

# **USACE Water Quality and Aquatic Life Adaptive Management Plan for the**

## **Proposed FERC Hydropower Project No. 12555**

### **At Mahoning Creek Lake Dam**

October 2012

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#### **1. Executive Summary**

The proposed hydropower project could impact water quality and aquatic life in Mahoning Creek Lake, the lake stilling basin, and Mahoning Creek downstream of the dam. Because it is the USACE Pittsburgh District's (District) policy is to sustainably manage resources by not allowing degradation worse than existing conditions, the District will require compliance with nondegradation water quality criteria to assure sustainable development and protection of aquatic resources. For reasons described herein, hydropower operation at Mahoning Dam will be permitted as long as the following water quality provisions for water temperature, dissolved oxygen, and percent total dissolved gas saturation (% TDG Sat) are maintained. These criteria will also be adopted in the Section 408 permit for the Mahoning Hydropower Project.

District nondegradation criteria are based on worst case pre-hydropower water quality conditions (ever recorded) at Mahoning Creek Lake and outflow waters. It is the District's position that the worst case readings are the lowest possible values that can be utilized for the development of water quality criteria while assuring compliance with USACE nondegradation policies. The worst case scenario for the Mahoning Dam outflow for District's entire 42-year period of record is a minimum dissolved oxygen level of 7.2 milligrams/liter (mg/l) and a maximum water temperature of 77 degrees Fahrenheit (°F). The worst case for Mahoning Creek at the McCrea Furnace Bridge, which is located approximately 1 mile downstream of the dam, is 7.0 mg/l minimum dissolved oxygen and 80 (°F) maximum water temperature. As a compromise, and also because the District has collected real-time, continuously recorded water quality data at the McCrea Furnace Bridge, nondegradation criteria were developed using the lower quality, downstream conditions. While utilizing worst case conditions for criteria development will allow some degradation of water quality parameters, the District assumes that the worst case readings are within acceptable ranges to support existing water quality and aquatic life throughout the year, and reserves the right to readdress these criteria if they are not effective.

For optimal maintenance of aquatic health, dissolved oxygen concentrations should approach 100% dissolved oxygen saturation. Mahoning Dam tailwaters are currently 100% saturated with dissolved oxygen, which translates to a dissolved oxygen level of 8.1 mg/l at 80 °F and 1 atmosphere pressure. With the proposed 7.0 mg/l dissolved oxygen criterion, at 80 °F and 1 atmosphere pressure, percent dissolved

oxygen saturation will be reduced to from 100% to 86.4%. This reduction is deemed acceptable based on research including Doudoroff & Shumway (1970)<sup>1</sup> and Davis (1975)<sup>2</sup>. In addition, the Mahoning Dam outflow supports a robust, reproducing coolwater fishery that includes walleye, northern pike, muskellunge, and smallmouth bass. According to Kendall, optimum water temperatures for these coolwater fishes range between 65 and 72 °F, with a maximum water temperature of approximately 77 °F (Kendall 1978)<sup>3</sup>. Thermal water temperature thresholds for these species identified for Ohio waters by the OEPA in 2006 were somewhat higher, particularly for smallmouth bass, with optimal temperatures ranging between 71.2 °F (21.8 °C) and 86 °F (30 °C), and the mean weekly average temperatures for growth ranging between 77.5 °F (25.3 °C) and 89.6 °F (32 °C). (Yoder 2006<sup>12</sup>). Currently, water temperatures in the stilling basin and Mahoning Creek directly downstream of the dam do not exceed 77 °F (25.0 °C). If the frequency of water temperatures greater than 77 °F increases, than the existing cold and cool water fisheries, particularly northern pike, muskellunge, and rainbow trout, could be impacted or lost. Therefore, it is the District's position that the worst case readings are the lowest possible values that can be used for the development of water quality criteria, in order to assure compliance with USACE natural resource management and nondegradation policies.

A summary of the District's nondegradation water quality criteria and requirements for flows through the existing dam gates that bypass the hydropower project (hereinafter called bypass flows) follow. Any deviation from these water quality criteria will be reported to the District immediately. For each occurrence of noncompliance, a corrective action plan must be submitted to minimize reoccurrence. All decisions regarding discharges from Mahoning Dam belong to District, so bypass flow may be increased to assure compliance with criteria. These water quality and aquatic life criteria are considered preliminary since they still need to be verified using current, edited water quality data and the resource agencies have not had an opportunity to review and comment (Pennsylvania Fish and Boat Commission (PFBC) and the Pennsylvania Department of Environmental Protection (PA DEP)). In addition, the District reserves the right to regulate other parameters if unexpected problems or issues develop. It is noteworthy that the design and the nondegradation criteria recommended by FERC and the resource agencies for the previous license, FERC Hydropower Project No. 10521, are very similar to the current project (No. 12555).

