WATER QUALITY IN DOWNSTREAM WEST CHANNEL STUDY REPORT

PARR HYDROELECTRIC PROJECT

(FERC NO. 1894)

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtGroup.com

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SOUTH CAROLINA ELECTRIC & GAS COMPANY

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1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is the Licensee for the Parr Hydroelectric Project (FERC No. 1894) (Project). SCE&G is currently seeking a new license from the Federal Energy Regulatory Commission (FERC), as their current license is set to expire on June 30, 2020. The Project consists of two developments, including the Parr Shoals Development and the Fairfield Pumped Storage Development.

The Parr Reservoir, located in Fairfield and Newberry counties, South Carolina, is a 4,400 acre impoundment formed by the Broad River and the Parr Shoals Dam and serves as the lower reservoir for the Fairfield Pumped Storage Development. Monticello Reservoir, a 6,800 acre impoundment is formed by a series of four earthen dams and serves as the upper reservoir for the pumped storage development. While the stretch of the Broad River downstream of the Parr Shoals Dam (Parr Dam) is not included in the Project Boundary Line (PBL), Project operations do influence this area. For this reason, this downstream area, specifically the west channel area of the Broad River immediately downstream of the Parr Dam, was examined for water quality.

The Project is currently involved in a relicensing process which involves cooperation and collaboration between SCE&G, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. SCE&G has established several Technical Working Committees (TWC's) comprised of members from the interested stakeholders. The TWC's objectives include the evaluation of relicensing issues and seeking consensus for addressing these issues in the new license.

A Water Quality TWC was formed to address potential water quality issues associated with the Project, and is comprised of a variety of stakeholders, including the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), the South Carolina Department of Health and Environmental Control (SCDHEC) and the South Carolina Department of Natural Resources (SCDNR), among others. During issues scoping, the TWC identified the west channel area of the Broad River downstream of the Parr Dam as a potential area in need of water quality study. SCDNR expressed concern regarding low dissolved oxygen (DO) levels in this area of the Broad River during the warmer months.

SCE&G developed a study plan to assess the water quality, specifically dissolved oxygen (DO) levels, of the west channel of the Broad River, immediately downstream the Parr Dam.

2.0 STUDY AREA

The Broad River immediately downstream of the Parr Dam is naturally divided by Hampton Island, creating an eastern and western channel along the length of the island, which is approximately 1.25 miles. Water temperature and DO were monitored at three sites along the western channel, including just downstream of the Parr Dam, midway down Hampton Island near the Highway 213 bridge, and at the lower extent of the western channel, just upstream of the confluence with the Broad River main channel. A fourth site was monitored as a control, and was located along the eastern channel, at the approximate mid-point of the island. The monitoring sites are shown below in Figure 2-1.

The study took place beginning April 1, 2015 and extended through October 15, 2015. The study was originally scheduled to extend through November 30, 2015, however due to extreme high flows and flooding in early October, HOBO monitors were removed from the river soon after high flows subsided, to ensure data would not be lost during another high flow event.

FIGURE 2-1 WATER QUALITY IN DOWNSTREAM WEST CHANNEL MONITORING SITES

3.0 COLLECTION METHODS

Water temperature and DO were monitored in the west channel area of the Broad River using HOBO U26 Dissolved Oxygen Loggers. The loggers were deployed at the four monitoring sites on March 31, 2015 and were attached to floats and concrete weights to allow for suspension at approximate mid-depth in the river channel. The loggers were calibrated according to the manufacturer's specifications and were set to collect temperature and DO data on hourly intervals. The logger manufacturer, Onset, specifies that the dissolved oxygen monitors have an accuracy of +/- 0.2 mg/L. Data were downloaded on a monthly basis using manufacturer's software and compiled at the end of the monitoring season. DO data werer also obtained from the USGS gage at Jenkinsville (2160991), which is located immediately downstream of the Parr Shoals Dam and powerhouse, on the east side of the channel.

Additionally, a calibrated YSI meter was used to collect DO and water temperature approximately once a month when data were downloaded from the HOBO loggers at each monitoring site.

Although the loggers were originally planned to be deployed through November, they were removed from the river in mid-October, following a series of heavy rain events that resulted in extreme flooding throughout the Broad River and the midlands of South Carolina. Due to the flooding, the logger located in the east channel was lost, along with the data it collected during September and October.

Data is also missing from the loggers located in the middle west channel and in the lower west channel, from late June through mid-July (middle west channel) and mid-June through late June (lower west channel). The loggers malfunctioned and had to be sent to the manufacturer for repair. The same loggers malfunctioned again in late July, and one day of data were lost at each site.

After the loggers were initially deployed, during the first download, it was obvious that the upper west channel logger was located in a poor area, where it was subject to extreme fouling from algae, sediments, and occasional de-watering. On May 11, the logger was removed from its initial location, cleaned, and re-deployed at a spot a few feet away, in a deeper pool. The logger remained in this location for the remainder of the study. Additionally during the first download,

the logger located in the east channel was found on the bank, de-watered. The logger was re-deployed deeper in the east channel downstream of a bridge piling, and re-secured with weights and buoys to ensure it would stay underwater. The logger remained in this location for the remainder of the study, until it was lost during the fall flood. Although the logger remained in this position, at the end of the study data collected by this logger was deemed unreliable, due to interference from the bridge piling, collected debris, and susceptibility to algal growth. Because of this, data collected by the USGS gage at Jenkinsville (2160991) was added to the report to act as a control. The gage is located downstream of the Parr Project powerhouse, in the east channel.

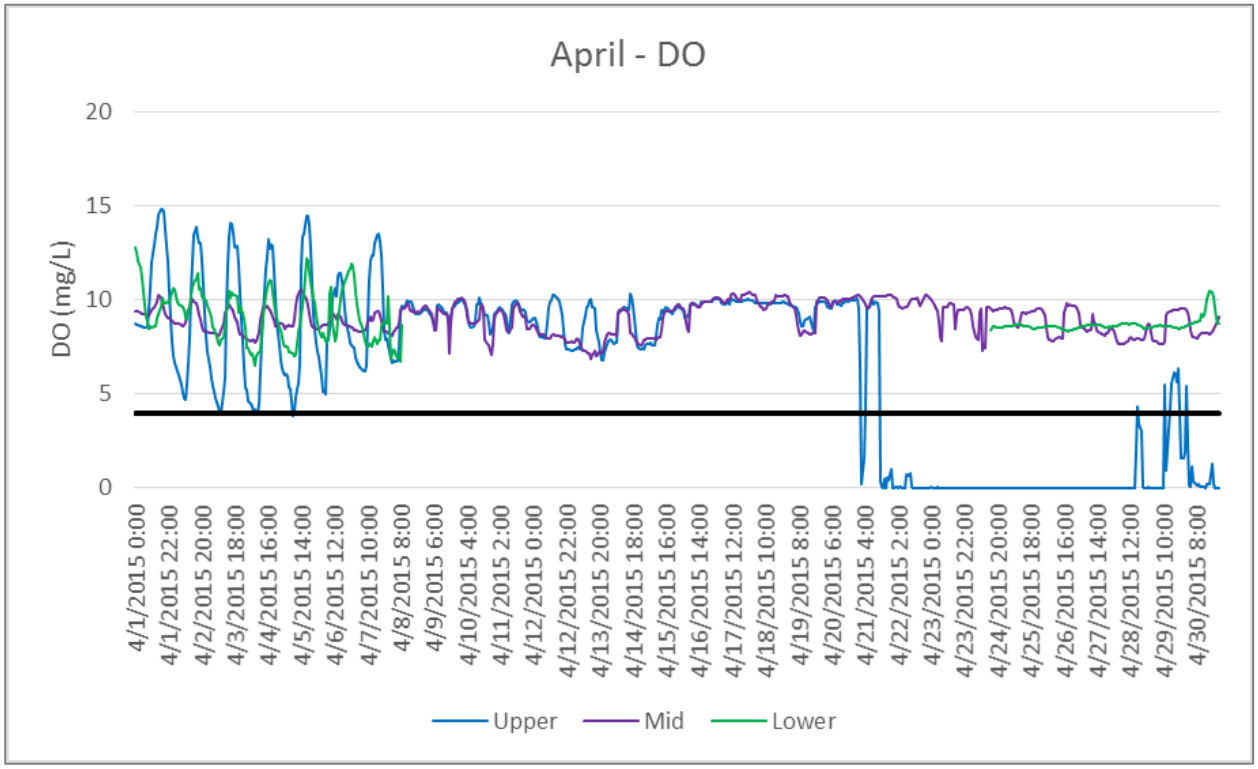
4.0 RESULTS

A summary of DO data collected each month is included in the following sections. Detailed temperature and DO data for each site is included in Appendix A.

4.1 APRIL

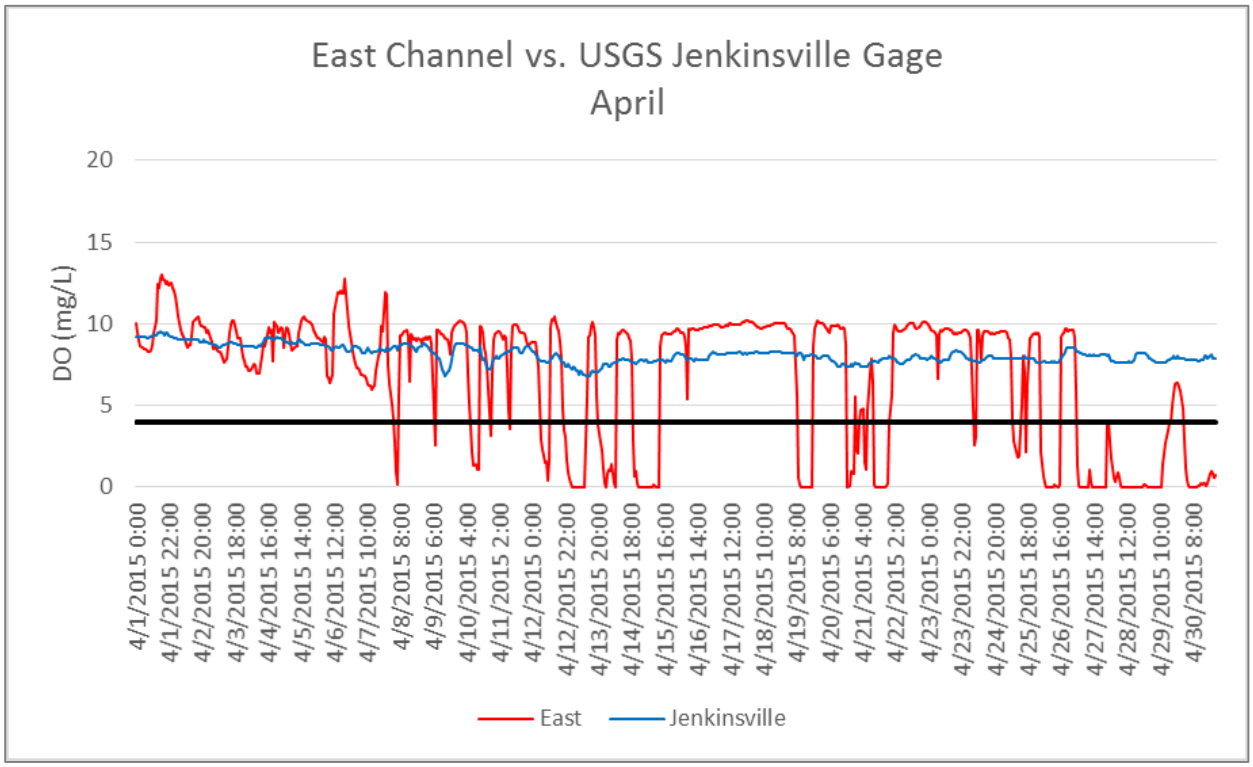
During the month of April (Figure 4-1; Figure 4-2; Table 4-1), DO levels at the upper west channel and east channel locations were not accurately collected. This is associated with poor site selection for the monitors and periodic dewatering. However, DO at the middle west channel and lower west channel locations reflected expected values for that time of year. DO levels were well above the DHEC instantaneous standard of 4.0 mg/L (SCDHEC 2012).

FIGURE 4-1 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – APRIL 2015



*The upper west channel monitor was initially located in an area subject to fouling and de-watering.

FIGURE 4-2 DISSOLVED OXYGEN AT THE EAST CHANNEL AND THE USGS JENKINSVILLE GAGE 2160991 – APRIL 2015



*The east channel monitor was initially located in an area subject to fouling and de-watering.

TABLE 4-1 MAXIMUM, MINIMUM AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR APRIL

April						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	77.3	55.7	65.3	14.8	0.0	6.3
Middle West	70.0	58.6	64.5	10.6	6.9	9.0
Lower West	76.8	59.0	68.9	12.8	6.5	8.9
East	71.5	58.5	65.0	13.0	0.0	6.8
Jenkinsville	69.8	58.3	64.6	9.5	6.8	8.1

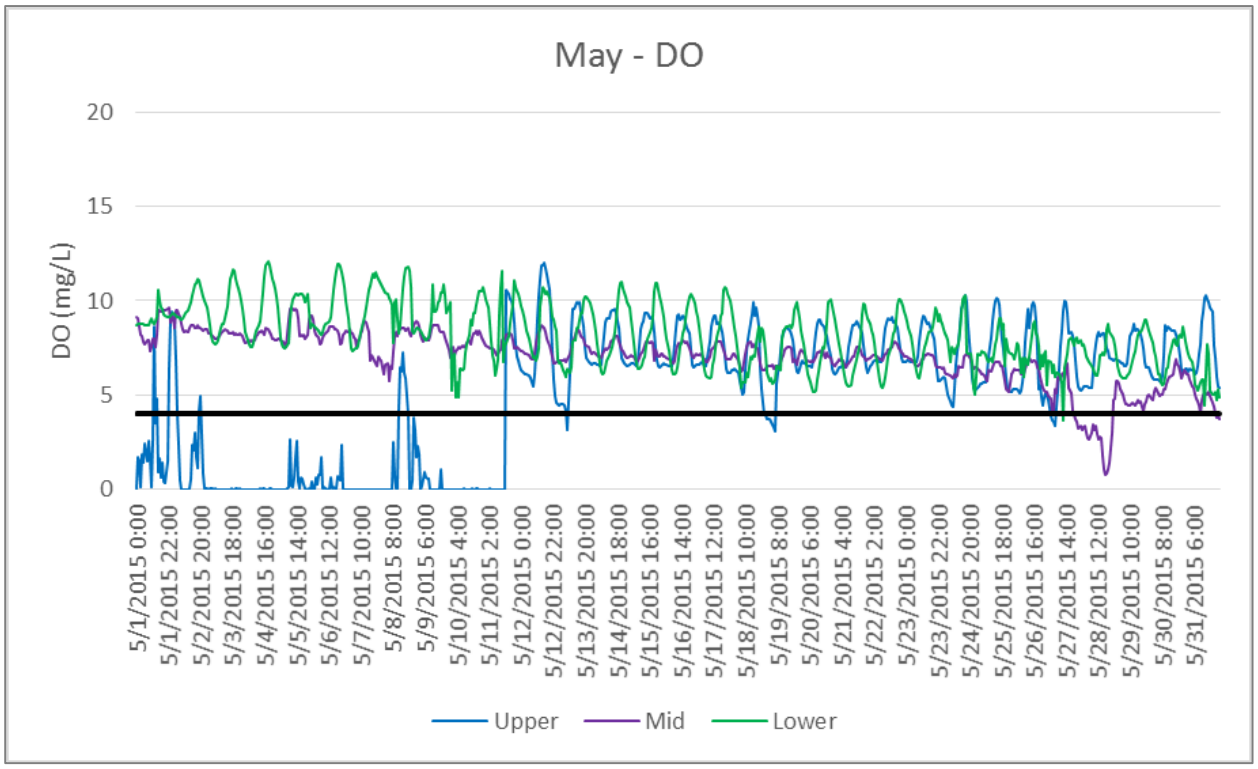
4.2 MAY

The first data download occurred on May 11, 2015. At this time, the loggers located at the upper west channel and the east channel were cleaned and relocated due to fouling and de-watering vulnerability. After May 11th, all four loggers appeared to be collecting accurate data. Diel

fluctuations at all sites were apparent, with DO at all sites ranging each day from approximately 5 to 10 mg/L (Figure 4-3; Figure 4-4; Table 4-2). DO occasionally dipped below the instantaneous minimum of 4.0 mg/L at the upper and middle west channel sites and once on the east channel site.

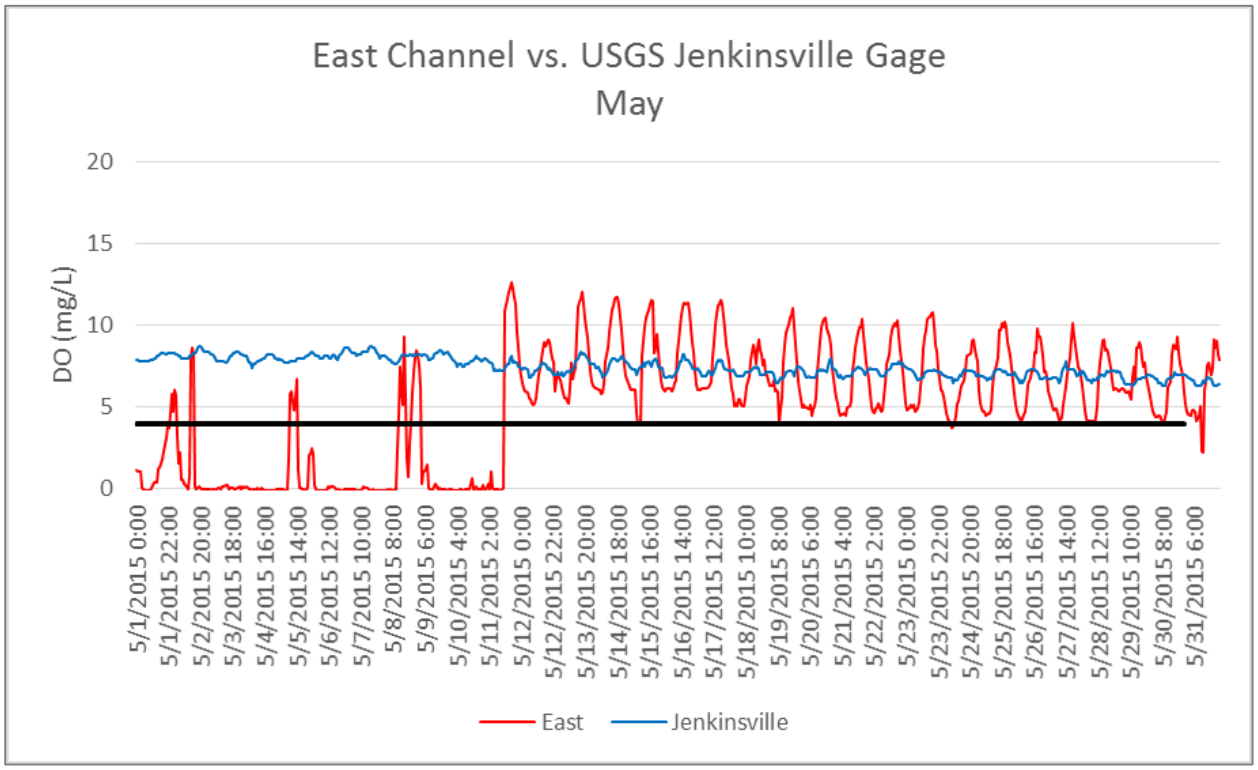
On the east channel, the Jenkinsville data and the east channel HOBO monitor data follow a similar diel pattern, however the east channel monitor exhibited a greater daily range in DO levels. This is likely caused by the east channel monitor being located in an area with less water exchange that was more susceptible to algal and aquatic plant growth, which might cause greater swings in DO throughout a normal day.

FIGURE 4-3 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – MAY 2015



*Upper west channel was relocated on May 11, 2015 during a routine data download. Previous to the relocation, the logger was subject to fouling and de-watering.

FIGURE 4-4 DISSOLVED OXYGEN AT THE EAST CHANNEL LOCATION AND USGS JENKINSVILLE GAGE 2160991 – MAY 2015



*East channel was relocated on May 11, 2015 during a routine data download. Previous to the relocation, the logger was subject to fouling and de-watering.

TABLE 4-2 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR MAY

May						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	86.5	63.5	73.5	12.0	0.0	5.0
Middle West	81.4	64.2	72.5	9.6	0.7	7.0
Lower West	82.0	63.8	74.2	12.1	3.6	8.2
East	85.8	62.9	73.9	12.6	0.0	5.0
Jenkinsville	81.1	64.0	73.0	8.7	6.3	7.4

4.3 JUNE

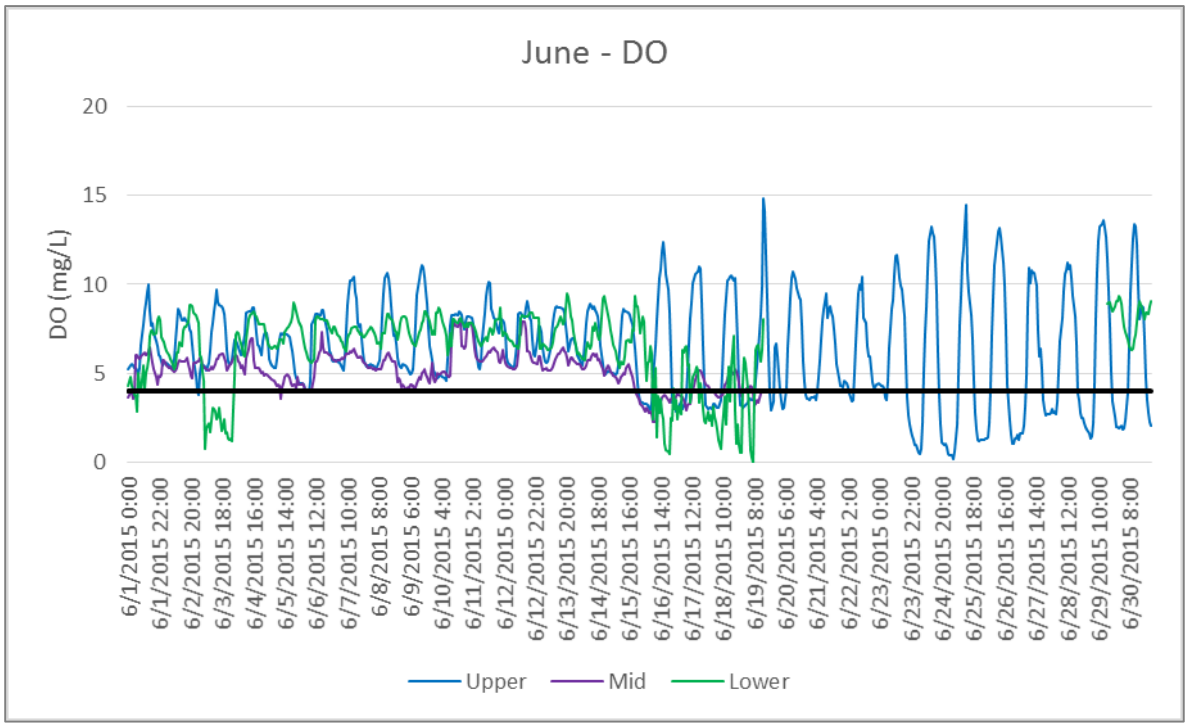
DO followed the same pattern at all logger sites through mid-June (Figure 4-5; Figure 4-6; Table 4-3), as air and water temperatures began to rise. As temperatures rose, DO levels ranged

from approximately 14 mg/L down to 1 mg/L at the upper west channel location. DO levels at the east channel location appeared to continue the same diel pattern observed during May. The pronounced swings in DO levels (especially in the upper west channel) are likely a result of heavy algal growth on the monitors. Technicians noted that on the days of downloading data several of the monitors were completely wrapped in dense layers of filamentous algae.

