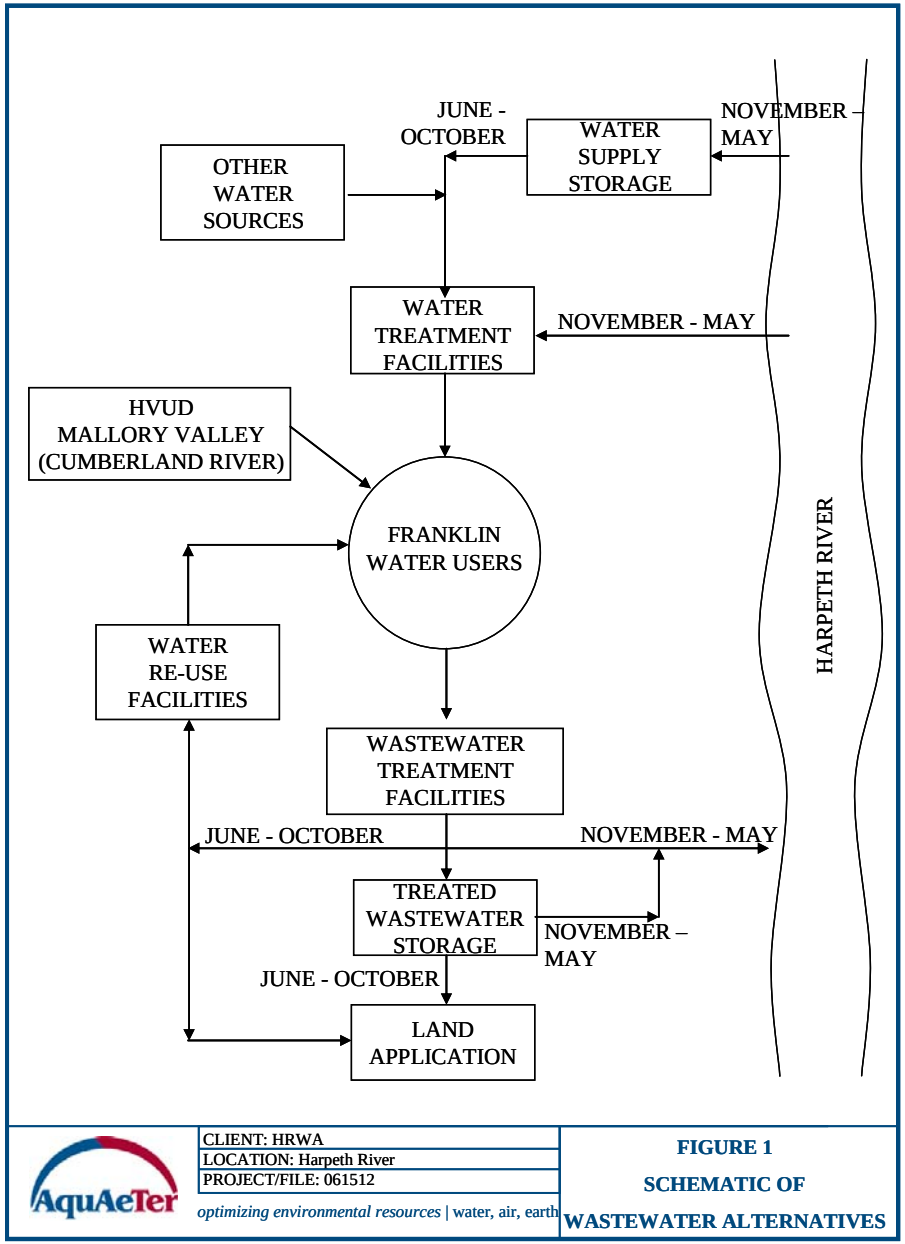
USGS Gage @ Franklin HRM 88.1
(WASP Model Start)
Franklin STP HRM 85.3
USGS Gage Below Franklin HRM 84.3
Lynwood Branch HRM 80.0
Lynwood STP HRM 77.9
USGS Gage @ Bellevue HRM 62.1
Newsom Branch HRM 50.0
Brush Creek HRM 44.3
South Harpeth River HRM 43.6
Turnbull HRM 35.2
USGS Gage @ Kingston Springs HRM 32.4
Franklin City Water Withdrawal HRM 89.2
Spencer Creek HRM 85.4
West Harpeth River HRM 78.7
Murray Branch HRM 73.4
Cartwright Creek STP HRM 68.8
Little Harpeth River HRM 62.5
Beech Creek HRM 50.0
Hanna Branch HRM 37.5
FLOW



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CLIENT: HRWA
LOCATION: Harpeth River
PROJECT/FILE: 061512

FIGURE 1

SCHEMATIC OF

WASTEWATER ALTERNATIVES

DEFINITIONS

- **ASSIMILATIVE CAPACITY – How much organic carbon and nitrogen mass loadings that the stream can accept without degrading the dissolved oxygen in the stream below 5 mg/L and not causing nuisance algal blooms in the Harpeth River**
- **DISSOLVED OXYGEN – USEPA established in 1972 a nation-wide standard of 5 mg/L for dissolved oxygen that has to be met in all U.S. streams and lakes**
- **ANTI-DEGRADATION – A stream that is not meeting water-quality standards cannot be further degraded**
- **EFFLUENT TECHNOLOGY LIMITS – Treatment standards that must be met by all municipal dischargers**
- **WATER-QUALITY BASED TREATMENT LIMITS – More stringent treatment standards that must be met if the technology limits do not result in stream water quality standards being met**
- **1 million gallons per day (mgd) = 1.547 cubic feet per second (cfs)**

REGULATORY REQUIREMENTS

1. **Franklin's water treatment plant can cause degradation of the water quality only if there are no other economically feasible alternatives for water supply.**
2. **Franklin POTW must meet its permit discharge limits for organics (BOD) and nutrients (nitrogen)**
3. **The Franklin POTW, Lynwood Utility and Cartwright Creek Utility must also meet the stream water quality standard for dissolved oxygen of 5 mg/L**
4. **Neither Franklin, Lynwood nor Cartwright Creek can further degrade the Harpeth River if it is not meeting the dissolved oxygen standard of 5 mg/L upstream from the effluent discharge point**