#### Water Quality, Stilling basin (MCHC monitor – to be installed)

- Minimum Dissolved Oxygen (DO) 7.0 mg/l
- Monthly or bimonthly, maximum Water Temperature (WT), not to exceed PA Trout Stocked Fishery Criteria<sup>4</sup> except in mid-August and early September (see Chart 1) when water temperatures will not exceed 80° F (26.7°C).

#### Water Quality, Mahoning Dam Outflow, Mahoning Creek directly downstream of the hydropower outfall (MCHC monitor – to be installed)

- Minimum DO 7.0 mg/l
- Maximum Percent Total Dissolved Gas Saturation (%TDG Sat) 103% when the DO is 7.0 mg/l or lower
- Monthly or bimonthly, maximum WT, not to exceed PA Trout Stocked Fishery Criteria, except in mid-August and early September (see Chart 1) when water temperatures will not exceed 80°F (26.7°C).



Water Quality Mahoning Dam Outflow, Mahoning Creek at the McCrea Furnace Bridge (existing Corps monitor) will be utilized to evaluate the effectiveness of DO, WT and %TDG Sat water quality criteria for the upstream WQ monitors.

- If the DO level drops below 7.0 mg/l more than 1% of the time during the summer/fall season, then the DO criterion for the hydropower tailrace outfall will be raised.
- If the WT rises above 80 °F more than 1% of the time during the summer/fall season, then the WT criteria for the hydropower tailrace outfall or the lake will be lowered.
- If the %TDG Sat level rises above 103% when DO levels are 7.0 mg/l or lower for more than 1% of the time during the summer fall season, then the %TDG saturation criterion for the hydropower tailrace outfall will be lowered.

Water Quality, Lake (MCHC monitor - to be installed)

- Minimum DO 3.6 mg/l at a depth of 24 feet at Summer Pool elevation (1098 ft NAVD)
- Maximum water temperature 80°F (26.7°C) at a depth of 24 feet (1074 ft NAVD). Monthly / bimonthly criteria are presented in Chart 1 and Table 1.

Bypass Flow.

- The baseline minimum bypass flow rate will be 60 cfs from June 15 through September 15; 40 cfs from November 1 through March 31; and 30 cfs between April 1 through June 14 and September 16 through October 31, as long as all water quality conditions and criteria described above are satisfied.

## 2. Background

The water quality of Mahoning Creek Lake and its tailwaters is excellent and shows a continual trend towards improvement over the District's period of record. In addition, the tailwaters support an exceptional, diverse macroinvertebrate community and coolwater fishery.

To assure that existing aquatic resources are not degraded by the proposed FERC Hydropower Project No. P-12555 at Mahoning Creek Lake Dam, the District recommends an adaptive management approach, utilizing real-time, continuously recording water quality monitors and nondegradation criteria. There were two previous Federal Energy Regulatory Commission (FERC) Licenses retrofit hydropower at Mahoning Dam, both of which were later surrendered; the first with Atlantic Power Development Corporation (FERC Project No. 3228, January 26, 1984), and the second with Mahoning Hydro Association (FERC Project No. 10521, May 7, 1990). In 1988, the PFBC and the US Fish and Wildlife Service (USFWS) appealed FERC Project 10521 and expressed support for maintenance of a minimum 7.3 mg/l DO level in the tailwaters. The PAFB also supports maintenance of existing conditions for the current FERC license. The proposed location and operation of FERC Project No. 10521 are very similar to the current application. In 1993, the USACE ran a CE-QUAL-R1<sup>5</sup> water quality model simulation, using 1985 data, to examine the effects of various withdrawal elevation scenarios proposed for FERC Project No. 10521. Results indicated that:

The turbine discharges of the proposed hydropower project would severely depress the dissolved oxygen concentration of the Mahoning Creek downstream of the power plant for most of the summer season.

The use of the existing plugged penstock openings for a retrofit hydropower conversion of the dam would raise the intake elevation by 30 to 40 ft (from 1015/1021/1025 to 1054 ft NAVD88). From the perspective of water quality, the low intake elevations of the outlets are important structural features of the dam because they influence thermal and chemical stratification patterns in the reservoir, which in turn affect the quality of water being released. The proposed hydropower project is therefore expected to influence reservoir stratification patterns and lake and downstream water quality. Withdrawal from a higher elevation for hydropower generation will create relatively strong summer thermal stratification near the intake elevation, leaving anoxic, dead storage in the deeper strata of the lake below the intake elevation. While continuous bypass discharge from the bottom gates will evacuate a portion of this anoxic storage, it may also degrade water quality of the stilling basin when the lake is stratified, since hypolimnetic discharges of this colder\ denser storage will contain elevated concentrations of reduced metals & nutrients, hydrogen sulfide, conductivity, and turbidity. Because this model is one-dimensional, it cannot accurately predict conditions for lakes with short hydraulic retention times and strong advective processes / riverine-like conditions like the Mahoning. Therefore, impacts could be even more severe than predicted since model results underestimated impacts to the quality of deep water lake habitat and lake and downstream water quality, and consequentially, fish and other aquatic life.

