3.0 RESULTS AND DISCUSSION

3.1 STRATIFICATION MONITORING

The following sections describe temporal and spatial patterns for the water quality parameters of temperature, dissolved oxygen (DO), pH, and conductivity measured throughout the F.E. Walter Reservoir watershed during 2006. Additionally, patterns related to season and depths are described for station WA-2 located in the reservoir. Maximum depths for WA-2 vary between approximately 55 to 115 feet due to operations in 2006 and rainfall. All of the data collected during the 2006 monitoring period are presented in Appendix A.

3.1.1 Temperature

Temperature is the primary influencing factor on water density, affects the solubility of many chemicals compounds, and can therefore influence the effect of pollutants on aquatic life. Increased temperatures elevate the metabolic oxygen demand, in conjunction with reduced oxygen solubility, and can impact many species. Vertical stratification patterns naturally occurring in lakes affect the distribution of dissolved and suspended compounds.

Temperature of the tributary surface waters of the F.E. Walter Reservoir watershed generally followed a similar pattern throughout the monitoring period. Temperatures increased throughout the summer and peaked in mid-July at approximately 22.25 °C, and decreased thereafter through November (Fig. 3-1). Temperatures in surface waters of the reservoir-body (station WA-2, -6, and -7) were generally warmer than in tributaries (stations WA-3, -4, and -5) and downstream of the dam (WA-1). In-lake reservoir surface temperatures peaked in late July at approximately 27.33 °C. Downstream release surface temperatures peaked in late August at approximately 22.13 °C.

The water column of F.E. Walter Reservoir was stratified during portions of the 2006 sampling season (Fig. 3-2). Stratification was evident from early June through most of July. A large storm event at the end of June resulted in the storage and subsequent release of storm flows. The water column remained stratified but a shift to warmer water temperatures, throughout the water column, was noted between the June and July sampling events. In addition, due to operational changes in 2006, specifically the raising of the base pool level and recreational release operations, the temperature stratification within the reservoir was likely affected by bottom flood gate releases on various occasions during the season. As a result, lower and typically cooler bottom waters are withdrawn first, likely causing a disruption in stratification and depletion of colder water. The extent and maintenance of temperature stratification as it relates to operating at a higher pool level could not be confidently established due to the modification of operations in response to flood control needs. Overall, 2006 release temperatures were lower than seen during operations in 2005. This can be a result of numerous factors to include operating at a higher pool level and experiencing above normal precipitation throughout the season.

3.1.2 Dissolved Oxygen

Dissolved oxygen (DO) is the measure of the amount of DO in water. Typically, DO concentrations in surface waters are less than 10 mg/L. Dissolved Oxygen concentrations are subject to diurnal and seasonal fluctuations that can be influenced, in part, by temperature, river discharge, and photosynthetic activity. Dissolved Oxygen is essential to the respiratory metabolism of most aquatic organisms. It affects the availability and solubility of nutrients and subsequently the productivity of aquatic ecosystems. Low levels of oxygen can facilitate the release of nutrients from bottom sediments.

In 2006, DO in the tributary surface waters of F.E. Walter Reservoir remained relatively constant in July and August with an increasing trend thereafter through November. Generally, DO concentrations in surface waters of the reservoir-body (station WA-2, -6, and -7) were slightly lower than in tributaries (stations WA-3, -4, and -5) and downstream of the dam (WA-1). This can be attributed to typically well oxygenated stream and river systems.

The water column of F.E. Walter Reservoir was weakly stratified with respect to DO during most of the sampling season (Fig. 3-4). During May, early June, and mid-September through November the water column was relatively uniform with concentrations remaining fairly stable and above state criteria (5 mg/l) throughout the water column. The rest of the sampling season has shown a trend of decreasing or varying DO concentrations at greater depths in the water column. Some of the inconsistent readings may be attributed to water chemistry changes resulting from the late June storm event.

The health of aquatic ecosystems can be impaired by low DO concentrations in the water column. Hypoxia, or conditions of DO concentrations less than 2 mg/L, is generally accepted as the threshold at which the most severe effects on biota occur. In August of 2006, the middle water column of F.E. Walter Reservoir experienced hypoxia or near hypoxic conditions (Fig. 3-4). Release water is re-aerated as it passes through the conduit system of the reservoir. As a result, release DO concentrations ranged from 8.02 mg/L to 13.64 mg/L throughout the sampling season downstream in the Lehigh River.

3.1.3 pH

PH is the measure of the hydrogen –ion concentration in the water. A pH below 7 is considered acidic and a pH above 7 is basic. The pH scale is 0-14 with the lower numbers being more acidic and the higher numbers being more basic. High pH values tend to facilitate solubilization of ammonia, salts, and heavy metals. Low pH levels tend to increase carbonic acid and carbon dioxide concentrations. Lethal effects of pH on aquatic life typically occur below pH 4.5 and above pH 9.5.

Measures of pH in tributary surface waters of F.E. Walter Reservoir generally followed a similar pattern during 2006; however, slight differences were apparent between reservoir body, upstream, and downstream waters (Figs. 3-5). All stations located within the reservoir (WA-2, -6, and -7), downstream (WA-1), and upstream (WA-3, -4, and –5) of the reservoir remained relatively constant or within a narrow range of values throughout the sampling season. The maximum and minimum insitu pH readings of 7.82 and 6.20, respectively was recorded at station WA-5 upstream of the reservoir.

On most monitoring dates in 2006, measures of pH were relatively uniform throughout the water column (Fig. 3-6). In most cases, higher pH levels were seen at or near the surface waters. Likely, this is a result of increased algal productivity in the trophic zone of the lake (influenced by sun light and primary production). Measures of pH in the water column of F.E. Walter Reservoir were occasionally not in compliance with PADEP water quality standards. The water quality standard for pH is a range of acceptable measures between 6 and 9. Station WA-2 was below the pH standard of 6.0 in the lower water column in May and in the middle water column in July (Appendix A).

3.1.4 Conductivity

Conductivity is the measure of the ability of water to conduct electric current. The greater the content of ions in the water, then the more current the water can carry. Ions are dissolved metals and other dissolved materials. Specific conductivity can be used to estimate the total ion concentration of the water and is sometimes used as an alternative measure of dissolved solids. Natural waters are found to vary between .05 and 1.5 mS/cm.

For the most part, conductivity among the surface waters of F.E. Walter Reservoir followed a fairly stable pattern during 2006 with maximum conductivity levels being seen in August (Fig. 3-7). Conductivity was routinely lower upstream of the reservoir at station WA-5. In most months, conductivity measures were generally uniform throughout the water column, but showed a slight increasing trend deeper in the water column notably in August (Fig. 3-8). Conductivity patterns in the water column at station WA-2 were at their lowest in November and July and at their highest levels in May and June.

3.2 WATER COLUMN CHEMISTRY MONITORING

Table 3-2 provides a summary of water column chemistry sampling for all stations and dates sampled at F.E. Walter Reservoir in 2006. The following sections describe the temporal, spatial, and depth related patterns for these water quality measures.

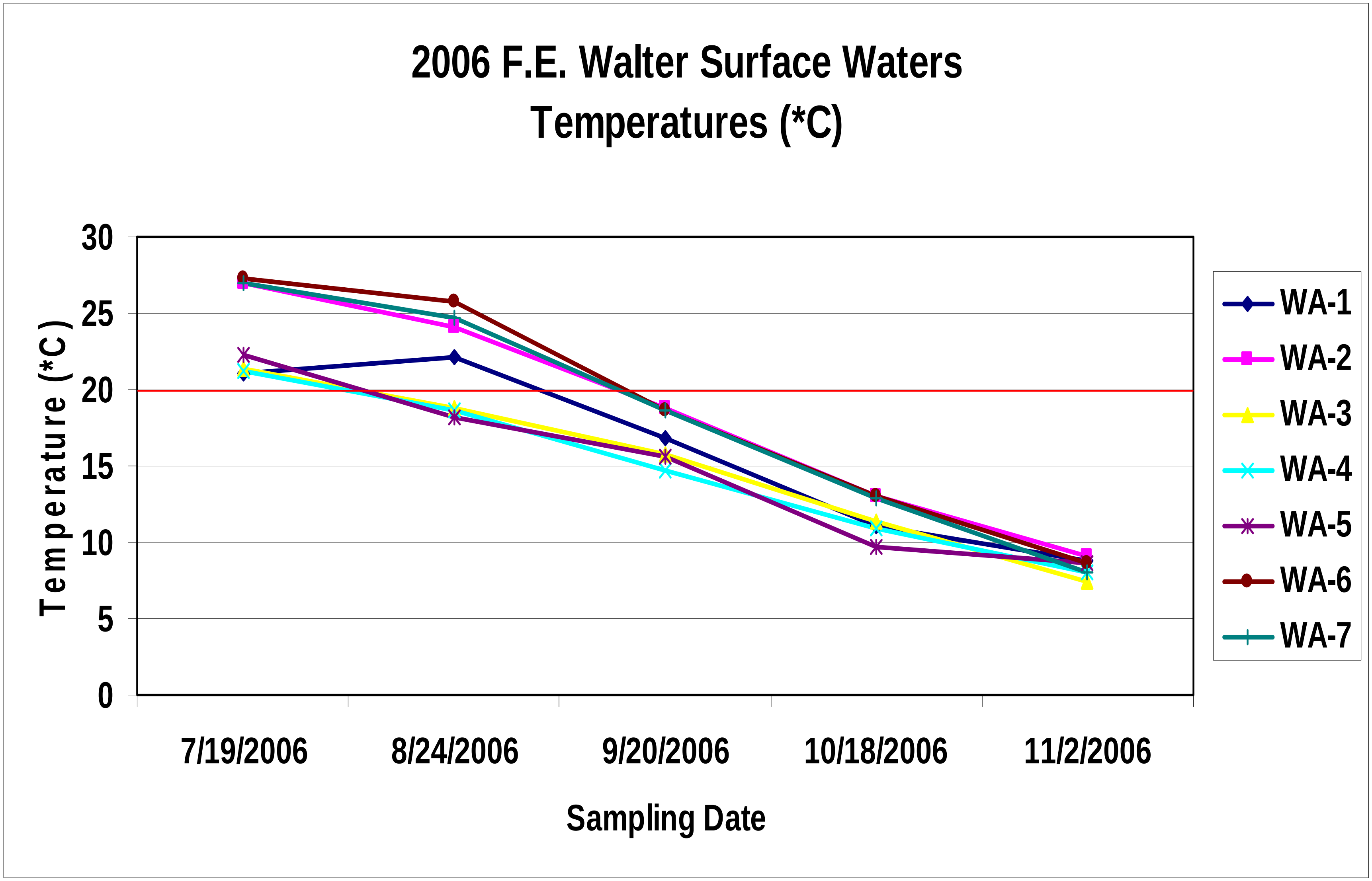

Figure 3-1. Temperature measured in surface waters of F.E. Walter Reservoir during 2006. See Appendix A for a summary of the plotted values.