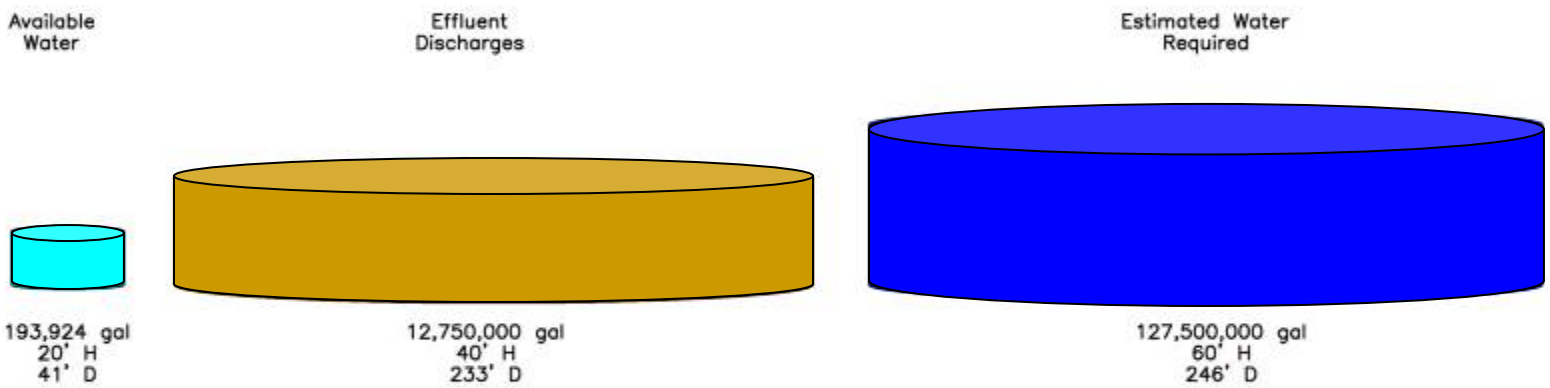
WATER WITHDRAWAL REGULATORY REQUIREMENTS

- **TDEC water pollution regulations exemption 4: "existing water withdrawals on July 25, 2000 which do not adversely alter or effect the classified use of the source stream are not subject to these requirements." (1200-4-7-.02) (Grandfather Clause)**
- **TDEC regulations and statute: "it is unlawful ... To carry out any activity which may result in the alteration of the physical, chemical, radiological, biological, or bacteriological properties of any waters of the state, including wetlands. These activities include, but are not limited to: ... water withdrawals, ..." (1200-4-7-.01)**

LOW-HEAD DAM

IMPORTANT CONSTRAINTS ON RIVER ASSIMILATIVE CAPACITY

- **FLOW UPSTREAM FROM THE FRANKLIN POTW**
- **WATER TEMPERATURE**
- **DISSOLVED OXYGEN IN THE RIVER WATER COMING TO EACH OF THESE FACILITIES**



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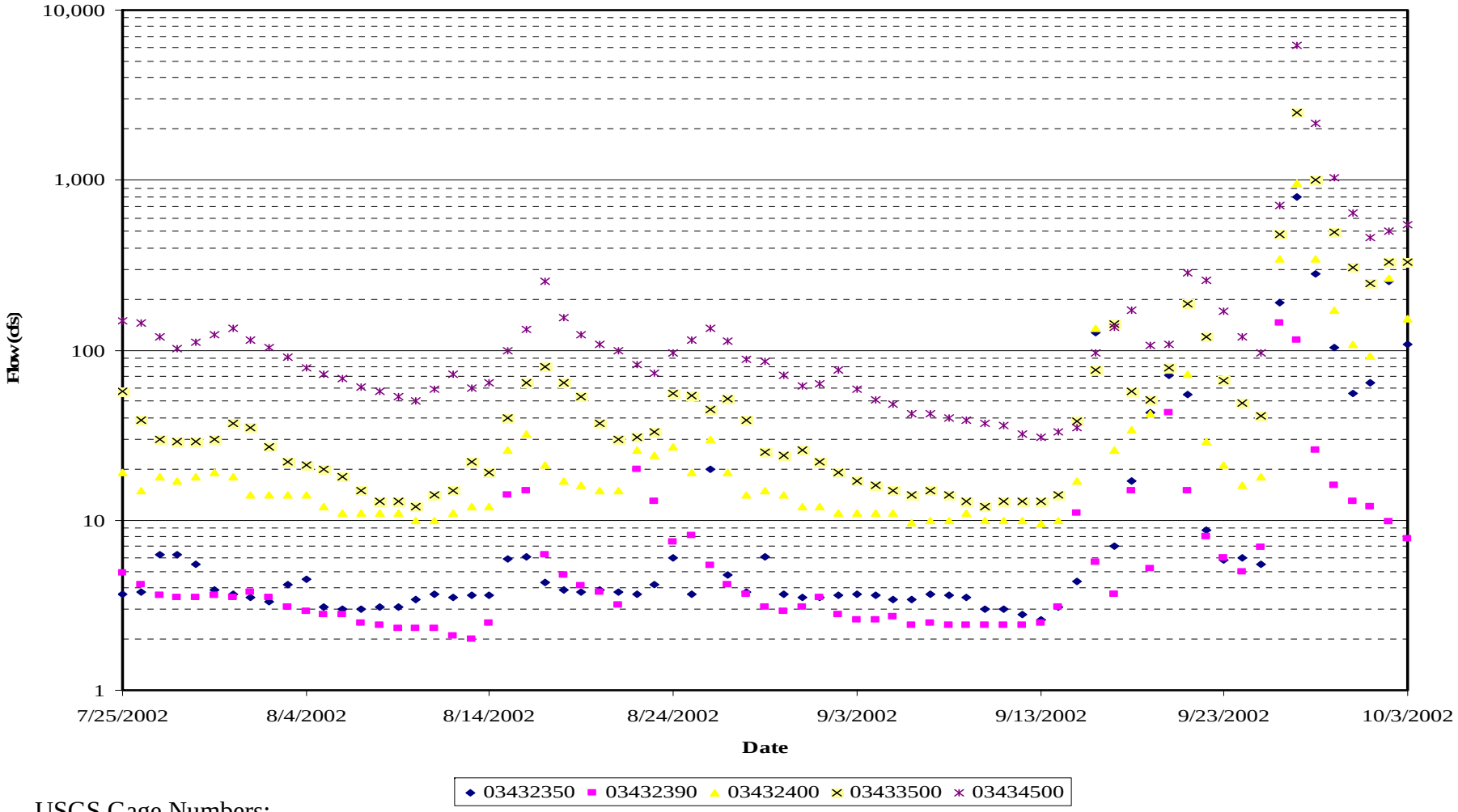
BRENTWOOD, TENNESSEE

AVAILABLE VS NEEDED WATER
IN THE HARPETH RIVER

HARPETH RIVER FLOWS



USGS Gage Numbers:

03432350 – Harpeth River at Franklin

03432390 – Spencer Creek at Franklin

03432400 – Harpeth River below Franklin

03433500 – Harpeth River at Bellevue

03434500 – Harpeth River at Kingston Springs

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CLIENT: Harpeth River Watershed Association

LOCATION: Franklin, Tennessee

PROJECT/FILE: 061512

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FIGURE – FLOWS

LOW FLOWS ON THE HARPETH RIVER

TABLE. SUMMARY OF 7Q10 FLOWS AT FRANKLIN

PERIOD	NUMBER OF RECORDS	7Q10 FLOW (cfs)	NPDES PERMITTED FLOW (cfs)
Annual	32	0.7	18.6
January	33	37	18.6
February	32	94	18.6
March	32	90	18.6
April	32	56	18.6
May	32	18	18.6
June	32	4	18.6
July	32	1.3	18.6
August	32	0.9	18.6
September	32	1.0	18.6
October	33	1.2	18.6
November	33	3	18.6
December	33	11	18.6

TABLE SUMMARY OF MONTHLY ANALYSIS

PERIOD	AVERAGE MONTHLY FLOW RETURN PERIOD (yrs)	
	20 year (cfs)	10 year (cfs)
January	15	126
February	186	206
March	169	248
April	77	97
May	24	31
June	12	21
July	4	5
August	2	4
September	1.3	2
October	1.1	3
November	7	14
December	44	75

Note: Two other NPDES Discharges, Lynwood and Cartwright Creek Utilities are permitted for approximately 1 cfs downstream from Franklin.