The differences between two bypass flow scenarios modeled (30 and 60 cfs) were negligible since both were drought flows; existing conditions were not analyzed. Either of these flows would decrease the frequency of high water events in the stilling basin and increase hydraulic retention times. . This could potentially impact stilling basin water quality and aquatic life during periods when the lake is stratified.

The model run showed only a mild warming in outflow water temperatures during August with both alternatives. However, even a slight increase in summer season outflow water temperatures could have a significant impact on the existing coolwater fishery.

While waters are currently withdrawn from anoxic strata near the bottom of the lake during the summer season, the dam is a very effective aerator and the waters discharged are consistently circumsaturated with dissolved oxygen. In addition, cool bottom releases from the dam support a coolwater downstream fishery, where maximum water temperatures do not exceed 80°F (26.7°C) and gas supersaturation problems have never been observed. Maintenance of these conditions is important to ensure that aquatic resources are protected. Since turbine discharges of the proposed hydropower project would severely depress DO and raising the intake elevation will increase downstream water temperatures, parameters of concern with hydropower generation include, but are not be limited to, dissolved oxygen (DO), water temperature (WT), and percent total dissolved gas saturation (%TDG Sat).

Because we are unsure of impacts of the proposed hydropower project on aquatic resources and suspect that impacts could be significant, we are requiring an adaptive management approach, utilizing real-time, continuously recording monitoring and implementation of nondegradation criteria. When criteria are violated, immediate actions by the hydropower operator will be required that could include oxygen injection or aeration of the hydropower outfall without nitrogen supersaturation, and/or bypassing flow, until the condition is remedied.



### 3. Water Quality Mission:

Water quality and natural resource management missions are supported by project-specific Congressional authorization and other Federal laws and regulations. Mahoning Creek Lake was authorized by the Flood Control Act of 22 June 1936 (Public Law No. 738, 74th Congress, Report No. 8455, Section 5), as modified by the Flood Control Act of 28 June 1938 (Public Law No. 761, 75th Congress, 3rd Session, Report No. 10618, Section 4). As mentioned above, the quality of waters impounded and discharged from Mahoning Creek Dam is now characterized as excellent and totally acceptable for project water management objectives. High quality Mahoning Dam releases contribute to the District's Allegheny River reservoir system operation to improve water quality in the lower Allegheny River. Approximately 23 miles of Mahoning Creek and 55 miles of the Allegheny River are directly influenced by Mahoning Dam releases. Water quality is integral to the protection of fish & wildlife and to the Corps of Engineers' resource management mission (Environmental Operating Principles). Nondegradation / anti-degradation policy is defined in ER 1110-2-1462, dated 20 February 1991, "Water Quality and Water Control Considerations for Non-Federal Hydropower Development at Corps of Engineers Projects". ER 200-1-5 establishes guidelines for compliance with Executive Order 112088, "Prevention, Control and Abatement of Environmental Pollution at Federal Facilities". In addition, the District has required implementation of nondegradation water quality criteria in the MOAs of existing nonfederal, add-on hydropower at other Corps reservoirs and navigation dams.

### 4. Water Temperature

#### 4. a. Mahoning Creek Dam Outflow Water Temperature

Dam outflow water temperatures are colder than they were before the dam was constructed because of the low intake elevation of the Mahoning Dam intakes. The elevations of the intakes influence thermal and chemical stratification patterns in the reservoir, which in turn affect the quality of water being released. As a consequence, water temperatures in the reach or Mahoning Creek downstream of the dam to the McCrea Furnace Bridge are close to the Pennsylvania Trout Stocked Fishery (TSF) criteria except during August and September, when temperatures are much cooler than these criteria. While the PA Code Chapter 93 designated use of the reach of Mahoning Creek downstream of the Dam is "warm water fishery"<sup>4</sup>, the PFBC stocks 1800 trout per year downstream of Mahoning Dam. It is noteworthy that, of the fish inhabiting the stilling basin, the trout stocked by the PFBC are overwintering. Anglers have caught trout in the stilling basin prior to their annual spring stocking indicating that these fish survive the summer warm temperatures in the stilling basin. . The reach of Mahoning Creek downstream of the stilling basin also supports a robust, reproducing coolwater fishery that includes walleye, northern pike, muskellunge, and smallmouth bass.<sup>6</sup> Chart 1 compares the PA warm water (WWF), cold water (CWF), and trout stocked (TSF) fishery water temperature criteria with the District's nondegradation water temperature criteria for Mahoning Creek Lake and outflow. These water temperature criteria are also tabulated in Table 1.

District real-time water temperature data collected at the McCrea Furnace Bridge, Mahoning Creek Mile 22, between 2007 and 2010, along with the PA water temperature criteria, are presented in Chart 2. Chart 3 shows data collected at the same location during 2009.