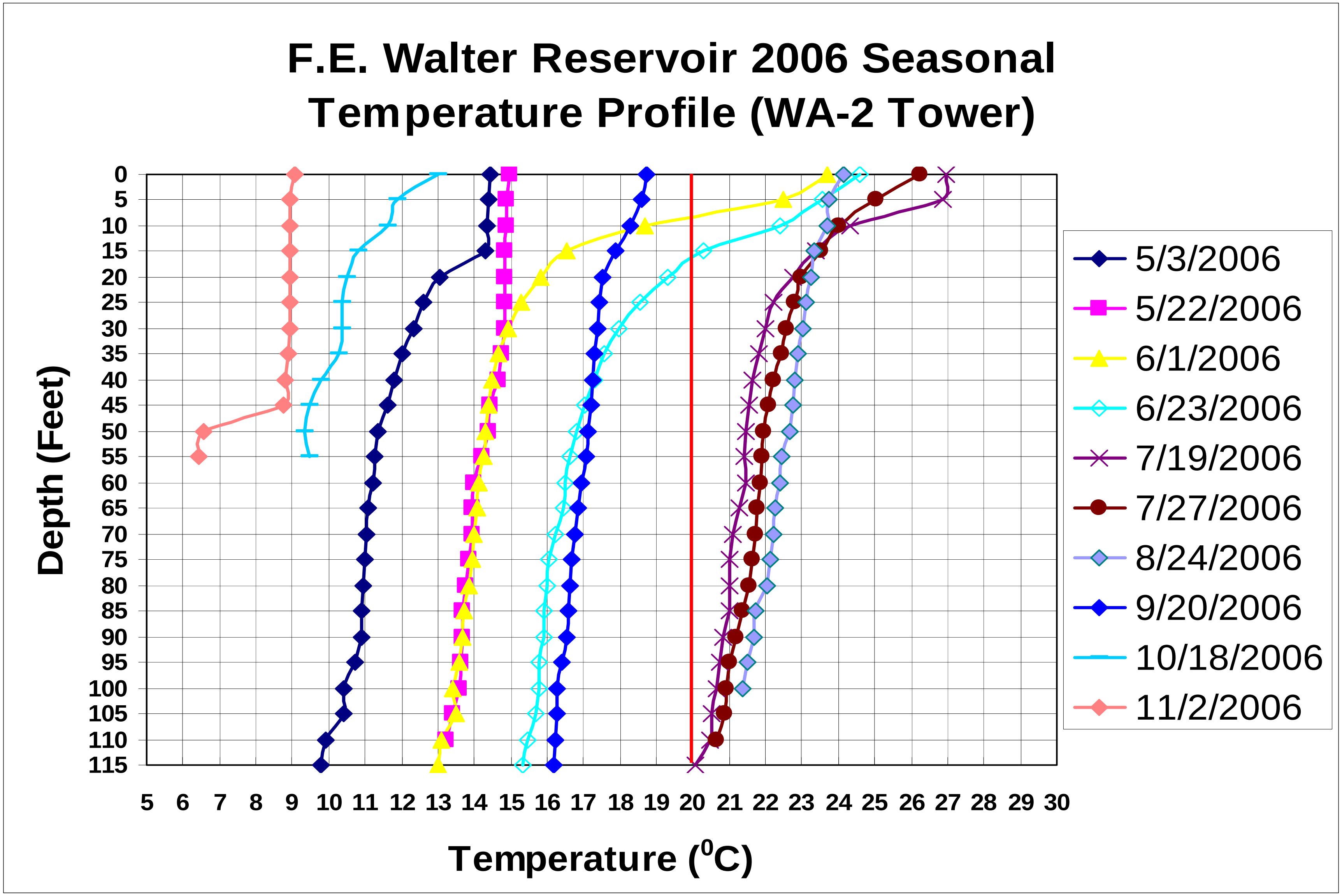

Figure 3-2. Stratification of temperature measured in the water column of F. E. Walter Reservoir at station WA-2 during 2006. See Appendix A for a summary of the plotted values.

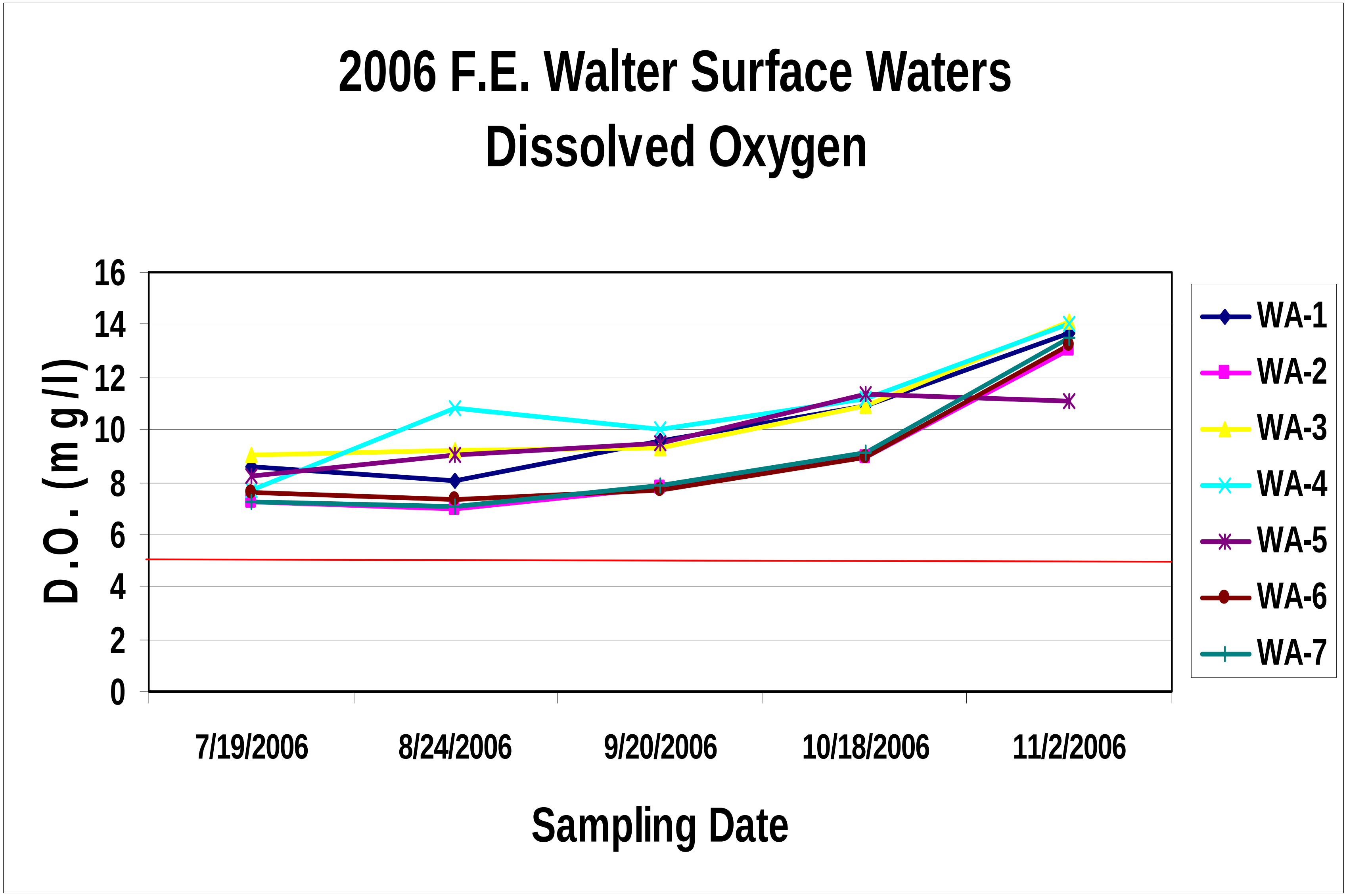

Figure 3-3. Dissolved oxygen measured in surface waters of F. E. Walter Reservoir during 2006. See Appendix A for a summary of the plotted value

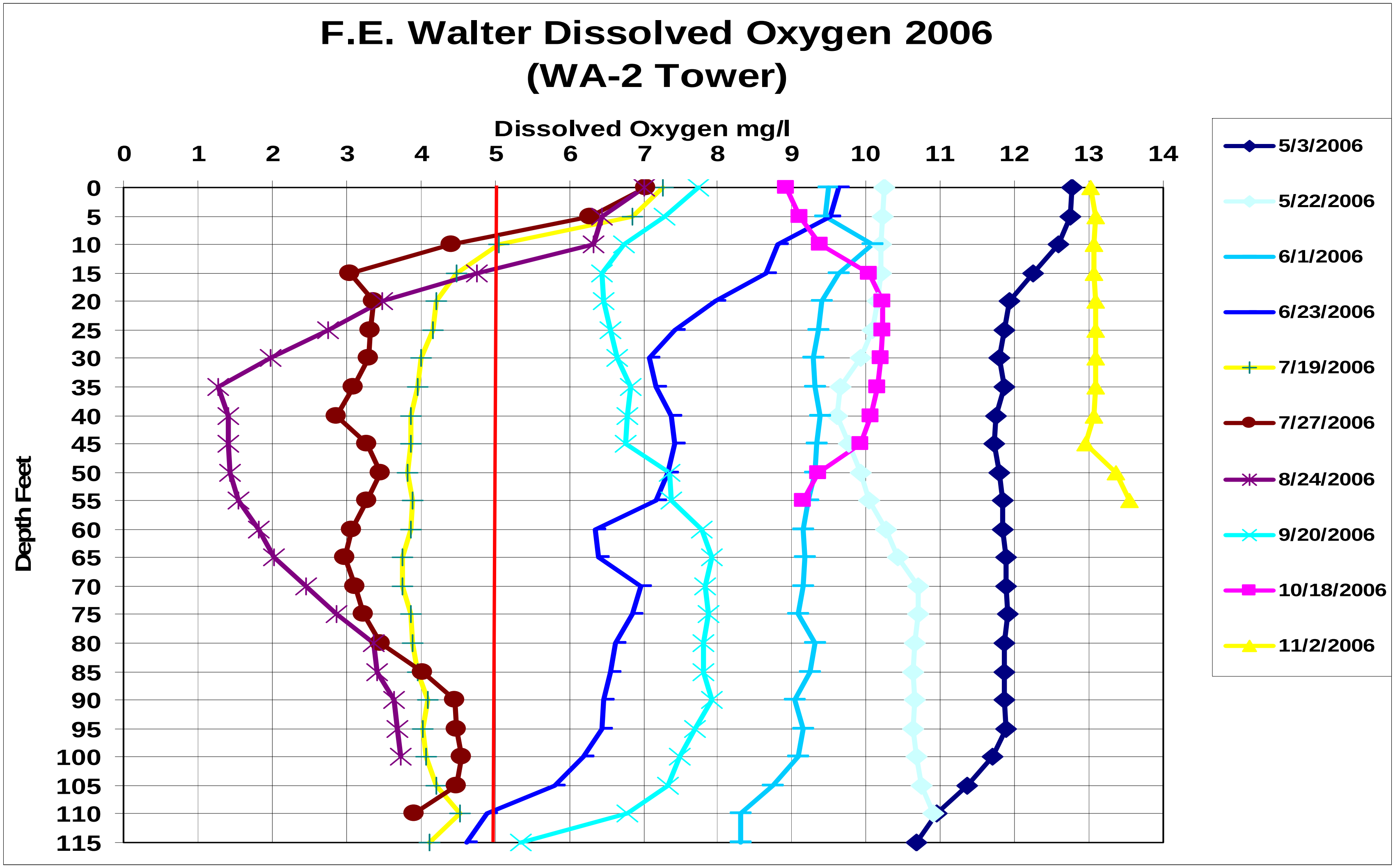

Figure 3-4. Dissolved oxygen measured in the water column of F.E. Walter Reservoir at station WA-2 during 2006. The PADEP water quality standard for DO is a minimum concentration of 5 mg/L. See Appendix A for a summary of the plotted values

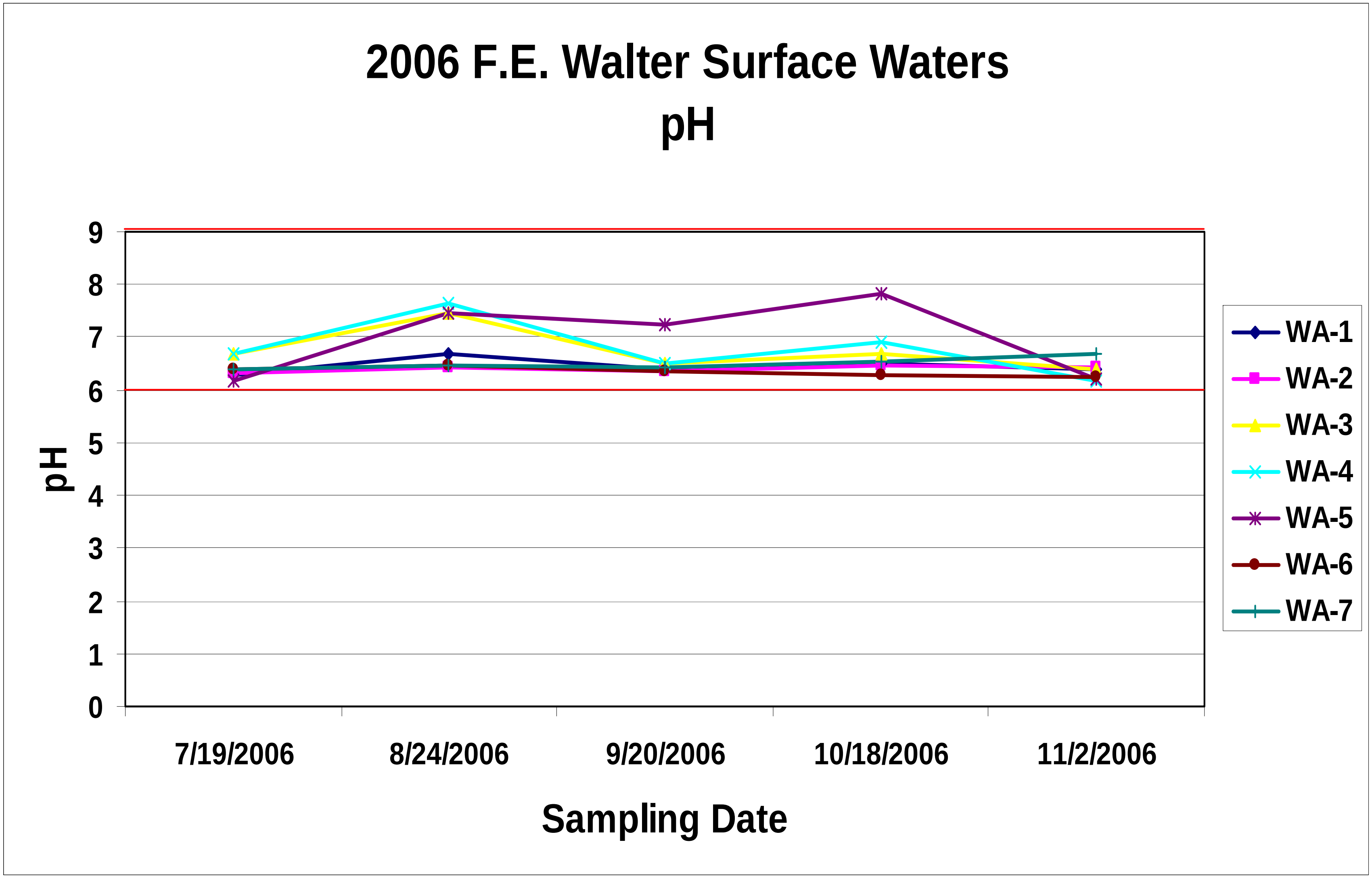

Figure 3-5. Measures of pH in surface waters of F.E. Walter Reservoir during 2006. The PADEP water quality standard for pH is an acceptable range from 6 to 9. See Appendix A for a summary of the plotted values.

