

Chart 15. Mahoning Lake Grab Dissolved Oxygen

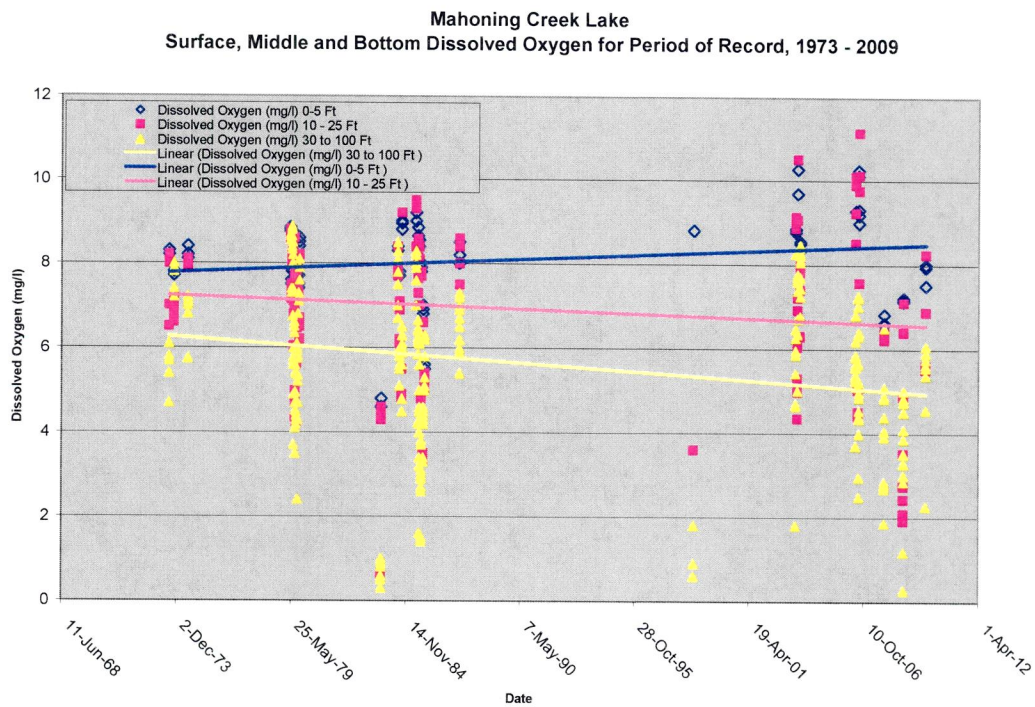


Chart 16. Mahoning Lake Grab Dissolved Oxygen

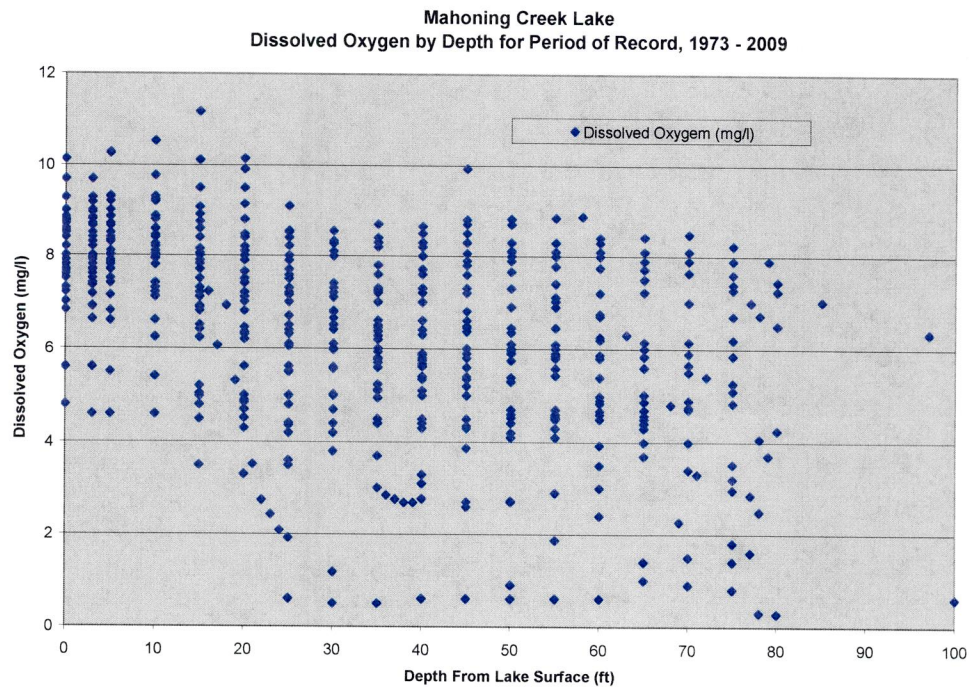
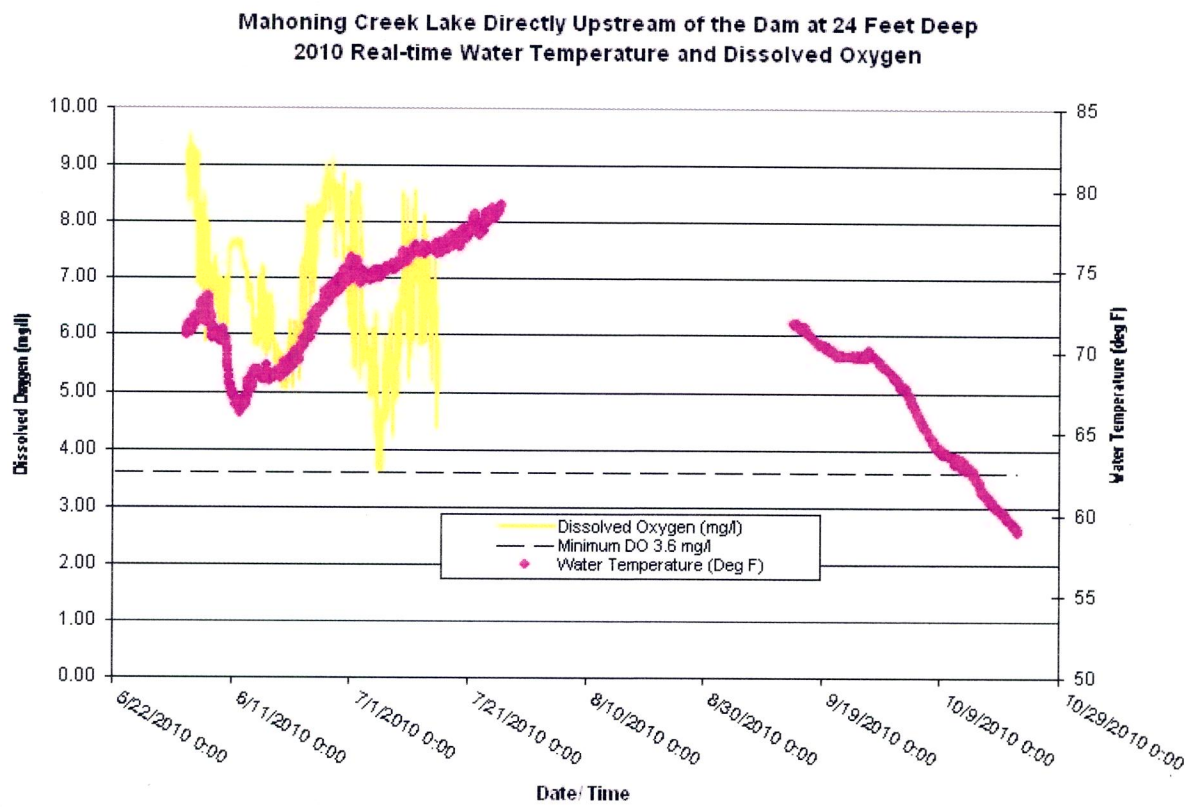


Chart 17. Mahoning Creek Lake Continuous Dissolved Oxygen & Water Temperature



The District Requires:

MCHC will monitor dissolved oxygen levels in the lake using data collected at their real-time, continuously recording dissolved oxygen monitor. Data from the District's lake water quality monitor will be used for verification if and when this monitor is operational. If lake dissolved oxygen levels at 24 ft deep at summer pool elevation (1073 ft NAVD) drop below 3.6 mg/l, the lowest real-time DO recorded during the District's 2010 monitoring period at this depth, then bypassed flow will be increased to modify lake stratification patterns. A summary of requirements for Mahoning Creek Lake, compared to PA specific dissolved oxygen criterion for the lake epilimnion and MCHP's adaptive management proposal¹⁰, are presented in Table 4.