District real-time water temperature data collected at the McCrea Furnace Bridge and also in the lake just upstream of the Dam near the elevations of the dam and hydropower intakes during 2007 and 2008, are presented in Charts 4 and 5, respectively. The District's nondegradation and the PA water temperature criteria are also presented in this chart.

Chart 6 shows grab water temperature data collected from Mahoning Creek from the dam (including the stilling basin) downstream to the McCrea Furnace bridge during the District's water quality monitoring period of record (1969 – 2011). While the location for this sampling station (Station MAH 1201) is described in the District's water quality database as being downstream of the stilling basin weir, project staff have collected routine, semi-monthly samples in the stilling basin (upstream of the weir), using this code since 1980. This makes comparison of water quality in and just downstream of the weir difficult. Therefore, from February through July 2011, project staff collected, grab water temperature and DO data upstream and downstream of the stilling basin weir when possible. Neither these 2011 data nor the District's limited historical water temperature data show much difference between the two locations. The District therefore recommends the same nondegradation criteria for both locations.

Chart 7 shows grab water temperature data collected in the stilling basin weir between 1989 and 1995.



Chart 1.

### Mahoning Creek Lake and Outflow Nondegradation and PA Water Temperature Criteria

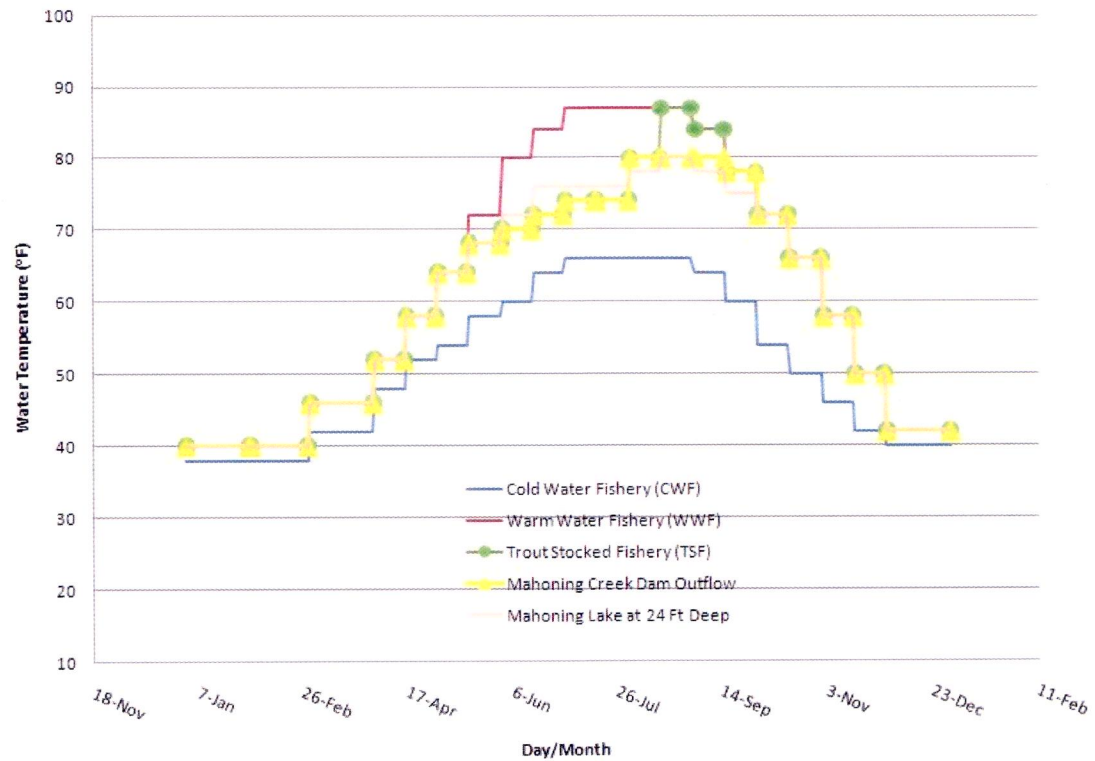


Table 1

PA Water Temperature Criteria and  
USACE Mahoning Lake and Outflow Nondegradation Water Temperature Criteria (°F)

<i>CRITICAL USE PERIOD</i>	<i>PA Cold Water Fishery (CWF) Criteria</i>	<i>PA Warm Water Fishery (WWF) Criteria</i>	<i>PA Trout Stocked Fishery (TSF) Criteria</i>	<i>USACE Mahoning Lake Outflow Nondegradation Criteria</i>	<i>USACE Mahoning Creek Lake, 24 feet deep at Summer Pool Elevation Nondegradation Criteria</i>
1-31 Jan	38	40	40	40	40
1-29 Feb	38	40	40	40	40
1-31 Mar	42	46	46	46	46
1-15 Apr	48	52	52	52	52
16-30 Apr	52	58	58	58	58
1-15 May	54	64	64	64	64
16-30 May	58	72	68	68	68
1-15 Jun	60	80	70	70	72
16-30 Jun	64	84	72	72	76
1-14 Jul	66	87	74	74	76
15-31 Jul	66	87	74	74	76
1-15 Aug	66	87	80	80	78
16-31 Aug	66	87	87	80	80
1-15 Sep	64	84	84	80	78
16-30 Sep	60	78	78	78	75
1-15 Oct	54	72	72	72	72
16-31 Oct	50	66	66	66	66
1-15 Nov	46	58	58	58	58
16-30 Nov	42	50	50	50	50
1-31 Dec	40	42	42	42	42



Chart 2.