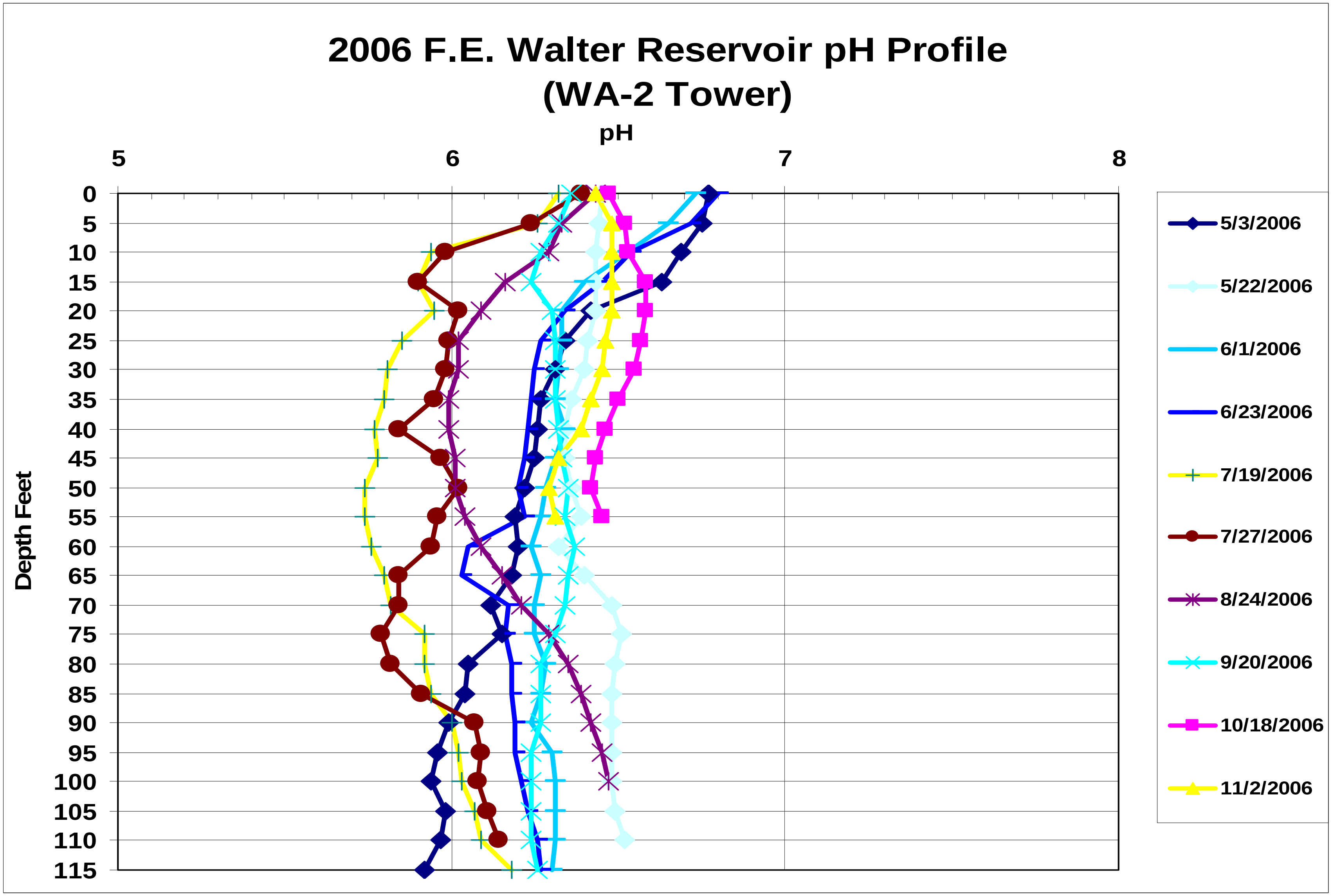

Figure 3-6. Stratification of pH measured in the water column of F.E. Walter Reservoir at station WA-2 during 2006. The PADEP water quality standard pH is an acceptable range from 6 to 9. See Appendix A for a summary of the plotted values.

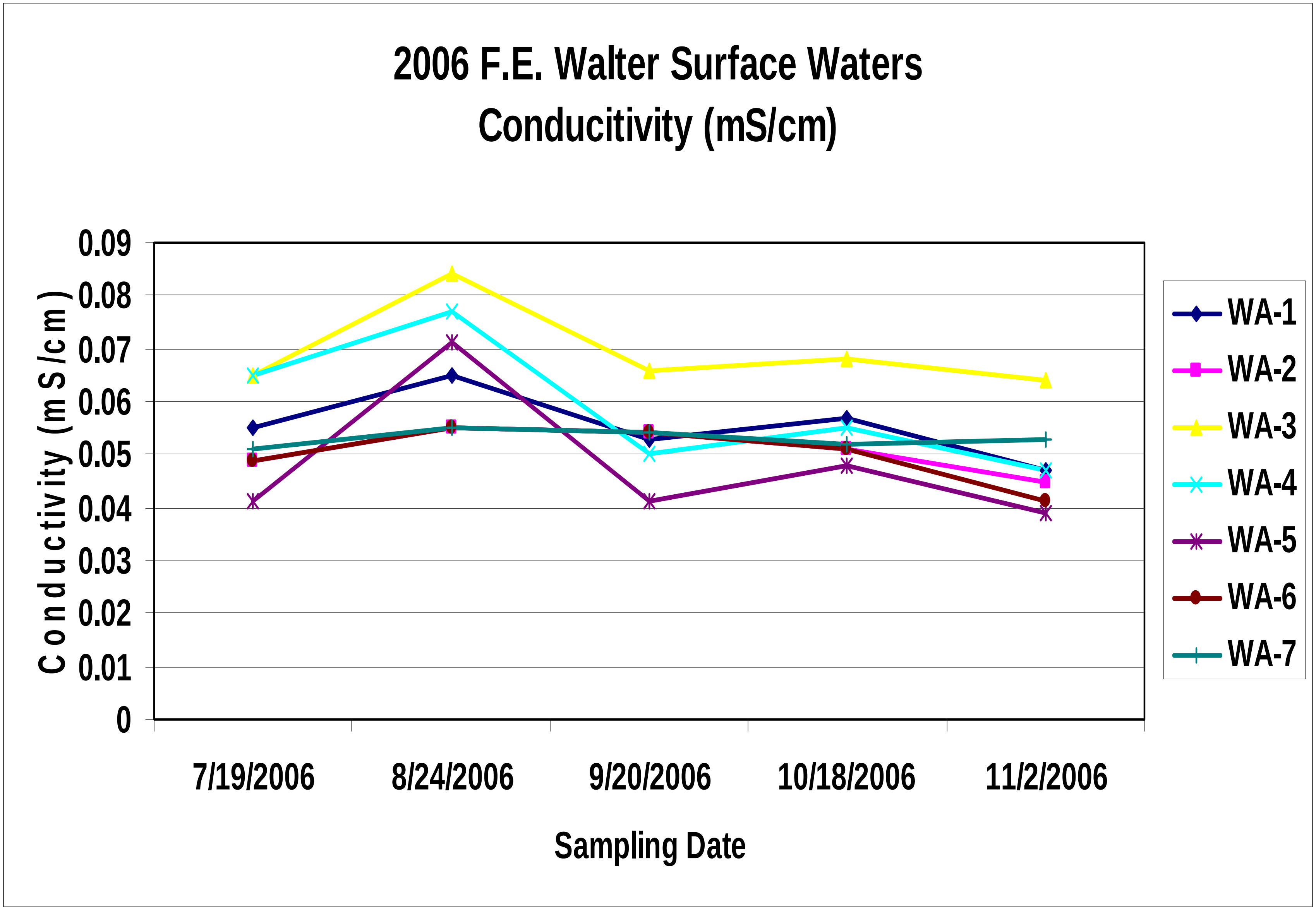

Figure 3-7. Conductivity measured in surface waters of F.E. Walter Reservoir during 2006. See Appendix A for a summary of the plotted values.

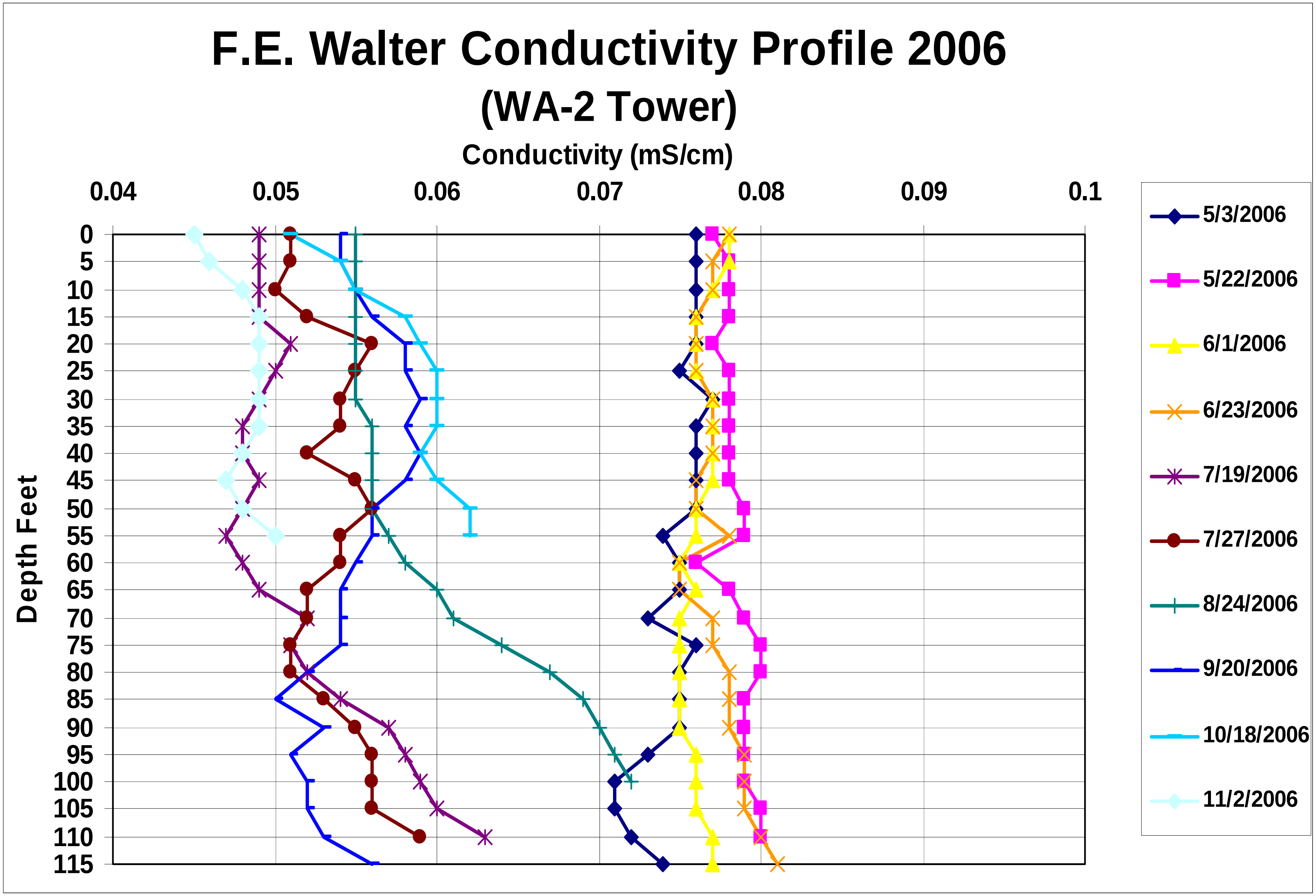

Figure 3-8. Stratification of conductivity measured in the water column of F. E. Walter Reservoir at station WA-2 during 2006. See Appendix A for a summary of the plotted values.