Action Plan:

When the hydroelectric plant is operating, if the dissolved oxygen level (measured at any continuously recording monitor in the lake at 24 ft deep) drops below 3.6 mg/l, bypass flow rate will be increased and/or flow through the turbine reduced to bring the dissolved oxygen level back into compliance. Effectiveness of bypassing flow will be apparent within 24 hours, and bypass flow will be increased until criterion is met. Immediate response time will be required during working hours. After working hours, a logistically reasonable response time will be determined by USACE project personnel, optimally, not to exceed 2 -hours. Verification of the accuracy of the real-time monitor will be at the discretion of the hydropower plant operator, and will have no impact response time.

6. Percent Total Dissolved Gas Saturation

The District collected a few grab total dissolved gas (TDG) measurements in the dam tailwaters during 2010, and collected real-time TDG and barometric pressure (BP) data in Mahoning Creek at the McCrea Furnace Bridge during 2009, 1010, and 2011. The percent total dissolved gas saturation (%TDG Sat) was calculated using TDG and barometric pressure data. Frequency analyses of % TDG Sat vs. dissolved oxygen (DO) in the Mahoning Dam tailwaters during the 2009, 2010, and 2011 monitoring periods are presented in Charts 18, 19, and 20, respectively. As can be seen in these charts, the maximum % TDG Sat value measured when dissolved oxygen levels were 7.0 mg/l or lower, was 102%. While % TDG Sat levels as high as 110% were recorded, they occurred only when DO levels >8 mg/l. In addition, gas supersturation problems have never been observed in the Mahoning Dam tailwaters. In general terms, total gas saturation should not exceed 103% to protect salmonid eggs⁸.

Chart 18.

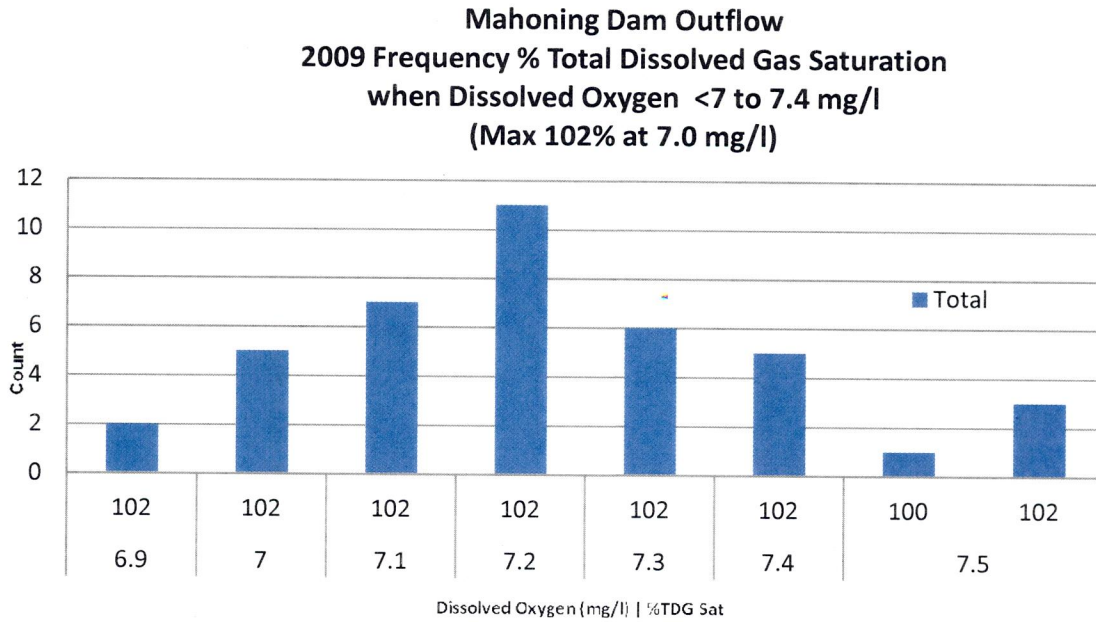


Chart 19.