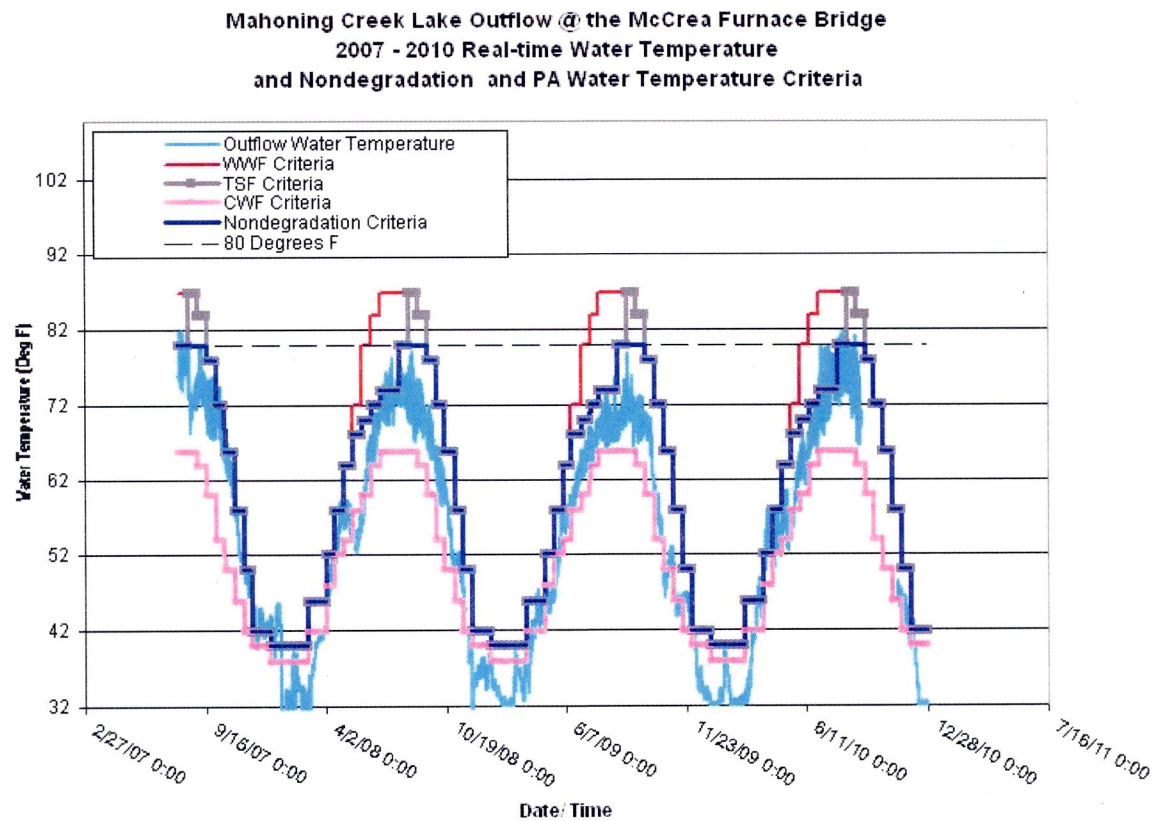


Chart 3.