Data were downloaded from all loggers on June 19, 2015. Loggers at the middle and lower west channel locations malfunctioned during downloading and had to be sent to the manufacturer for repair. No data were collected at these sites during the repair process.

When data were downloaded on June 19th, DO and temperature were recorded with a YSI meter at each site at approximately 2:00 PM. At the upper west channel site, the YSI meter recorded DO as 11.92 mg/L and temperature as 91.4°F. The upper west channel monitor recorded DO as 14.88 mg/L and temperature as 93.45°F. At the middle west channel site, the YSI meter recorded DO as 7.66 mg/L and temperature as 90.68°F. The middle west channel monitor recorded DO as 4.04 mg/L and temperature as 85.71°F. At the lower west channel site, the YSI meter recorded DO as 9.36 mg/L and temperature as 92.3°F. The lower west channel monitor recorded DO as 8.02 mg/L and temperature as 89.56°F. At the east channel site, the YSI meter recorded DO as 6.5 mg/L and temperature as 86.0°F. The east channel monitor recorded DO as 6.92 mg/L and temperature as 88.41°F.

FIGURE 4-5 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – JUNE 2015



*Loggers at the middle and lower west channel locations were removed from the river on June 19, 2015 and sent to the manufacturer for repair. The lower west channel logger was replaced to the river on June 29, 2015.

FIGURE 4-6 DISSOLVED OXYGEN AT THE EAST CHANNEL LOCATION AND USGS JENKINSVILLE GAGE 2160991 – JUNE 2015

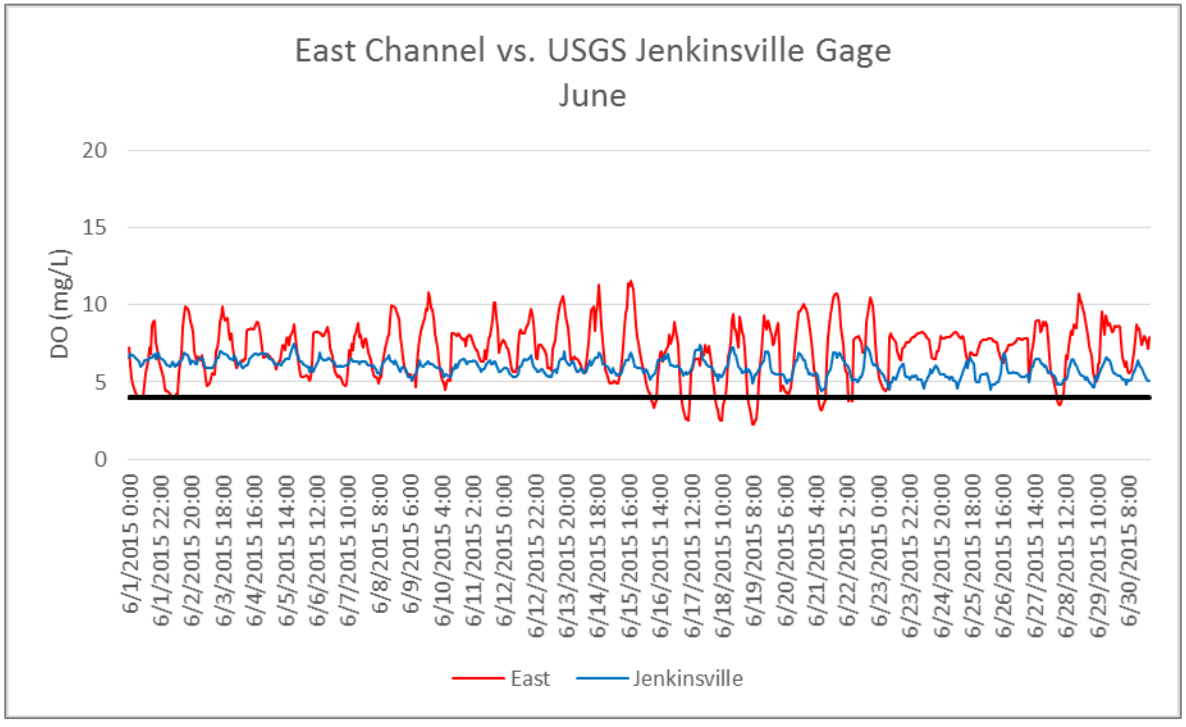


TABLE 4-3 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR JUNE

June						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	98.2	74.5	82.4	14.9	0.2	6.5
Middle West	87.7	75.7	79.6	8.0	2.3	5.2
Lower West	89.6	72.8	81.6	9.5	0.0	6.4
East	109.7	74.3	82.9	11.6	2.3	7.0
Jenkinsville	88.7	76.1	81.5	7.5	4.4	6.0

4.4 JULY

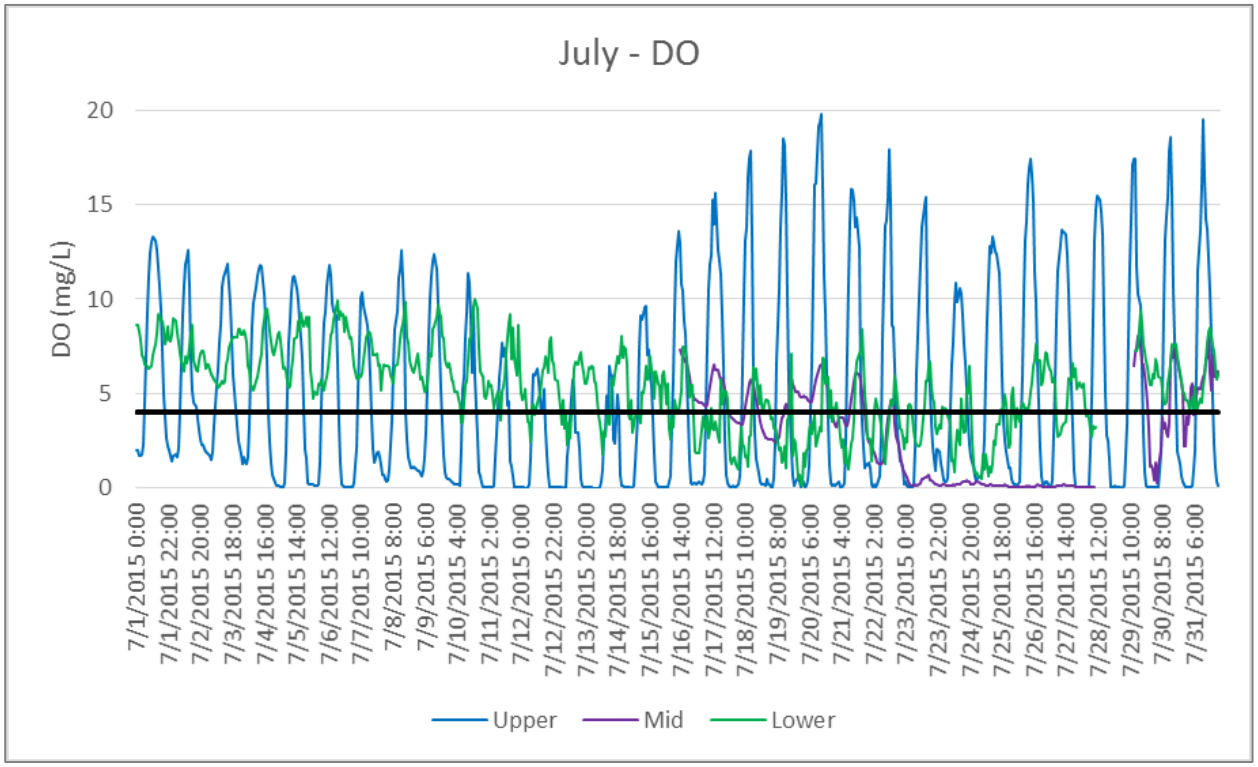
During early July (Figure 4-7; Figure 4-8; Table 4-4), DO levels at the lower west channel and east channel locations followed generally the same pattern, ranging from approximately 5 mg/L to 10 mg/L. As the month progressed, and water temperatures rose, DO levels decreased, ranging from approximately 2-3 mg/L to 7 mg/L. DO at the upper west channel location ranged from approximately 0 mg/L to 13 mg/L during early July. In mid to late July, DO at the upper west channel location experienced huge swings in DO from approximately 0 mg/L to 20 mg/L. These swings in DO were associated with dense growth of filamentous algae that resulted in DO levels that rose rapidly at sunup and throughout the day (production) and then dropped rapidly after dark (consumption).

The logger at the middle west channel location remained at the manufacturer for repair until July 16, 2015.

When data were downloaded on July 28th, DO and temperature were recorded with a YSI meter at each site at approximately 12:00 PM. At the upper west channel site, the YSI meter recorded DO as 10.12 mg/L and temperature as 89.78°F. The upper west channel monitor recorded DO as 15.49 mg/L and temperature as 90.75°F. At the middle west channel site, the YSI meter recorded DO as 6.08 mg/L and temperature as 86.0°F. The middle west channel monitor recorded DO as 0.0 mg/L and temperature as 86.29°F. At the lower west channel site, the YSI meter recorded DO as 5.89 mg/L and temperature as 86.0°F. The lower west channel monitor

recorded DO as 3.21 mg/L and temperature as 86.18°F. At the east channel site, the YSI meter recorded DO as 6.23 mg/L and temperature as 86.0°F. The east channel monitor recorded DO as 5.84 mg/L and temperature as 87.69°F. Technicians also noted some sediment build up on the monitors.

FIGURE 4-7 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – JULY 2015



*The middle west channel logger was at the manufacturer for repair through July 16, 2015. The lower west channel logger was also removed from the river for repair in the Kleinschmidt office for one day in late July.

FIGURE 4-8 DISSOLVED OXYGEN AT THE EAST CHANNEL LOCATION AND THE USGS JENKINSVILLE GAGE 2160991 – JULY 2015

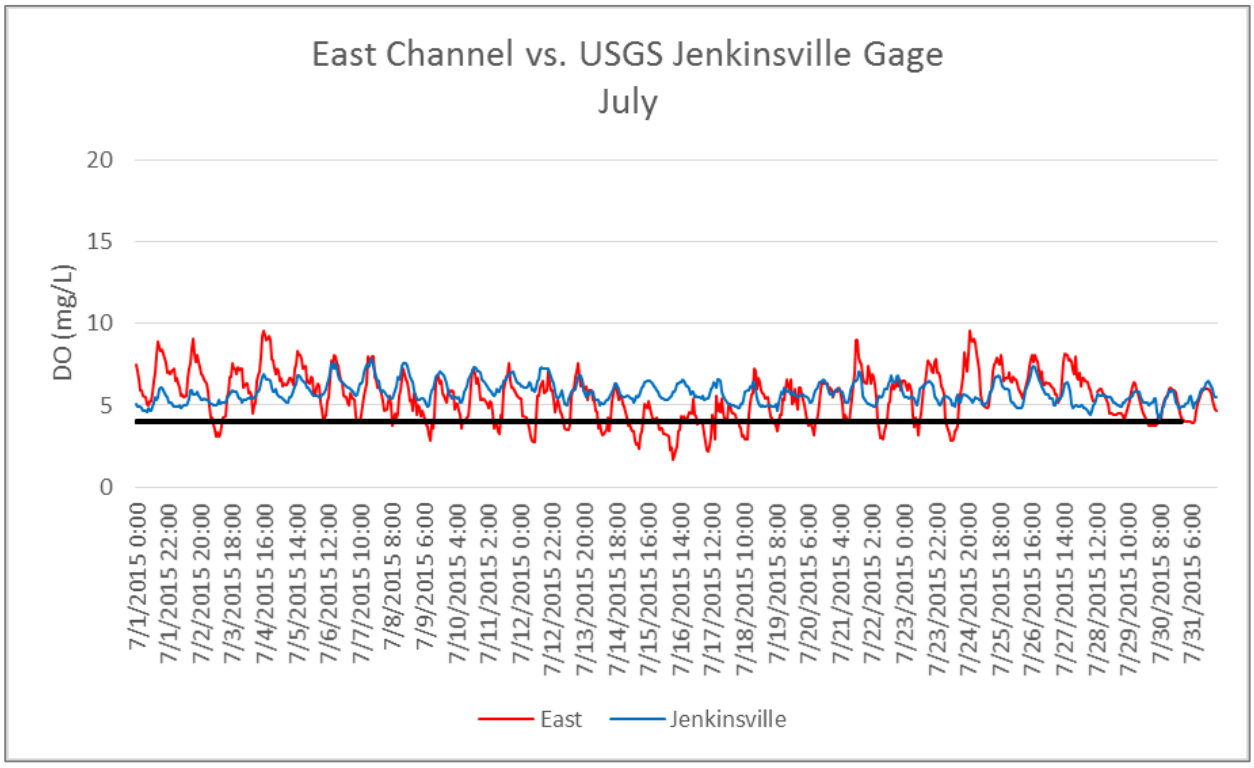


TABLE 4-4 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR JULY

July						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	96.7	77.3	85.7	19.8	0	4.9
Middle West	89.7	81.6	85.9	8.1	0	2.8
Lower West	92.8	79.7	86.4	10	0.1	5.3
East	92.1	78.2	86	9.6	1.7	5.5
Jenkinsville	88.5	80.2	84.7	7.8	4.2	5.8

4.5 AUGUST

During the month of August (Figure 4-5; Table 4-5), DO levels for the middle and lower west channel and the east channel followed similar patterns, with DO readings ranging from approximately 4 mg/L up to 10 mg/L. Diel fluctuations were obvious and DO levels rarely dropped below 4 mg/L. Throughout the month of August, the upper west channel logger continued the same pattern as observed in late July, with DO levels ranging from 0 mg/L to 17-

20 mg/L. Technicians again noted that large mats of filamentous algae were present in the monitor location. Technicians noted that the east channel monitor area was influenced by a log and debris that lodged upstream of the monitor and had further cut off flow to the monitor location. Low water levels, sediment build up, and debris likely resulted in the periodic low DO levels observed at the HOBO monitor as opposed to the DO measured at the Jenkinsville gage.

FIGURE 4-9 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – AUGUST 2015

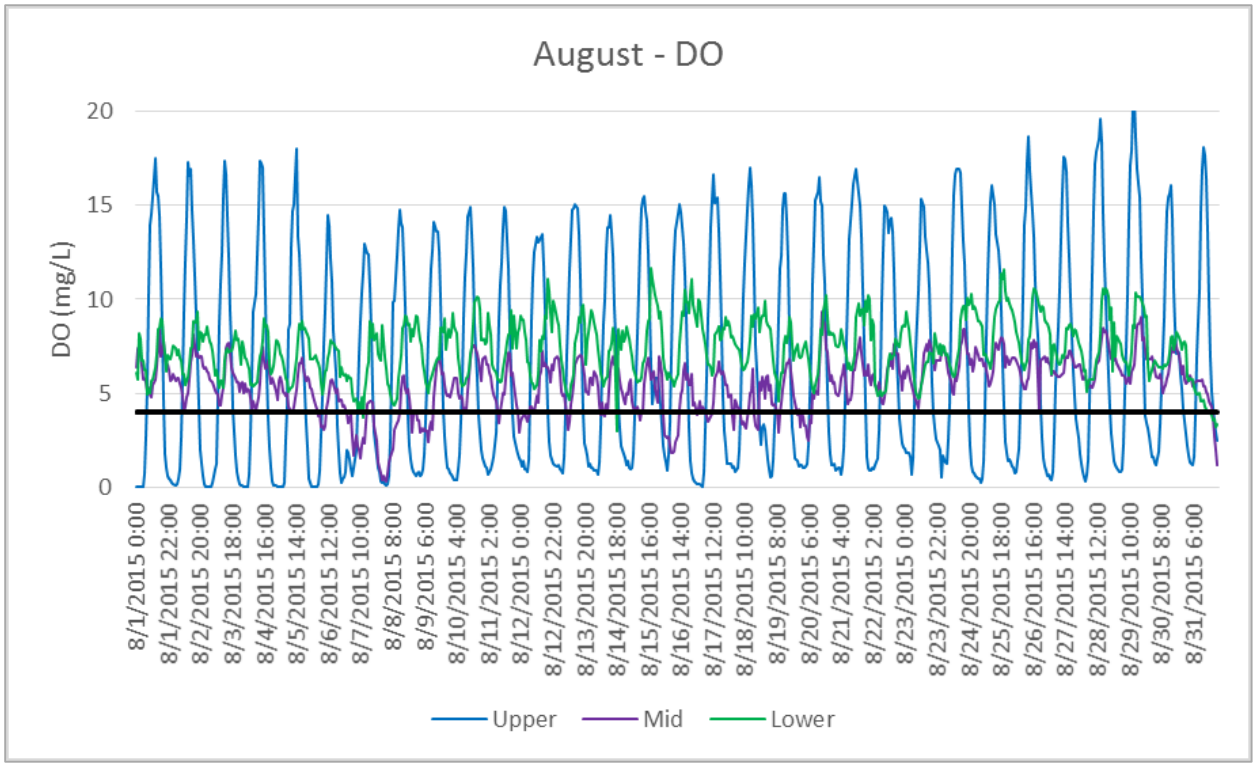


FIGURE 4-10 DISSOLVED OXYGEN AT THE EAST CHANNEL LOCATION AND THE USGS JENKINSVILLE GAGE 2160991 – AUGUST 2015

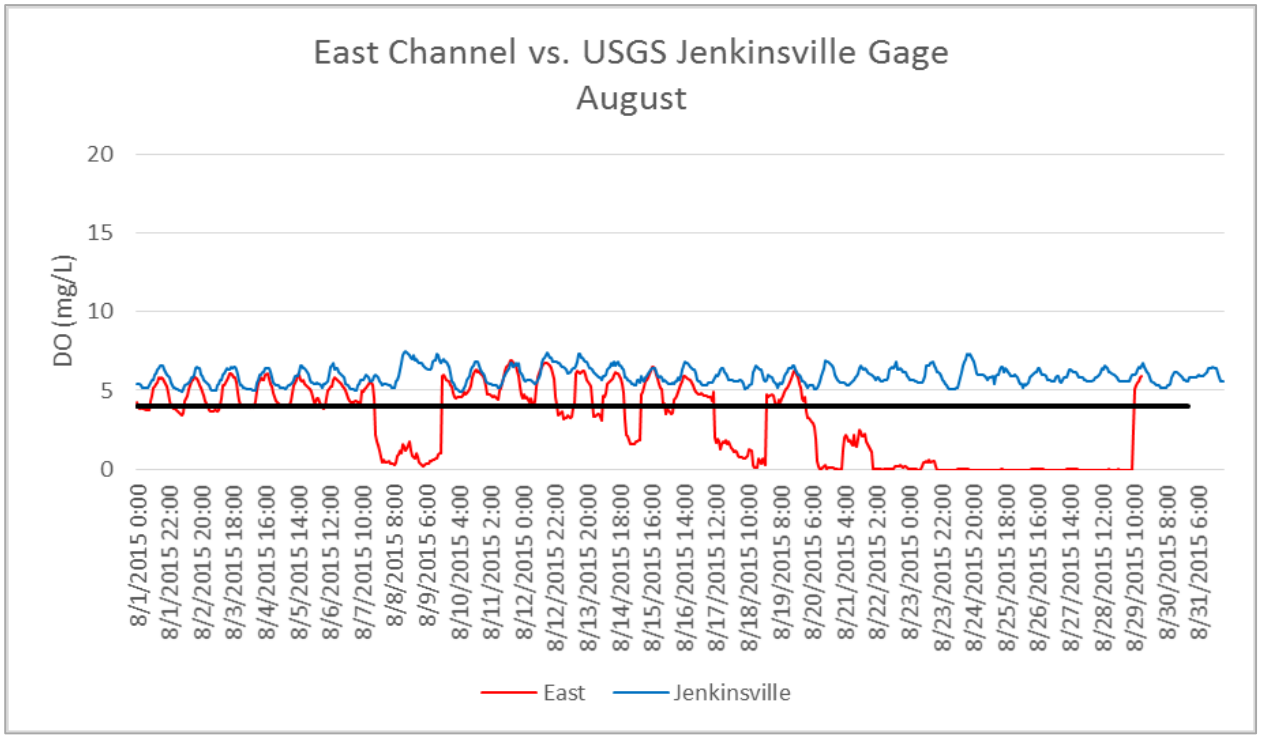


TABLE 4-5 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR AUGUST

August						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	95.4	74.3	85.1	20.8	0.0	6.7
Middle West	90.0	71.2	84.2	9.4	0.3	5.5
Lower West	90.9	72.9	85.5	11.7	3.0	7.4
East	89.6	82.7	85.8	6.9	0.0	2.9
Jenkinsville	88.9	80.8	86.0	7.5	4.9	5.9

4.6 SEPTEMBER

At the upper west channel location (Figure 4-6; Table 4-6), DO readings continued to range from 0 mg/L to 20 mg/L daily through early September. As water temperatures began to decrease, DO levels began to normalize and technicians noted that algae mats were decreasing in density, with smaller daily fluctuations, ranging from 2-3 mg/L to 12-15 mg/L. DO readings collected in the

middle and lower west channel also began to rise throughout September, with very few instances of DO levels below 4.0 mg/L.

As mentioned, data collected in the east channel was lost when the logger could not be recovered after the flood that occurred in early October.

When data were downloaded on September 30th, DO and temperature readings were recorded with a YSI meter at the upper and middle west channel sites at approximately 12:00 PM. At the upper west channel site, the YSI meter recorded DO as 7.8 mg/L and temperature as 76.46°F. The upper west channel monitor recorded DO as 8.69 mg/L and temperature as 76.93°F. At the middle west channel site, the YSI meter recorded DO as 7.68 mg/L and temperature as 76.46°F. The middle west channel monitor recorded DO as 8.16 mg/L and temperature as 76.28°F.