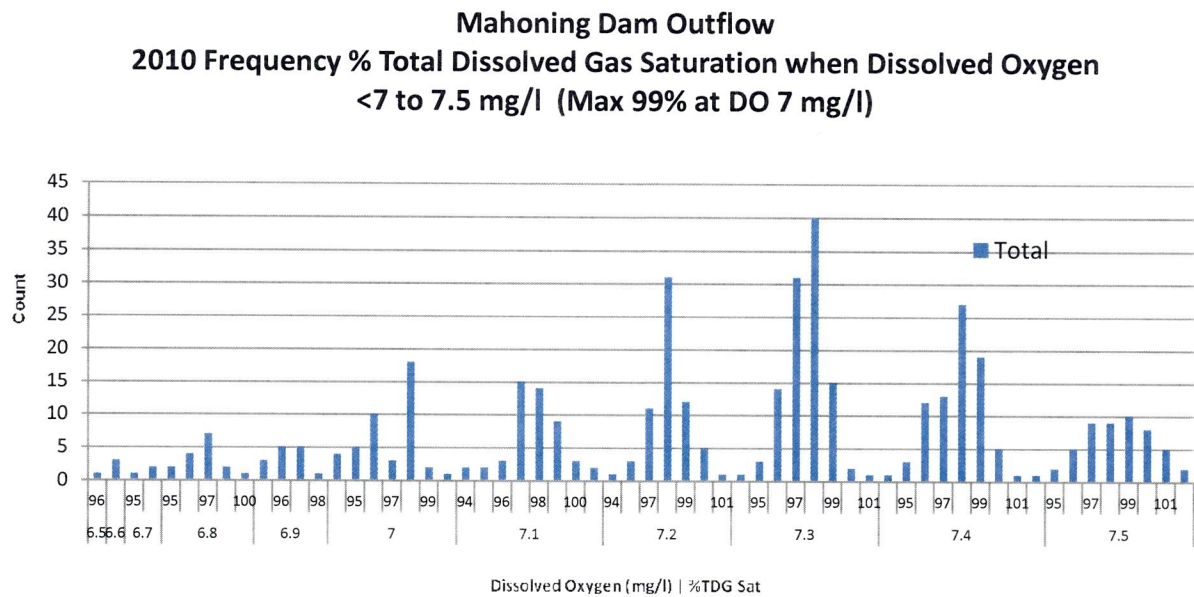
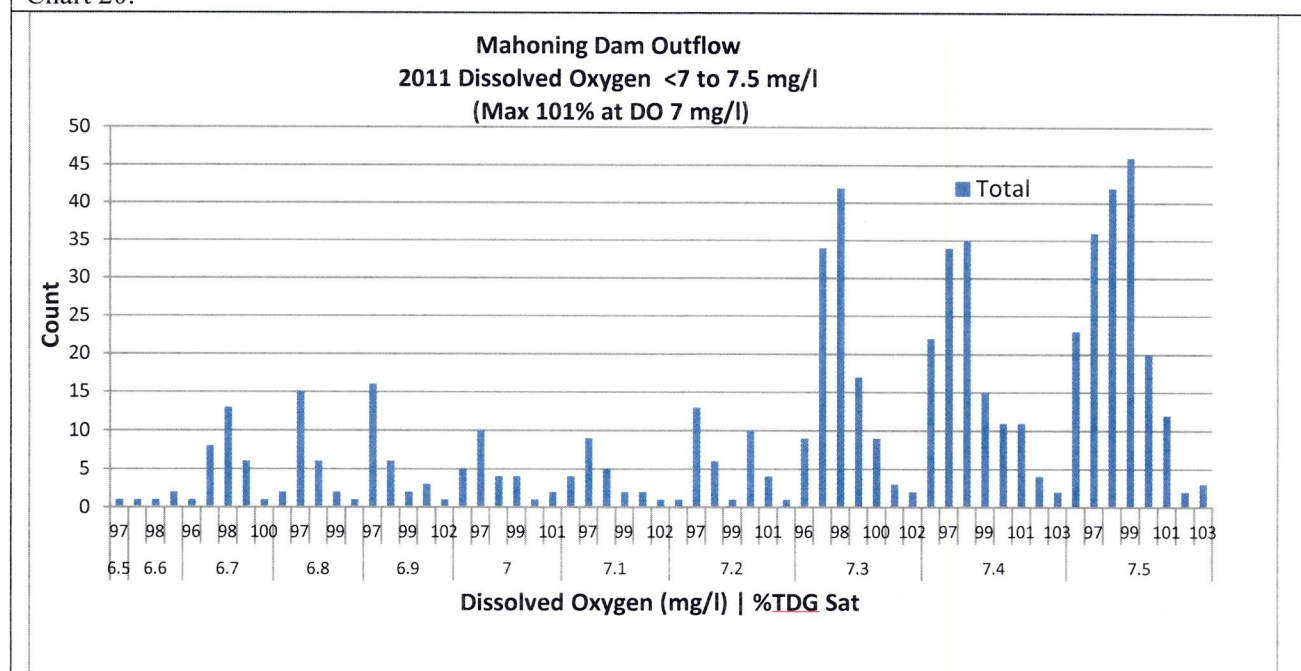


Chart 20.