Table 3-1. Summary of surface, middle and bottom water quality monitoring data for F.E. Walter Reservoir in 2006.

STATION	DATE		ALK		BOD5		TDS		TSS		PO4		DISS P		TP		NH3		NO2		NO3		TKN		TC		TOC		TIC
WA-1S	19-Jul-06		4		19		120		4		0.02	<	0.05		0.37		0.18	<	0.02	<	0.04		0.9		12		9	<	0.5
WA-1S	24-Aug-06		2		5		36		4	<	0.01		0.05		0.06		0.34	<	0.02		0.11	<	0.5		11		7	<	0.5
WA-1S	20-Sep-06		2	<	1		10		6	<	0.01	<	0.05	<	0.01		0.41	<	0.01	<	0.5		0.7		15.1		11		3.8
WA-1S	18-Oct-06		4		1		72		14	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		0.6	<	0.5		5.9		4.3		1.5
WA-1S	2-Nov-06		4	<	2		22		4	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01	<	0.5	<	0.5		6.5		5.1		1.4
Mean			3		6		52		6		0.01		0.05		0.09		0.20		0.01		0.35		0.62		10.1		7.3		1.5
Maximum			4		19		120		14		0.02		0.05		0.37		0.41		0.02		0.60		0.90		15.1		11.0		3.8
Minimum			2		1		10		4		0.01		0.05		0.01		0.03		0.01		0.04		0.50		5.9		4.3		0.5
Std. Dev.			1		8		45		4		0.00		0.00		0.16		0.17		0.01		0.26		0.18		3.9		2.8		1.4
No. of D.			5		3		5		5		1		1		2		3		0		2		2		5		5		3
WA-2S	19-Jul-06		2		21		44	<	3		0.02		0.24		0.5		0.11	<	0.02	<	0.04		0.8		17		14	<	0.5
WA-2S	24-Aug-06		8		5		218		3	<	0.01		0.39		0.4		0.32		0.06		0.08		1.4		11		8	<	0.5
WA-2S	20-Sep-06		2	<	1		38		5	<	0.01	<	0.05	<	0.01		0.19	<	0.01	<	0.5		0.6		16.2		10.2		6.1
WA-2S	18-Oct-06		2		1		92		10	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		0.95	<	0.5	<	0.5	<	0.5	<	0.5
WA-2S	2-Nov-06		4	<	2		26		5	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01	<	0.5	<	0.5		6.8		5.5		1.3
Mean			4		6		84		5		0.01		0.16		0.19		0.14		0.02		0.41		0.76		10.3		7.6		1.8
Maximum			8		21		218		10		0.02		0.39		0.50		0.32		0.06		0.95		1.40		17.0		14.0		6.1
Minimum			2		1		26		3		0.01		0.05		0.01		0.03		0.01		0.04		0.50		0.5		0.5		0.5
Std. Dev.			3		9		79		3		0.00		0.15		0.24		0.12		0.02		0.37		0.38		6.9		5.1		2.4
No. of D.			5		3		5		4		1		2		2		3		1		2		3		4		4		2
WA-2M	19-Jul-06		4		30		48	<	3		0.05	<	0.05		0.26		0.18	<	0.02	<	0.04		0.9		14		10	<	0.5
WA-2M	24-Aug-06		4		2		36		4		0.02		0.26		0.3		0.28		0.08		0.1		2.1		11		8	<	0.5
WA-2M	20-Sep-06		4	<	1		24	<	3	<	0.01	<	0.05	<	0.01		0.3	<	0.01		0.65	<	0.5		15.2		10.3		4.3
WA-2M	18-Oct-06		4		1		66		8	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		1.55	<	0.5	<	0.5	<	0.5	<	0.5
WA-2M	2-Nov-06		4	<	2		34	<	3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01	<	0.5	<	0.5		9.3		6.2		3.1
Mean			4		7		42		4		0.02		0.09		0.12		0.16		0.03		0.57		0.90		10.0		7.0		1.8
Maximum			4		30		66		8		0.05		0.26		0.30		0.30		0.08		1.55		2.10		15.2		10.3		4.3
Minimum			4		1		24		3		0.01		0.05		0.01		0.03		0.01		0.04		0.50		0.5		0.5		0.5
Std. Dev.			0		13		16		2		0.02		0.09		0.15		0.13		0.03		0.61		0.69		5.8		4.0		1.8
No. of D.			5		3		5		2		2		1		2		3		1		3		2		4		4		2

Table 3-1. Continued

WA-2B	19-Jul-06		6		12		66	<	3		0.16		0.08		0.18		0.19	<	0.02	<	0.04		0.8		12		9	<	0.5
WA-2B	24-Aug-06		4		2		42		29		0.01		0.15		0.17		0.14	<	0.02		0.12		1.4		11		7	<	0.5
WA-2B	20-Sep-06		4		3		34		25		0.01	<	0.05	<	0.01		0.21	<	0.01	<	0.5	<	0.5		15.9		11.1		3.7
WA-2B	18-Oct-06		4		1		72		12		0.03	<	0.05	<	0.01		0.08	<	0.01		0.97	<	0.5	<	0.5	<	0.5	<	0.5
WA-2B	2-Nov-06		4	<	2		20	<	3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01	<	0.5	<	0.5		5.9		4.5		1.4
Mean			4		4		47		14		0.04		0.08		0.08		0.13		0.01		0.43		0.74		9.1		6.4		1.3
Maximum			6		12		72		29		0.16		0.15		0.18		0.21		0.02		0.97		1.40		15.9		11.1		3.7
Minimum			4		1		20		3		0.01		0.05		0.01		0.03		0.01		0.04		0.50		0.5		0.5		0.5
Std. Dev.			1		5		22		12		0.07		0.04		0.09		0.08		0.01		0.37		0.39		6.0		4.1		1.4
No. of D.			5		4		5		3		4		2		2		4		0		2		2		4		4		2
WA-3S	19-Jul-06		4		14		62	<	3		0.03	<	0.05	<	0.01		0.09	<	0.02	<	0.04		0.8		12		9	<	0.5
WA-3S	24-Aug-06		6		2		54		3		0.02		0.17		0.2	T	0.12		0.07		0.18		2.1	<	0.5	<	0.5	<	0.5
WA-3S	20-Sep-06		4	<	1		60		5	<	0.01	<	0.05	<	0.01		0.16	<	0.01		0.55	<	0.5		17.5		11.2		5.8
WA-3S	18-Oct-06		2		5		98		10	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		2.04	<	0.5		10		7.7		2.5
WA-3S	2-Nov-06		4		6		50		3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01	<	0.5	<	0.5		8.3		7.4		0.9
Mean			4		6		65		5		0.02		0.07		0.05		0.09		0.02		0.66		0.88		9.7		7.2		2.0
Maximum			6		14		98		10		0.03		0.17		0.20		0.16		0.07		2.04		2.10		17.5		11.2		5.8
Minimum			2		1		50		3		0.01		0.05		0.01		0.03		0.01		0.04		0.50		0.5		0.5		0.5
Std. Dev.			1		5		19		3		0.01		0.05		0.08		0.06		0.03		0.80		0.69		6.2		4.0		2.3
No. of D.			5		4		5		4		2		1		1		2		1		3		2		4		4		3
WA-4S	19-Jul-06		8		11		42	<	3	<	0.01	<	0.05		0.02		0.07	<	0.02	<	0.04		0.9	<	0.5	<	0.5	<	0.5
WA-4S	24-Aug-06		8		5		44		5	<	0.01		0.27		0.3		0.11		0.08		0.12		3	<	0.5	<	0.5	<	0.5
WA-4S	20-Sep-06	<	0.4	<	1		40		5	<	0.01	<	0.05	<	0.01		0.14	<	0.01		0.82	<	0.5		15		8.8		6.2
WA-4S	18-Oct-06		4	<	1		70	<	3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		2.18	<	0.5	<	0.5	<	0.5	<	0.5
WA-4S	2-Nov-06		6	<	2		32	<	3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01	<	0.5	<	0.5		6.9		5.1		1.8
Mean			5		4		46		4		0.01		0.09		0.07		0.08		0.03		0.73		1.08		4.7		3.1		1.9
Maximum			8		11		70		5		0.01		0.27		0.30		0.14		0.08		2.18		3.00		15.0		8.8		6.2
Minimum			0		1		32		3		0.01		0.05		0.01		0.03		0.01		0.04		0.50		0.5		0.5		0.5
Std. Dev.			3		4		14		1		0.00		0.10		0.13		0.05		0.03		0.87		1.09		6.4		3.8		2.5
No. of D.			4		2		5		2		0		1		2		3		1		3		2		2		2		2

Table 3-1. Continued

WA-5S	19-Jul-06		2		14		54	<	3		0.17	<	0.05		0.03		0.09	<	0.02	<	0.04		1	<	0.5	<	0.5	<	0.5
WA-5S	24-Aug-06		2	<	1		550	<	3		0.01		0.3		0.39		1.05	<	0.02		0.12		3.1	<	0.5	<	0.5	<	0.5
WA-5S	20-Sep-06		2	<	1		24		10	<	0.01	<	0.05	<	0.01		0.23	<	0.01		0.75		0.5		14.4		10.3		3.8
WA-5S	18-Oct-06		4		1		42		3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		1.83	<	0.5		2.6		2.5	<	0.5
WA-5S	2-Nov-06		4	<	2		20	<	3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		0.55	<	0.5		6.4		4.8		1.6
Mean			3		4		138		4		0.04		0.10		0.09		0.29		0.01		0.66		1.12		4.9		3.7		1.4
Maximum			4		14		550		10		0.17		0.30		0.39		1.05		0.02		1.83		3.10		14.4		10.3		3.8
Minimum			2		1		20		3		0.01		0.05		0.01		0.03		0.01		0.04		0.50		0.5		0.5		0.5
Std. Dev.			1		6		231		3		0.07		0.11		0.17		0.43		0.01		0.72		1.13		5.8		4.1		1.4
No. of D.			5		2		5		2		2		1		2		3		0		4		3		3		3		2
WA-6S	19-Jul-06		4		7		52	<	3		0.95	<	0.05		0.06		0.12	<	0.02	<	0.04		1.1	<	0.5	<	0.5	<	0.5
WA-6S	24-Aug-06		2		1		45	<	3	<	0.01		0.05		0.09		0.44		0.06		0.09		0.8		11		8	<	0.5
WA-6S	20-Sep-06		2		2		22		5	<	0.01	<	0.05	<	0.01		0.42	<	0.01		0.79		0.6		14.2		10.4		3.6
WA-6S	18-Oct-06		2	<	1		48	<	3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		0.53	<	0.5		5.3		4.6		0.7
WA-6S	2-Nov-06		2	<	2		22	<	3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01	<	0.5	<	0.5		5.7		3.5		2.2
Mean			2		3		38		3		0.20		0.05		0.04		0.21		0.02		0.39		0.70		7.3		5.4		1.5
Maximum			4		7		52		5		0.95		0.05		0.09		0.44		0.06		0.79		1.10		14.2		10.4		3.6
Minimum			2		1		22		3		0.01		0.05		0.01		0.03		0.01		0.04		0.50		0.5		0.5		0.5
Std. Dev.			1		3		15		1		0.42		0.00		0.04		0.21		0.02		0.32		0.25		5.3		3.9		1.4
No. of D.			5		3		5		1		1		1		2		3		1		3		3		4		4		3
WA-6M	19-Jul-06		4		21		64	<	3	<	0.01	<	0.05		0.12		0.14	<	0.02	<	0.04		1.8		13		10	<	0.5
WA-6M	24-Aug-06		2		2		40	<	3		0.03		0.09		0.14		0.23		0.07		0.1		2.7		12		8	<	0.5
WA-6M	20-Sep-06		4		2		36		3	<	0.01	<	0.05	<	0.01		0.13	<	0.01		0.63	<	0.5		15.5		10.7		4.2
WA-6M	18-Oct-06		2	<	1		36	<	3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		1.75	<	0.5		4.7		4.1		0.6
WA-6M	2-Nov-06		4	<	2		40		3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01	<	0.5	<	0.5		8.1		6.2		1.9
Mean			3		6		43		3		0.01		0.06		0.06		0.11		0.02		0.60		1.20		10.7		7.8		1.5
Maximum			4		21		64		3		0.03		0.09		0.14		0.23		0.07		1.75		2.70		15.5		10.7		4.2
Minimum			2		1		36		3		0.01		0.05		0.01		0.03		0.01		0.04		0.50		4.7		4.1		0.5
Std. Dev.			1		9		12		0		0.01		0.02		0.07		0.08		0.03		0.69		1.01		4.3		2.7		1.6
No. of D.			5		3		5		2		1		1		2		3		1		3		2		5		5		3