USEPA DISSOLVED OXYGEN DATA AUGUST 2000

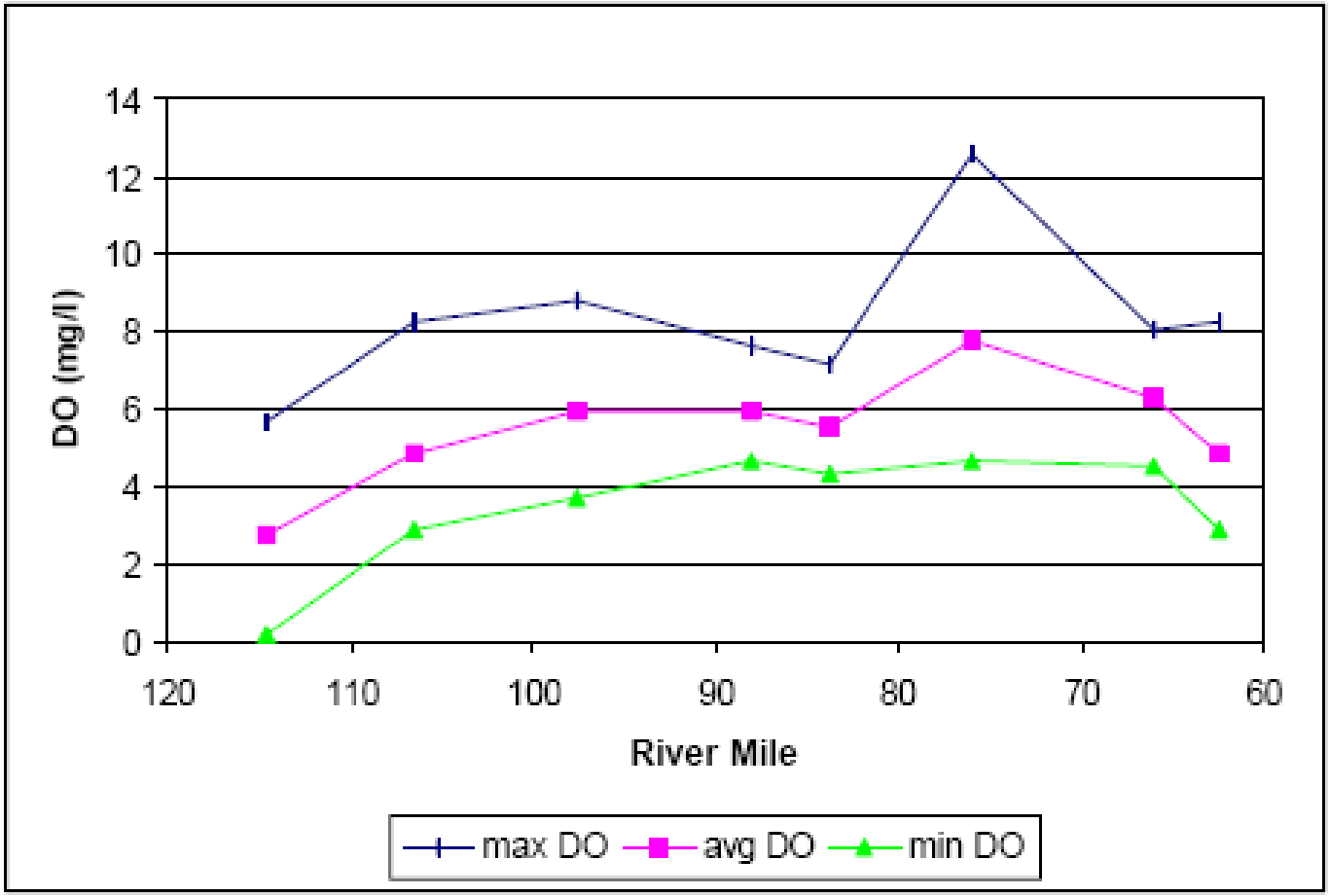
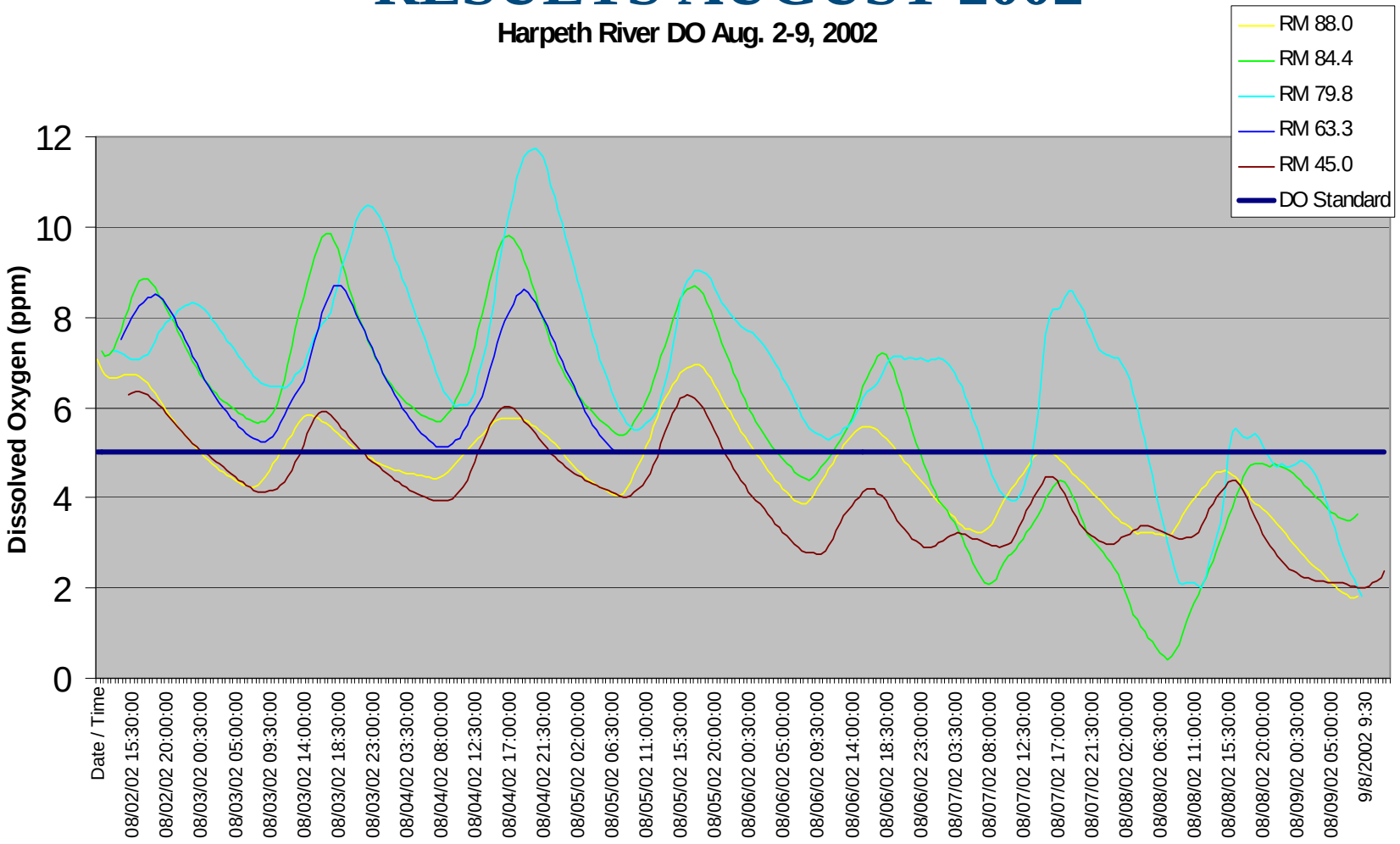