The District Requires:

The %TDG Sat in Mahoning Creek in the hydropower plant outfall must not exceed 103%, based on the highest pre-hydropower value measured in the dam tailwaters when the dissolved oxygen is 7.0 mg/l or less. Percent TDG Sat values (collected during 2010 & 2011) were utilized to define existing conditions and develop the criterion. The District's water quality monitor located on Mahoning Creek at the McCrea Furnace Bridge will be utilized to evaluate the effectiveness of, and possibly modify, the %TDG Sat water quality criterion. A summary of requirements for the Mahoning Creek Lake outflow, compared to MCHP's adaptive management proposal¹⁰, is presented in Table 2.

Action Plan:

When the hydroelectric plant is operating, if the total dissolved gas percent saturation (%TDG Sat) level measured at the monitor in hydropower plant outfall exceeds the criterion, then the hydropower plant will immediately decrease the volume of air being forced into their discharge in order to reduce nitrogen supersaturation and/or the District will immediately increase bypass flow until levels are in compliance.

Effectiveness of reducing forced air and/or bypassing flow will be apparent immediately, and will be continued until criterion is met. Immediate response time will be required during working hours. After working hours, a logistically reasonable response time will be determined by USACE project personnel, optimally, not to exceed 2 -hours. Verification of the accuracy of the real-time monitor will be at the discretion of the hydropower plant operator, and will have no impact response time. If the %TDG Sat level rises above 103% at the District's water quality monitor located at the McCrea Furnace Bridge 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 Sat criterion at the hydropower tailrace outfall will be lowered.

7. Minimum Bypass Flow Rate

MCHC has proposed a baseline 30/40/60 cfs bypass flow which will reduce the frequency of high water events and will increase hydraulic retention times in the stilling basin. This could potentially impact aquatic life (fishery and shoreline wetlands) and water quality.

The District agreed to the 30/40/60 cfs bypass flow as long as the nondegradation criteria established for the lake, the stilling basin, and the Mahoning Creek regulated reach are being met and other aquatic resources are not being degraded (i.e. the existing fisheries as determined by the Pennsylvania Fish and Boat Commission (PFBC), water quality as determined by the District, etc.).

Additionally, during cold weather, the District requires that the dam ring jet be kept at a 10% or greater opening in order to prevent freezing of the equipment. Depending on the reservoir elevation, this setting typically releases 35 – 40 cfs. For simplicity, this flow will be described as 40 cfs.

Synergics, Inc, contractor for Mahoning Hydro Associates' Mahoning Creek Hydro Power Project, FERC Project No. 10521, conducted an energy analysis⁹ for the project to determine bypass flows necessary to meet FERC's proposed 7.0 mg/l nondegradation dissolved oxygen criterion. This analysis assumed that during June, 2/3 of the flow will be diverted through the power house and 1/3 through the dam. During the months of July, Sept, and October, 1/2 of the flow will be diverted through the power house and 1/2 through the dam. And, during the month of August, 1/3 of the available flow will be diverted through the powerhouse and 2/3 through the dam. The District expects that bypass flow requirements will be similar with this FERC project.

The District requires:

The baseline minimum bypass flow rate will be 60 cfs from June 15 through September 15; 40 cfs from November 1 through March 31 (in order to prevent freezing of the ring jet); 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. When nondegradation criteria in the lake, the stilling basin, or in Mahoning Creek downstream of the dam are violated, the District will increase bypass flow and direct MCHC to decrease their flow in order to meet criteria. District Water Management staff will determine the bypass flow rate required and when the temperature trend is stable or decreasing (i.e. the temperature is not rising).

8. Aquatic life and habitat

Water quality, aquatic life, and habitat will be monitored by the District and the PFBC throughout the duration of the license. There is concern that the existing coolwater and trout fisheries could be impacted with the proposed 80 °F maximum water temperature criteria since the frequency of days or hours where water temperatures exceed critical thermal thresholds for key cool and coldwater species. If trends towards the degradation of aquatic resources are noted then monitoring needs, nondegradation criteria, and mitigation will be revisited.

