DEEP CREEK STATION

April 30, 2020

YOUGHIOGHENY RIVER WATER TEMPERATURE ENHANCEMENT PLAN

OBJECTIVE

This plan prescribes how the Permittee will operate Deep Creek Station to enhance water temperature in the Youghiogheny River and to monitor river water temperature in in the Youghiogheny River and to monitor river water temperature in accordance with Condition 16 of the Water Appropriation and Use Permit (Permit Number GA1992S009) issued by the Maryland Department of the Environment (MDE). Temperature enhancement will support the Maryland Department of Natural Resources' (MDNR's) program to establish and sustain a quality brown and rainbow trout fishery in the Youghiogheny River downstream from the Deep Creek Station tailrace. MDNR is primarily concerned with the reach between the tailrace and Sang Run. To the extent possible, operation for temperature enhancement is to provide releases usable for whitewater boating.

ENHANCEMENT PERIOD AND WATER TEMPERATURE MONITORING

This plan will be implemented during the months of June, July, and August and September 1 through 15. [These have been the only months in which water temperatures in the reach between the Deep Creek Station tailrace and Sang Run have exceeded 25.0°C.]

When river flows at the U.S. Geological Survey (USGS) gage at Oakland are greater than or equal to 180 cfs, temperature enhancement will not be required.

Only monitoring of river temperature, and not releases for temperature enhancement, will be implemented from May 15- May 31.

WATER TEMPERATURE MONITORING INSTRUMENT

Prior to May 15 of each year, a water temperature monitoring instrument will be installed in the river at the Sang Run bridge and will remain in the river to record water temperatures through September 15. The instrument will be connected to the local telephone company network for remote interrogation. Temperatures will be recorded at intervals of not less than one half hour either by the instrument for later downloading or by a computer automatically interrogating the instrument. [MDNR and The Permittee have determined that Sang Run bridge is the best location for

both monitoring temperatures and predicting maximum temperatures between the tailrace and Sang Run.]

The instrument will have a monitoring accuracy of 0.1 C°. Calibration will be checked at intervals not less than the interval recommended by the manufacturer.

MONITORING OF YOUGHIOGHENY RIVER FLOWS

The USGS gage at Oakland will be used to monitor Youghiogheny River flows. If flows at the Oakland gage are less than 180 cfs, the Water Temperature Enhancement Protocol (or Contingency Protocol) described below will be implemented.

The Oakland flow data will be obtained from the USGS gage 0700 hours. The most current data available from the Oakland gage will be used to determine if flows are less than 180 cfs.

If Oakland gage data is unavailable, flow data from the USGS gage at Hoyes Maryland will be used to estimate the natural flows at Oakland. If the lowest flow at the Hoyes Maryland gage over the previous 24 hour period is less than 255 cfs, the Water Temperature Enhancement Protocol (or Contingency Protocol) will be implemented.

If both the Oakland and Hoyes Maryland gage data are unavailable, flow data from the USGS gage at Friendsville will be used to estimate natural river flow at Oakland. If the lowest flow at Friendsville over the previous 24 hour period is less than 340. cfs, the Water Temperature Enhancement Protocol (or Contingency Protocol) will be implemented. [A flow of 340. cfs at Friendsville (with no contribution from Deep Creek Station) is equivalent to a flow of 180 cfs at Oakland.] *[Note: the flow value at Friendsville that is equivalent to 180 cfs at Oakland was determined using the equation on page 3-5 of the Deep Creek Station Support Document for Permit Application to Appropriate and Use Water of the State, dated August 1993]*

If neither Oakland, nor Hoyes Run, nor Friendsville gage data are available, the Water Temperature Enhancement Protocol (or Contingency Protocol) will be implemented.

TEMPERATURE RELEASES

Releases to enhance river water temperature ("temperature releases") will be made in accordance with the Water Temperature Enhancement Protocol (or Contingency Protocol), below. Temperature releases will be made by operating both units at maximum capacity.

SCHEDULED RELEASES

On days of scheduled releases for whitewater events as outlined in condition 19 of the permit (GA 1992S009(09)), the permittee is not required to run the water temperature enhancement protocol, unless the scheduled whitewater release would not occur due to low lake levels.

WATER TEMPERATURE ENHANCEMENT PROTOCOL

On each day from June 1 through September 15 that this protocol is implemented, the daily forecasted maximum air temperature and cloud cover for Elkins, West Virginia will be obtained at approximately 0700 hours. At approximately 0700, 0900, 1100, 1200, 1400, and 1500 hours, the river water temperature at Sang Run will be read and a prediction of the daily maximum water temperature will be made based on whether the flow at Oakland is less than or equal to, or greater than 30 cfs, using the equations presented below (see Youghiogheny River Temperature Enhancement Protocol Revision 1, Versar Inc., March 1995 and Versar memorandum to Penelec dated May 4, 1995 for supporting information). If a temperature release is determined to be necessary, no additional predictions will be required that day. If the water temperature monitoring instrument is inoperative, the Contingency Protocol (below) will be implemented.