Table 3-1. Continued

WA-6B	19-Jul-06		6		10		60		11	<	0.01		0.07	<	0.01		0.2	<	0.02	<	0.04		1.8		12		9	<	0.5
WA-6B	24-Aug-06		2		4		52		82		0.04		0.3		0.39		0.35	<	0.02		0.1		2.3	<	0.5	<	0.5	<	0.5
WA-6B	20-Sep-06		2	<	1		34		14	<	0.01	<	0.05		0.01		0.46	<	0.01		0.91		0.6		14.7		11.1		4.1
WA-6B	18-Oct-06		2	<	1		24		17	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		0.85	<	0.5		4.1		3.6		0.5
WA-6B	2-Nov-06		4	<	2		32		107	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01	<	0.5	<	0.5		8.3		5.1		3.2
Mean			3		4		40		46		0.02		0.10		0.09		0.21		0.01		0.48		1.14		7.9		5.9		1.8
Maximum			6		10		60		107		0.04		0.30		0.39		0.46		0.02		0.91		2.30		14.7		11.1		4.1
Minimum			2		1		24		11		0.01		0.05		0.01		0.03		0.01		0.04		0.50		0.5		0.5		0.5
Std. Dev.			2		4		15		45		0.01		0.11		0.17		0.19		0.01		0.41		0.85		5.8		4.2		1.8
No. of D.			5		2		5		5		1		2		2		3		0		3		3		4		4		3
WA-7S	19-Jul-06		2		14		58		5		0.37	<	0.05		0.2		0.1	<	0.02	<	0.04		1.6		12		9	<	0.5
WA-7S	24-Aug-06		4		2		30		5	<	0.01		0.06		0.08		0.18		0.05		0.1	<	0.5		11		8	<	0.5
WA-7S	20-Sep-06		4	<	1		48		12	<	0.01	<	0.05	<	0.01		0.22	<	0.01		0.88	<	0.5		8.3		5.9		2.1
WA-7S	18-Oct-06		2	<	1		30	<	3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		0.94	<	0.5		5.8		5		0.8
WA-7S	2-Nov-06		2		2		38		3	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01	<	0.5	<	0.5		9.1		6.2		2.9
Mean			3		4		41		6		0.08		0.05		0.06		0.11		0.02		0.49		0.72		9.2		6.8		1.4
Maximum			4		14		58		12		0.37		0.06		0.20		0.22		0.05		0.94		1.60		12.0		9.0		2.9
Minimum			2		1		30		3		0.01		0.05		0.01		0.03		0.01		0.04		0.50		5.8		5.0		0.5
Std. Dev.			1		6		12		4		0.16		0.00		0.08		0.09		0.02		0.42		0.49		2.4		1.6		1.1
No. of D.			5		3		5		4		1		1		2		3		1		3		1		5		5		3
WA-7M	19-Jul-06		4		7		50		7	<	0.01	<	0.05	<	0.01		0.16	<	0.02	<	0.04		1.5		18		15	<	0.5
WA-7M	24-Aug-06		4		2		30		5	<	0.01		0.21		0.3		0.21		0.07		0.11		2		11		8		3
WA-7M	20-Sep-06		4	<	1		30		16	<	0.01	<	0.05	<	0.01		0.46	<	0.01		0.65		0.6		16.2		10.2		5.8
WA-7M	18-Oct-06		4	<	1		36		4	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		0.9	<	0.5		2.9		2.1		0.8
WA-7M	2-Nov-06		6	<	2		44		6	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01	<	0.5	<	0.5		8.8		5.7		3.1
Mean			4		3		38		8		0.01		0.08		0.07		0.18		0.02		0.44		1.02		11.4		8.2		2.6
Maximum			6		7		50		16		0.01		0.21		0.30		0.46		0.07		0.90		2.00		18.0		15.0		5.8
Minimum			4		1		30		4		0.01		0.05		0.01		0.03		0.01		0.04		0.50		2.9		2.1		0.5
Std. Dev.			1		3		9		5		0.00		0.07		0.13		0.18		0.03		0.36		0.69		6.0		4.8		2.1
No. of D.			5		2		5		5		0		1		1		3		1		3		3		5		5		4

Table 3-1. Continued

WA-7B	19-Jul-06		6		18		76		4		0.47	<	0.05		0.17		0.33	<	0.02	<	0.04		1.4		14		11	<	0.5
WA-7B	24-Aug-06		4		5		94		7		0.02		0.31		0.4		0.24	<	0.02		0.11	<	0.5		11		7		4
WA-7B	20-Sep-06		4		7	<	9		6	<	0.01	<	0.05		0.03		0.49	<	0.01		0.73		0.6		16.7		11.5		5.1
WA-7B	18-Oct-06		4	<	1		30		12	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01		0.52	<	0.5		3.7		3.2		0.5
WA-7B	2-Nov-06		4	<	2		34		6	<	0.01	<	0.05	<	0.01	<	0.03	<	0.01	<	0.5	<	0.5		10.3		7.8		2.5
Mean			4		7		49		7		0.10		0.10		0.12		0.22		0.01		0.38		0.70		11.1		8.1		2.5
Maximum			6		18		94		12		0.47		0.31		0.40		0.49		0.02		0.73		1.40		16.7		11.5		5.1
Minimum			4		1		9		4		0.01		0.05		0.01		0.03		0.01		0.04		0.50		3.7		3.2		0.5
Std. Dev.			1		7		35		3		0.20		0.12		0.17		0.20		0.01		0.29		0.39		4.9		3.4		2.1
No. of D.			5		3		4		5		2		1		3		3		0		3		2		5		5		4

< - indicates the result was non-detect or a result below the laboratories reporting detection limit.

3.2.1 Ammonia

Total Ammonia is a measure of the most reduced inorganic form of nitrogen in water and includes dissolved ammonia and the ammonium ion. Ammonia is a small component of the nitrogen cycle but as an essential plant nutrient, it contributes to the trophic status of a water body. Excess ammonia contributes to eutrophication of water bodies. This can result in excessive algal growths and impacts on recreation and drinking water supplies. In high concentrations, ammonia is toxic to aquatic life.

Ammonia in the water column of F.E. Walter Reservoir was consistently low throughout the monitoring period. Measures of ammonia did not exceed 1.05 mg/L and ranged to less than the detection limit of 0.03-mg/L. (Table 3-1). F.E. Walter Reservoir was in compliance with the PADEP water quality standard for ammonia during 2006. The water quality standard of ammonia is dependent on temperature and pH (Table 3-2). Throughout the monitoring period, all measures of ammonia were less than their respective criteria values.

Table 3-2. PADEP ammonia nitrogen criteria (Pennsylvania Code, Title 25 1984). Specific ammonia criteria dependent on temperature and pH.

PH	0 °C	5 °C	10 °C	15 °C	20 °C	25 °C	30 °C
6.50	25.5	25.5	25.5	17.4	12.0	8.4	5.9
6.75	23.6	23.6	23.6	16.0	11.1	7.7	5.5
7.00	20.6	20.6	20.6	14.0	9.7	6.8	4.8
7.25	16.7	16.7	16.7	11.4	7.8	5.5	3.9
7.50	12.4	12.4	12.4	8.5	5.9	4.1	2.9
7.75	8.5	8.5	8.5	5.8	4.0	2.8	2.0
8.00	5.5	5.5	5.5	5.8	4.0	2.8	2.0
8.25	3.4	3.4	3.4	2.3	1.6	1.2	0.9
8.50	2.0	2.0	2.0	1.4	1.0	0.7	0.6
8.75	1.2	1.2	1.2	0.9	0.6	0.5	0.4
9.00	0.8	0.8	0.8	0.5	0.4	0.3	0.3

3.2.2 Nitrite and Nitrate

Nitrite is a measure of a form of nitrogen that occurs as an intermediate in the nitrogen cycle. It is unstable and can rapidly be oxidized to nitrate or reduced to nitrogen gas. Nitrite is a source of nutrients for plants and can be toxic to aquatic life in relatively low concentrations. Concentrations of nitrite at F.E. Walter Reservoir were consistently low during 2006. Concentrations of nitrite measured at all stations and all depths ranged from less than method detection limits (0.01-mg/L) to 0.08 mg/L for the entire monitoring period (Table 3-1).

Nitrate is the measure of the most oxidized and stable form of nitrogen. It is the principal form of combined nitrogen in natural waters. Nitrate is the primary form of nitrogen used by plants as a nutrient to stimulate plant growth. Nitrate was also distributed uniformly at F.E. Walter Reservoir during 2006. For all stations and depths, concentrations ranged from less than the method detection limit (0.04 mg/L) to 2.18 mg/L.

In 2006, F.E. Walter Reservoir was in compliance with the PADEP water quality standard for nitrogen. The water quality standard for nitrogen is a summed concentration of nitrite and nitrate of less than 10-mg/L. Throughout the monitoring period, the summed concentrations for each station were well below this standard with a maximum summed concentration of 2.26 mg/L at station WA-4S on the Lehigh River upstream of the reservoir.

3.2.3 Total Kjeldahl Nitrogen

Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen that includes ammonia. Organic nitrogen is not immediately available for biological activity and is therefore not available for plant growth until decomposition to inorganic form occurs. TKN in the water column of F.E. Walter Reservoir was generally low during 2006 (Table 3-1). Concentrations measured at all reservoir stations ranged from below the detection limit of 0.50 mg/L to a maximum measure of 3.10 mg/L at station WA-5S on the Tobyhanna Creek upstream of the reservoir in August.

3.2.4 Total Phosphorus

Total phosphorus is a measure of both organic and inorganic forms of phosphorus. It is an essential plant nutrient and is often the most limiting nutrient to plant growth in freshwater systems. Inputs of phosphorus are the prime contributing factors to eutrophication in most freshwater systems. Phosphorus bound to bottom sediments in lakes can be released when oxygen levels are depleted in bottom waters. This phosphorus then becomes available for plant growth.

Concentrations of total phosphorus were elevated at most of the reservoir surface water stations during late summer (Table 3-1). This may be a result of the influx of nutrients during the late June storm event in the watershed. The highest concentration of 0.50 mg/L was seen in the 19 July surface water sample at station WA-2. EPA guidance for nutrient criteria in lakes and reservoirs suggests a maximum concentration for total phosphorus of 0.01-mg/L (EPA 2000). Lakes and reservoirs exceeding this concentration are more likely to experience algal bloom problems during the growing season. Twenty three of twenty four measures that exceeded the EPA concentration guideline for all the reservoir sampling stations occurred in July and August.

3.2.5 Dissolved Phosphorus

Dissolved or soluble phosphorus in the water column of F.E. Walter Reservoir varied during 2006. Concentrations measured at most stations and depths during the sampling season were below the detection limit of 0.05 mg/L (Table 3-1). The highest concentration of dissolved phosphorus (0.39 mg/L) was measured in the surface waters of the reservoir at Station WA-2 on 24 August. In freshwater environments, dissolved phosphorus is usually a limiting nutrient and is readily taken up by freshwater plants and algae.

3.2.6 Dissolved Phosphate

Orthophosphate is a measure of the inorganic oxidized form of soluble phosphorus. This form of phosphorus is the most readily available for uptake during photosynthesis. In 2006, concentrations of dissolved phosphate were generally at or below the detection limit of 0.01 mg/L. Most stations and depths had seasonal mean values ranging from 0.01 mg/L up to 0.04 mg/L (Table 3-1) with the exception of stations WA-6 and WA-7 located in the upstream arms of the reservoir. The mean values at these stations appeared to be greatly influenced by high readings shortly after the late June flooding event. The highest concentration of 0.95 mg/L was recorded on 19 July in the surface waters of station WA-6.

3.2.7 Total Dissolved Solids

Total dissolved solids (TDS) is a measure of the amount of filterable dissolved material in the water. Dissolved salts such as sulfate, magnesium, chloride, and sodium contribute to elevated levels. TDS in the lake and tributary stations of F.E. Walter Reservoir remained relatively constant and low during 2006. Concentrations at all stations and depths averaged 56-mg/L over the monitoring period while ranging from 9 to 550 mg/L (Table 3-1). The highest mean seasonal concentration of 138 mg/L was seen at the upstream surface tributary station WA-5. F.E. Walter Reservoir and its tributaries were in compliance with the PADEP water quality standard for total dissolved solids during 2006. The water quality standard is a maximum concentration of 500-mg/L.

3.2.8 Total Suspended Solids

Total suspended solids (TSS) is a measure of the amount of non-filterable particulate matter that is suspended within the water column. High concentrations increase the turbidity of the water and can hinder photosynthetic activity, result in damage to fish gills, and cause impairment to spawning habitat (smothering). TSS measures in the water column of F.E. Walter Reservoir were consistently low in 2006 with many samples less then the detection limit of 3.0 mg/L. Overall concentrations at all stations and depths ranged from less than the detection limit to an isolated 107 mg/L concentration (Table 3-1) in the bottom waters at Station WA-6. This is likely due to contamination of sediment in the sampling apparatus during bottom water sample collection.