9 . Conclusion

District nondegradation criteria are based on worst case pre-hydropower water quality conditions 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 °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. The proposed hydropower project could impact water quality and aquatic life in the lake, the stilling basin, and Mahoning Creek downstream of the dam. Therefore, the District will require the following nondegradation criteria and bypass flows to assure sustainable development and protection of aquatic resources. 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. In addition, the District reserves the right to control other parameters if unexpected problems develop.

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

- Minimum DO 7.0 mg/l
- Monthly or bimonthly, maximum water temperature 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 Criteria, Mahoning Dam Outflow, Mahoning Creek downstream of the hydropower outfall (MCHC monitor)

- Minimum DO 7.0 mg/l
- Maximum % TDG saturation 103% when the DO is 7.0 mg/l or lower
- Monthly or bimonthly, maximum water temperature 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 criterion 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 Criteria, Lake (MCHC monitor)

- Minimum DO 3.6 mg/l at a depth of 24 feet at summer pool elevation (1073 ft NAVD)
- Maximum water temperature 80°F (26.7°C) at a depth of 24 feet (1073 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 (in order to prevent freezing of the ring jet); 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 . When nondegradation criteria in the lake, the stilling basin, or in Mahoning Creek downstream of the dam are violated, the District will increase bypass flow and direct MCHC to decrease their flow in order to meet criteria. District Water Management staff will determine the bypass flow rate required and when the temperature trend is stable or decreasing (i.e. the temperature is not rising).

Table 2

TABLE 2 Mahoning Creek Immediately Downstream of Hydropower Outfall														
Period	Licensee ¹	Corps ²	Min Dissolved O ₂ (mg/l)				Max Water Temperature (F)					Max Total Dissolved Gas (%)		
			PA CWF, HQ: WWF, HQ-TSF ³	PA WWF ³	PA TSF ³	PA HQ: CWF ³	Licensee ³	Corps ⁴	PA WWF ⁵	PA CWF ⁵	PA TSF ⁵	Licensee	Corps ⁵	PA Criteria
January 1-31					Min Daily Avg 5.0, Min 4.0		40	40	40	38	40			
February 1-14							40	40	40	38	40			
February 15-29							40	40	40	38	40			
March 1-31							46	46	46	42	46			
April 1-15							52	52	52	48	52			
April 16-30					Min Daily Avg 6.0, Min 5.0		58	58	58	52	58			
May 1-15							64	64	64	54	64			
May 16-31							68	68	72	58	68			
June 1-15							70	70	80	60	70			
June 16-30	7.0	7.0	Min Daily Avg 6.0, Min 5.0	Min Daily Avg 5.0, Min 4.0		7.0	72	72	84	64	72	105%	103% (To Be Verified)	None
July 1-31							74	74	87	66	74			
August 1-15							80	80	87	66	80			
August 16-31							87	80	87	66	87			
September 1-15							84	80	84	64	84			
September 16-30							78	78	78	60	78			
October 1-15					Min Daily Avg 5.0, Min 4.0		72	72	72	54	72			
October 16-31							66	66	66	50	66			
November 1-15							58	58	58	46	58			
November 16-30							50	50	50	42	50			
December 1-31							42	42	42	40	42			

¹ Licensee's proposed Action level is min DO at BOTH outfall and McCrea Bridge gages to bring back to min

² Corps' proposed action level is min DO at outfall gage to bring DO back to min **immediately**, and also at McCrea Furnace gage when it is operational (Historical Max =15.4, Min = 7.2, Avg = 9.4)

³ Licensee's proposed Action level is 3 degrees above Max for 12 hours or more to bring temperature 2 degrees F below Max

⁴ Corps' proposed action level to meet criteria, at BOTH the outfall and McCrea Bridge gages, **immediate response** to bring back to max (Historical Max =78, Average 66)

⁵ PA Code § 93.7. Specific water quality criteria

⁶ CWF = cold water fishery, WWF = warm water fishery, TSF = Trout stocked fishery, HQ = High Quality

⁷ Corps' proposed action level is max % Sat at the Outfall and also the McCrea Furnace gage when it is operational