Time	Q(cfs)	Equations To Predict Maximum River Temperature
0700	≤ 30[1]	$TMAX = 10.93 + 0.322*TAIR - 0.019*CCF + 0.338*T_7$
	>30	Subtract $0.04*(Q-30)$ from above equation
0900	≤ 30	$TMAX = 10.20 + 0.284*TAIR - 0.021*CCF + 1.208*T_9 - 0.779*T_7$
	>30	Subtract $0.04*(Q-30)$ from above equation
1100	all	$TMAX = 6.20 + 0.247*TAIR - 0.010*CCF + 1.393*T_{11} - 0.828*T_9$
1200	all	$TMAX = 5.56 + 0.214*TAIR - 0.008*CCF + 1.059*T_{12} - 0.448*T_9$
1400	all	$TMAX = 3.56 + 0.103*TAIR + 1.356*T_{14} - 0.600*T_{12}$
1500	all	$TMAX = 3.08 + 0.049*TAIR + 1.140*T_{15} - 0.312*T_{12}$

where Q is the Youghiogheny River flow at Oakland,

TMAX is the predicted daily maximum river water temperature in °C

[1] If Oakland, Hoyes and Friendsville gage data are unavailable, assume $Q \leq 30$ cfs.

at Sang Run rounded to the nearest 0.1 °C,
TAIR is the 0700 daily maximum air temperature forecast in °C at Elkins,
CCF is the cloud cover factor obtained from the table below based on the 0700 hour daily cloud cover forecast at Elkins, and T_7, T_9, T_{11}, T_{12}, T_{14}, and T_{15} are the 0700, 0900, 1100, 1200, 1400, and 1500 hour river water temperature readings at Sang Run in °C, respectively.

CCF will be selected from the following table. [CCF is determined by squaring the equivalent numeric value of the descriptive cloud cover based on the National Weather Service (NWS) convention. CCF is based on the NWS upper limit numeric values for cloud cover. Use of the upper limit will minimize the number of unnecessary releases.]

Cloud Cover Forecast (Elkins, WV)	Cloud Cover Factor (CCF)
Overcast or cloudy	100
Variable cloudiness	100
Mostly cloudy or considerable cloudiness	64
Thunder Storms	36
Shower	36
Partly cloudy or partly sunny	36
Fair	16
Mostly clear or mostly sunny	9
Clear or sunny	1

If TMAX predicted at 0700 hours is less than or equal to 20.0°C, no further water temperature predictions that day are necessary and no temperature releases will be scheduled or made.

If TMAX predicted at 0700 hours exceeds 20.0°C and is less than or equal to 26.4°C, TMAX will be predicted at 0900 hours, and again at 1100, 1200, 1400 and 1500 hours unless an earlier prediction determines that a temperature release is necessary.

If TMAX predicted at the times shown in the following table exceeds the respective threshold temperatures, or if the actual temperature reading exceeds 25.0°C, a release will be scheduled as shown in the table and announced on the recording as stated below.

Time	Threshold Temperature	Begin Release	Duration of Release	Announcement on Recording
0700	26.4°C	1100 hours	2 hours	yes
0900	25.9°C	1100 hours	2 hours	yes
1100	25.4°C	1130 hours	2 hours	yes
1200	25.3°C	ASAP[2] - not later than 1230 hours	1 hour	no
1400	25.2°C	ASAP[2] - not later than 1430 hours	1 hour	no
1500	25.1°C	ASAP[2] - not later than 1530 hours	1 hour	no

Because of the lack of advance notice to whitewater boaters and the short (one-hour) duration, temperature releases from the 1200, 1400 or 1500 hour measurements or predictions would not be usable by the boaters. Therefore, no recording will be made of these releases.

CONTINGENCY PROTOCOL

If the water temperature monitoring instrument at Sang Run is inoperative at 0700 hours, TMAX will be calculated according to the following equation:

Q	≤30 cfs	TMAX = 14.43 + 0.356*TAIR – 0.017*CCF + 0.109*TMIN
Q	>30 cfs	Subtract 0.04*(Q–30) from above equation

where Q, TMAX, and TAIR are defined above, CCF is the cloud cover factor for the 0700 daily cloud cover forecast at Elkins using the values from the above table, and TMIN is the minimum (overnight low) air temperature in °C at Elkins. If TMAX exceeds 25.0°C, a temperature release from 1100 to 1300 hours will be scheduled and announced on the recording.

If the water temperature monitoring instrument at Sang Run becomes inoperative after 0700 hours, TMAX from the most recent prediction will be used as the basis for scheduling releases; if the most recent TMAX exceeds 25.0°C, a temperature release will be scheduled and announced on the recording as described in the Water Temperature Enhancement Protocol.

[2] ASAP—As soon as Possible

REPORTING OF WATER TEMPERATURES

A monthly report shall be submitted to MDE detailing all occurrences of water temperatures at Sang Run exceeding 25.0°C, along with the date and times of occurrence. The report shall be submitted within 14 days of the end of the month. All daily maximum water temperatures for the June 1 through September 15 period will be submitted to the MDE in an annual report. The report will contain the dates and times of temperature releases, the daily maximum air temperature and cloud cover forecasts obtained in the implementation of the Water Temperature Enhancement Protocol, the predicted daily maximum river water temperature at Sang Run (TMAX), and the actual river water temperature at Sang Run prior to and at the time TMAX is predicted. A copy of the monthly report should also be sent to MDNR.

REVISION OF PLAN

The Permittee will annually review the results of this plan with MDE and MDNR and, in consultation with MDE, refine or revise this plan with the objective of keeping water temperatures at Sang Run from exceeding 25.0°C.