FIGURE 4-11 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL LOCATIONS – SEPTEMBER 2015

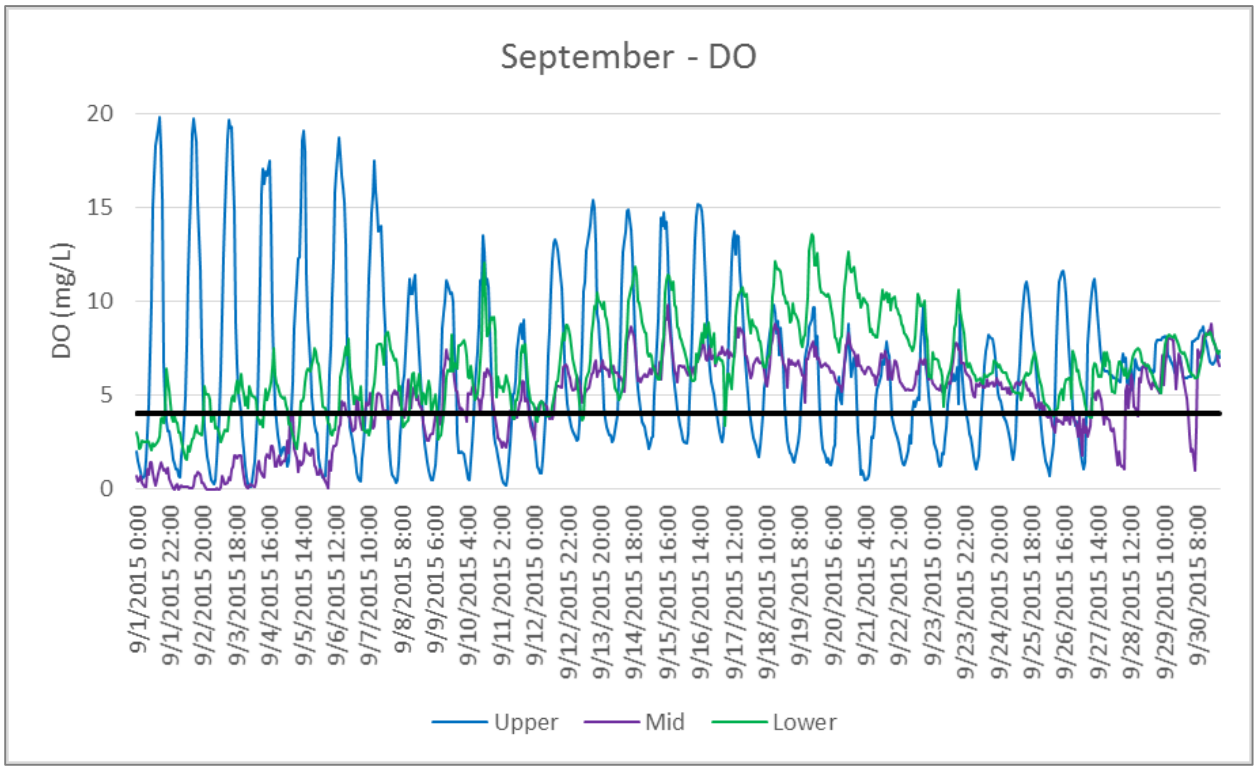


TABLE 4-6 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR SEPTEMBER

September						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	88.7	69.2	77.7	19.8	0.1	6.4
Middle West	83.4	67.1	76.0	9.9	0.0	4.7
Lower West	87.6	70.2	78.1	13.6	1.6	6.6
East	-	-	-	-	-	-
Jenkinsville	86.7	73.4	80.4	8.2	5.0	6.6

4.7 OCTOBER

On October 3-4, 2015, a large rain event occurred that caused wide-spread flooding in South Carolina, including the Broad River Basin. Because of this flood, large amounts of water with debris and sediment moved through the water system, causing the loggers to collect widely variable data. Therefore, data collected during the month of October is unreliable, and should not be considered as a normal representation of DO in the east and west channels during this timeframe.

FIGURE 4-12 DISSOLVED OXYGEN AT THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST CHANNEL LOCATIONS – OCTOBER 2015

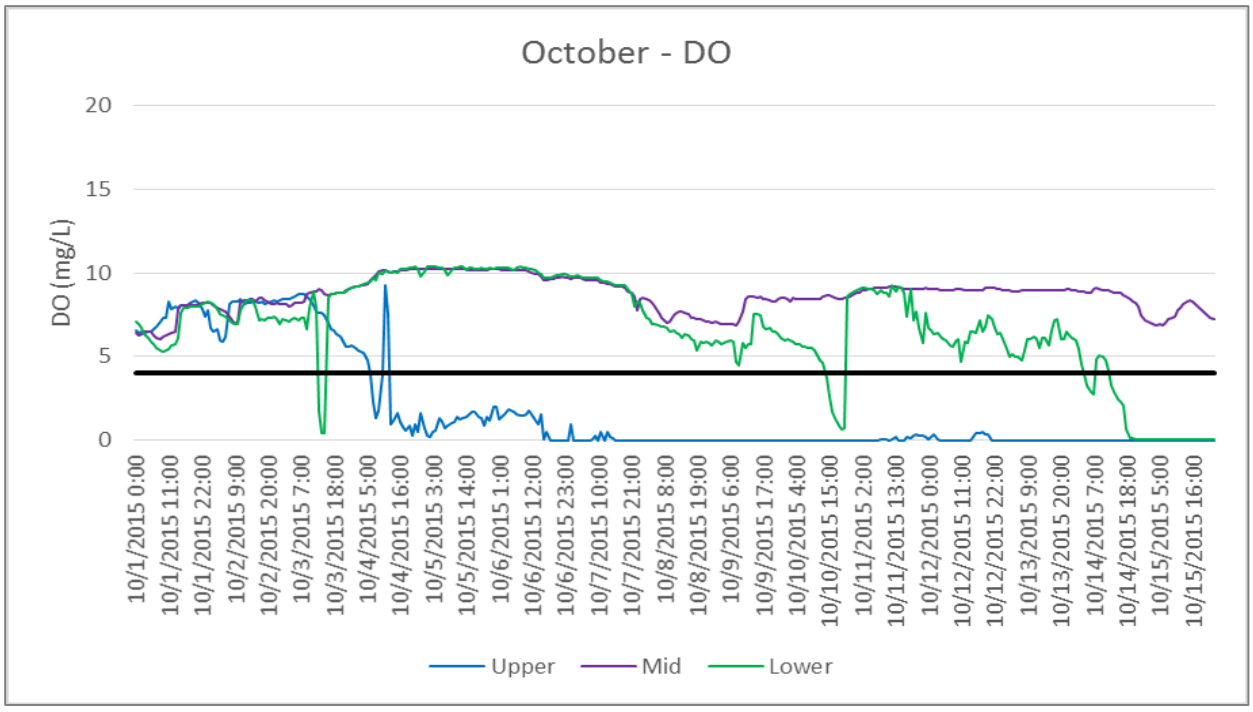


TABLE 4-7 MAXIMUM, MINIMUM, AND AVERAGE TEMPERATURES AND DISSOLVED OXYGEN FOR OCTOBER

October						
	Temperature			Dissolved Oxygen		
	Max	Min	Ave	Max	Min	Ave
Upper West	76.8	63.3	67.7	9.3	0.0	1.9
Middle West	76.4	63.2	67.8	10.3	6.1	8.7
Lower West	76.7	63.2	67.7	10.4	0.0	6.8
East	-	-	-	-	-	-
Jenkinsville	77.7	63.5	67.8	10.0	6.3	7.3

5.0 DISCUSSION

This study identified that DO levels in the west channel are periodically below the SCDHEC standard of 4.0 mg/l. Dissolved oxygen levels in the upper west channel of the Broad River, downstream of Parr Shoals Dam, were consistently lower than those further down the west channel and in the east channel. This is likely due to the shallow nature of the river in this area, as well as the presence of dense algal mats. Also, during drier weather conditions, the west channel does not receive a consistent flow of water, except for small amounts of leakage from the dam.

Throughout the study, fouling of the HOBO loggers was a constant issue. DO measurements recorded by the YSI meter often displayed very different readings than those collected by the HOBO loggers in the same locations.

The study data shows that DO levels in the west channel are variable. Dissolved oxygen levels are lowest in the west channel directly below the dam during the summer months, however these levels increase as the distance from the dam increases. Dissolved oxygen levels at the lower west channel site, located approximately 1 mile downstream of the dam, and at the east channel site, located approximately 0.5 miles downstream of the dam, were generally above the SCDHEC instantaneous standard of 4.0 mg/L and were often similar. As water depths increase in the middle west channel site, the influence of diel respiration was less drastic and there is likely some re-aeration that occurs in the shallow sections of the lower west channel. The lower west channel site DO levels may also periodically (based on flows) receive some positive influence from main channel flows

6.0 REFERENCES

SCDHEC. 2012. Water Classifications and Standards (R. 61-68). [Online] URL: https://www.scdhec.gov/Agency/docs/lwm-regs/r61-68.pdf. Accessed December 29, 2015.