3.2.9 Biochemical Oxygen Demand

Biochemical oxygen demand (BOD) is a test to measure biodegradable organic matter concentrations in a water sample. It measures the rate of oxygen uptake by organisms in the water sample over a period of time. It is an indicator of the quality of a water body and the degree of pollution by biodegradable organic matter is therefore inferred. Measurements of 5-day Biochemical oxygen demand (BOD) in F.E. Walter Reservoir and tributary stations ranged from 1.0 mg/L to 30.0 mg/L (Table 3-1). The highest BOD measures were collected at all stations and depths during the 19 July sampling event. The higher BOD measures during this period are likely related to the influx of organic matter into the watershed during the late June flooding event.

3.2.10 Alkalinity

Alkalinity is a measure of the acid-neutralizing capacity of water. Waters that have high alkalinity values are considered undesirable because of excessive hardness and high concentrations of sodium salts. Water with low alkalinity has little capacity to buffer acidic inputs and is susceptible to acidification (low pH). The PADEP standard is a minimum concentration of 20-mg/L $CaCO_3$ except where natural conditions are less.

Alkalinity measurements in the waters of F.E. Walter Reservoir were routinely low during 2006. Concentrations measured at all stations and depths averaged 3.5 mg/L throughout the monitoring period (Table 3-1). The greatest concentration of 8.0 mg/L was measured on 19 July and 24 August in the surface waters at Station WA-4 and in the surface waters of the reservoir at station WA-2 on 24 August. The lowest measurement was 0.4 mg/L, measured on 20 September at upstream station WA-4. The natural alkalinity of water is largely dependent on the underlying geology and soils within the surrounding watershed. The low alkalinity measured at F.E. Walter Reservoir probably results from the regional geology, which is primarily sandstone and shale (Van Diver 1990).

3.2.11 Total Inorganic and Organic Carbon

Total organic carbon (TOC) is a measure of the dissolved and particulate organic carbon in water. The bulk of organic carbon in water is composed of humic substances and partly degraded animal and plant materials. High levels of organic carbon coincide with a lowering of dissolved oxygen concentrations. Total inorganic carbon (TIC) is a measure of the sum of carbonates, bicarbonates, and carbonic acid. The relative amount of each of these is dependent on the pH of the water. The inorganic forms of carbon are part of the carbon cycle. The bicarbonate ions serve as the main buffer in freshwater systems and provide carbon dioxide for photosynthesis. Carbon is a nutrient required for biological processes.

Total inorganic carbon (TIC) and total organic carbon (TOC) were measured in the water column and tributaries of F.E. Walter Reservoir (Table 3-1). Concentrations of TIC at all stations and depths ranged from 6.2 mg/L to less than the method detection limit of 0.5 mg/L. Additionally, concentrations of TOC at all stations and depths ranged from 15.0 mg/L to less than the method detection limit of 0.5 mg/L. Total carbon is the sum of TIC and TOC. Total carbon in the waters of F.E. Walter Reservoir at all stations and depths ranged from 0.5 mg/L to 18.0 mg/L. The highest single measured concentration of 18.0 mg/L was in the middle waters of station WA-7 on 19 July.

3.2.12 Chlorophyll *a*

Chlorophyll a is the measure of the plant chlorophyll a primary pigment which helps plants get energy from light. It is found in most plants, algae, and cyanobacteria. Chlorophyll a measures increase in relation to algal densities in a water body. For the most part, chlorophyll *a* was low in the waters of F.E. Walter Reservoir during 2006 (Appendix A). Concentrations at all stations and depths had a value range of 0.0 ug/L to 16.5 ug/L throughout the monitoring season. The highest single surface water concentration of 8.8 ug/L was measured at station WA-6 on 24 August. The lowest single measured concentration of 1.1 ug/L was taken at station WA-5 on 24 August.

3.3 TROPHIC STATE DETERMINATION

Carlson's (1977) trophic state index (TSI) is a method of expressing the extent of eutrophication of a lake, quantitatively. The trophic state analysis calculates separate indices for eutrophication based on measures of total phosphorus, chlorophyll *a*, and secchi disc depth. Index values for each parameter range on the same scale from 0 (least enriched) to 100 (most enriched). The resulting indices can also be compared to qualitative threshold values that correspond to levels of eutrophication. Classification of F.E. Walter Reservoir was based on a single sample each month during the sampling season. It is important to note that variability in measurements not captured between sampling events and the resulting classification can occur. Figure 3-9 graphically shows this potential variability between samples.

TSIs calculated for measures of Total Phosphorus classified F.E. Walter Reservoir as oligotrophic in September, October, and November with TSI values of 37.4, 37.4, and 37.4 respectively. TSIs calculated for measures of Total Phosphorus were elevated in July and August at 93.8 and 90.5 respectively. The higher measure of Total Phosphorus in late summer may have been associated with the late June flooding event. The calculated values would classify the reservoir as hyper-eutrophic during the summer months and oligotrophic into the fall season.

TSIs calculated for measures of secchi disk depth classified F.E. Walter Reservoir as mesotrophic/eutrophic throughout the sampling season with values ranging from 49.3 to 59.3.

TSIs calculated for measures of chlorophyll *a* classified F.E. Walter Reservoir as mesotrophic throughout the sampling season with values ranging from 44.1 to 49.9.

Carlson (1977) warned against averaging TSI values estimated for different parameters, and instead suggested giving priority to chlorophyll a during the summer and to phosphorus in the spring, fall, and winter. With this in mind, and based on the pattern of TSI values for secchi disk depth, chlorophyll a and Total Phosphorus, F.E. Walter Reservoir was mesotrophic during summer and oligotrophic in fall of 2006.

The EPA (1983) also provides criteria for classifying the trophic conditions of lakes of the North Temperate Zone based on concentrations of total phosphorus, chlorophyll *a*, and secchi disk depth (Table 3-3). Taking into account the general agreement between the EPA classifications with that of the TSIs, the trophic condition of F.E. Walter Reservoir was mesotrophic during summer and oligotrophic in fall of 2006.

Table 3-3. EPA trophic classification criteria and average monthly measures for F.E. Walter Reservoir in 2006

Water Quality Variable	**Oligo-trophic**	**Meso-trophic**	**Eutrophic**	**19 July**	**24 Aug.**	**20 Sep.**	**18 Oct.**	**02 Nov.**
Total phos. (ppb)	<10	10-20	>20	500	400	10	10	10
Chlorophyll a (ppb)	<4	4-10	>10	5.55	7.15	4.15	3.95	3.25
Secchi depth (m)	>4	2-4	<2	1.05	1.55	2	1.3	2.1

NM = not measured

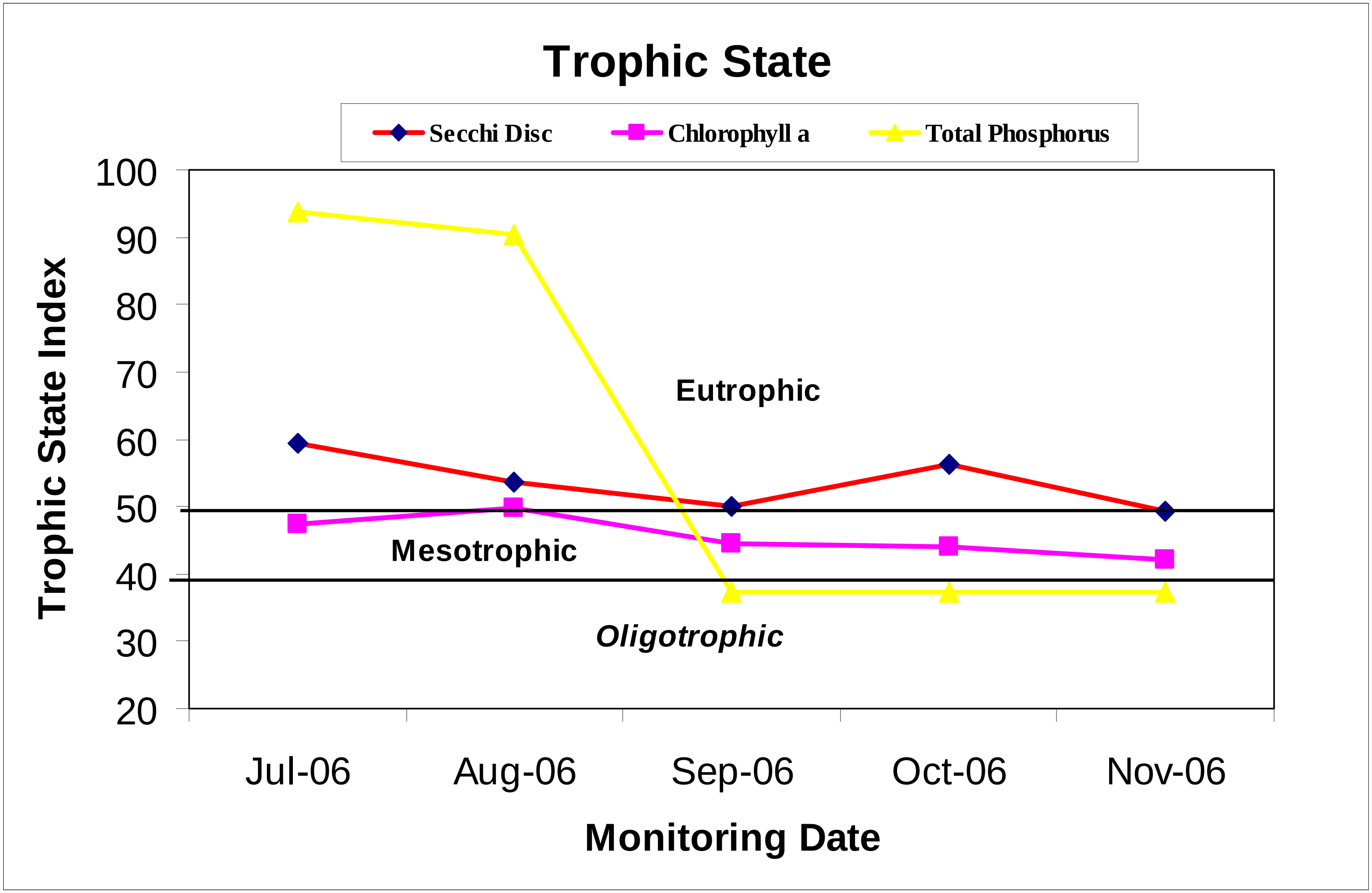

Figure 3-9. Carlson Trophic state indices calculated from secchi disk depth, concentrations of chlorophyll a and Total Phosphorus measured in surface waters of F.E. Walter Reservoir at Station WA-2 during 2006.

3.4 RESERVOIR BACTERIA MONITORING

Two forms of coliform bacteria contamination were monitored at F.E. Walter Reservoir during 2006 including total and fecal coliform (Table 3-4). Total coliform includes *Escherica coli* (*E. coli*) and related bacteria that are associated with fecal discharges. Fecal coliform bacteria are a subgroup of the total coliform and are normally associated with waste derived from human and other warm-blooded animals. Total coliform contamination was low at F.E. Walter Reservoir during 2006. Total coliform measures ranged from 8 to 800-clns/100-ml. Fecal coliform contamination at F.E. Walter Reservoir during 2006 ranged from 2 to 530-clns/100-ml throughout the monitoring period. Coliform bacteria levels were low at F.E. Walter Reservoir with respect to PADEP water quality standards throughout the monitoring period. For waters with contact recreation, the water quality standard for bacteria contamination is a geometric mean of less than 200 colonies/100-ml. At no point did the geometric means approach the PADEP water contact recreation standard. Water contact recreation is not permitted at F.E. Walter Reservoir.

Table 3-4. Bacteria counts (colonies/100 ml) at F.E. Walter Reservoir surface stations during 2006.

STATION	DATE	Total Coliform (TC)	Fecal Coliform (FC)
WA-1S	19-Jul	216	12
	24-Aug	600	250
	20-Sep	52	20
	18-Oct	26	20
	02-Nov	92	28
WA-2S	19-Jul	292	128
	24-Aug	450	130
	20-Sep	24	4
	18-Oct	16	10
	02-Nov	92	34
WA-3S	19-Jul	192	134
	24-Aug	520	330
	20-Sep	86	40
	18-Oct	70	56
	02-Nov	302	88
WA-4S	19-Jul	116	172
	24-Aug	550	210
	20-Sep	100	12
	18-Oct	76	28
	02-Nov	254	104
WA-5S	19-Jul	148	124
	24-Aug	730	180
	20-Sep	56	4
	18-Oct	90	42
	02-Nov	156	16
WA-6S	19-Jul	32	2
	24-Aug	480	240
	20-Sep	32	2
	18-Oct	8	4
	02-Nov	106	44
WA-7S	19-Jul	172	148
	24-Aug	800	530
	20-Sep	24	4
	18-Oct	22	8
	02-Nov	212	138

3.5 SEDIMENT PRIORITY POLLUTANT MONITORING

In an effort to screen and identify potential contaminants of concern within the sediments of F.E. Walter Reservoir, sediment samples were collected at station WA-2 and analyzed for priority pollutant contaminants to include PCB's, pesticides and semi-volatile organic compounds. Resulting concentrations were compared against New Jersey Soil Cleanup Criteria (NJDEP 1999). The NJDEP criteria are human health based with categories addressing residential and non-residential settings, and impacts to groundwater. The sediment sampling results were evaluated using the residential and non-residential criteria (Table 3-5),

Of the 98 priority pollutant contaminants that F.E. Walter sediments were analyzed for, ten were detected (Table 3-5). The recorded level of each contaminant was well below its respective residential and non-residential criteria, where applicable.