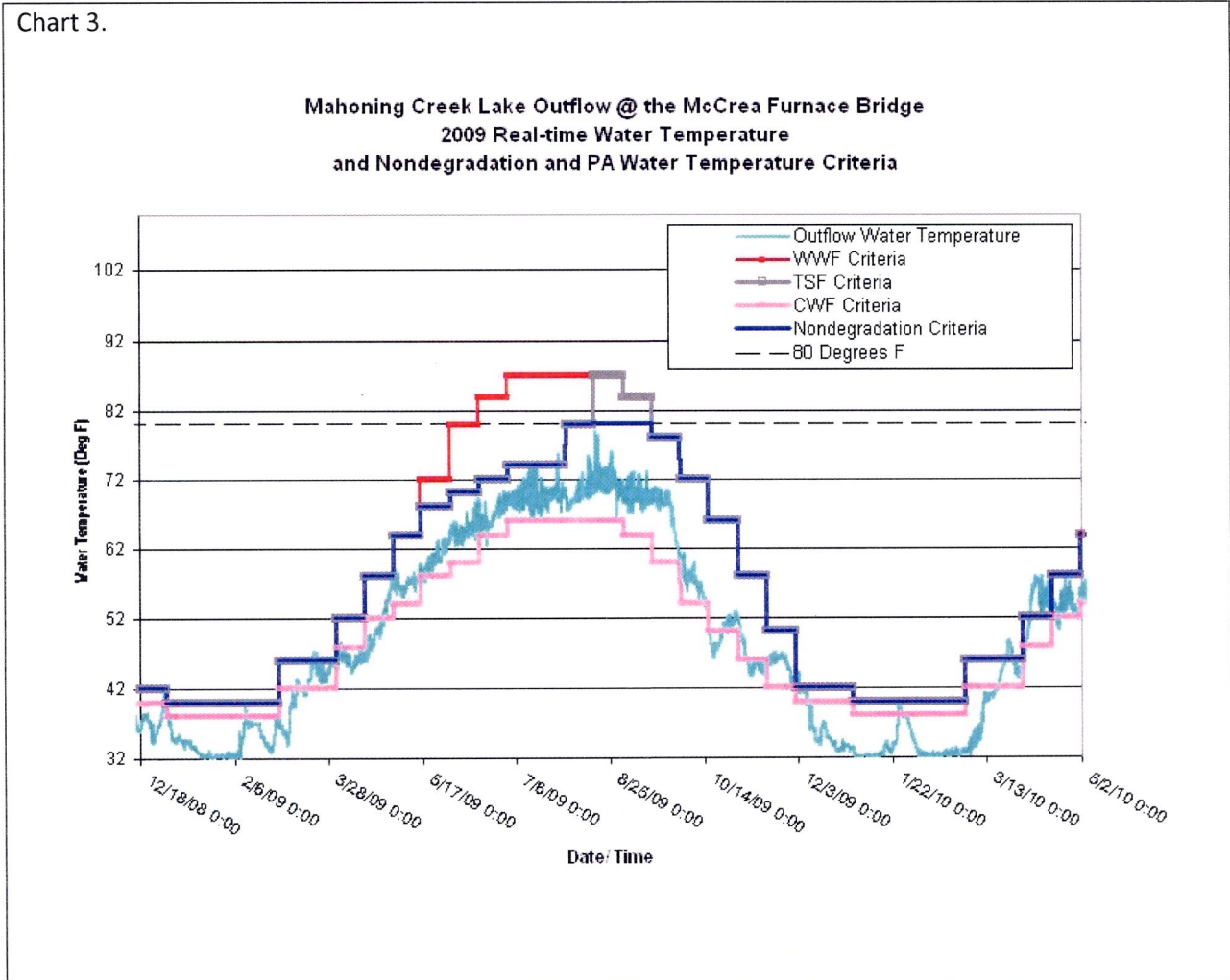




Chart 4.