APPENDIX A
ADDITIONAL GRAPHS

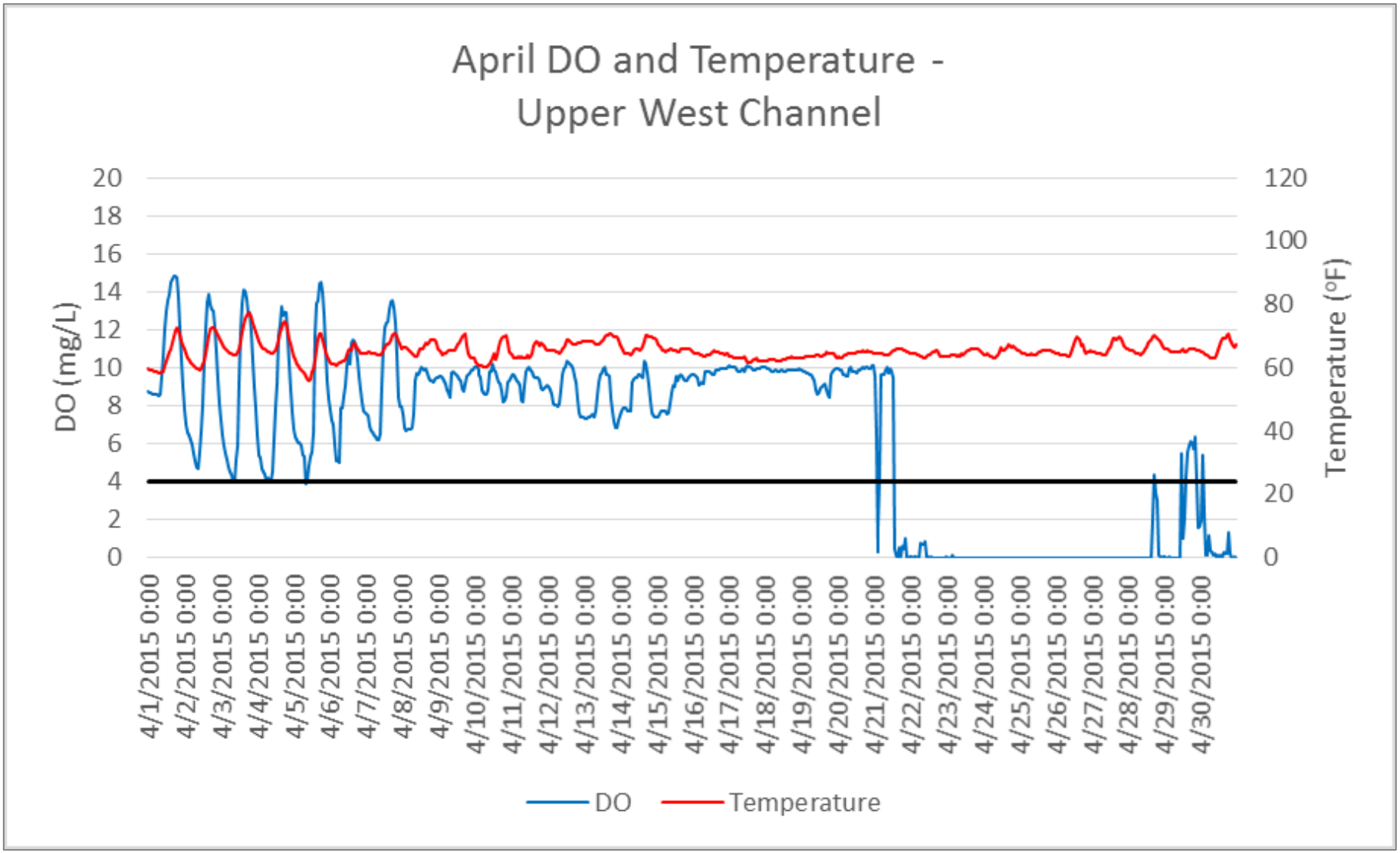


FIGURE 1 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – APRIL 2015

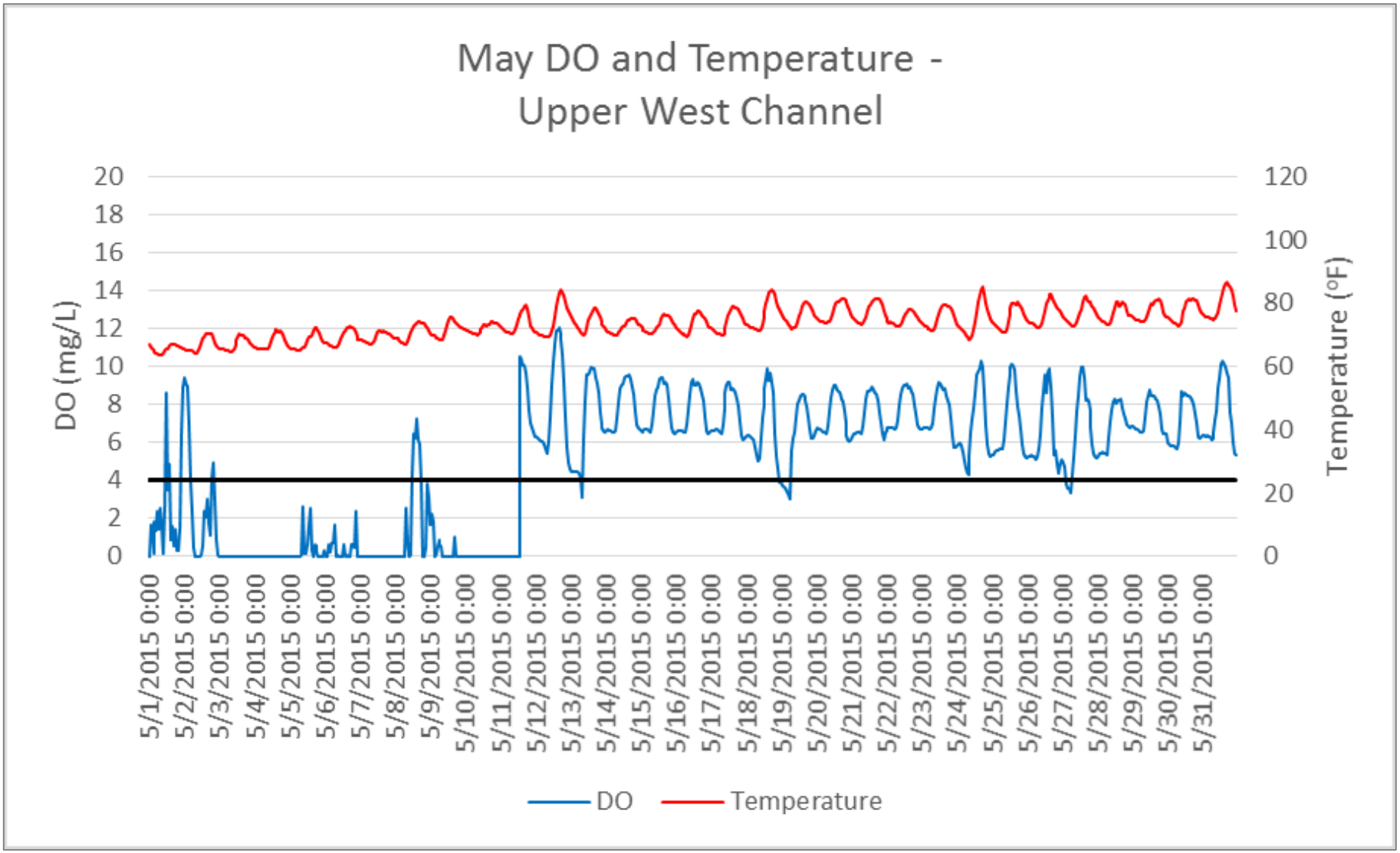


FIGURE 2 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – MAY 2015

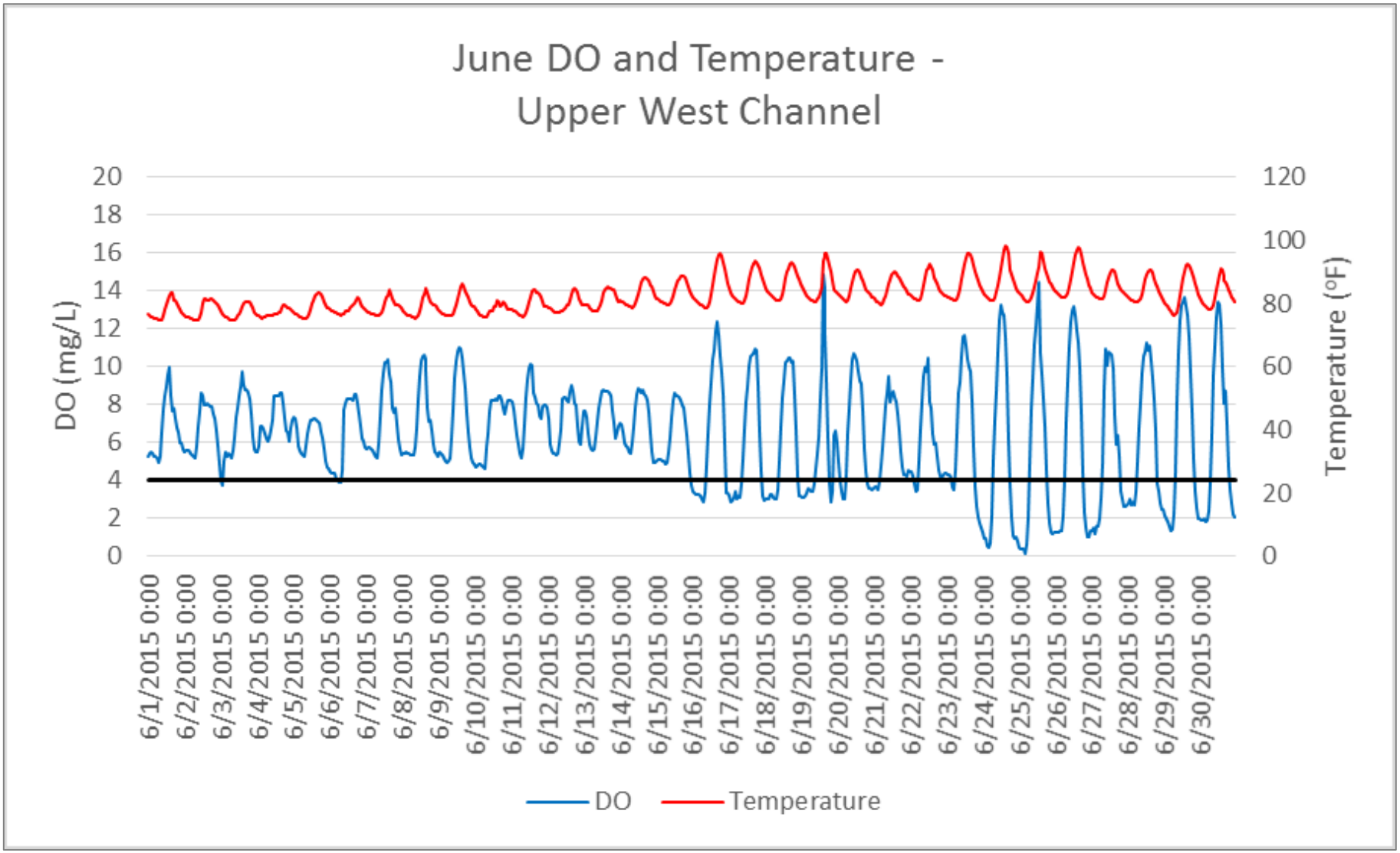


FIGURE 3 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – JUNE 2015

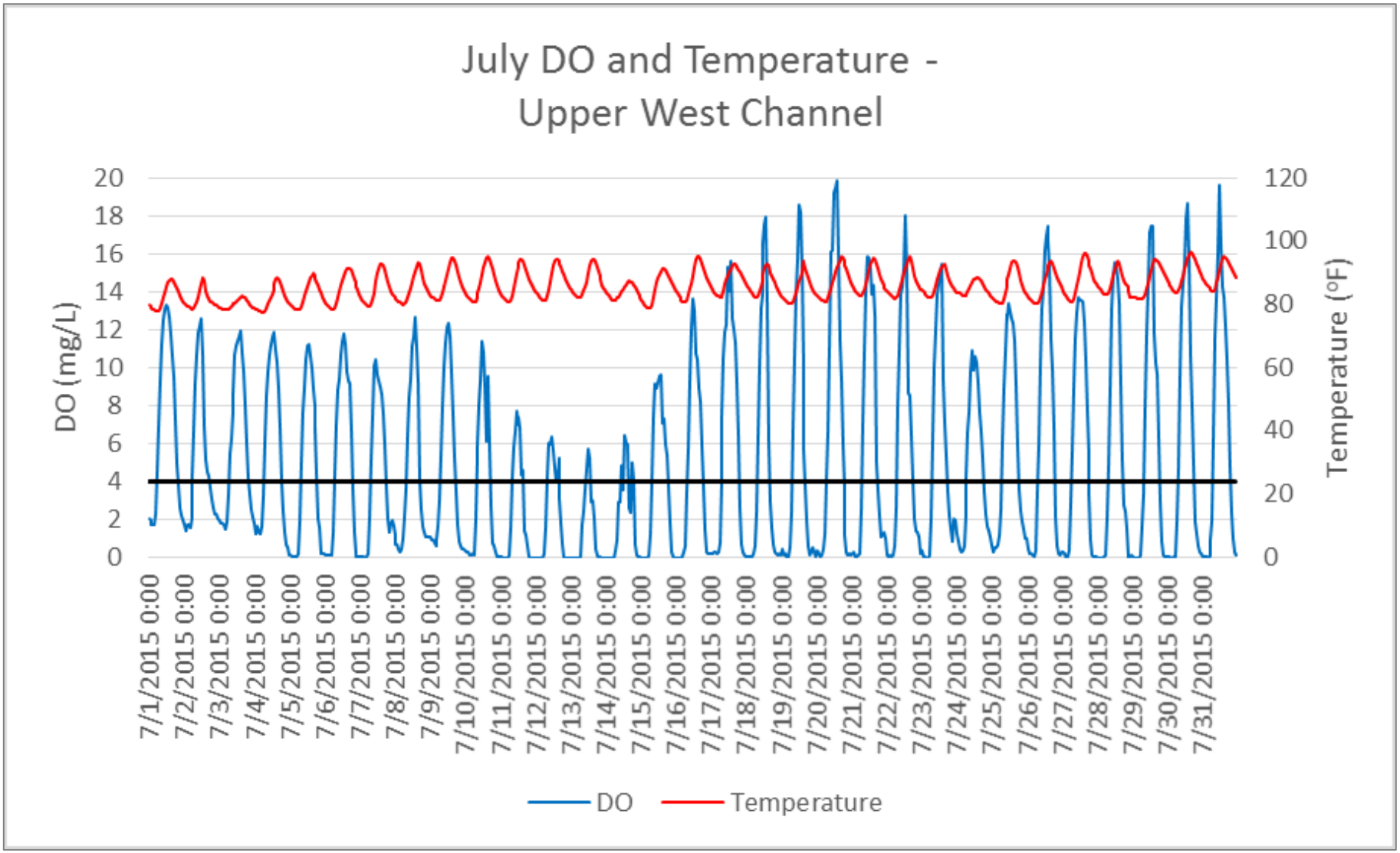


FIGURE 4 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – JULY 2015

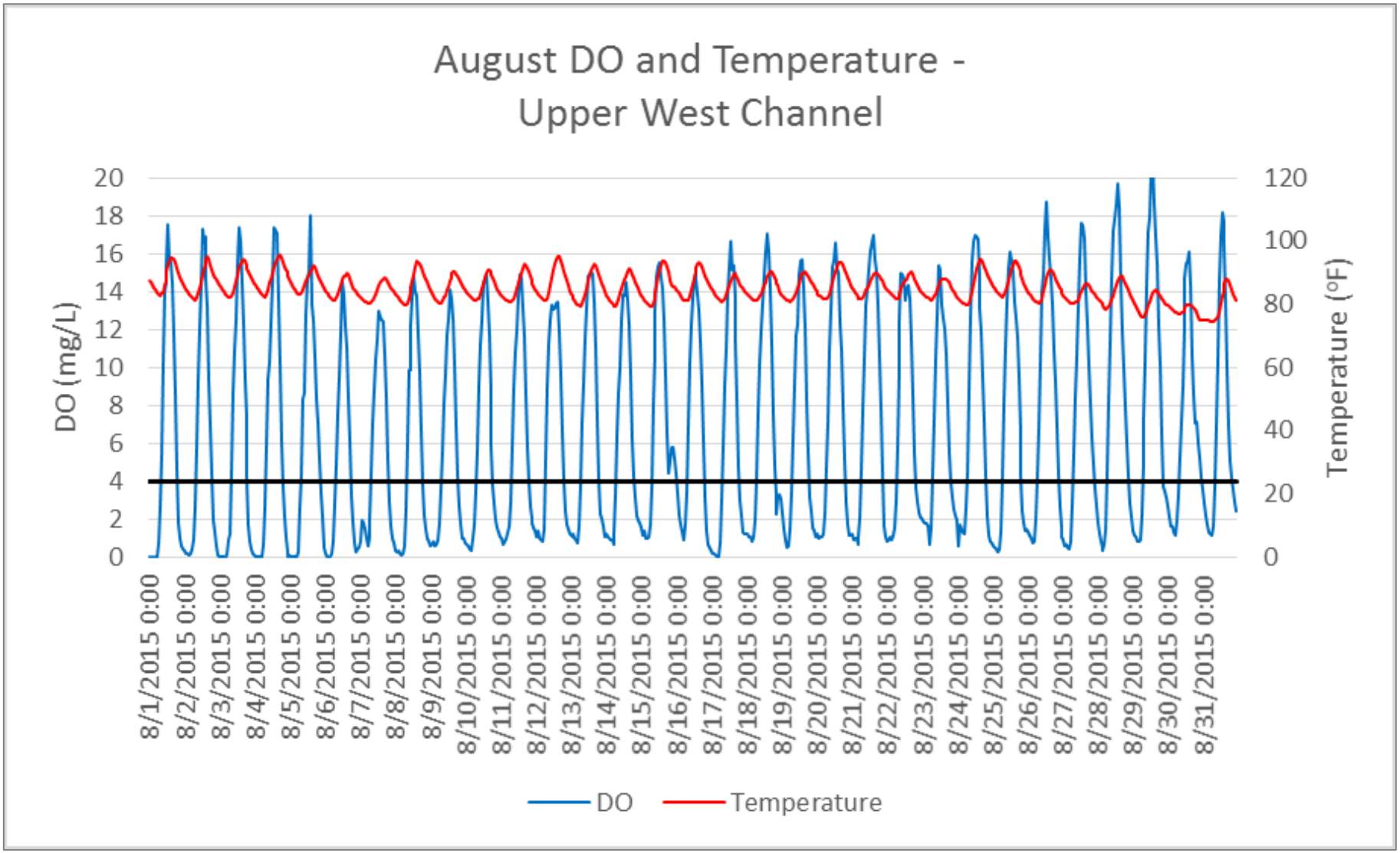


FIGURE 5 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – AUGUST 2015

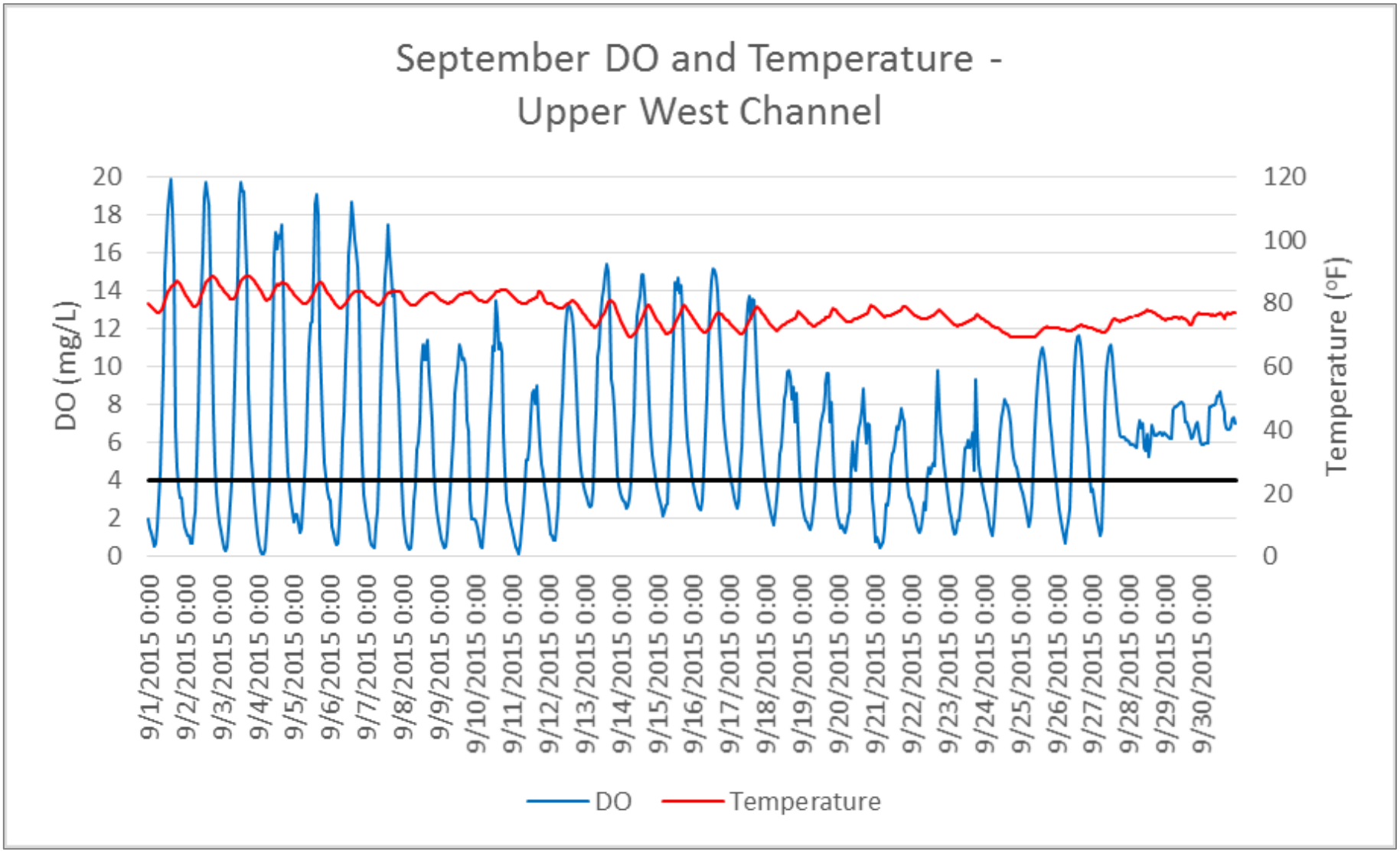


FIGURE 6 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – SEPTEMBER 2015

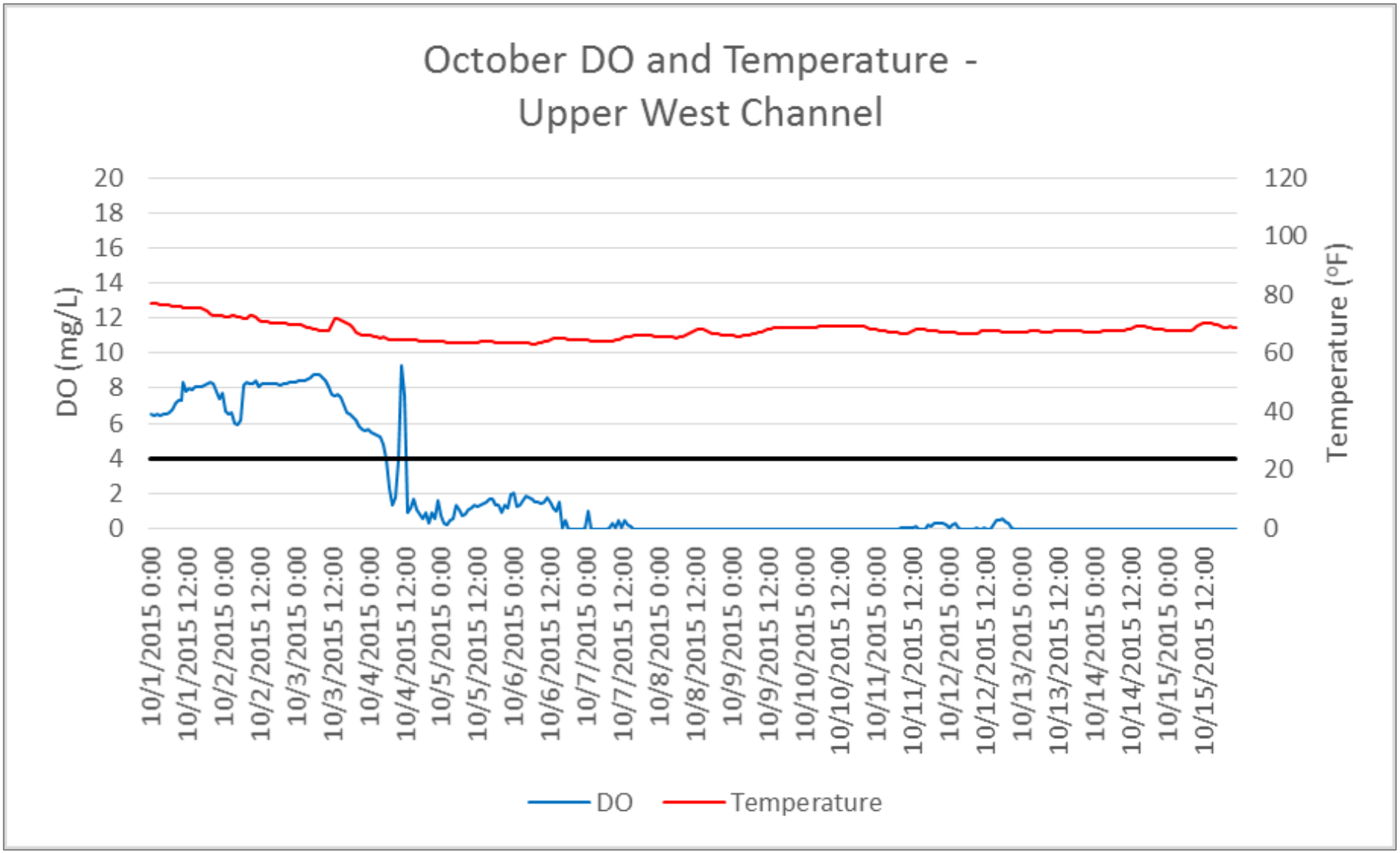