Figure 5 Longitudinal DO profile during the August 2000 study

TDEC DIURNAL DISSOLVED OXYGEN STUDY RESULTS AUGUST 2002

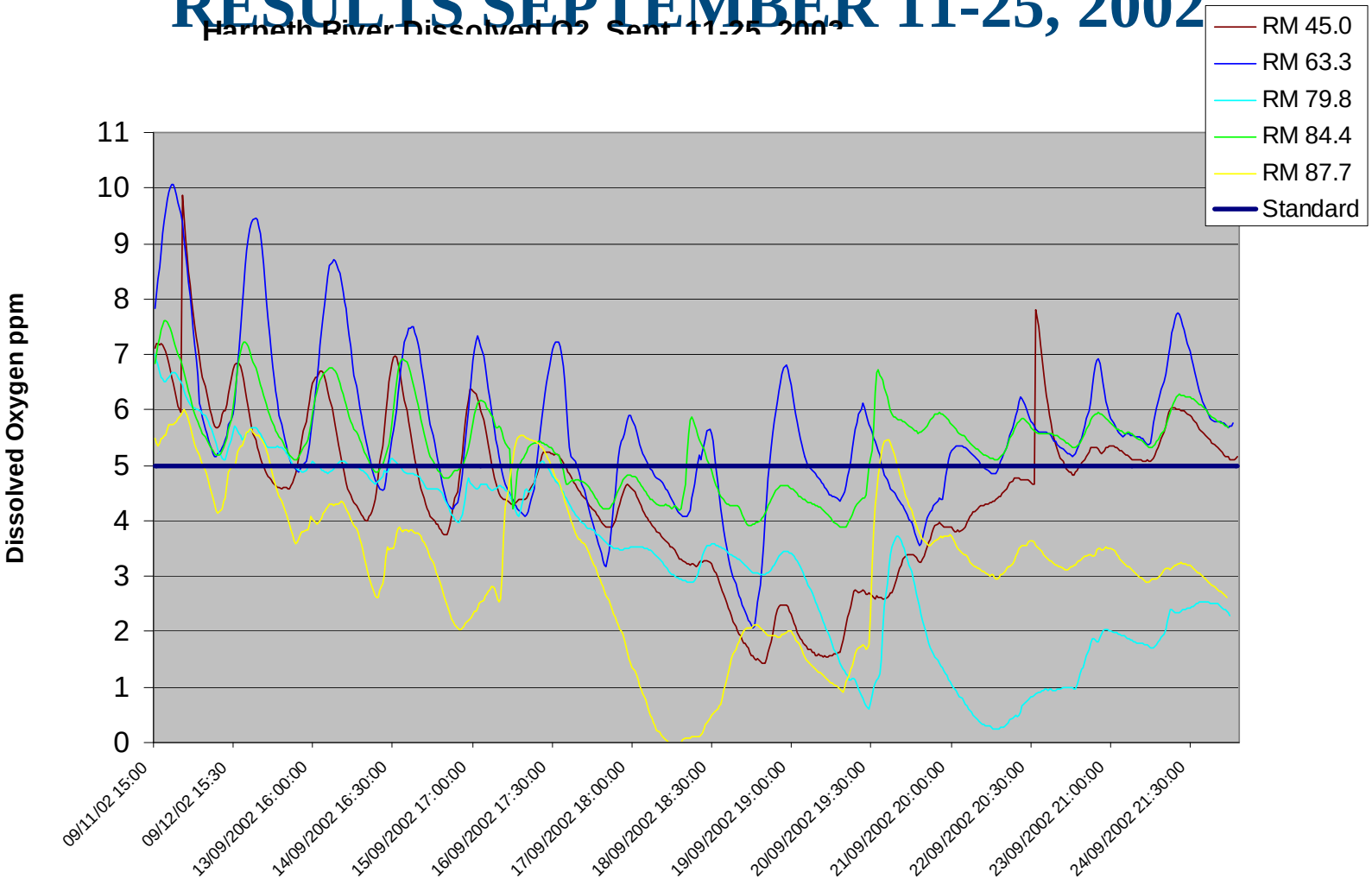


Flow range coming to Franklin POTW – 3 to 4.5 cfs. Downstream from Franklin POTW – 11 to 14 cfs