Table 3-5. PCB's, pesticides, and volatile organic compounds (Goup1) measured in sediments of F.E. Walter Reservoir in 2006

Units	Residential Direct Contact Soil Cleanup Criteria	Non-Residential Direct Contact Soil Cleanup Criteria		Method Detection Limit	WA-2 Sed.
PCBs - Method 8082					
Aroclor-1016	----	----	ppb	489	ND
Aroclor-1221	----	----	ppb	489	ND
Aroclor-1232	----	----	ppb	489	ND
Aroclor-1242	----	----	ppb	489	ND
Aroclor-1248	----	----	ppb	489	ND
Aroclor-1254	----	----	ppb	489	ND
Aroclor-1260	----	----	ppb	489	ND
Pesticides - Method 8081A					
4,4'-DDD	3000	12000	ppb	78.2	ND
4,4'-DDE	2000	9000	ppb	78.2	ND
4,4'-DDT	2000	9000	ppb	78.2	ND
alpha-BHC	----	----	ppb	39.1	ND
a-Chlordane	----	----	ppb	39.1	ND
Aldrin	40	170	ppb	39.1	ND
beta-BHC	----	----	ppb	39.1	ND
Chlordane, technical	----	----	ppb	----	ND
delta-BHC	----	----	ppb	39.1	ND
Dieldrin	42	180	ppb	78.2	ND
Endosulfan I	340000	6200000	ppb	39.1	ND
Endosulfan II	340000	6200000	ppb	78.2	ND
Endrin	17000	310000	ppb	78.2	ND
Endrin aldehyde	----	----	ppb	78.2	ND
Endrin ketone	----	----	ppb	78.2	ND
Endosulfan Sulfate	----	----	ppb	78.2	ND
gamma-BHC (Lindane)	520	2200	ppb	450	ND
g-Chlordane	----	----	ppb	39.1	ND
Heptachlor	150	650	ppb	39.1	ND
Heptachlor epoxide	----	----	ppb	39.1	ND
Methoxychlor	280000	5200000	ppb	39.1	ND
Toxaphene	100	200	ppb	489	ND
Semi-volatile Organic Compounds					
1,2,4-Trichlorobenzene	68000	1200000	ppb	20	ND
1,2-Dichlorobenzene	5100000	10000000	ppb	20	ND
1,2-Diphenylhydrazine	----	----	ppb	20	ND
1,4-Dichlorobenzene	570000	10000000	ppb	20	ND
2,3,4,6-Tetrachlorophenol	----	----	ppb	100	ND

2,4,5-Trichlorophenol	5600000	10000000	ppb	100	ND
2,4,6-Trichlorophenol	62000	270000	ppb	100	ND
2,4-Dichlorophenol	170000	3100000	ppb	100	ND
2,4-Dimethylphenol	1100000	10000000	ppb	20	ND
2,4-Dinitrophenol	110000	2100000	ppb	100	ND
2,4-Dinitrotoluene	----	----	ppb	100	ND
2,6-Dichlorophenol	----	----	ppb	100	ND
2,6-Dinitrotoluene	----	----	ppb	100	ND
2-Chloronaphthalene	----	----	ppb	20	ND
2-Chlorophenol	280000	5200000	ppb	20	ND
2-Methylnaphthalene	----	----	ppb	20	ND
2-Methylphenol	2800000	10000000	ppb	20	ND
2-Nitroaniline	----	----	ppb	100	ND
2-Nitrophenol	----	----	ppb	100	ND
3,3-Dichlorobenzidine	2000	6000	ppb	100	ND
3,4-Methylphenol	----	----	ppb	100	ND
3-Nitroaniline	----	----	ppb	100	ND
4,6-Dinitro-2-methylphenol	----	----	ppb	100	ND
4-Bromophenyl phenyl ether	----	----	ppb	20	ND
4-Chloro-3-methylphenol	10000000	10000000	ppb	100	ND
4-Chloroaniline	230000	4200000	ppb	20	ND
4-Chlorophenyl phenyl ether	----	----	ppb	20	ND
4-Nitroaniline	----	----	ppb	100	ND
4-Nitrophenol	----	----	ppb	100	ND
Acenaphthene	3400000	10000000	ppb	20	ND
Acenaphthylene	----	----	ppb	10	ND
Anthracene	10000000	10000000	ppb		14
Benz(a)anthracene	900	4000	ppb		73
Benzidine	----	----	ppb	100	ND
Benzo(a)pyrene	660	660	ppb		41
Benzo(b,k)fluoranthene	900	4000	ppb		102
Benzo(g,h,i)perylene	----	----	ppb	100	ND
Benzoic acid	----	----	ppb	100	ND
Benzyl alcohol	10000000	10000000	ppb	100	ND
Bis(2-chloroethoxy)methane	----	----	ppb	20	ND
Bis(2-chloroethyl) ether	660	3000	ppb	20	ND
Bis(2-chloroisopropyl) ether	2300000	10000000	ppb	20	ND
Bis(2-ethylhexyl) phthalate	49000	210000	ppb		239
Butyl benzyl phthalate	1100000	10000000	ppb	20	ND
Carbazole	----	----	ppb	20	ND
Chrysene	9000	40000	ppb		93
Dibenz(a,h)anthracene	660	660	ppb	100	ND

Dibenzofuran	----	----	ppb	20	ND
Diethylphthalate	10000000	10000000	ppb	20	ND
Dimethyl phthalate	10000000	10000000	ppb	20	ND
Di-n-butyl phthalate	----	----	ppb	20	ND
Di-n-octyl phthalate	----	----	ppb	20	ND
Fluoranthene	2300000	10000000	ppb		159
Fluorene	2300000	10000000	ppb		12
Hexachlorobenzene	660	2000	ppb	20	ND
Hexachlorobutadiene	1000	21000	ppb	20	ND
Hexachlorocyclopentadiene	400000	7300000	ppb	100	ND
Hexachloroethane	6000	100000	ppb	20	ND
Indeno(1,2,3-cd)pyrene	900	4000	ppb	100	100
Isophorone	1100000	10000000	ppb	20	ND
Naphthalene	230000	4200000	ppb	10	ND
Nitrobenzene	28000	520000	ppb	20	ND
N-Nitrosodimethylamine	----	----	ppb	100	ND
N-Nitroso-di-n-propylamine	660	660	ppb	20	ND
N-Nitrosodiphenylamine	140000	600000	ppb	20	ND
Pentachlorophenol	6000	24000	ppb	100	ND
Phenanthrene	----	----	ppb		128
Phenol	10000000	10000000	ppb	20	ND
Pyrene	1700000	10000000	ppb		196
Pyridine	----	----	ppb	100	ND

3.6 TEMPERATURE PROBE MONITORING

In-situ TidbiT^{tm} temperature probes were deployed at five Lehigh River monitoring stations to continuously record surface water temperatures in ½ hour increments over the sampling period from April through October 2006. Station WA1 (LH-2) was located just downstream of the F. E. Walter dam outfall (Fig. 3-10). The storm event experienced in late June of 2006 resulted in the loss of the temperature probe at this station. Station LH3 was located at Tannery Bridge near White Haven, PA (Fig. 3-11). Station LH10 was located near the Lehighton water intake structure in Lehighton, PA (Fig. 3-12). Station LH-15 was located near the Walnutport USGS gauging station in Walnutport, PA (Fig. 3-13). A complete seasonal temperature graph was not possible at this station as a result of the loss of a temperature probe.

The Commonwealth of Pennsylvania provides water temperature standards that are based on a particular water body's protected use (Pennsylvania Code, Title 25, Chapter 93 2001). Stations LH-2 and LH-3 are classified as a High Quality-Cold Water Fishes (HQ-

CWF) by PADEP. Pennsylvania Department of Environmental Protection defines Cold Water Fishes as the "*maintenance and/or propagation of fish species including the family Salmonidae and additional flora and fauna that are indigenous to a coldwater habitat*". The maximum temperature criterion for this reach of the Lehigh River is 66 degrees Fahrenheit (18.87 degrees Celsius) from 01 July through 30 August. From early July through August of 2006, the temperatures recorded in this section (LH-3) of the river routinely exceeded this criterion (Fig. 3-10 and Fig. 3-11). The maximum temperature recorded during this monitoring period at LH-3 was 80.77 °F (27.07 degrees Celsius). The average temperature recorded during this monitoring period was 70.86 °F (21.57 degrees Celsius).

Stations LH10 and LH15 are classified a Trout Stocking Fishery (TSF). Pennsylvania Department of Environmental Protection defines Trout Stocking as the "*maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat*". The maximum temperature criterion for this reach of the Lehigh River varies during the season from 70 degrees Fahrenheit (21.1 degrees Celsius) from 01 June through 15 June; 72 degrees Fahrenheit (22.2 degrees Celsius) from 16 June through 30 June; 74 degrees Fahrenheit (23.3 degrees Celsius) from 01 July through 31 July; 80 degrees Fahrenheit (26.6 degrees Celsius) from 01 August through 15 August; and 87 degrees Fahrenheit (30.5 degrees Celsius) from 16 August through 30 August. In general, stations LH-10 and LH-15 routinely did not exceed the state criterion throughout the sampling season of 2006 (Fig. 3-12 and Fig. 3-13). The maximum temperature recorded during the monitoring period at LH-10 and LH-15 was 79.86 °F (26.56 degrees Celsius) and 83.62 °F (28.65 degrees Celsius), respectively.

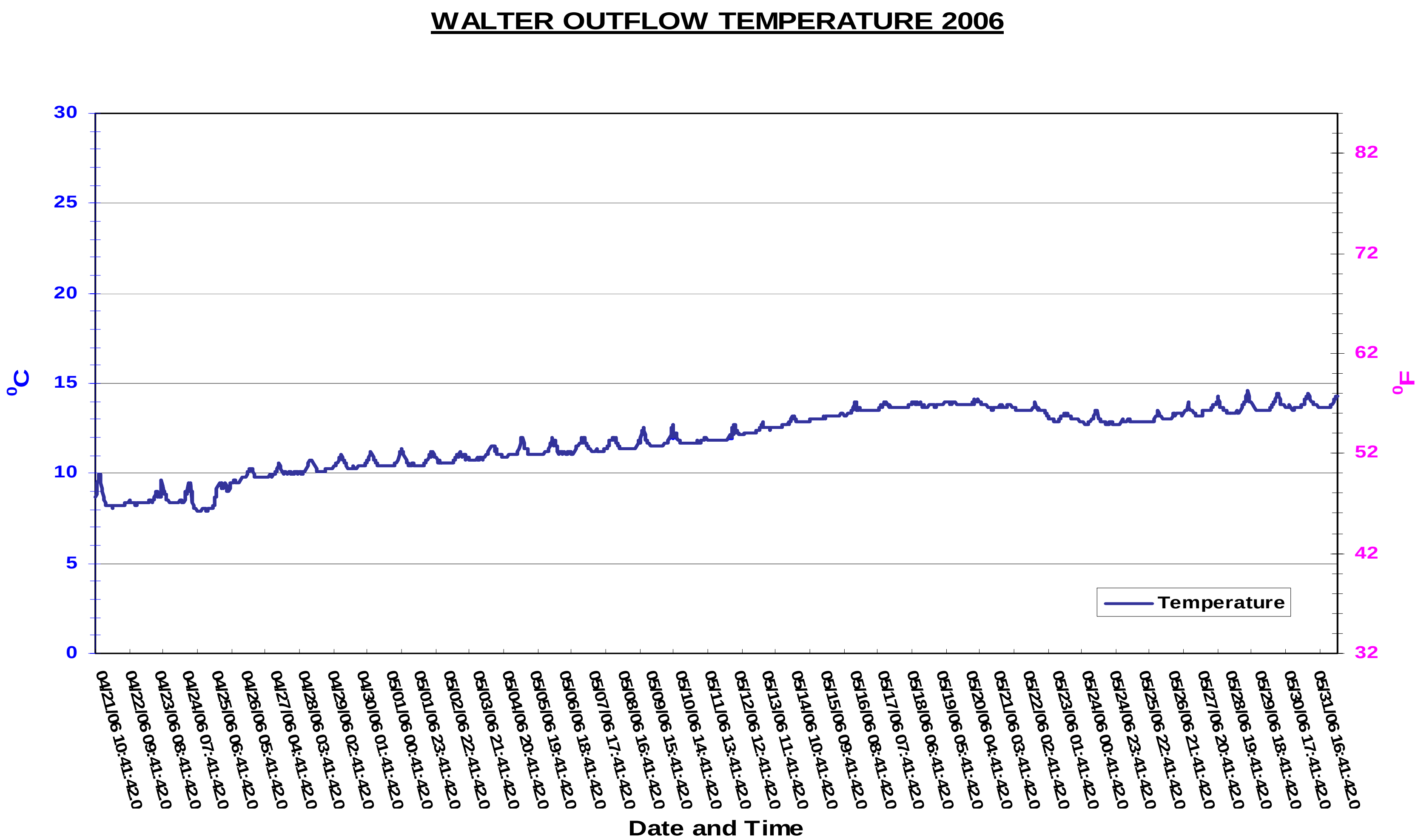

Figure 3-10. In-situ temperature measured in surface waters of Lehigh River immediately downstream of F.E. Walter Reservoir (LH_2) during 2006.