FIGURE 7 DISSOLVED OXYGEN AND TEMPERATURE IN THE UPPER WEST CHANNEL – OCTOBER 2015

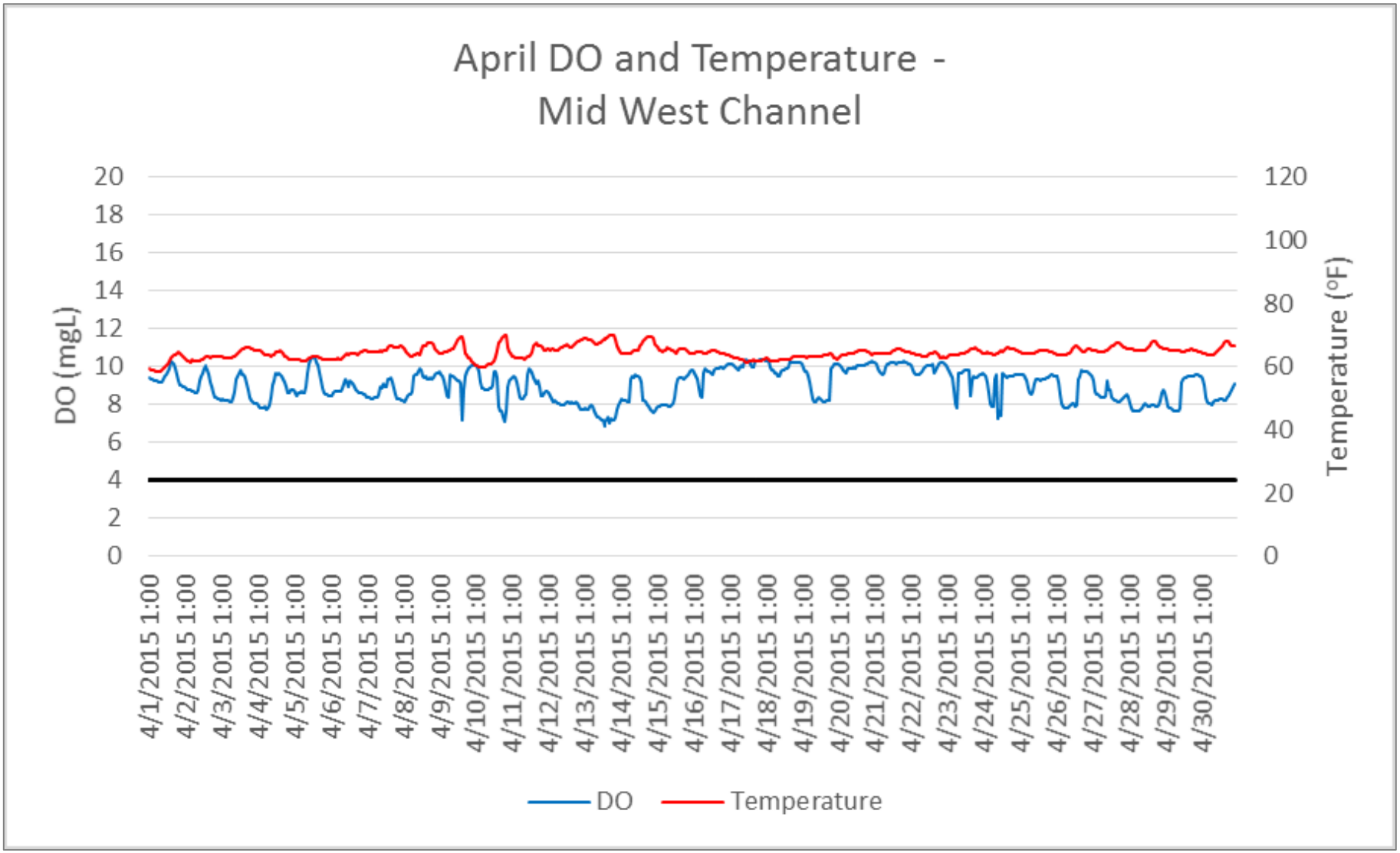


FIGURE 8 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – APRIL 2015

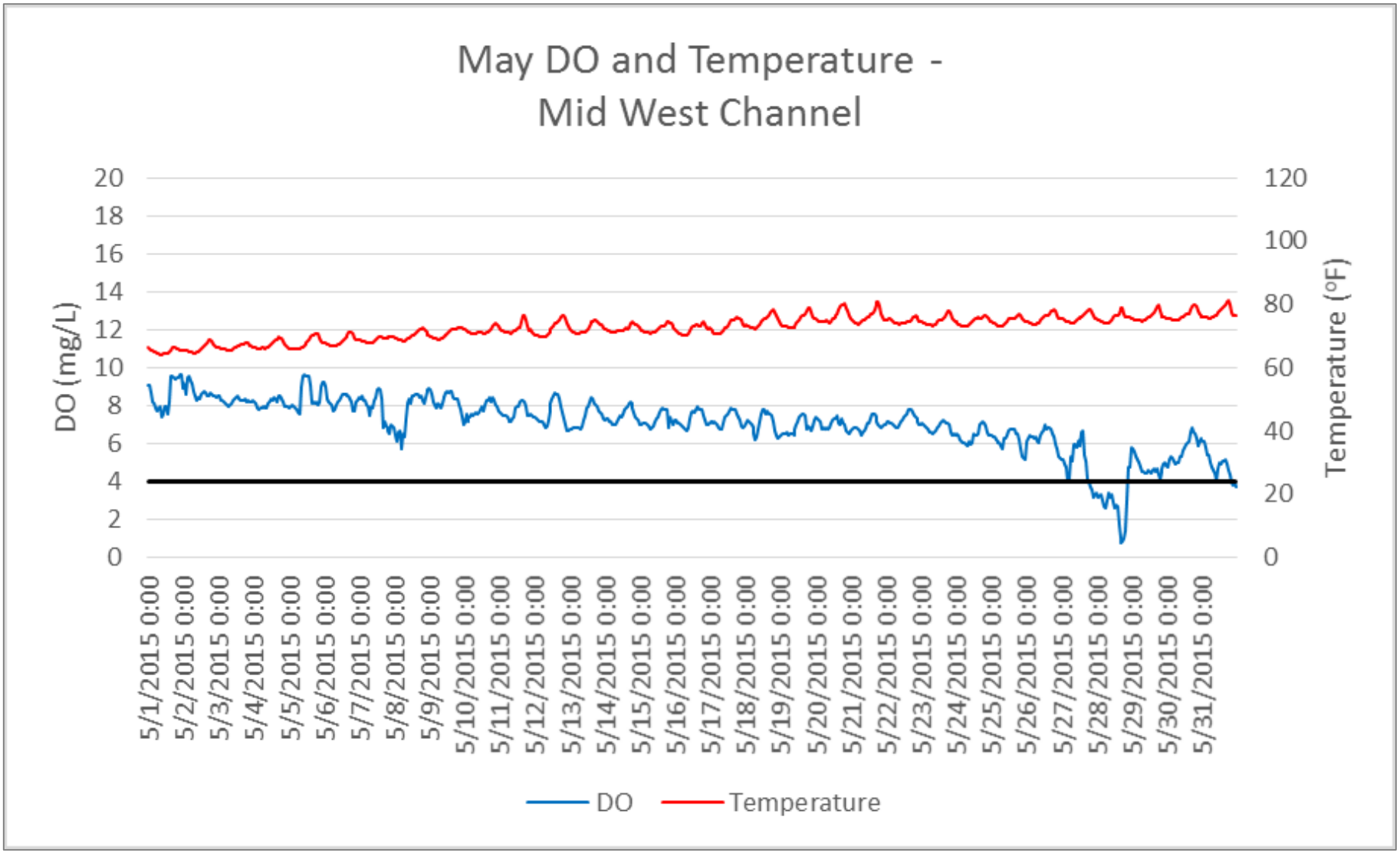


FIGURE 9 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – MAY 2015

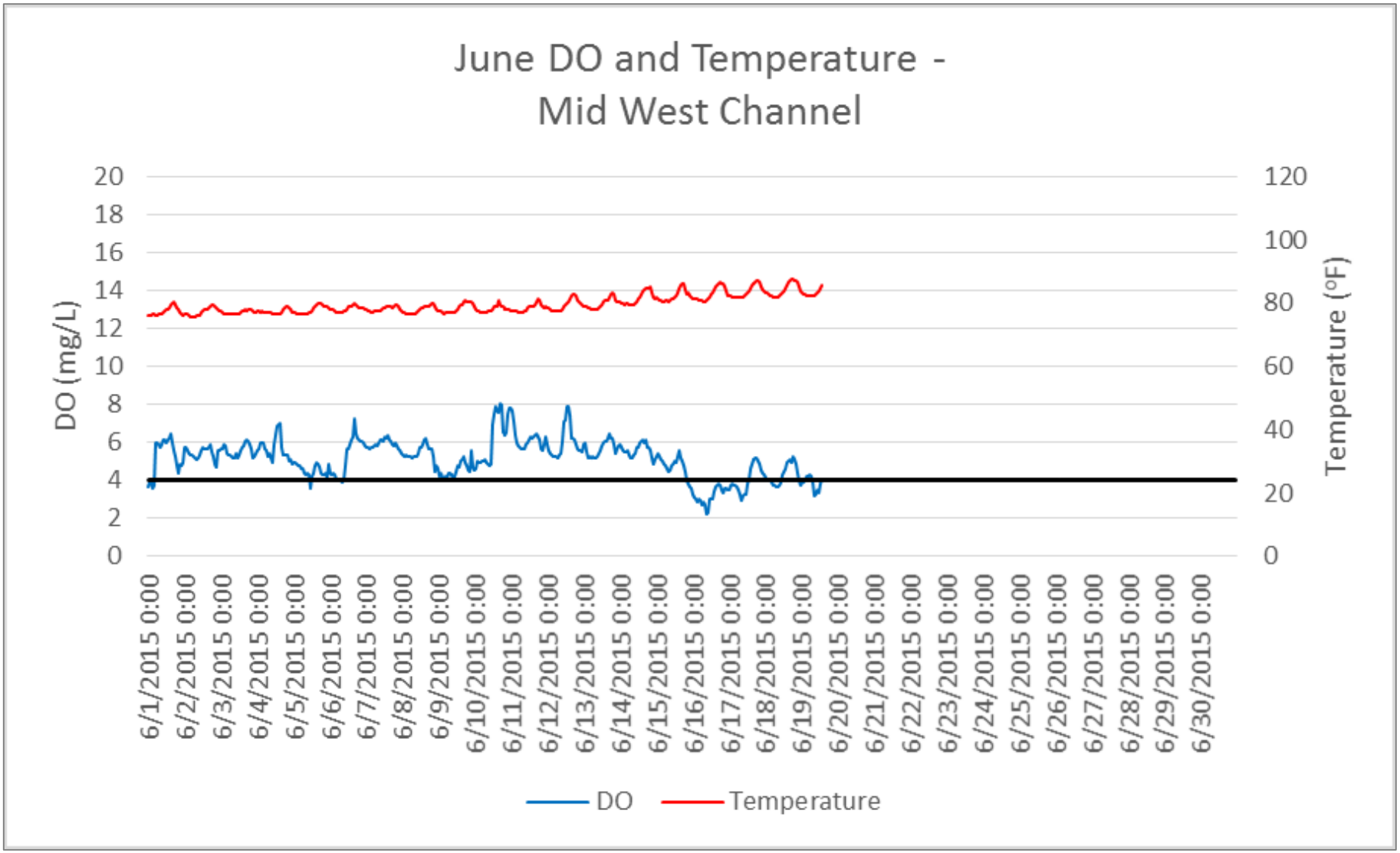


FIGURE 10 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – JUNE 2015

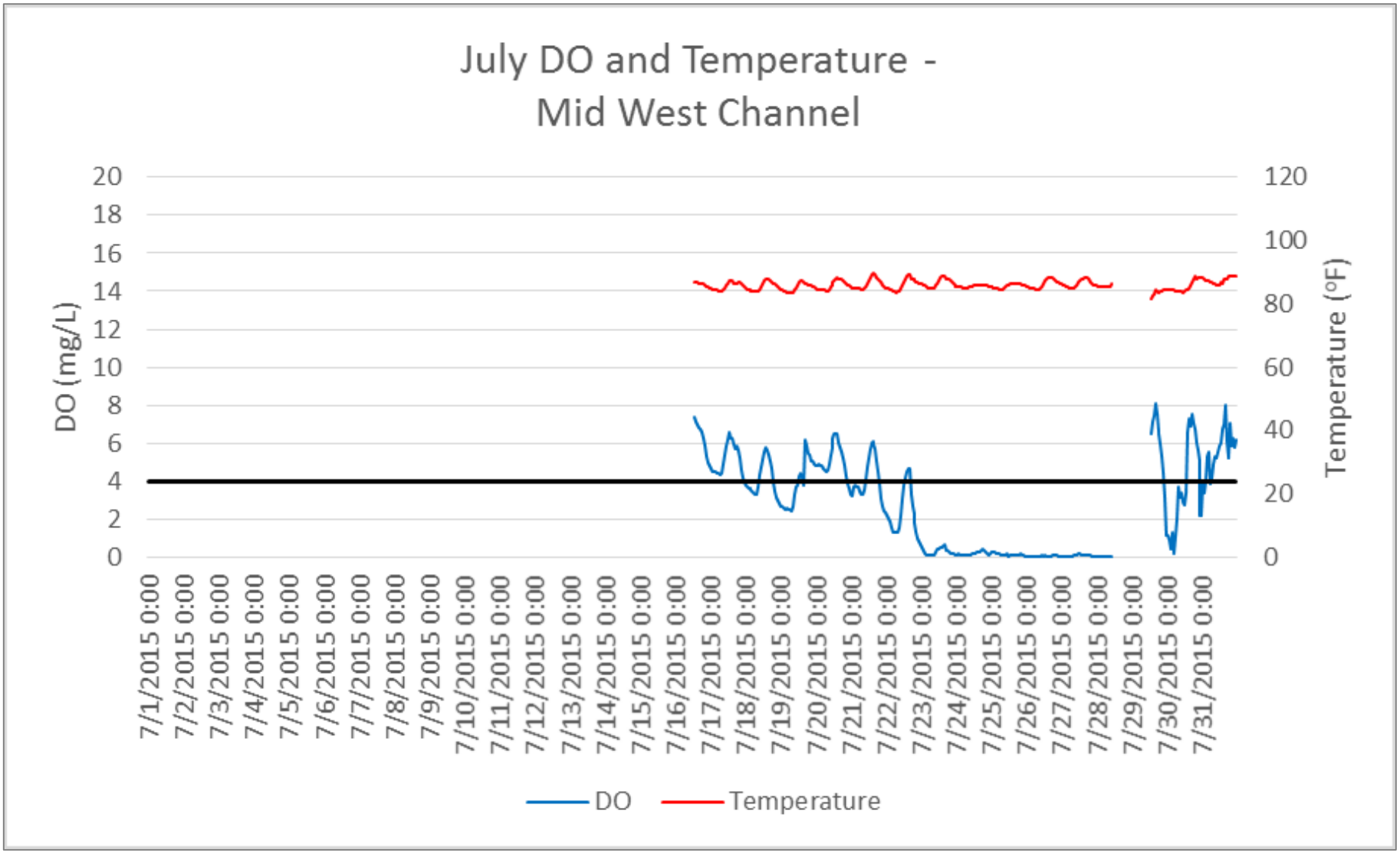


FIGURE 11 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – JULY 2015

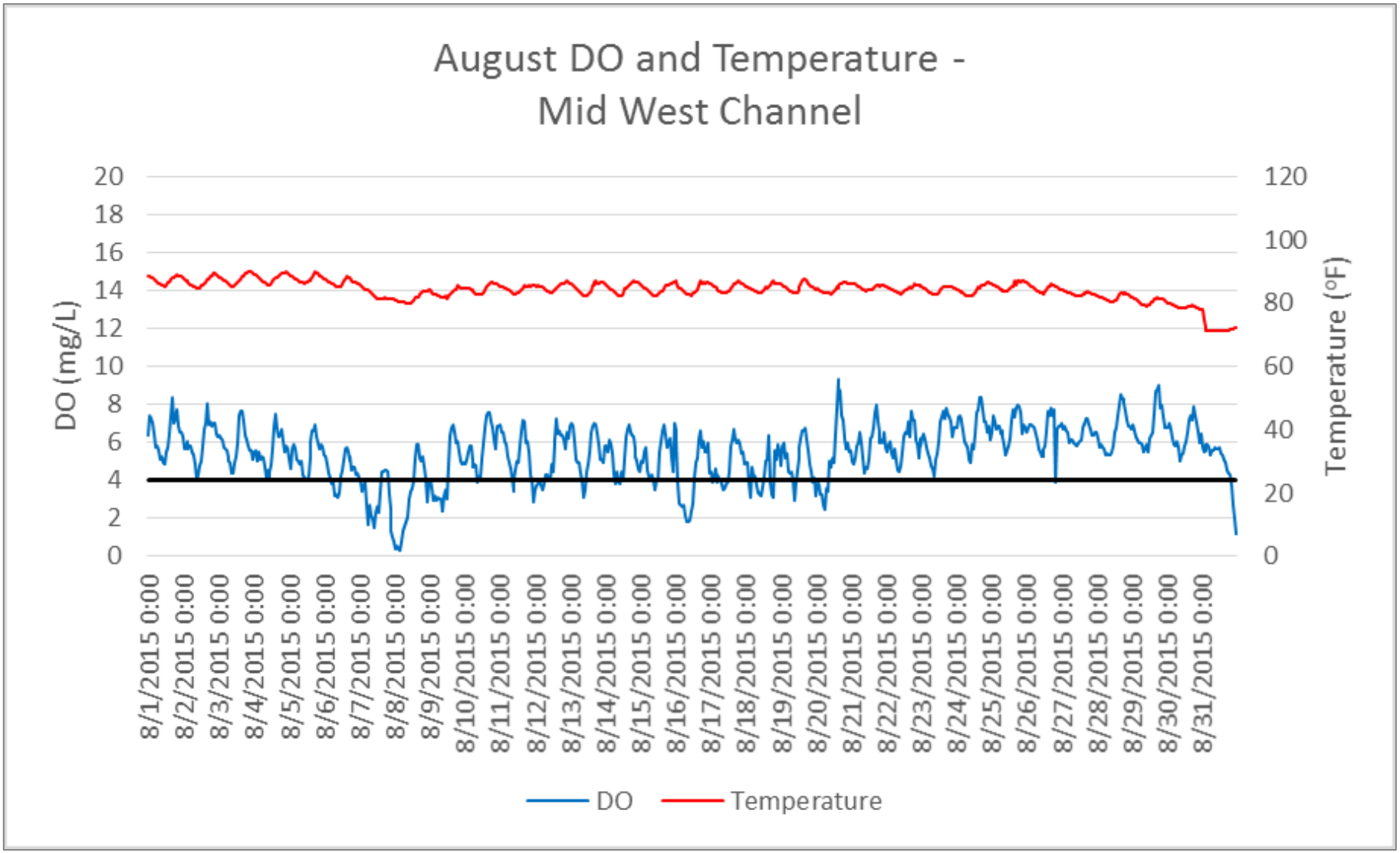


FIGURE 12 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – AUGUST 2015

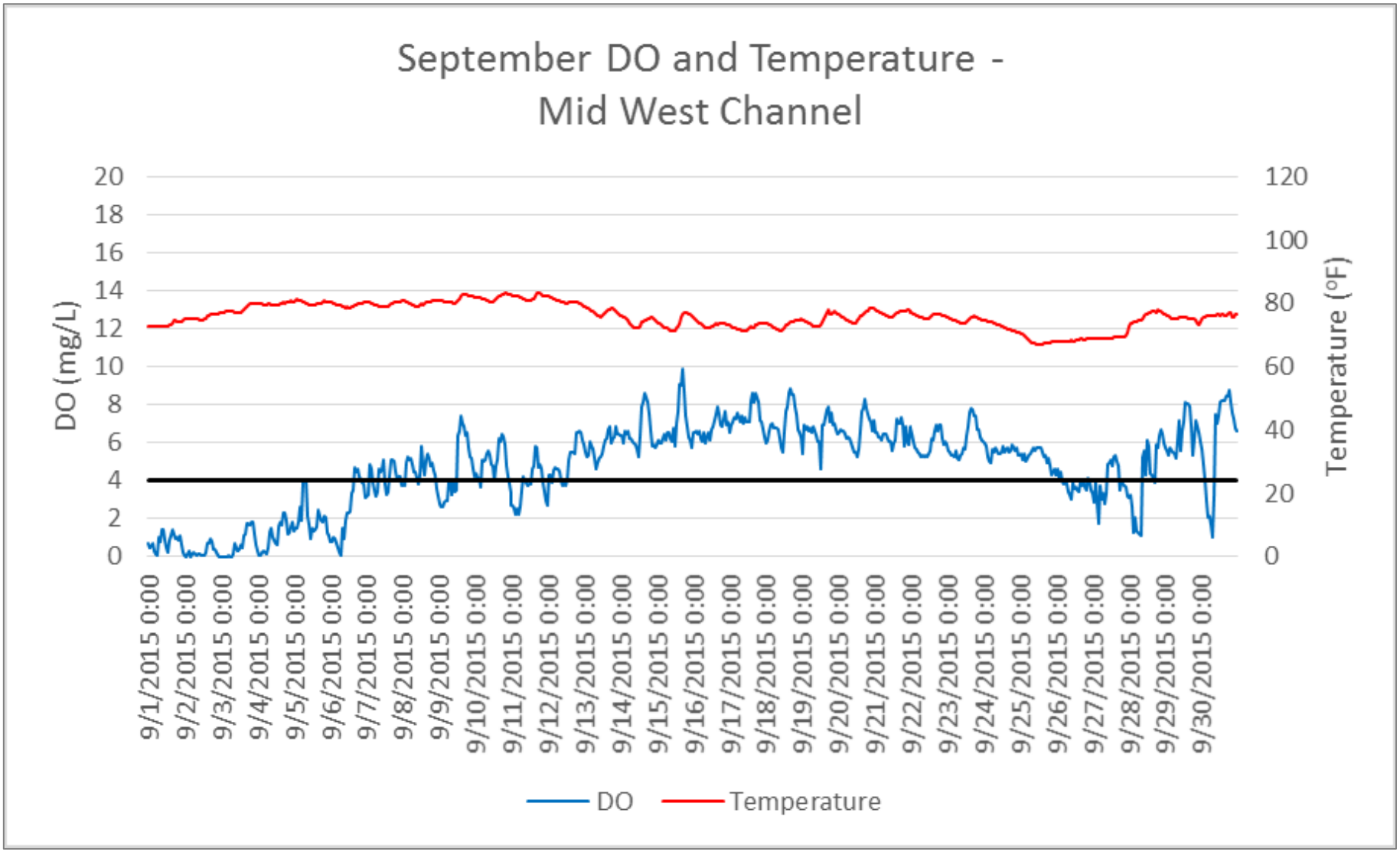


FIGURE 13 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – SEPTEMBER 2015