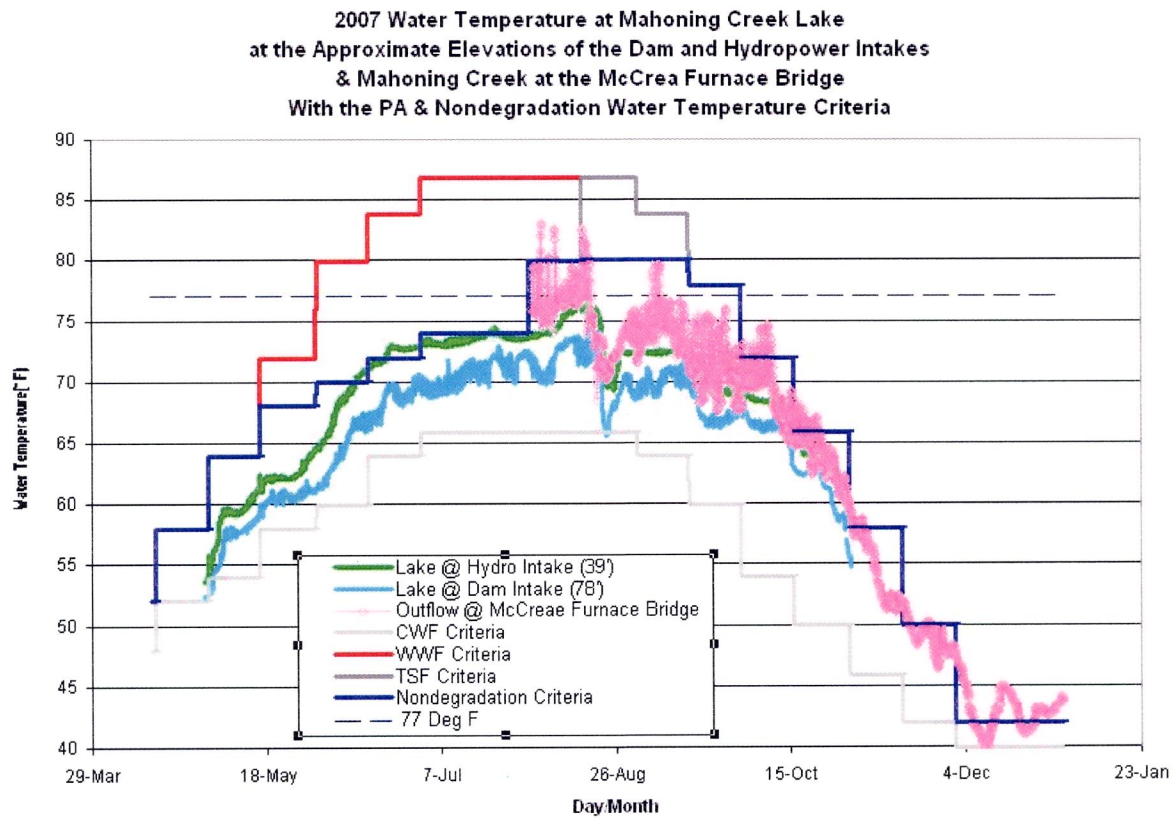


Chart 5.

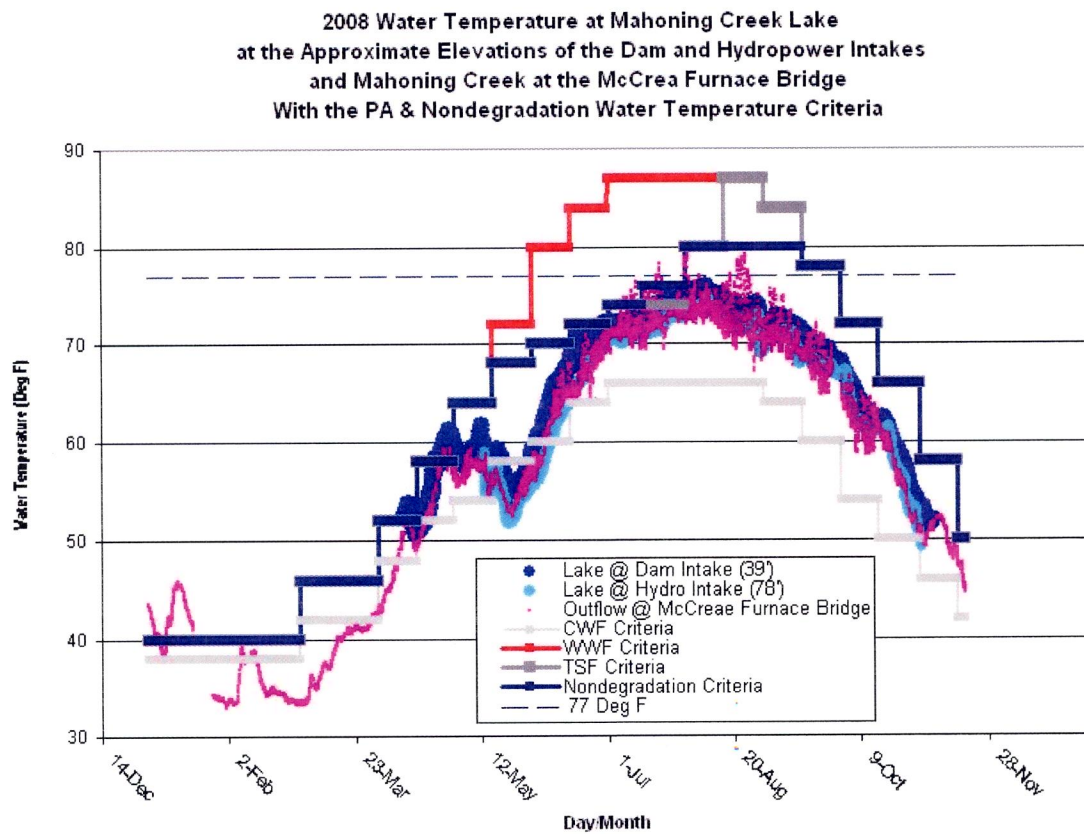
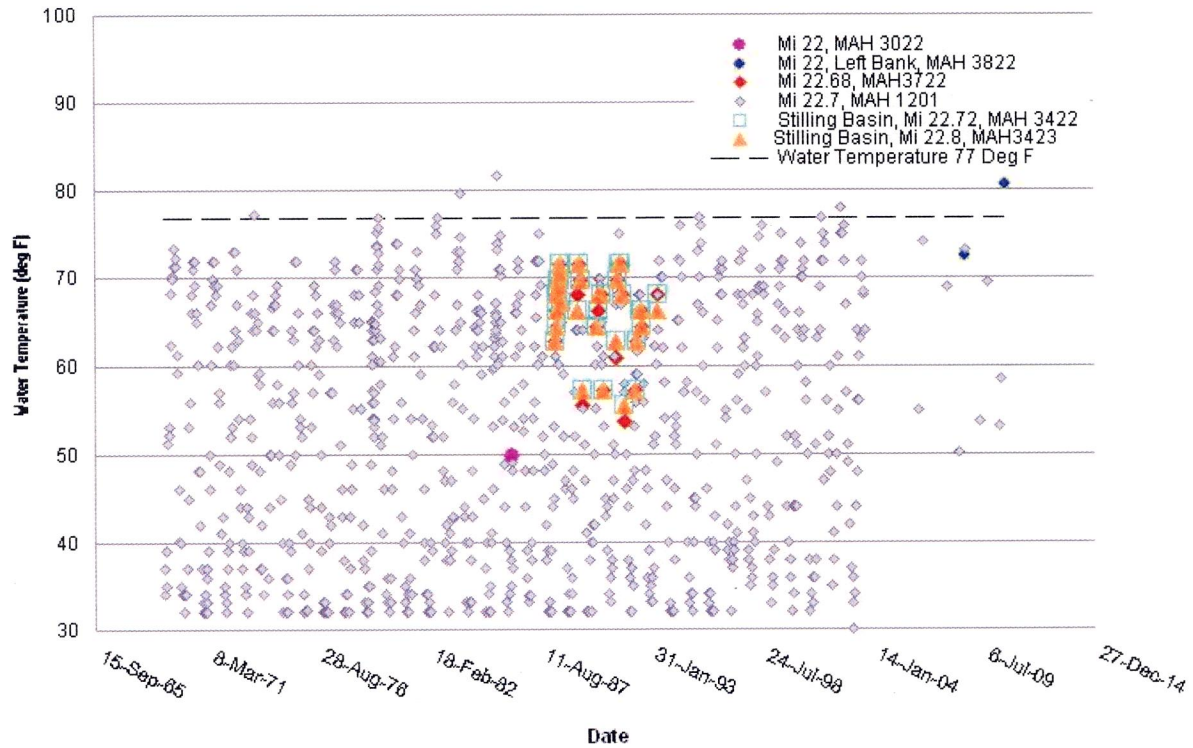