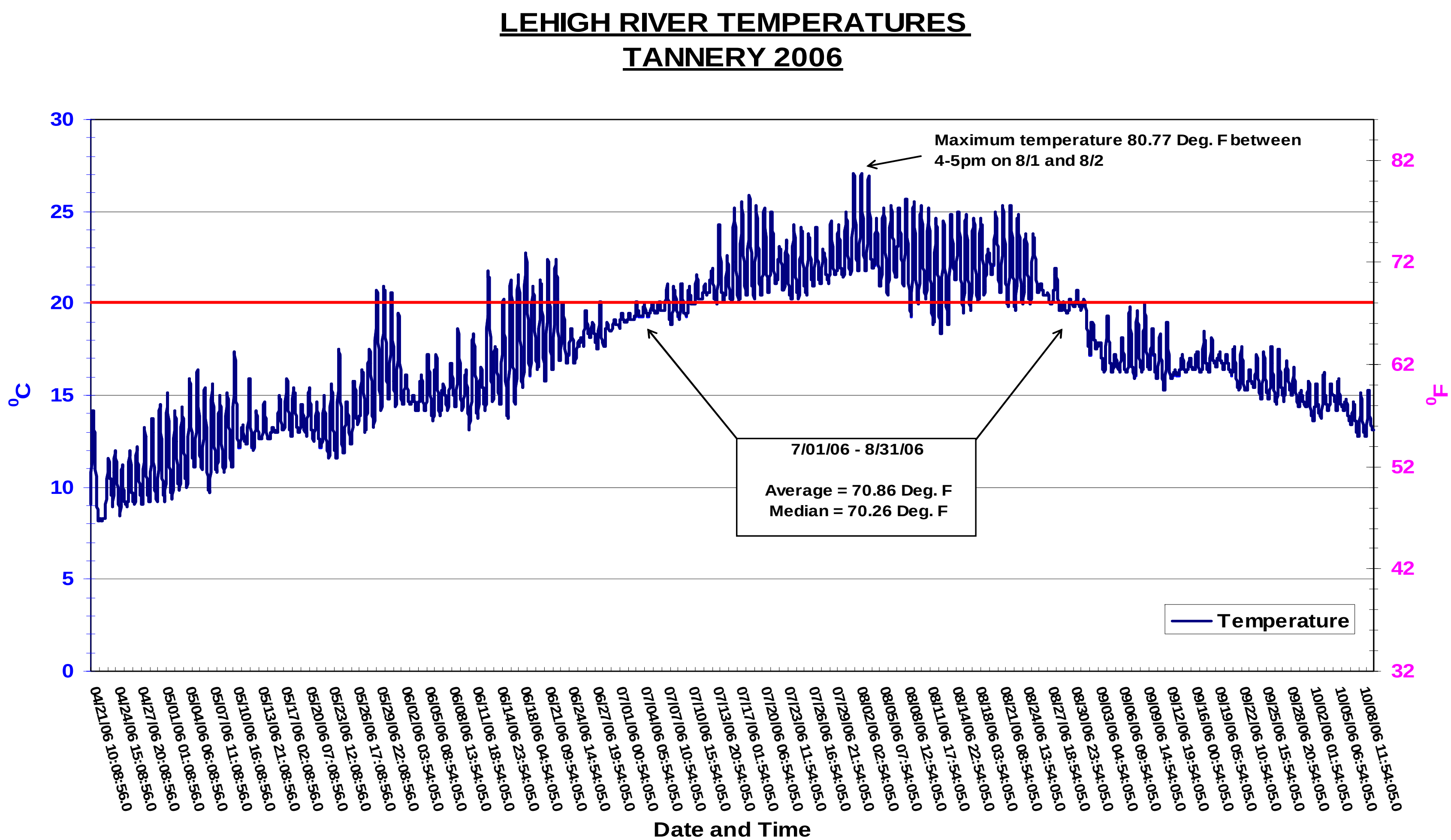

Figure 3-11. In-situ temperature measured in surface waters of Lehigh River at Tannery Bridge (LH-3) near White Haven, PA during 2006.

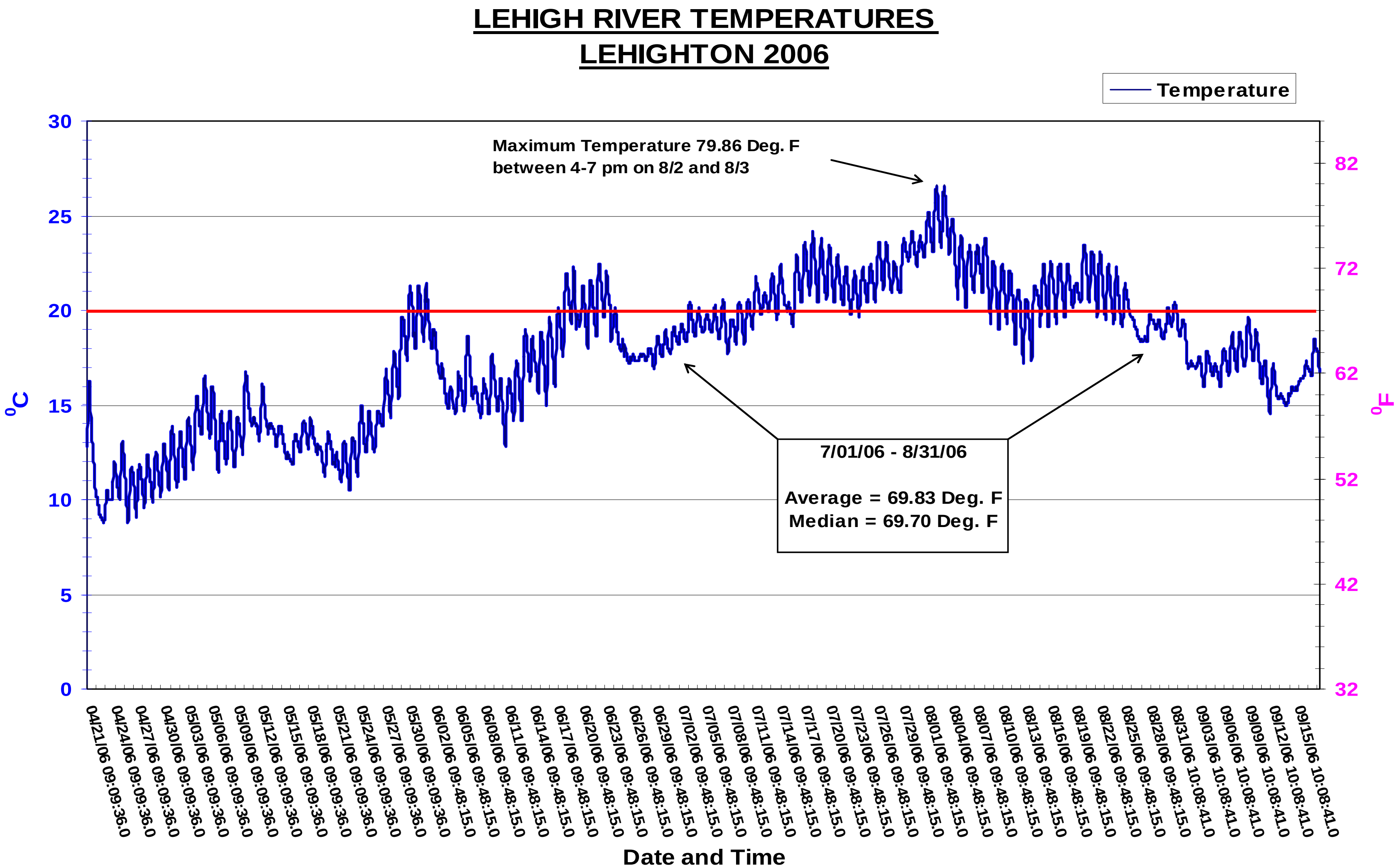

Figure 3-12. In-situ temperature measured in surface waters of Lehigh River near Lehighton (LH-10), PA during 2006.

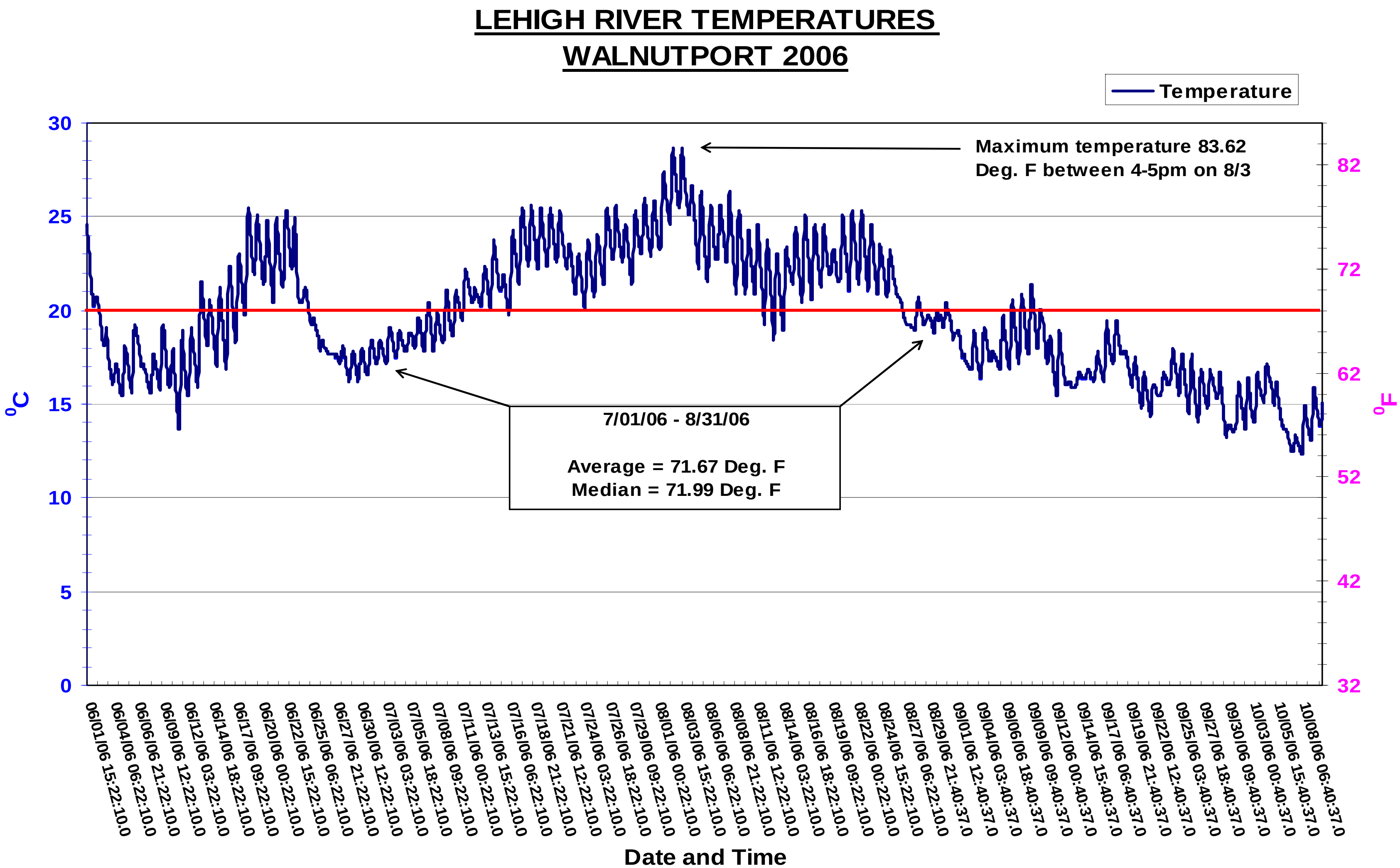

Figure 3-13. In-situ temperature measured in surface waters of Lehigh River near Walnutport (LH-15), PA during 2006.