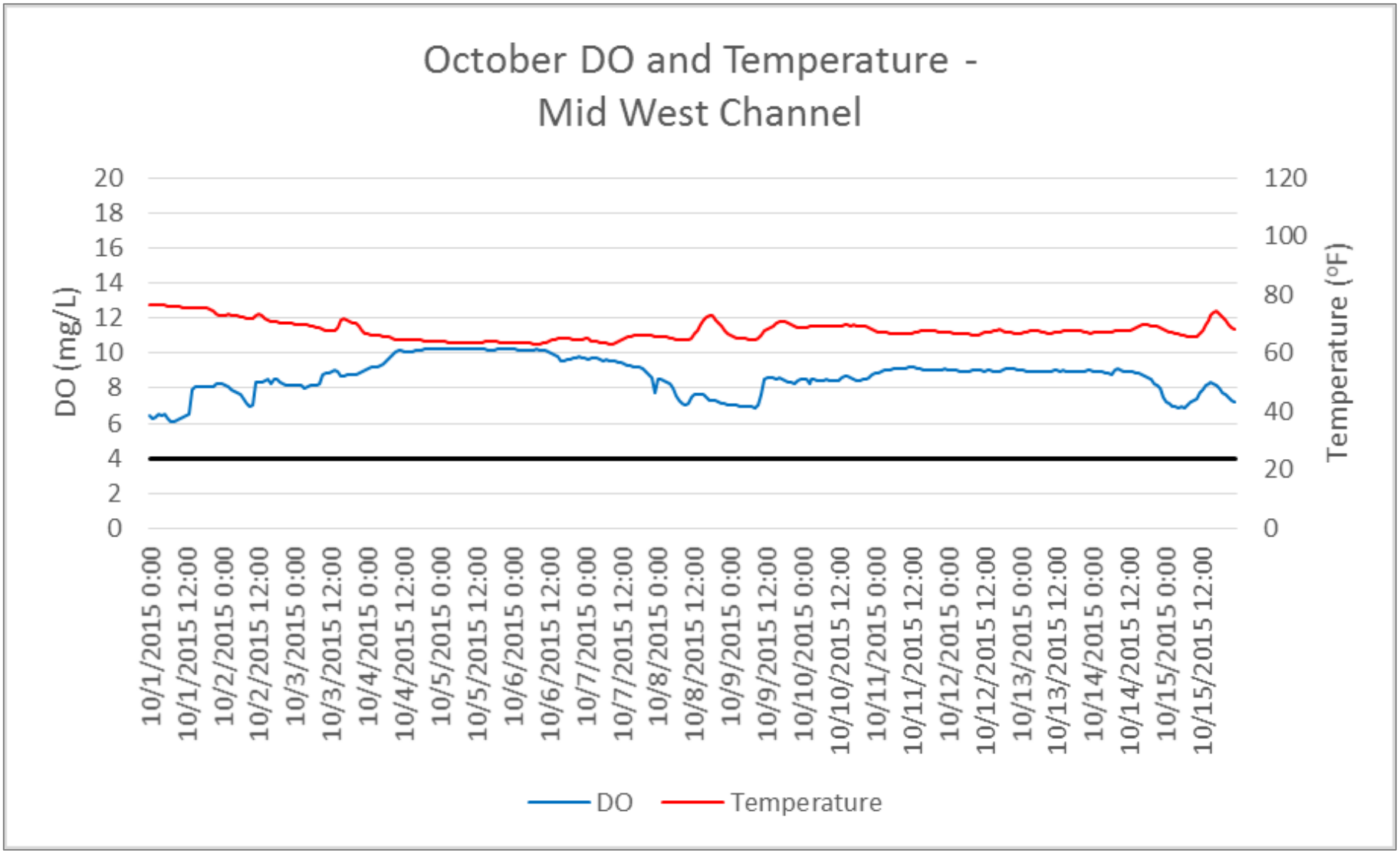


FIGURE 14 DISSOLVED OXYGEN AND TEMPERATURE IN THE MIDDLE WEST CHANNEL – OCTOBER 2015

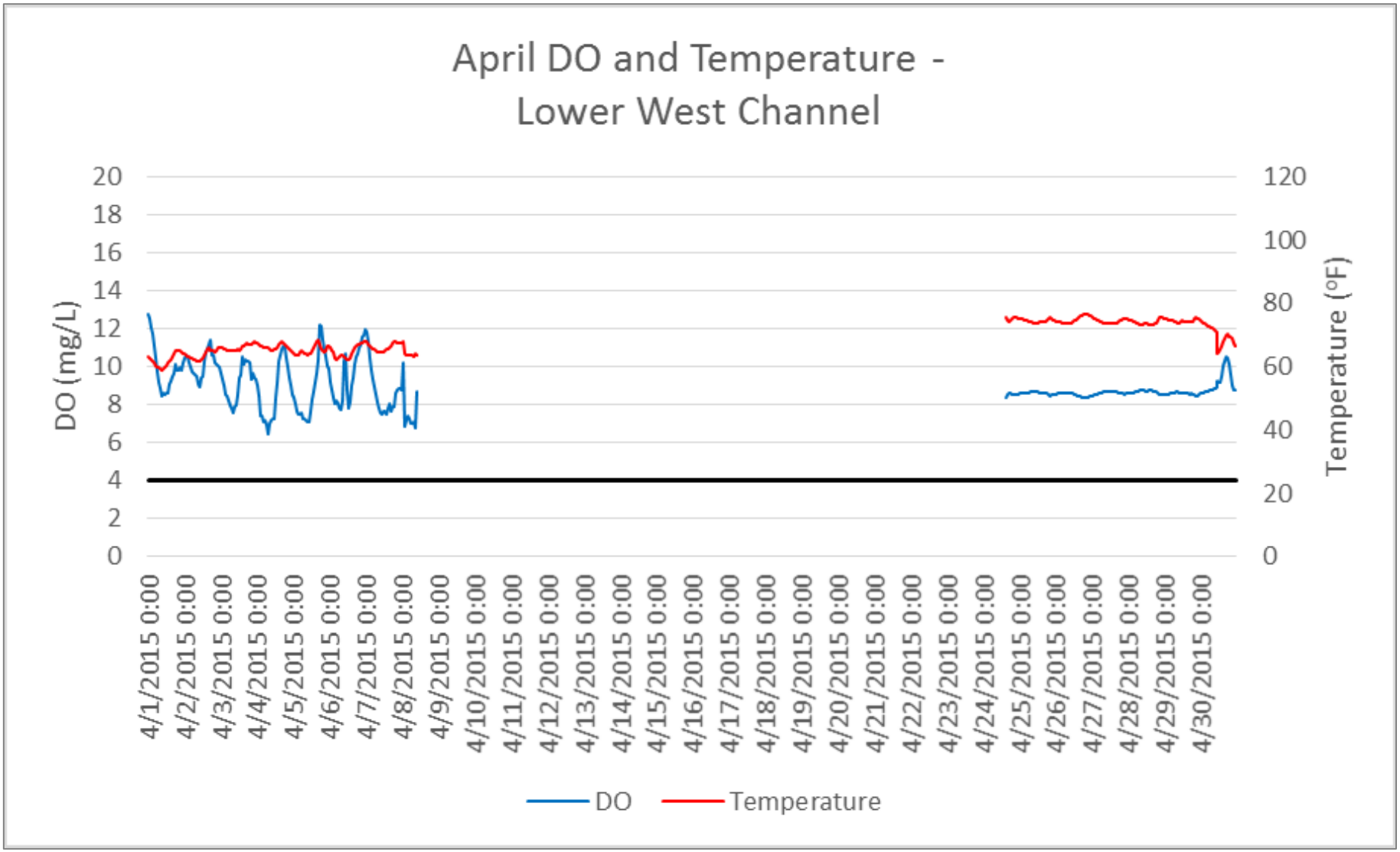


FIGURE 15 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – APRIL 2015

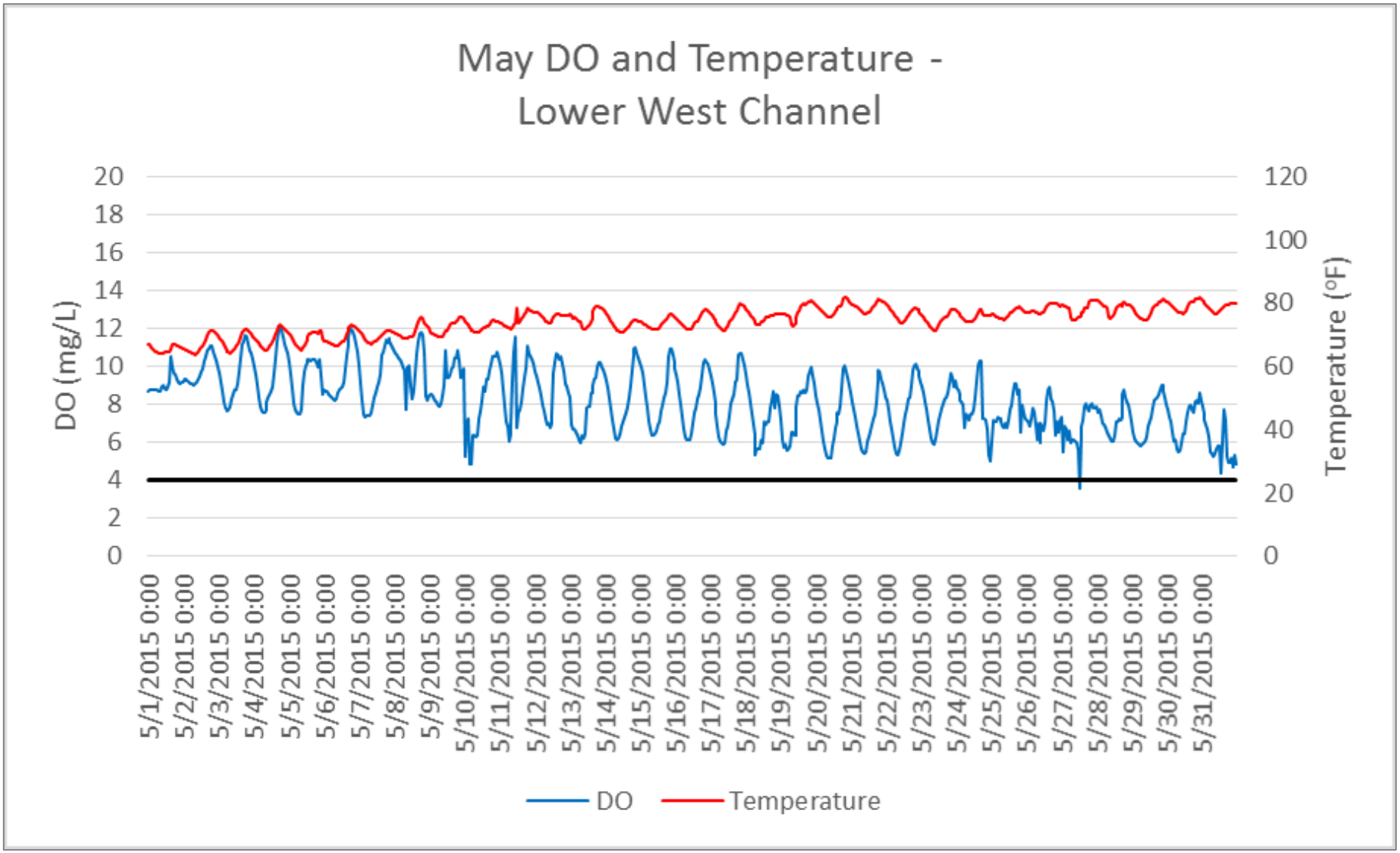


FIGURE 16 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – MAY 2015

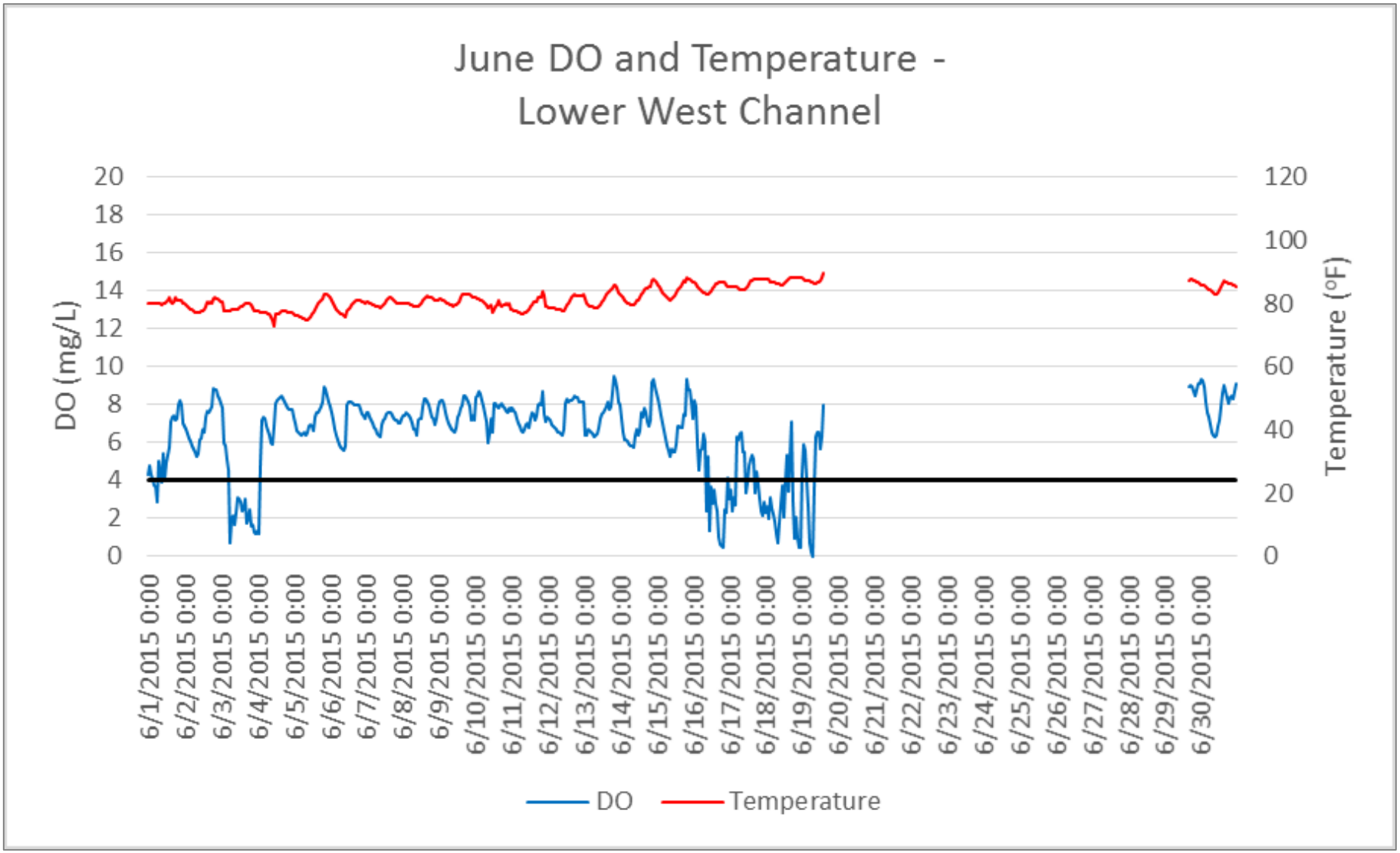


FIGURE 17 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – JUNE 2015

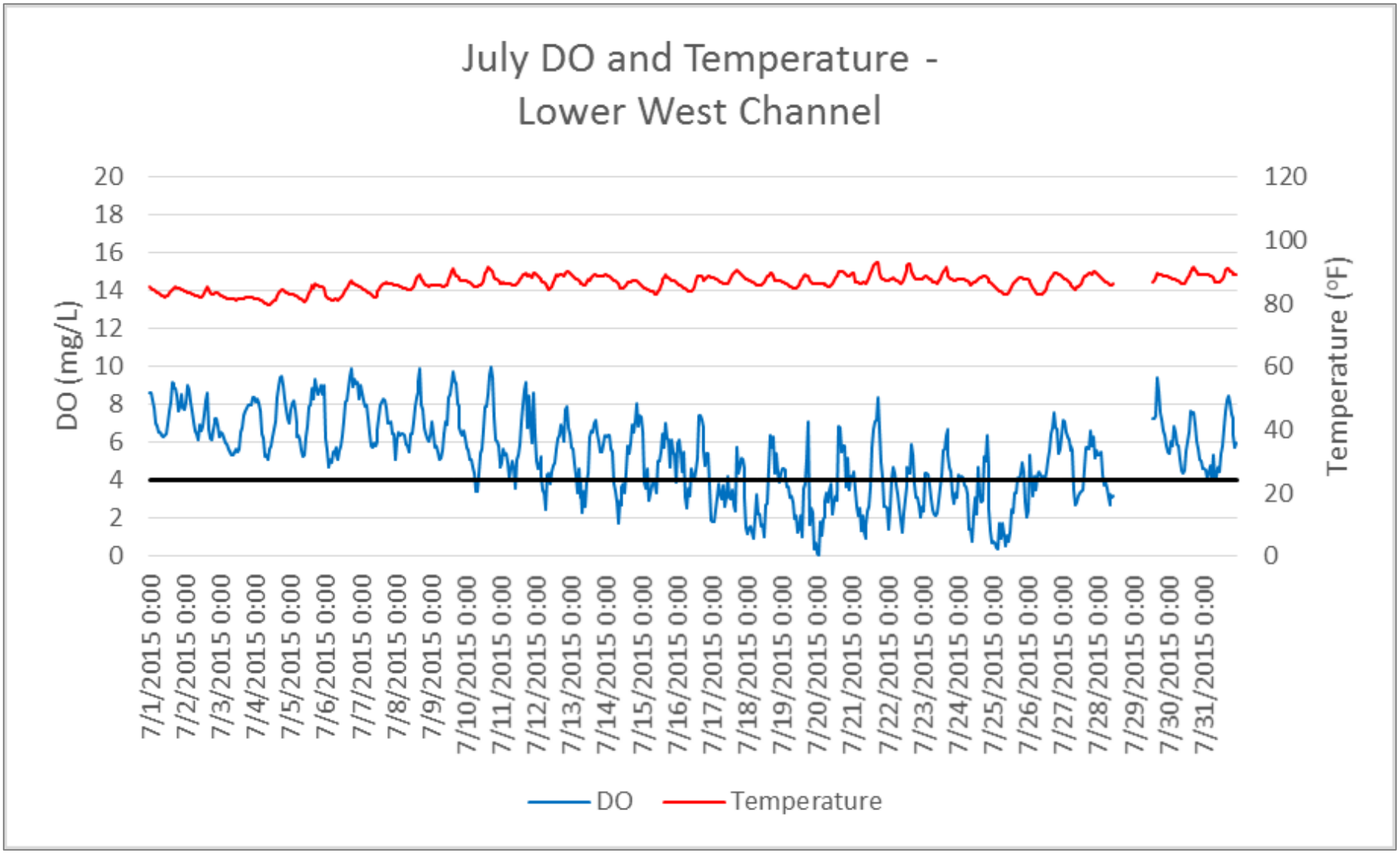


FIGURE 18 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – JULY 2015

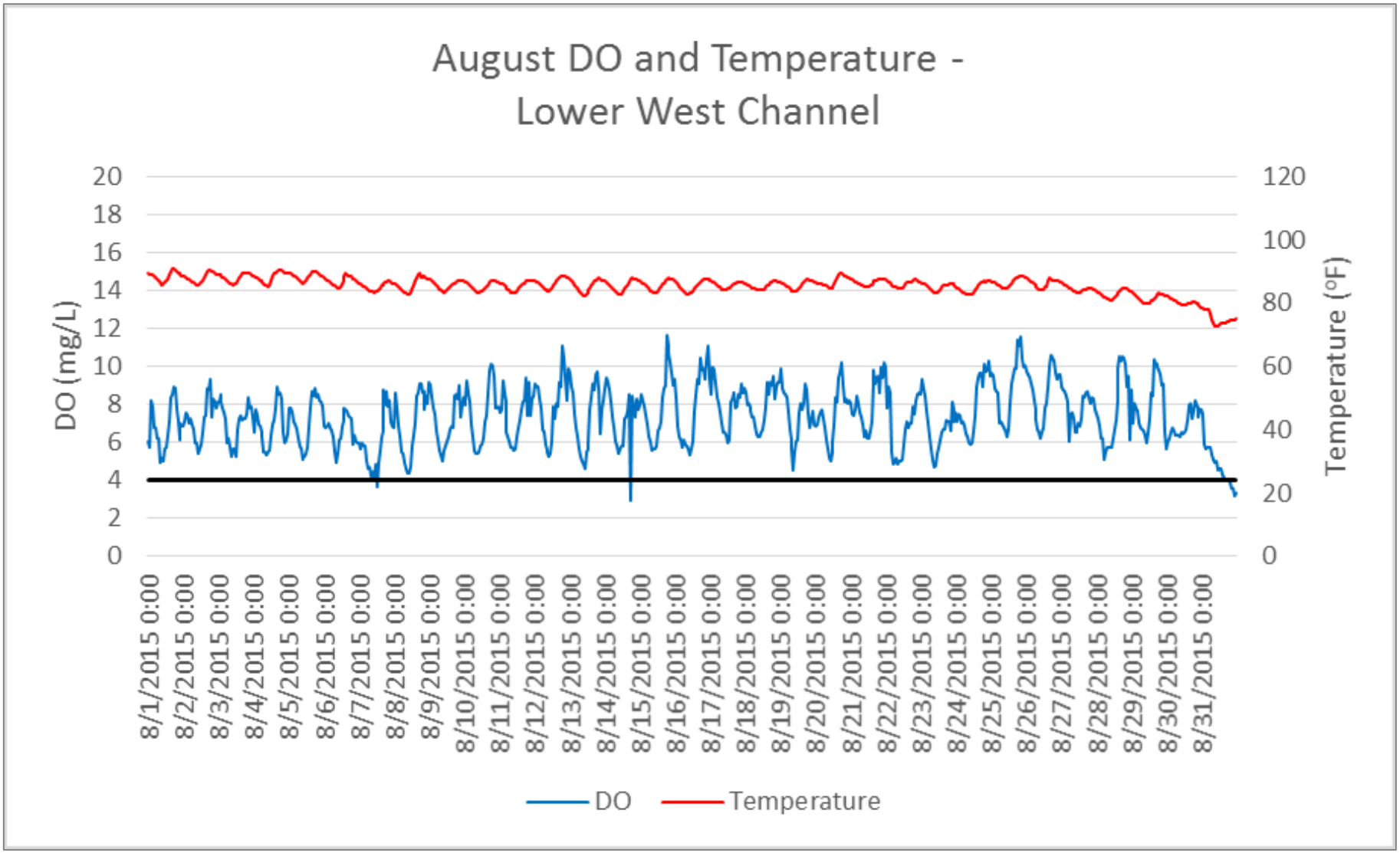


FIGURE 19 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – AUGUST 2015

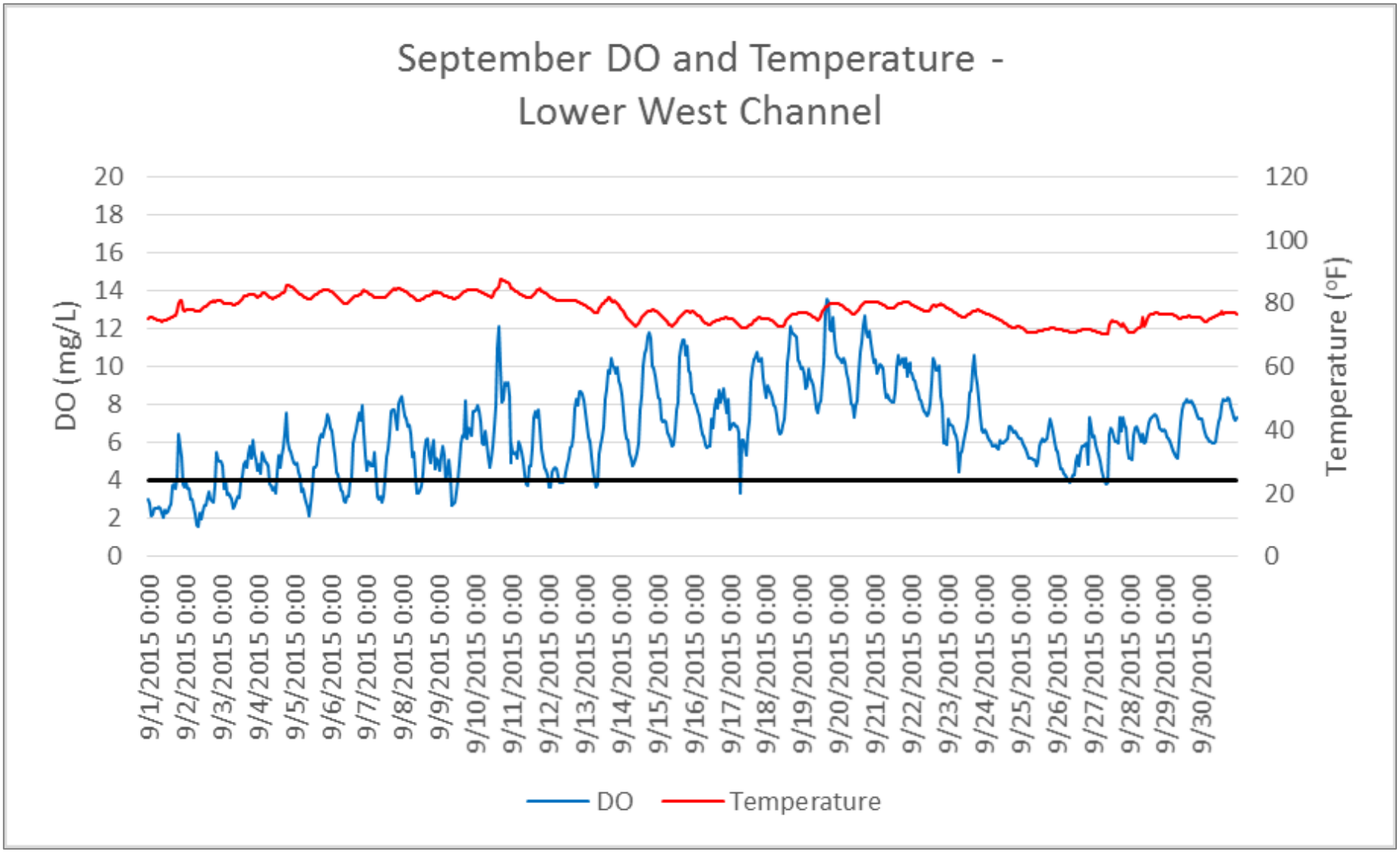


FIGURE 20 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – SEPTEMBER 2015