Estimated Effluent Percentage Downstream Using POTW Flow of 3 mgd – 33% to 42%

Estimated Effluent Percentage Downstream Using POTW Flow of 6 mgd – 66% to 84%

TDEC DIURNAL DISSOLVED OXYGEN STUDY RESULTS SEPTEMBER 11-25, 2002

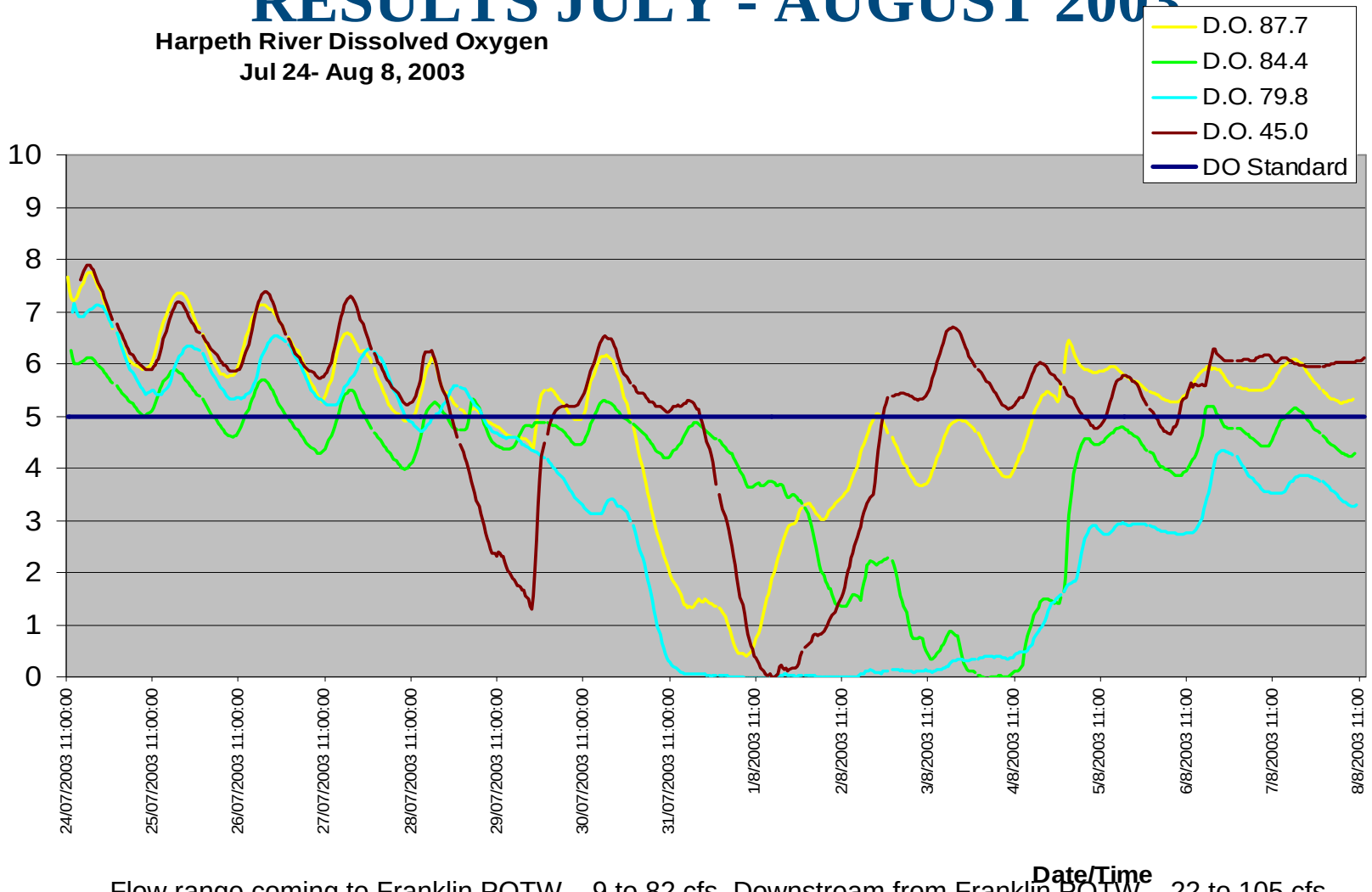


Flow range coming to Franklin POTW – 2.6 to 127 cfs. Downstream from Franklin POTW – 10 to 135 cfs

Estimated Effluent Percentage Downstream Using POTW Flow of 3 mgd – 3% to 49%

Estimated Effluent Percentage Downstream Using POTW Flow of 6 mgd – 7% to 73%

TDEC DIURNAL DISSOLVED OXYGEN STUDY RESULTS JULY - AUGUST 2003

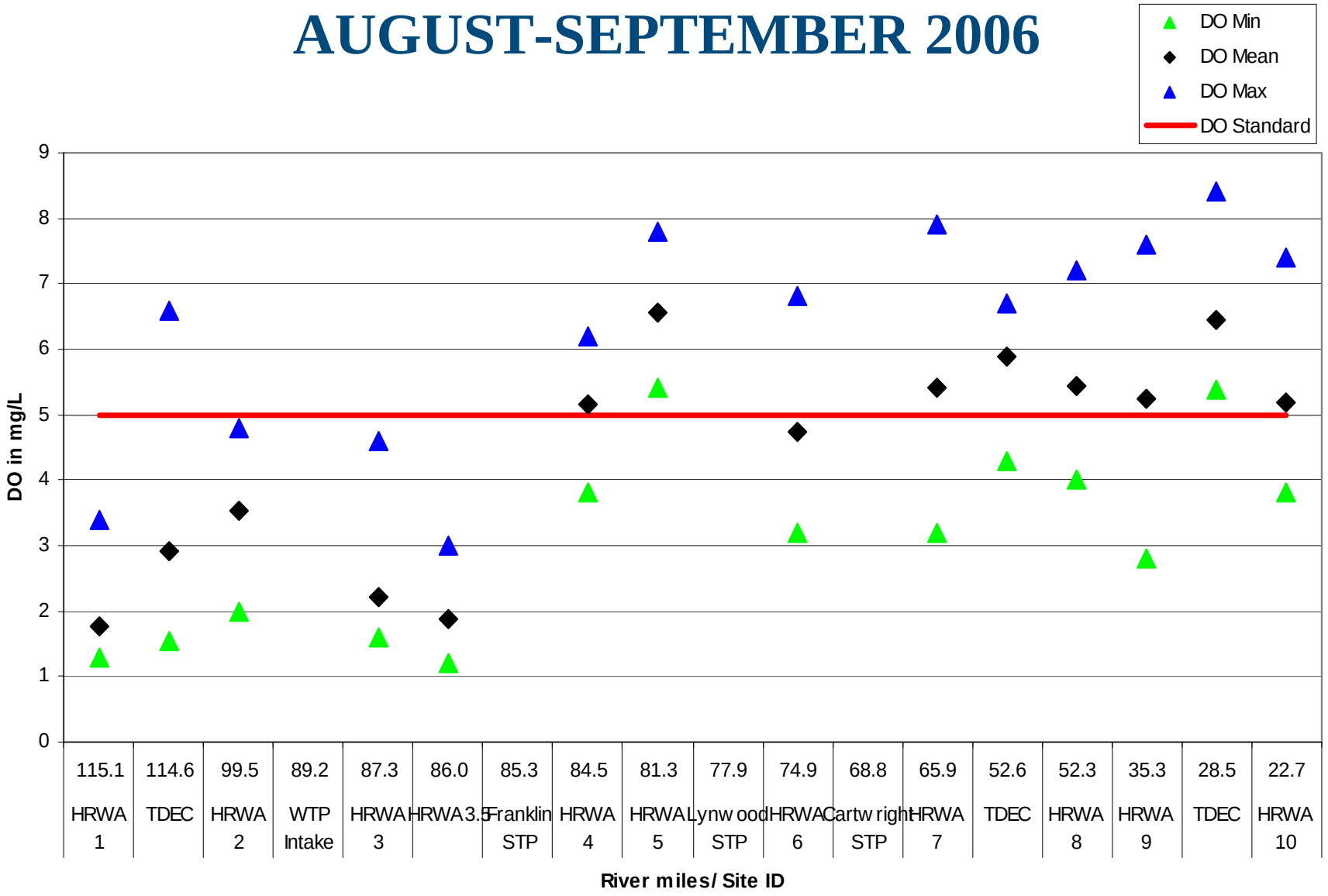


Flow range coming to Franklin POTW – 9 to 82 cfs. Downstream from Franklin POTW – 22 to 105 cfs