Table 3

Min Dissolved O ₂ (mg/l)						Max Water Temperature (F)						Max Total Dissolved Gas (%)		
Period	Licensee	Corps ¹	PA CWF, HQ-WWF, HQ-TSF ²	PA WWF ²	PA TSF ²	PA HQ-CWF ²	Licensee	Corps ³	PA WWF ²	PA CWF ²	PA TSF ²	Licensee	Corps	PA Criteria
January 1-31					Min Daily Avg 5.0,		40	40	40	38	40			
February 1-14					Min 4.0		40	40	40	38	40			
February 15-29							40	40	40	38	40			
March 1-31							46	46	46	42	46			
April 1-15							52	52	52	48	52			
April 16-30					Min Daily Avg 6.0,		58	58	58	52	58			
May 1-15					Min 5.0		64	64	64	54	64			
May 16-31							68	68	72	58	68			
June 1-15							70	70	80	60	70			
June 16-30	7.0	7.0	Min Daily Avg 6.0,	Min Daily Avg 5.0,		7.0	72	72	84	64	72	None	None	None
July 1-31			Min 5.0	Min 4.0			74	74	87	66	74			
August 1-15							80	80	87	66	80			
August 16-31							87	80	87	66	87			
September 1-15							84	80	84	64	84			
September 16-30							78	78	78	60	78			
October 1-15					Min Daily Avg 5.0,		72	72	72	54	72			
October 16-31					Min 4.0		66	66	66	50	66			
November 1-15							58	58	58	46	58			
November 16-30							50	50	50	42	50			
December 1-31							42	42	42	40	42			

¹ Corps' proposed action level is min DO at stilling basin gage with immediate response to bring DO back up to min (Historical Max =11.8, Min = 7.45, Avg = 8.9)

² PA Code § 93.7. Specific water quality criteria

² CWF = cold water fishery, WWF = warm water fishery, TSF = Trout stocked fishery, HQ = High Quality

³ Corps' proposed action level above max at the stilling basin gage, immediate response to bring back down to max (Historical Max =71.6, Average = 55)

Table 4

Period	Min Dissolved O ₂ (mg/l)					Max Water Temperature (F)					Max Total Dissolved Gas (%)		
	Licensee ¹	Corps ²	PA CWF, HQ-WWF, HQ-TSF ³	PA WWF ³	PA TSF ³	Licensee	Corps ⁴	PA WWF ³	PA CWF ³	PA TSF ³	Licensee	Corps	PA Criteria
January 1-31					Min Daily Avg 5.0,	40	40	40	38	40			
February 1-14					Min 4.0	40	40	40	40	40			
February 15-29						40	40	40	38	40			
March 1-31						46	46	46	42	46			
April 1-15						52	52	52	48	52			
April 16-30					Min Daily Avg 6.0,	58	58	58	52	58			
May 1-15					Min 5.0	64	64	64	54	64			
May 16-31						68	68	72	58	68			
June 1-15						70	72	80	60	70			
June 16-30	3.6?	3.6	5.0	Min Daily Avg 5.0,		72	76	84	64	72	None	None	None
July 1-31				Min 4.0	7.0	74	76	87	66	74			
August 1-15						80	78	87	66	80			
August 16-31						87	80	87	66	87			
September 1-15						84	78	84	64	84			
September 16-30					Min Daily Avg 5.0,	78	75	78	60	78			
October 1-15					Min 4.0	72	72	72	54	72			
October 16-31						66	66	66	50	66			
November 1-15						58	58	58	46	58			
November 16-30						50	50	50	42	50			
December 1-31						42	42	42	40	42			

¹ Licensee DO monitor at intake elevation , 3.6 mg/l criteria?

² Corps DO action level at a depth of 24 feet at summer pool elevation (1073 ft NAVD) bring DO back to minimum within 24 hours. (Historical Max =9.5, Min = 3.7, Avg = 6.8),

³ PA Code § 93.7. Specific water quality criteria. Criteria apply to lake epilimnion

⁴ CWF = cold water fishery, WWF = warm water fishery, TSF = Trout stocked fishery, HQ = High Quality

⁵ Corps max water temperature action level at a depth of 24 feet or deeper at Summer Pool Elevation, bring back to max withing 24 hours. (1073 ft NAVD) (Historical Max =79, average = 70)

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5. Mahoning Creek Lake Reservoir Limnology, Aquatic Life and Water Quality, U.S. Army Engineer District, Pittsburgh Corps of Engineers, Pittsburgh, Pennsylvania 1993
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