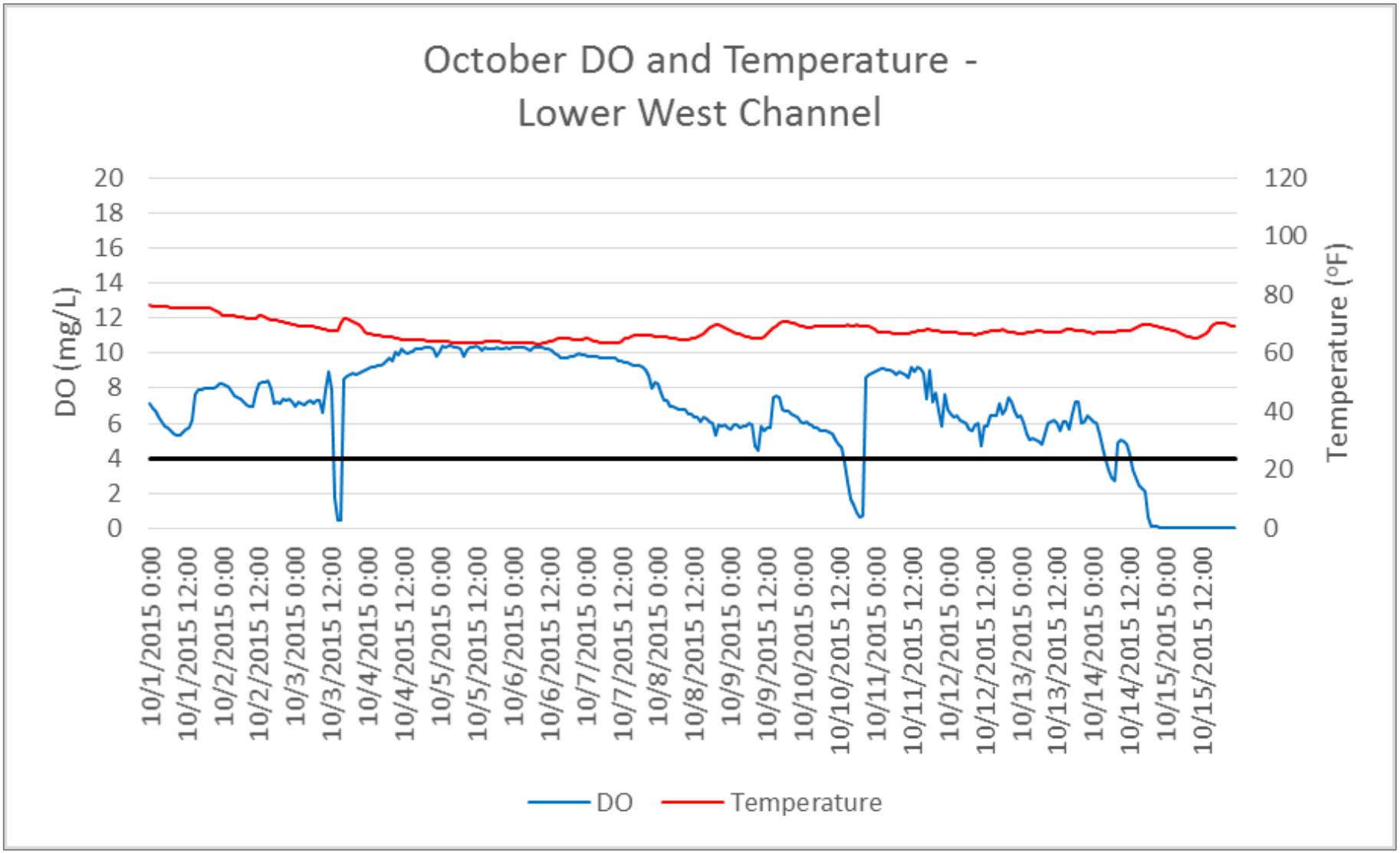


FIGURE 21 DISSOLVED OXYGEN AND TEMPERATURE IN THE LOWER WEST CHANNEL – OCTOBER 2015

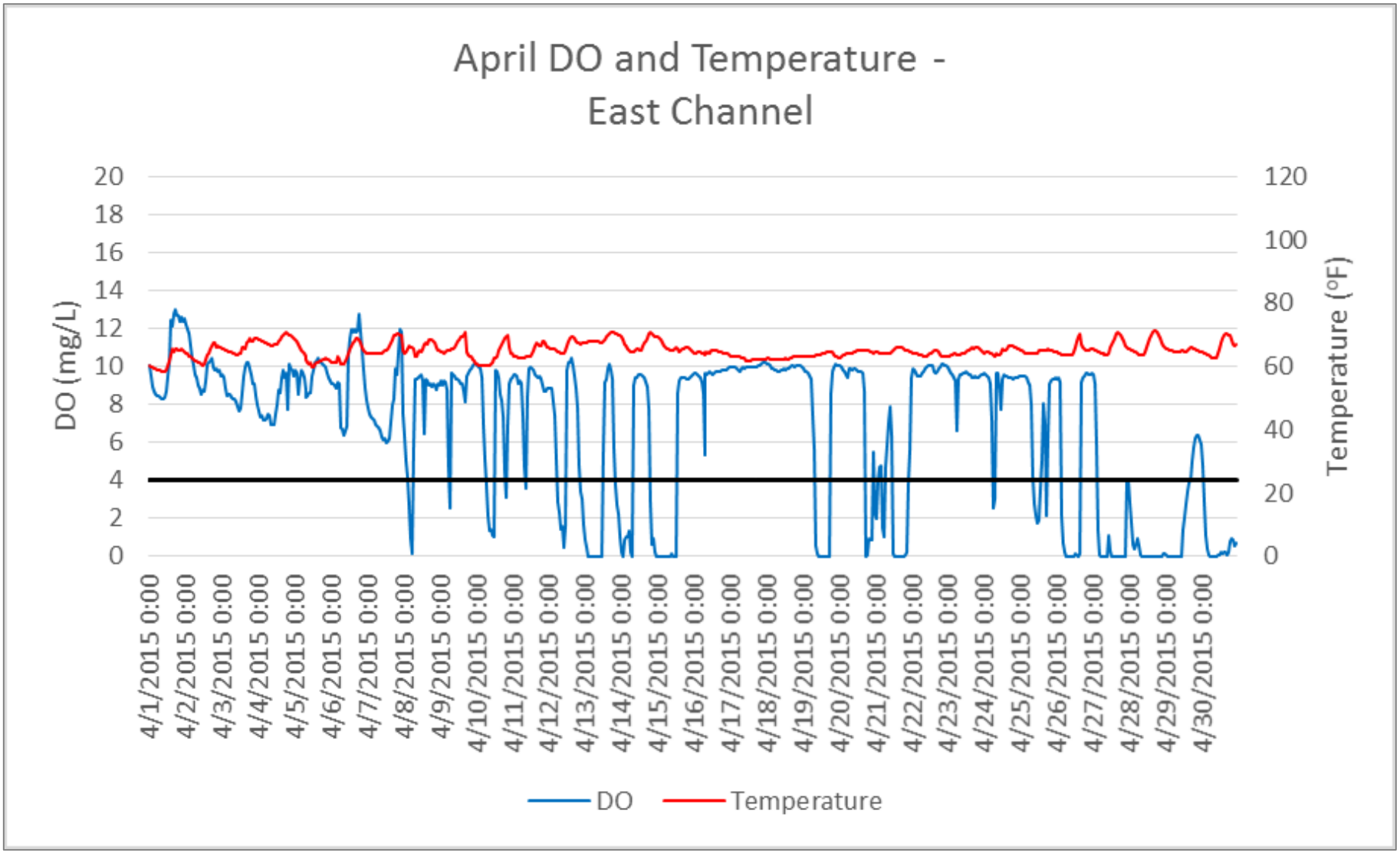


FIGURE 22 DISSOLVED OXYGEN AND TEMPERATURE IN THE EAST CHANNEL – APRIL 2015

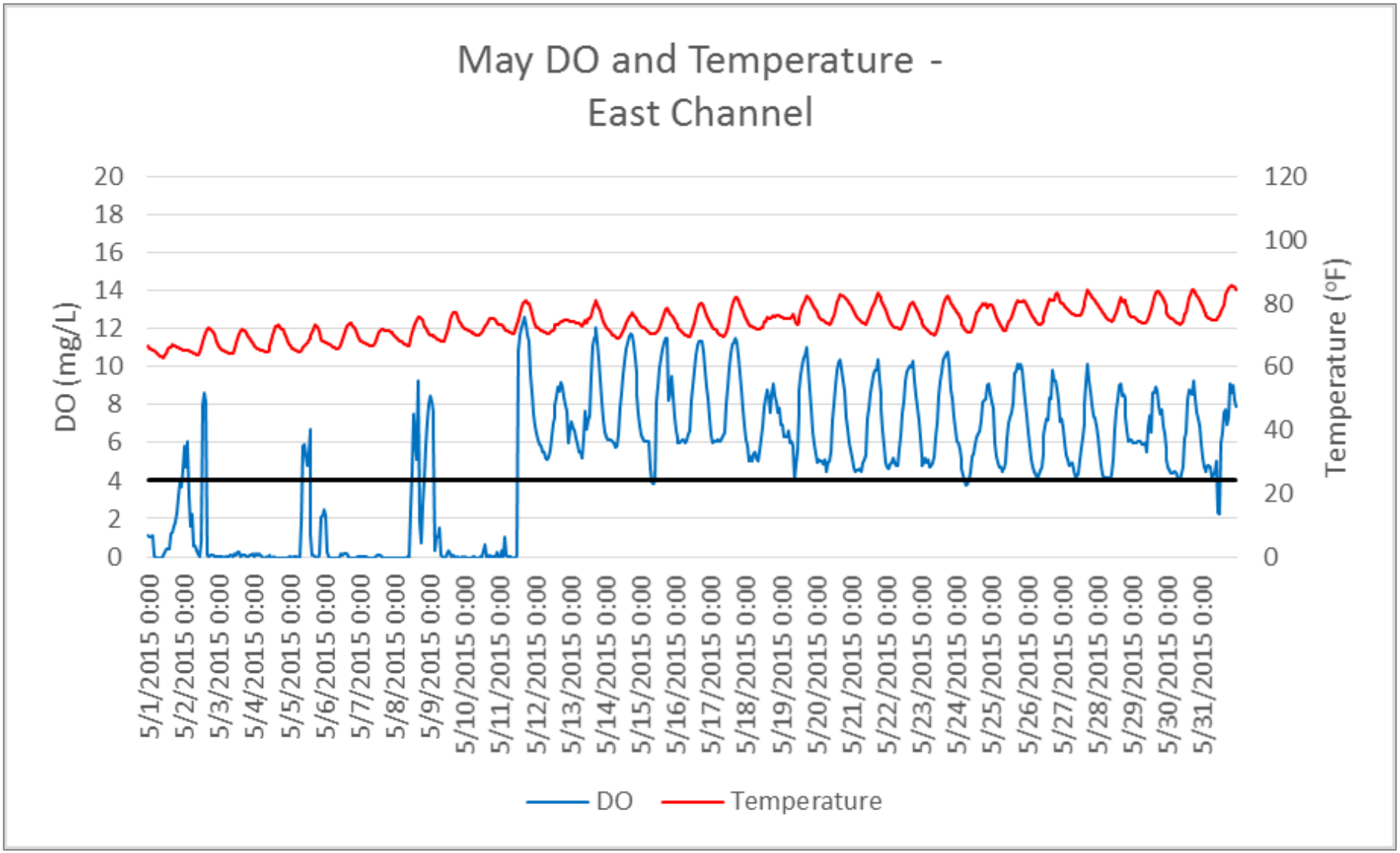


FIGURE 23 DISSOLVED OXYGEN AND TEMPERATURE IN THE EAST CHANNEL – MAY 2015

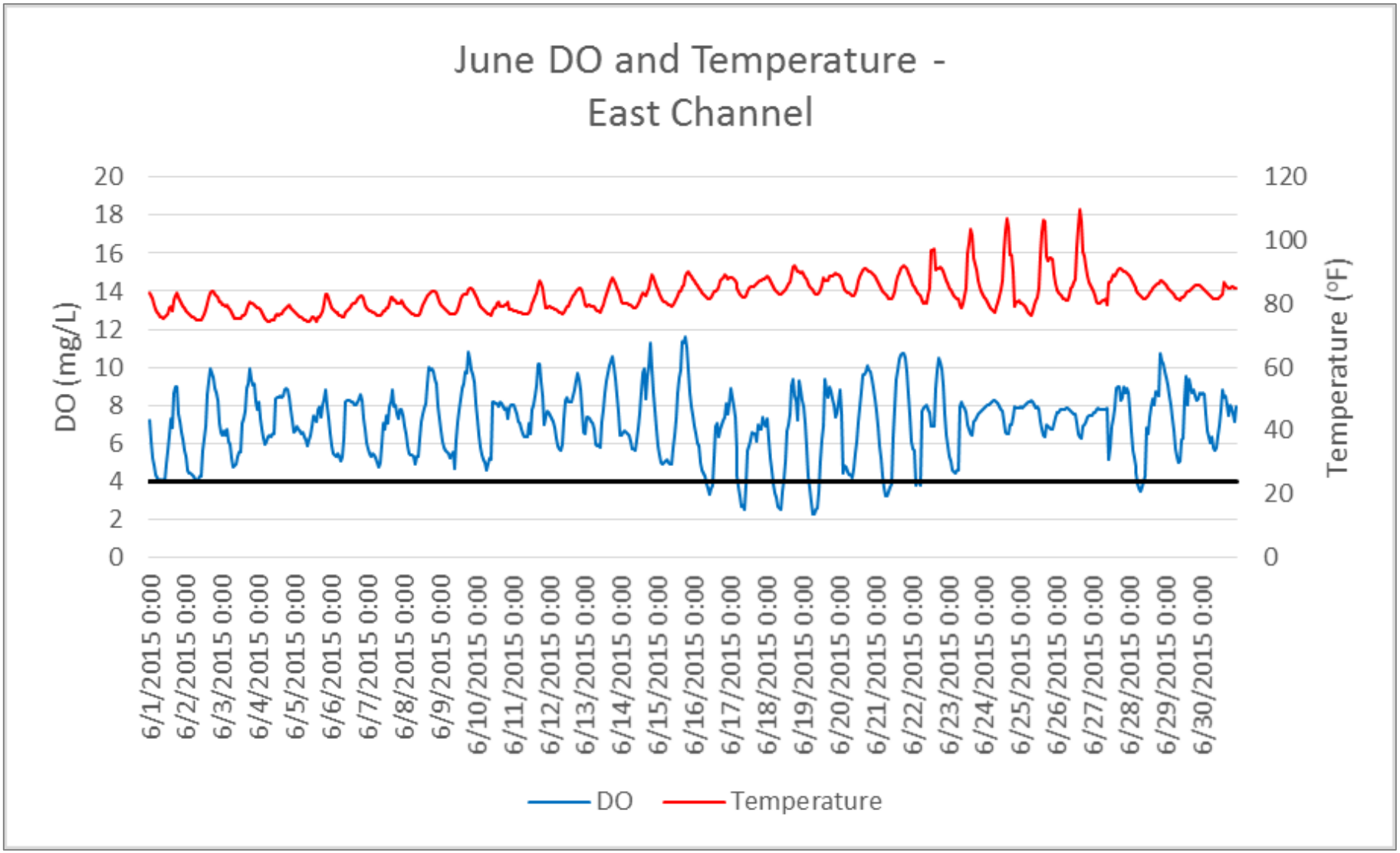


FIGURE 24 DISSOLVED OXYGEN AND TEMPERATURE IN THE EAST CHANNEL – JUNE 2015

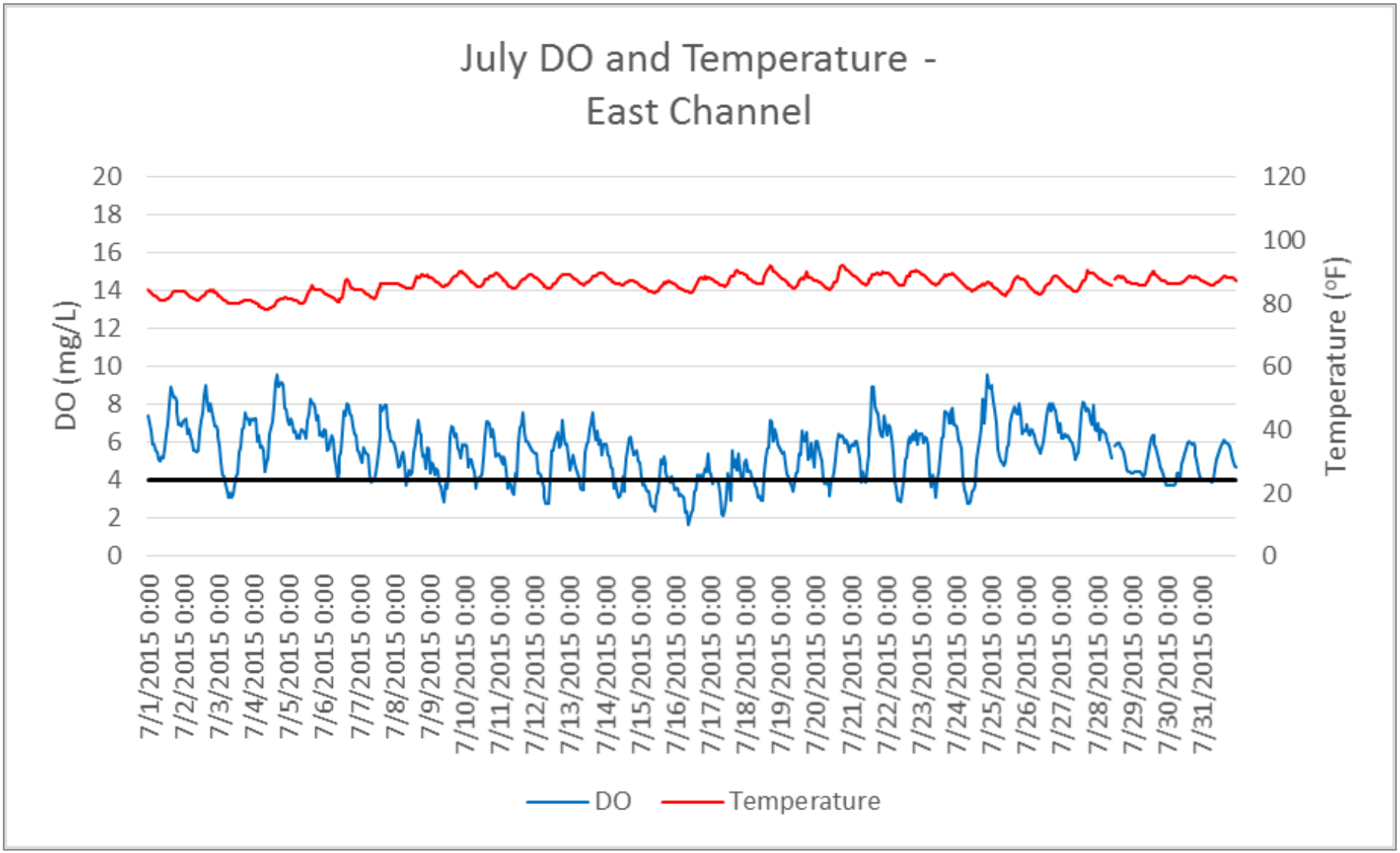


FIGURE 25 DISSOLVED OXYGEN AND TEMPERATURE IN THE EAST CHANNEL – JULY 2015

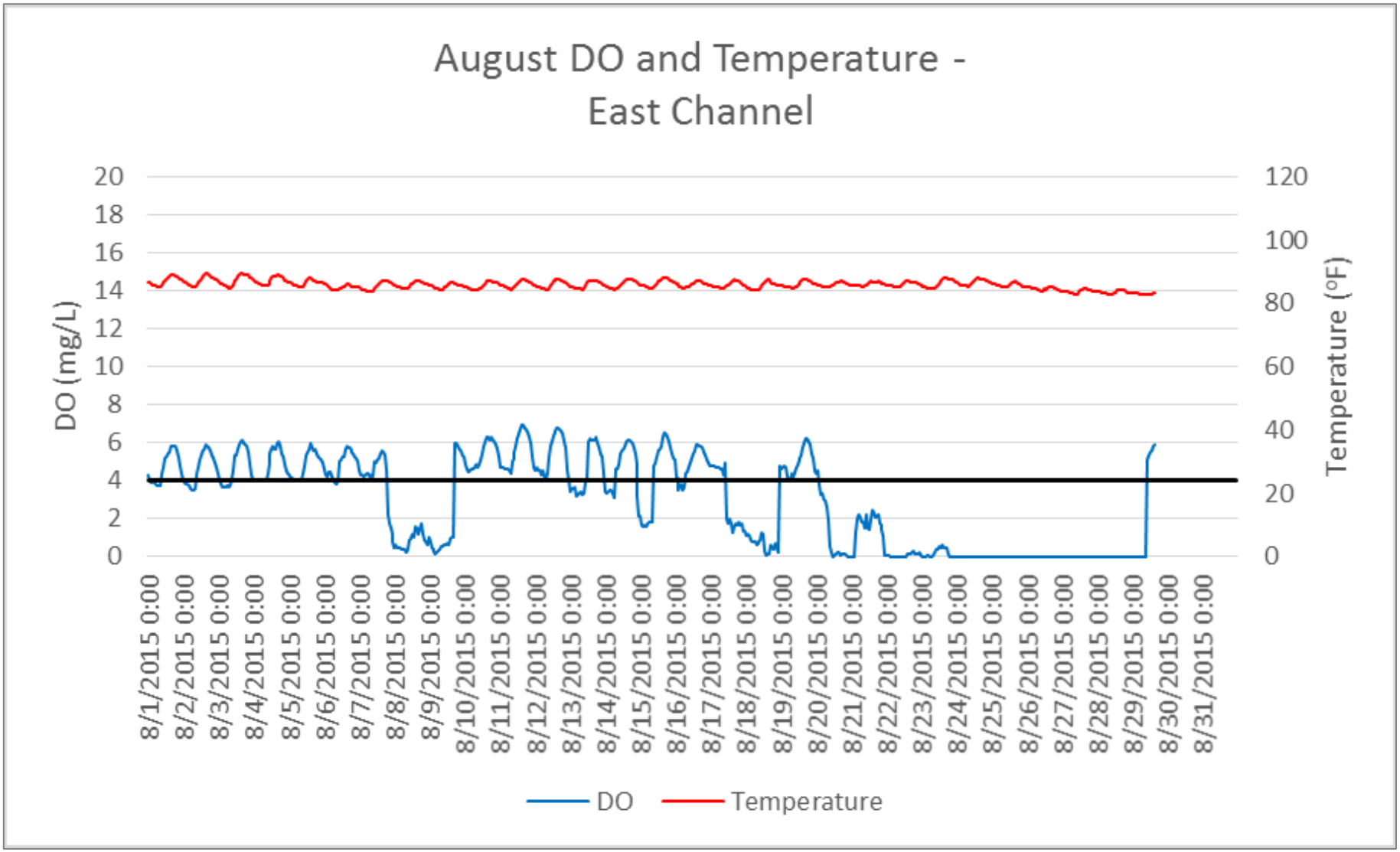


FIGURE 26 DISSOLVED OXYGEN AND TEMPERATURE IN THE EAST CHANNEL – AUGUST 2015

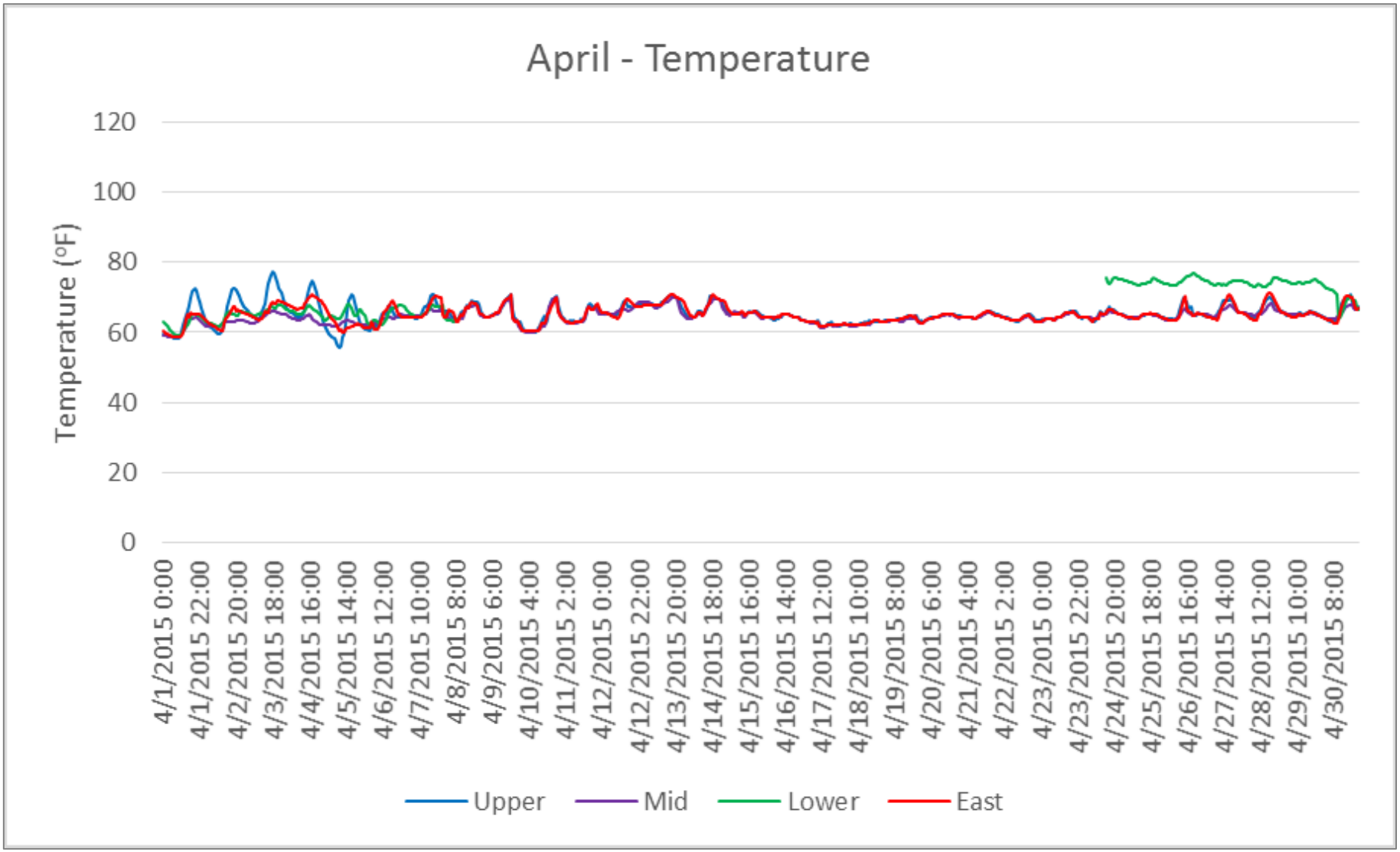