Chart 6.

**Mahoning Creek Dam Outflow Grab Water Temperature  
Collected Between the Dam and the McCrea Furnace Bridge (Mi 22-22.8)  
1969 - 2008**







As can be seen in Charts 2 and 3, water temperature at the McCrea Furnace Bridge, which is located about 1 mile downstream of the dam, only exceeds 80°F (26.7°C) at the most, a few hours every few years, generally in late August.

Charts 4 and 5 compare water temperatures in the lake at the elevations of the dam and hydropower intakes with those recorded downstream at the McCrea Furnace Bridge during 2007 and 2008, respectively. Water temperatures at both intake elevations did not exceed 77 °F (25 °C) during either year. Assuming the water temperatures directly downstream of the dam would be similar to those in the lake near the intake elevation, outflow water temperatures in this reach were also likely cooler than 77 °F (25 °C). Again, water temperatures recorded at the McCrea Furnace Bridge, which are warmed by radiant energy during the summer months through the mile-long reach between the dam and the bridge, rarely exceeded 80 °F (26.7 °C).

As can be seen in Chart 6, the maximum water temperature collected in the stilling basin and/or directly downstream of the weir was 80°F (26.7°C) (Station 1201). However, there were only two, 80 °F (26.7°C) readings during the District's entire period of record at this station. Maximum water temperatures were generally about 77°F (25°C).

As can be seen in Chart 7, maximum water temperature measured at the Districts two sampling sites in the stilling basin, during their period of record, was only 71.6 °F (22.8 °C) (Stations MAH3423, mi 22.72, and MAH3424, mi 22.8). As mentioned above, the District began collecting grab water temperature data upstream and downstream of the stilling basin weir in February 2011, and will begin continuous water quality monitoring in the stilling basin in June 2011 to better define existing conditions.

These charts demonstrate that managing the outflow as a warm water or trout stocked fishery would result in a significant change from the existing coolwater use. According to Kendall, optimum water temperatures for coolwater walleye, muskellunge and smallmouth bass range between 65 and 72 degrees F, and the maximum water temperature is approximately 77 °F (25 °C) (Kendall 1978).<sup>4</sup> Basin specific water temperature criteria were also developed by the OEPA in 2006 for Ohio rivers, streams, and the open and shoreline waters of Lake Erie<sup>12</sup>. Critical thermal thresholds identified in this report for the key coolwater species found in the Mahoning Dam outflow are presented in Table 1.5. As can be seen in this table, optimum water temperatures were 71.2 °F (21.8 °C), 73.0 (22.8 °C), 75.6 (24.2 °C), and 86°F (30 °C), and the mean weekly average temperatures for growth were 77.5 °F (25.3 °C), 88.95 °F (31.6 °C), 80.6 °F (27.0 °C), and 89.6°F (32 °C) for coolwater northern pike, walleye, muskellunge, and smallmouth bass, respectively.

Therefore, it can be assumed that increasing the frequency (days or even hours) when water temperatures exceed 80°F, or higher than optimum critical thermal thresholds for key species, especially northern pike, muskellunge, and rainbow trout, will impact the existing use.