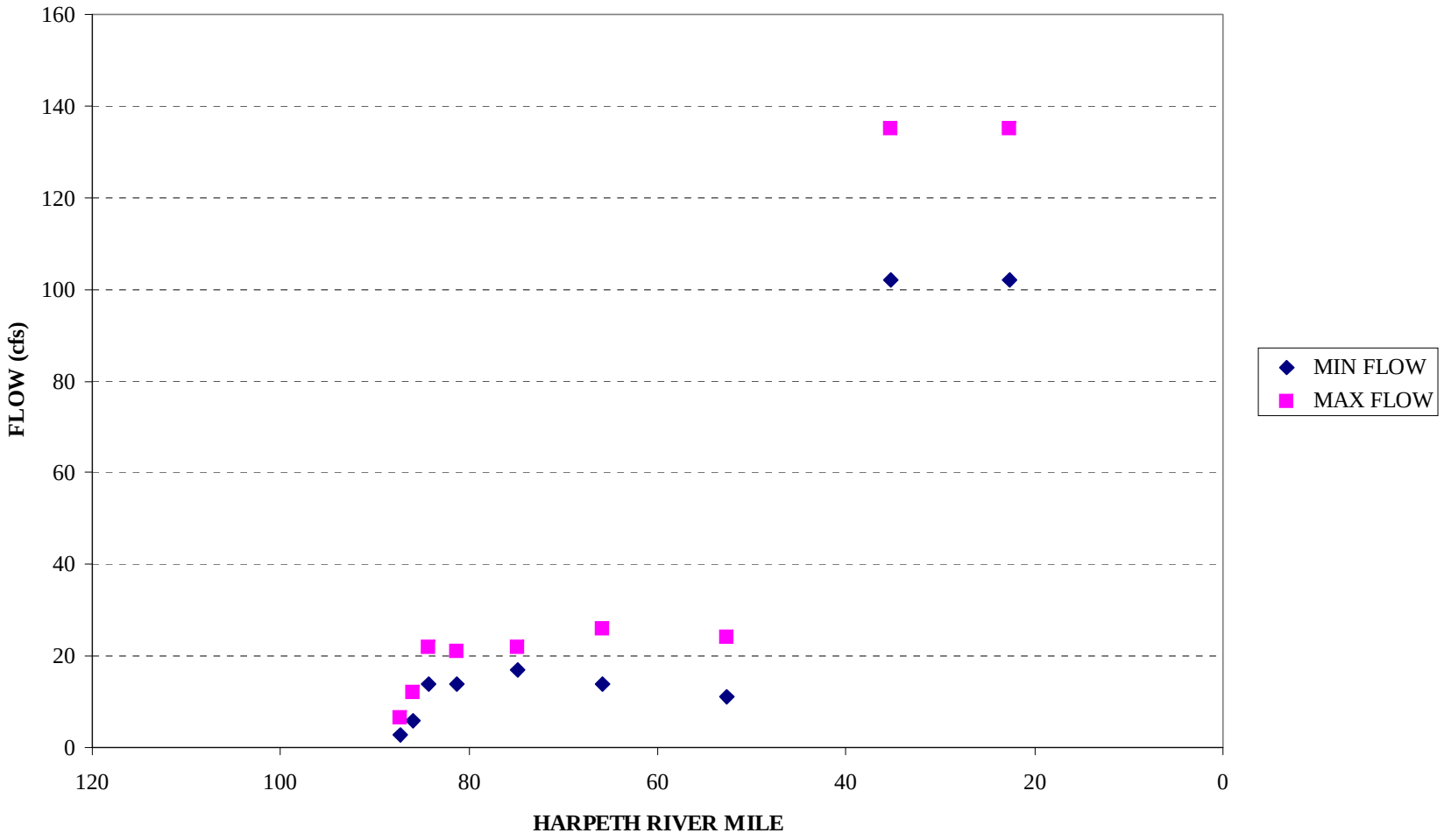
Estimated Effluent Percentage Downstream Using POTW Flow of 3 mgd – 4% to 21%

Estimated Effluent Percentage Downstream Using POTW Flow of 6 mgd – 9% to 42%

HRWA & TDEC DISSOLVED OXYGEN DATA AUGUST-SEPTEMBER 2006



FLOW DURING HRWA STUDY AUGUST-SEPTEMBER 2006



SIMPLE MASS BALANCE

- Assumptions
  - **$CBOD_u$:BOD_5 = 5.4**
  - **Temperature = 25 °C**
  - **Franklin POTW Effluent**
    - **BOD_5 = 5 mg/L**
    - **TKN = 1 mg/L**
    - **DO = 85% of saturation**
    - **DO = 7.0 mg/L**
    - **Flow = 12 mgd permitted**
  - **Background, Harpeth River**
    - **$CBOD_u$ = 1 mg/L**
    - **TKN = 0.42 mg/L**
    - **Flow = 0.7 cfs (7Q10)**
    - **Flow = 0.45 mgd (7Q10)**
    - **DO = 6 mg/L**

- Franklin POTW
  - **Oxygen Demand = 3,159 lb/day**
  - **Oxygen Addition = 701 lb/day**
- Background
  - **Oxygen Demand = 11 lb/day**
  - **Oxygen In the River = 22.6 lb/day**
- Oxygen Deficit = 2,446 lb/day

- Flow required to meet effluent demand:
  - **Assuming 6 mg/L in the River**
    - **~95 cfs**
  - **Assuming 5 mg/L in the River**
    - **~140 cfs**

REAERATION

- **Reaeration depends upon turbulence, primarily provided by elevation changes.**
- **The amount of time a segment of water is exposed to elevation changes is critical**
- **The Harpeth River is a pool and riffle stream**
  - The riffle areas are the primary means of natural in-stream reaeration due to the turbulence
  - However, the time spent by any slug of water in the Harpeth River is primarily in pools.
- **Increasing the flow of the River increases the effects of reaeration**

WATER WITHDRAWAL

- **Effects of Water Withdrawals on Reaeration**
  - Decreases the turbulence across riffle areas
  - Increases the time across riffle areas
  - Increases the length of time for a slug of water to pass through a pool
  - Net change is a decrease in the Harpeth River's ability to physically add oxygen
- **Effects of Water Withdrawals on SOD**
  - With less water in the river bed, the effects of SOD are increased because more of the water column can be influenced