FIGURE 27 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – APRIL 2015

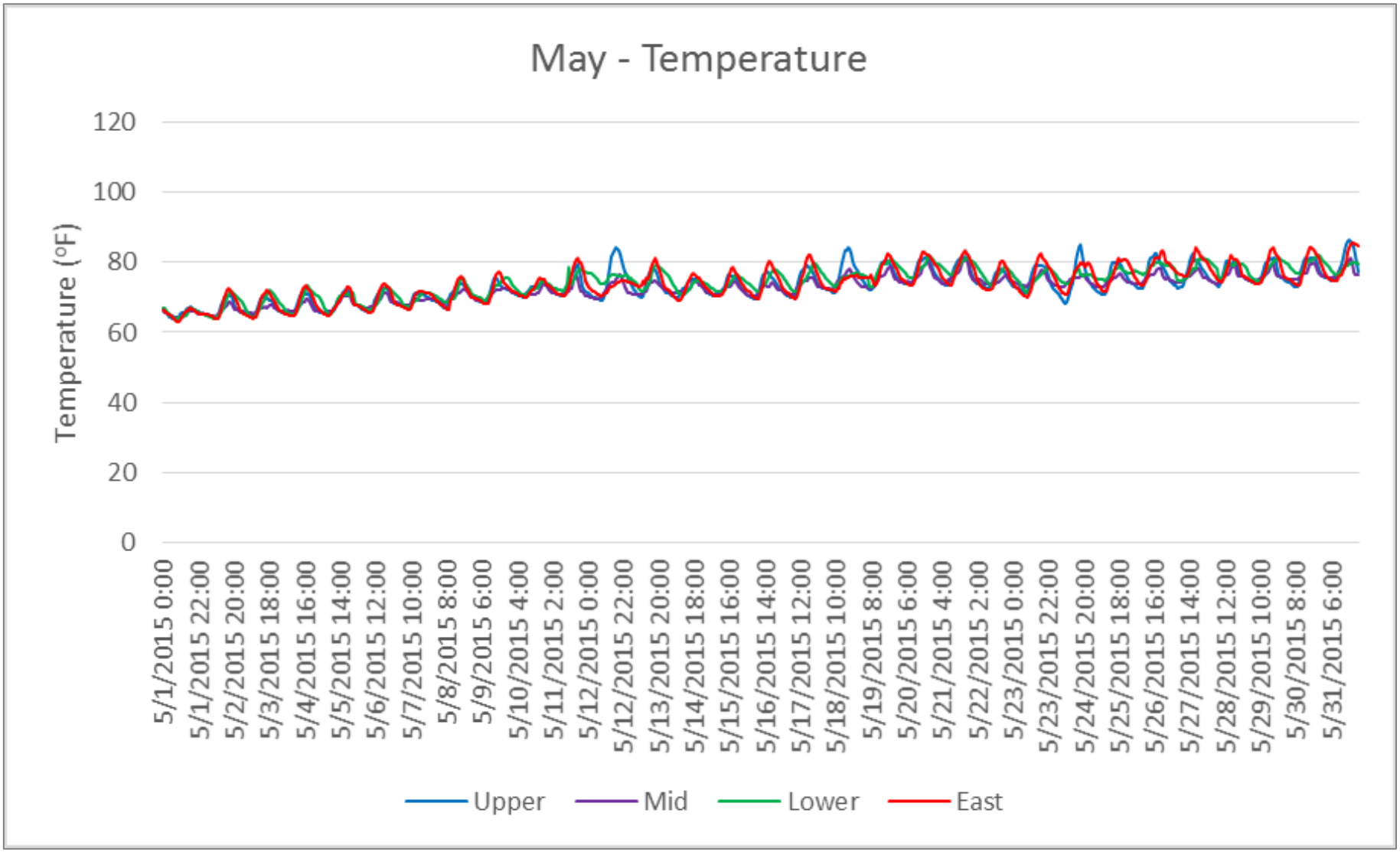


FIGURE 28 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – MAY 2015

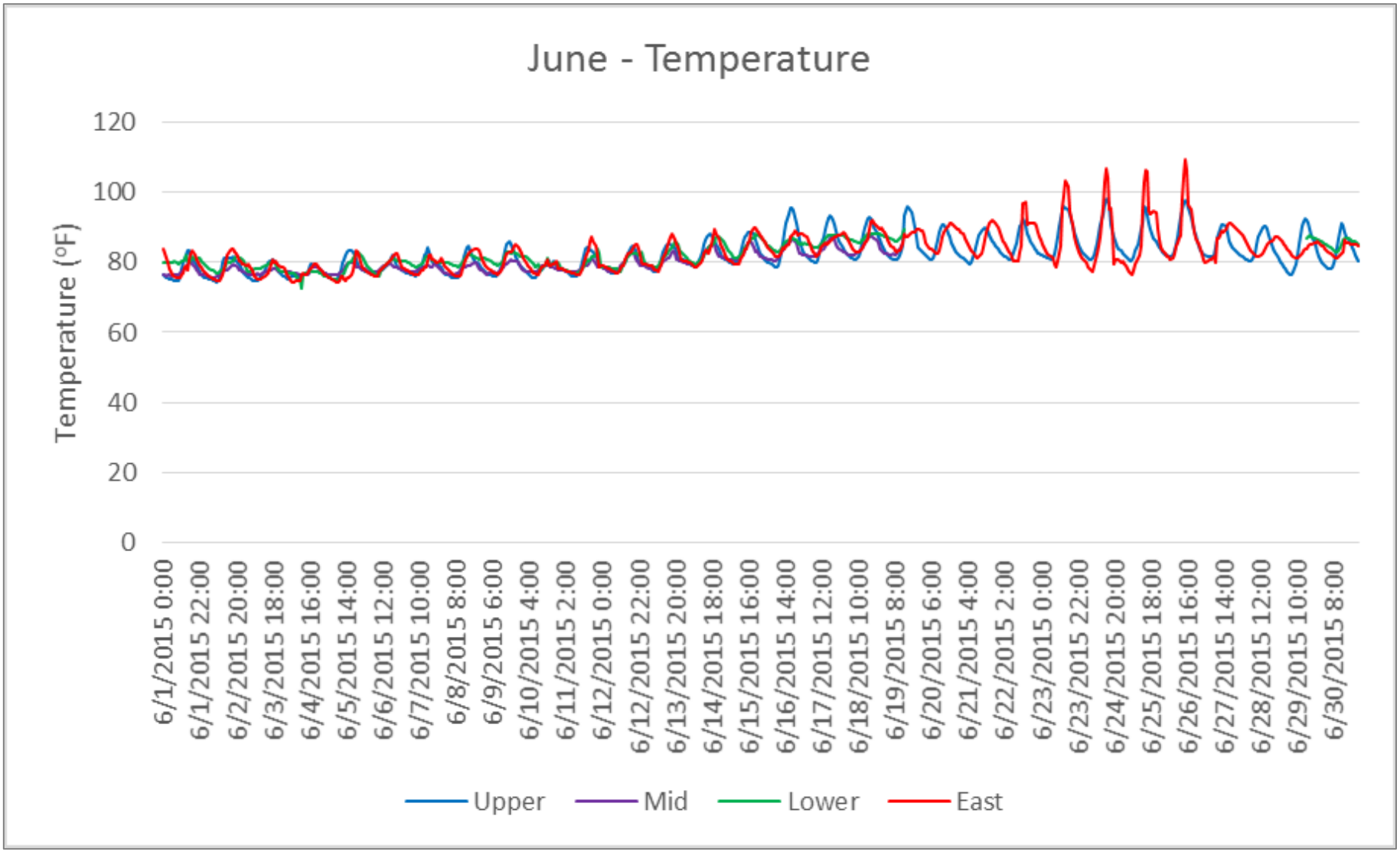


FIGURE 29 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – JUNE 2015

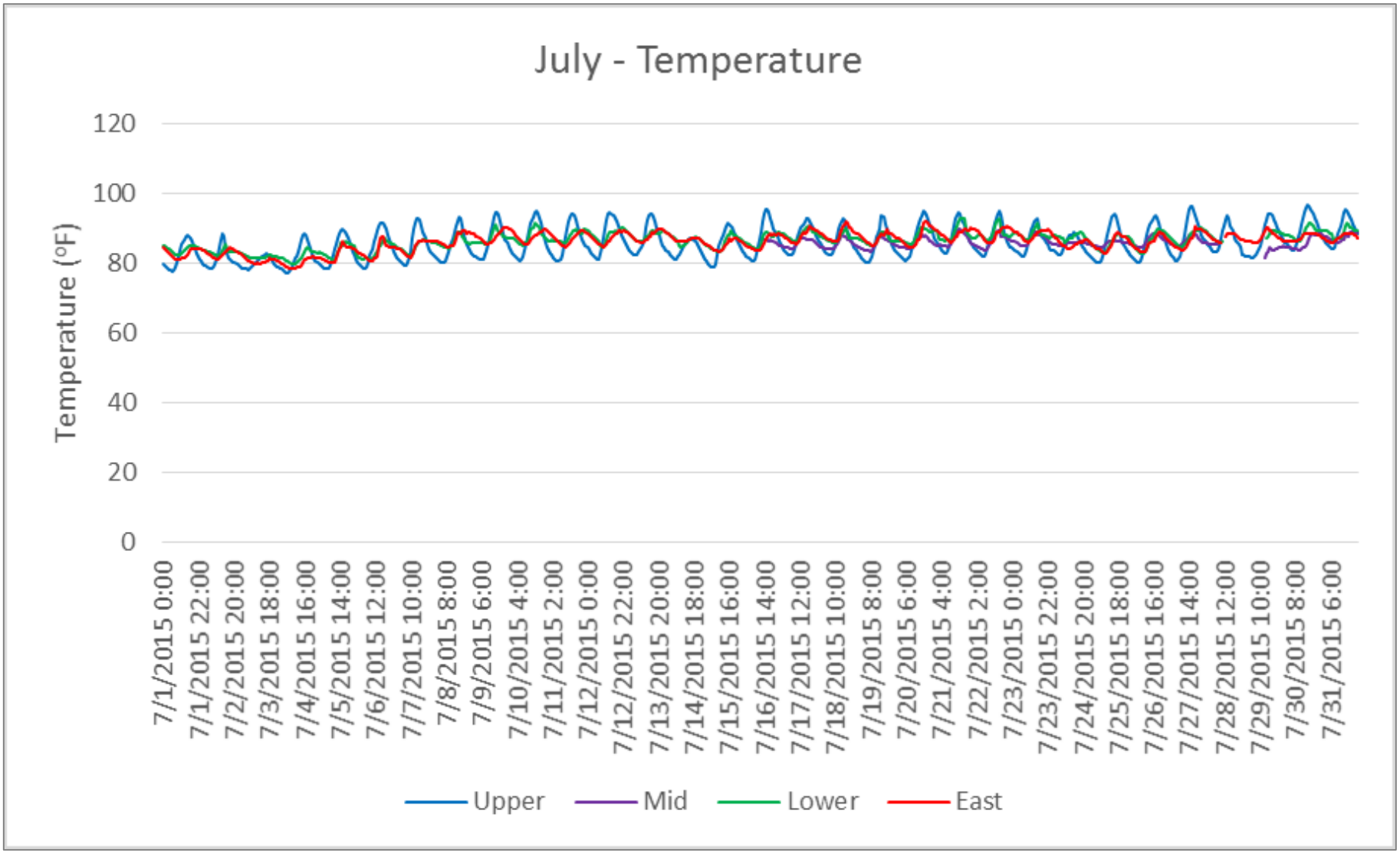


FIGURE 30 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – JULY 2015

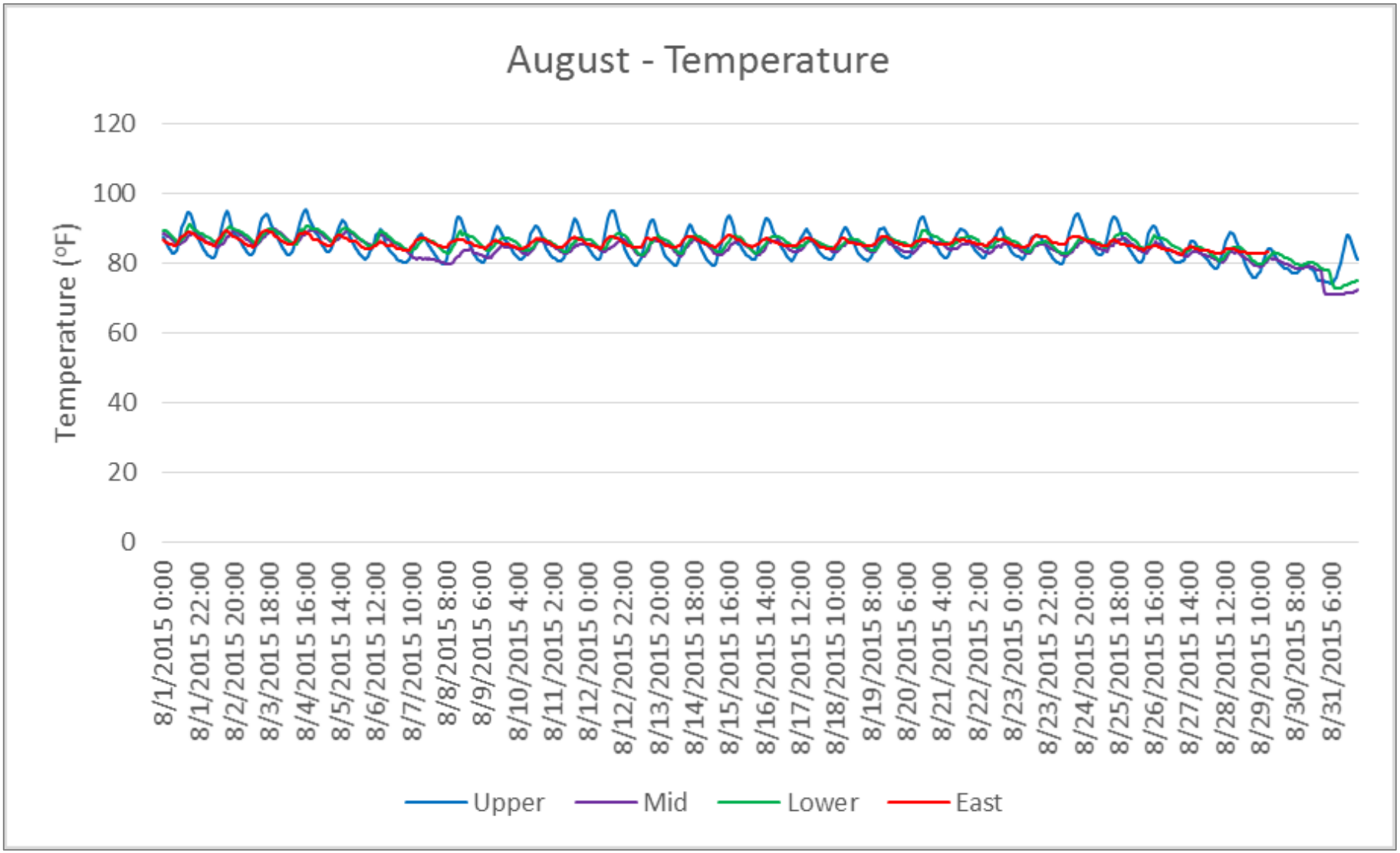


FIGURE 31 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – AUGUST 2015

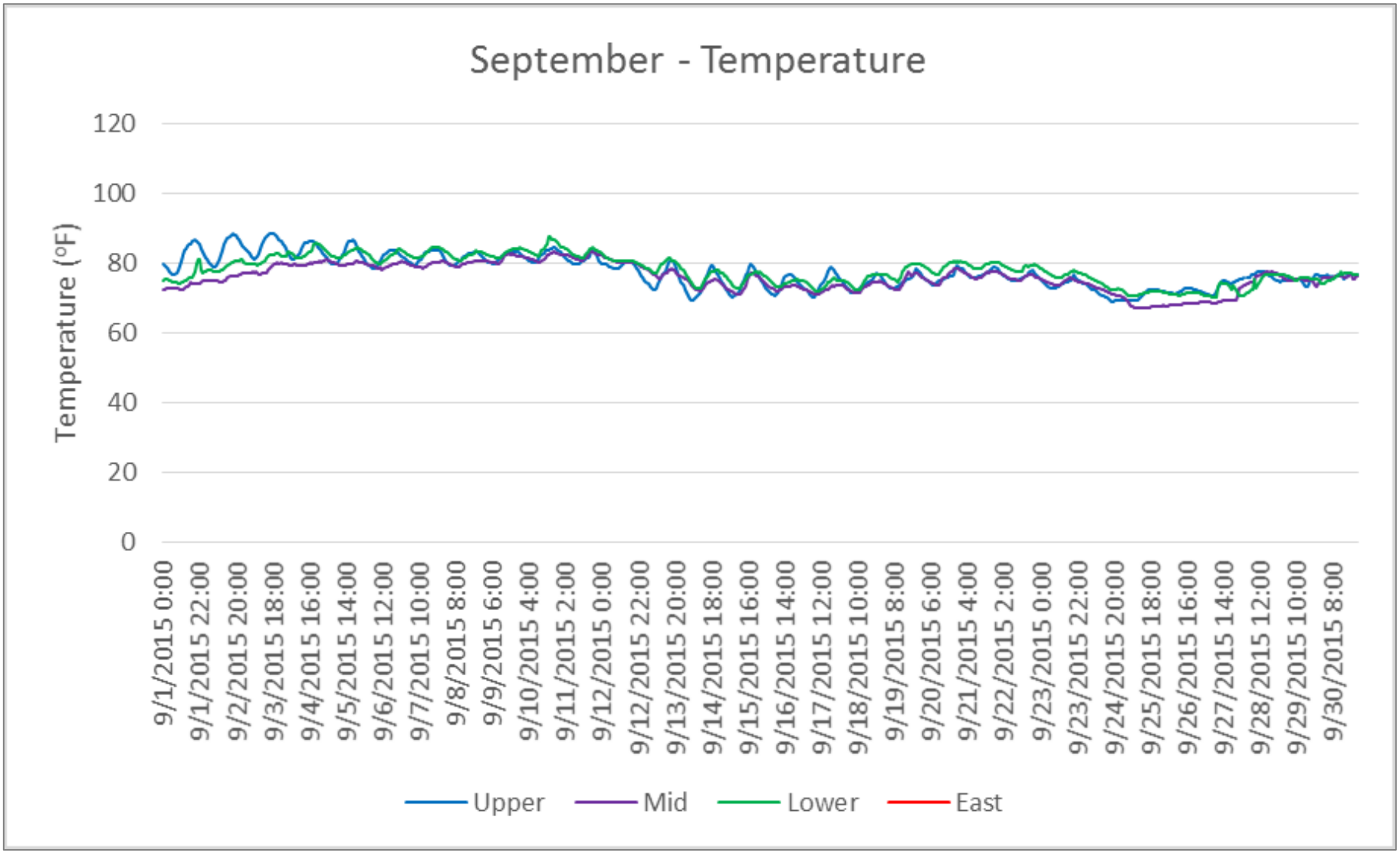


FIGURE 32 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – SEPTEMBER 2015

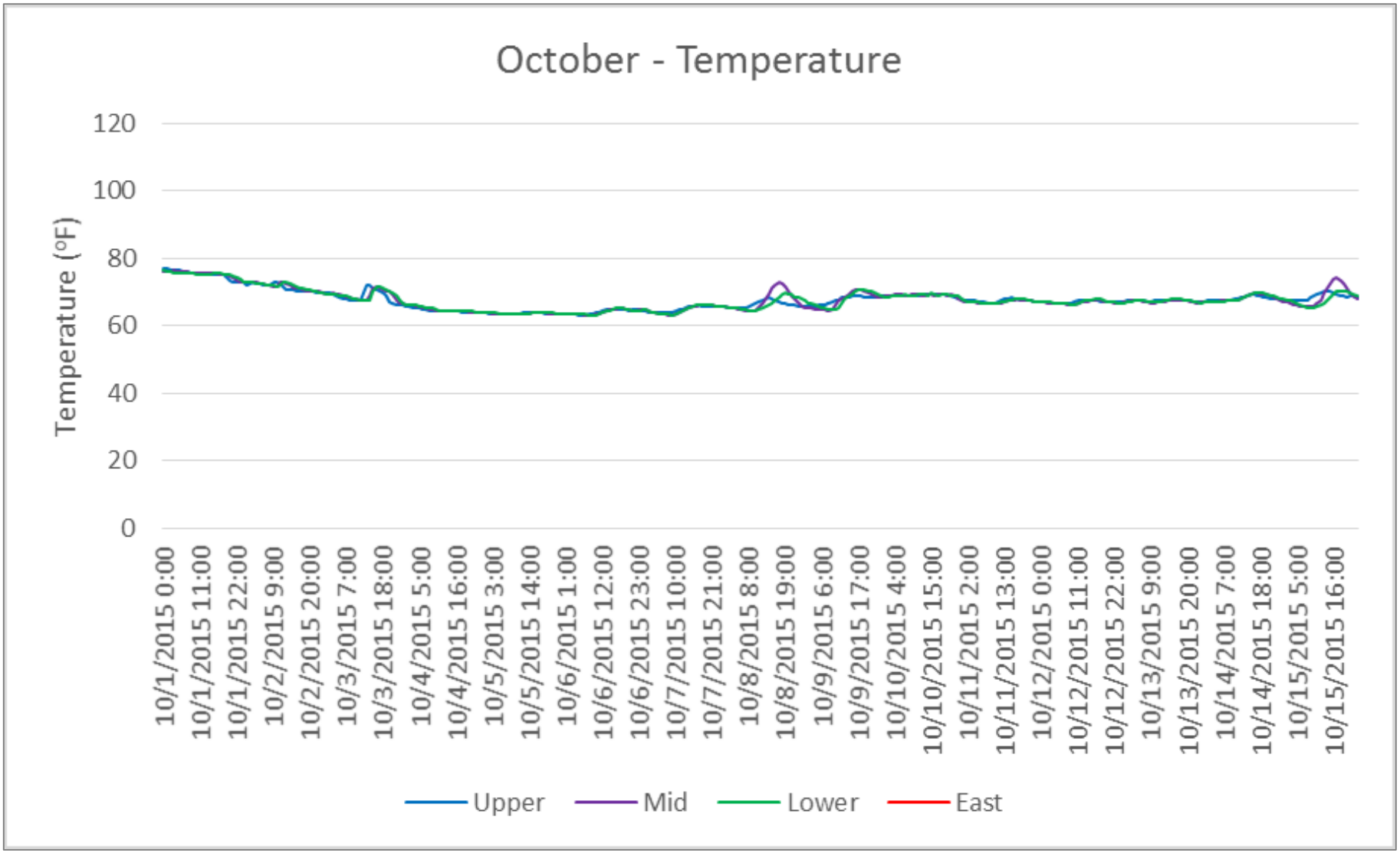


FIGURE 33 TEMPERATURE IN THE UPPER, MIDDLE, AND LOWER WEST CHANNEL AND EAST – OCTOBER 2015