EPA MODEL – NON-POINT AND POINT SOURCE REDUCTIONS

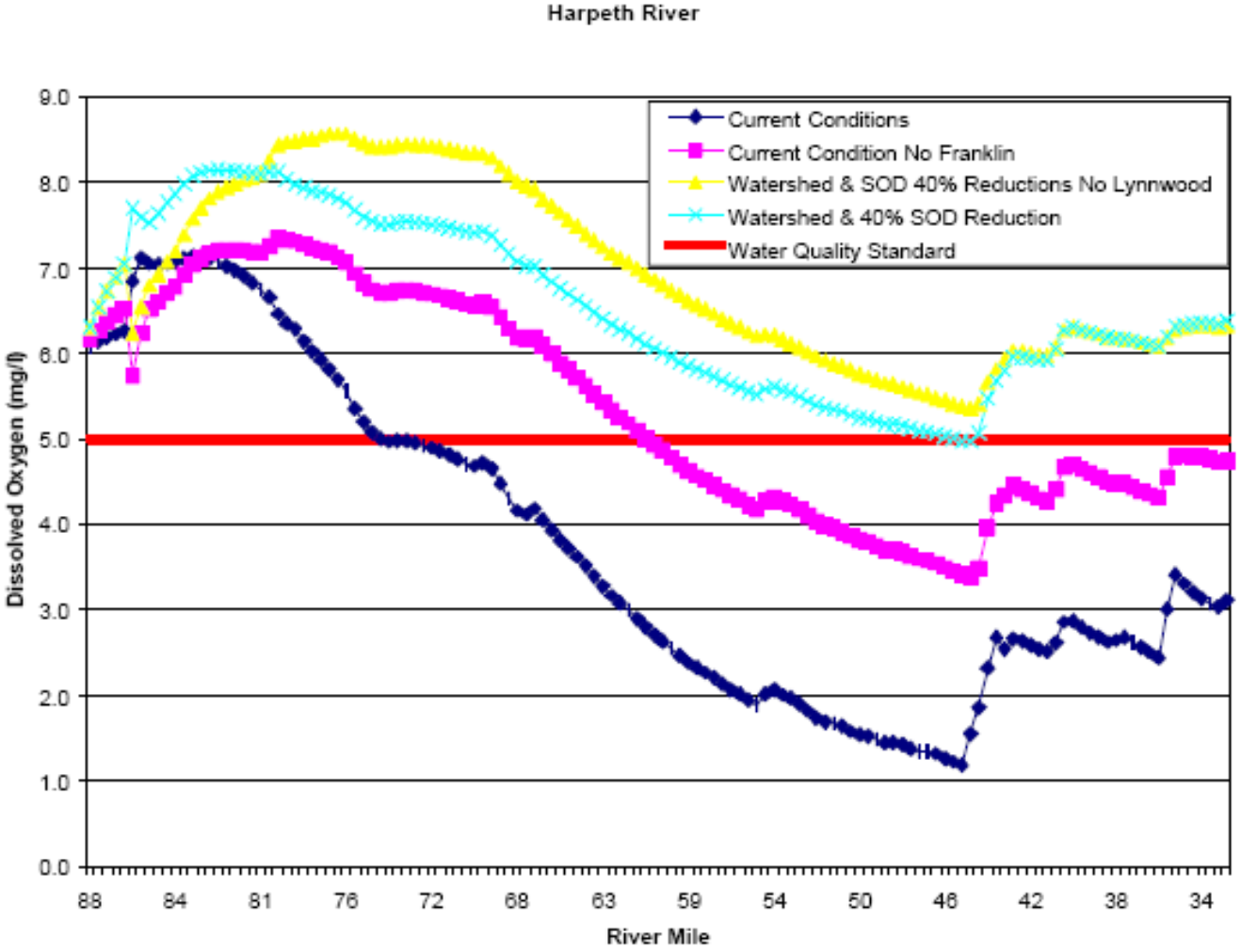


Figure 16 Predicted DO levels versus Pollutant Reduction Scenarios at Critical Conditions

EPA – FRANKLIN SCENARIOS

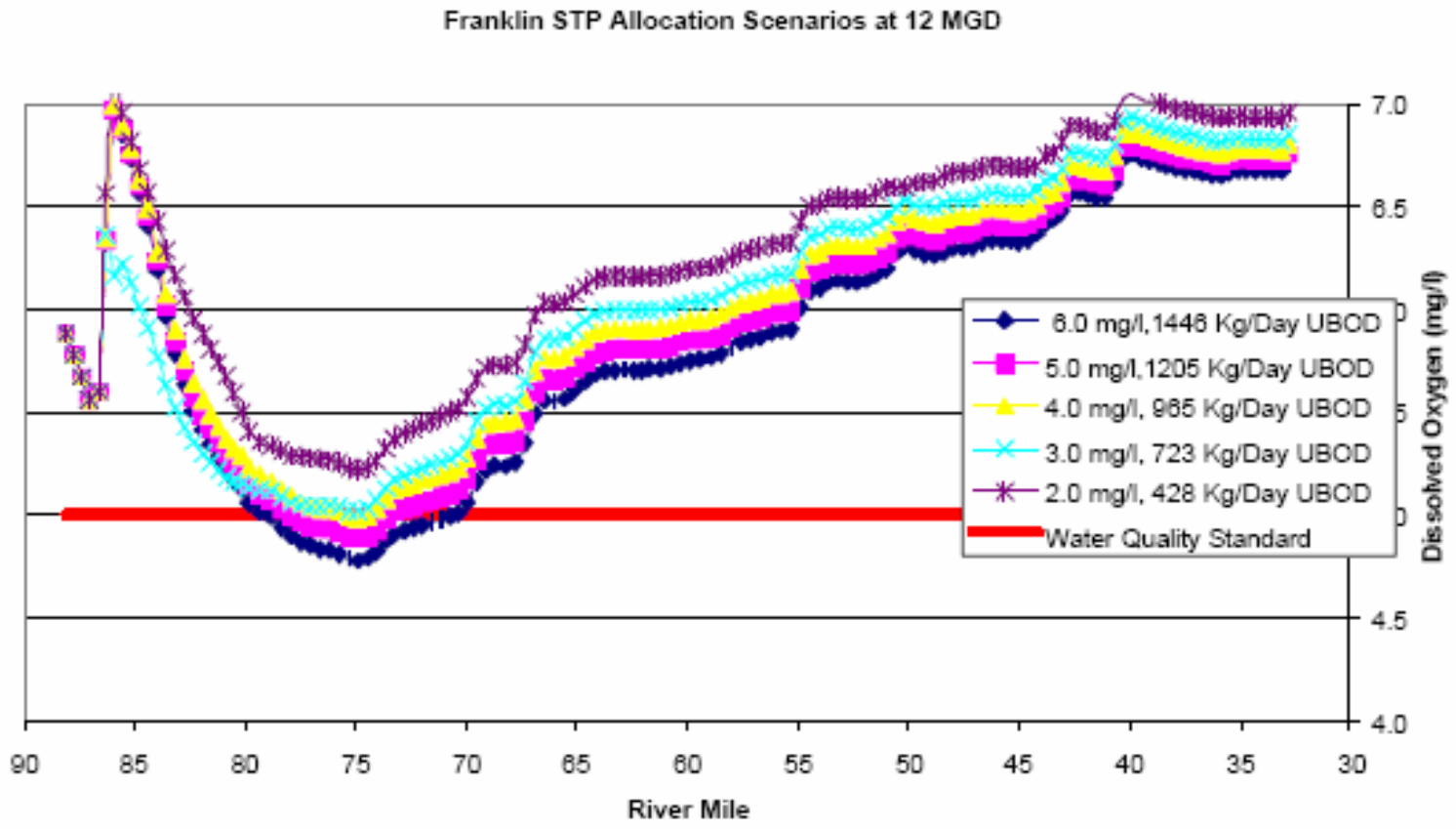


Figure 18 Predicted DO levels versus Franklin STP Treatment Levels at Critical Conditions

PROBLEM IDENTIFICATION

1. **Foremost is that the natural flows in the Harpeth are not sufficient during low-flow warm months from June through October to assimilate the current effluent discharges to the River**
2. **Water withdrawal exacerbates the problems downstream**
3. **EPA Model Assumed 6 mg/L of DO in the River coming to the Franklin POTW and still showed violations of the water quality standard**
4. **Data collected in 1987, 2000, 2002, 2003, and 2006 showed violations of the DO water quality standard**

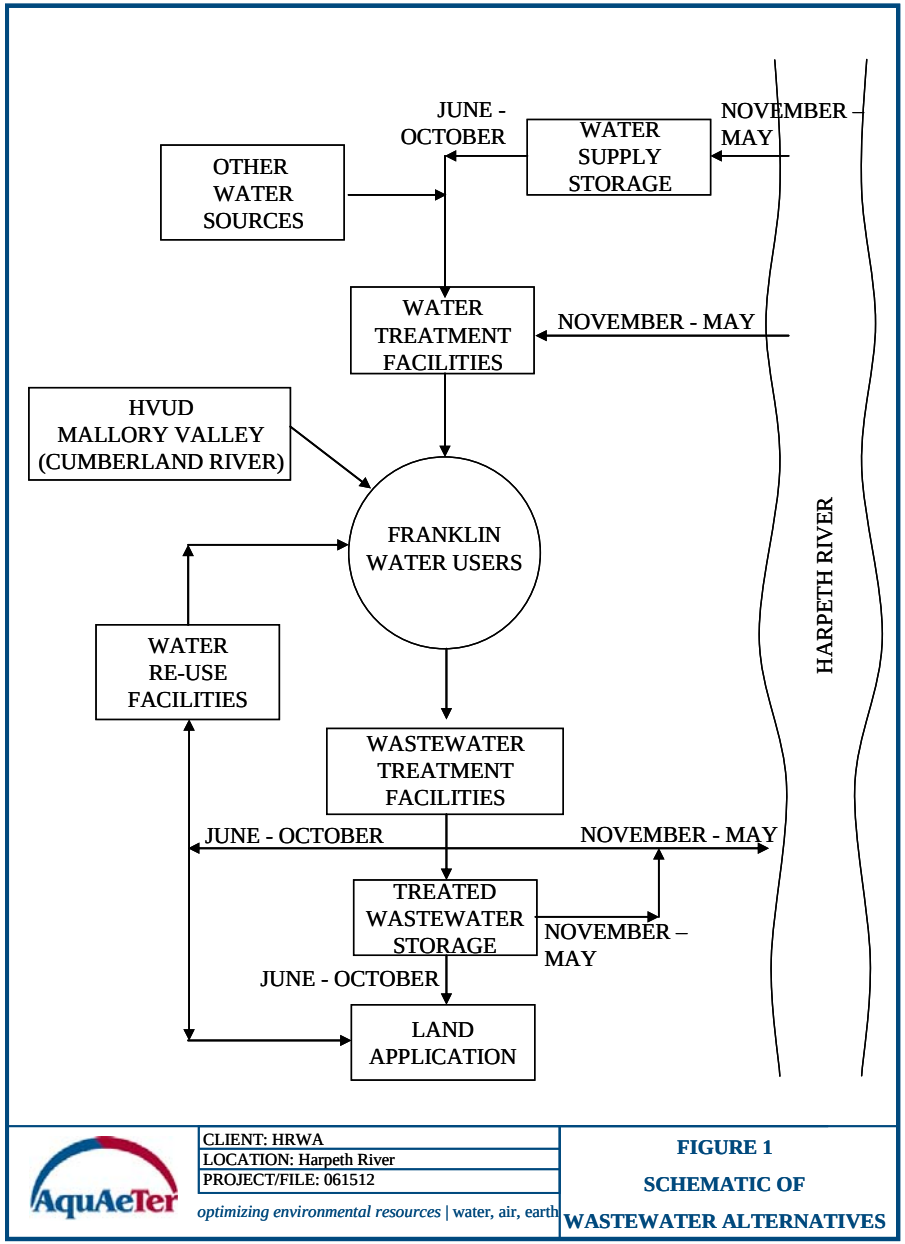


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FIGURE 1

SCHEMATIC OF

WASTEWATER ALTERNATIVES

OPTIONS

1. **No discharges to the Harpeth River during summer months**
   a. **Hold and Release;**
   b. **Water Reuse, either for water supply or irrigation; or**
   c. **Pipe to a larger stream – Cumberland River or to Harpeth at Kingston Springs.**
2. **Carbon or RO at end of pipe for all dischargers on the Harpeth River**
   a. For Franklin, $5 million to $10 million capital;
   b. For Franklin, $1 million to $2 million added operating expenses per year;
   c. **Present Worth = $16.5 million to $33 million**
3. **Reaerate the River at strategic locations downstream from Franklin**
4. **Consider Regional Water Supply and Treatment for Franklin/Williamson County**
5. **Water withdrawals from the Harpeth should be limited during warm-weather months from June through October**
6. **Improve water quality in upper Harpeth River watershed**
7. **Build an upstream reservoir on the Harpeth or a tributary to provide additional flow of about 100 cfs daily during the summer months**
8. **Investigate the possibility of using other streams, such as, the West Harpeth, to discharge a portion of the Franklin POTW effluent**
9. **Change the Discharge location on the Harpeth River**


NPDES SEWAGE TREATMENT PLANT PERMITS FOR FRANKLIN, LYNWOOD UTILITY AND CARTWRIGHT CREEK UTILITY WILL BE EVALUATED THIS FALL DURING THE RENEWAL PROCESS