Real-Time Water Quality Deployment Report

Outflow of the Steady at Rambler Mine

July 16 to
September 6, 2019

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Municipal Affairs and Environment
Water Resources Management Division

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General

- The Water Resources Management Division, in partnership with Rambler Metals and Mining Canada Ltd., maintain one real-time water quality and water quantity station at the Outflow of the Steady.
- This station is situated downstream of the Nugget Pond Mill tailings management facility (Figure 1).
- On July 16, 2019, a real-time water quality monitoring instrument was deployed at the station Outflow of the Steady shortly after installation of the station. The instrument was deployed for a period of 56 days. This was the first deployment for this station in 2019.
- Water Resources Management Division staff monitor the real-time web pages regularly.

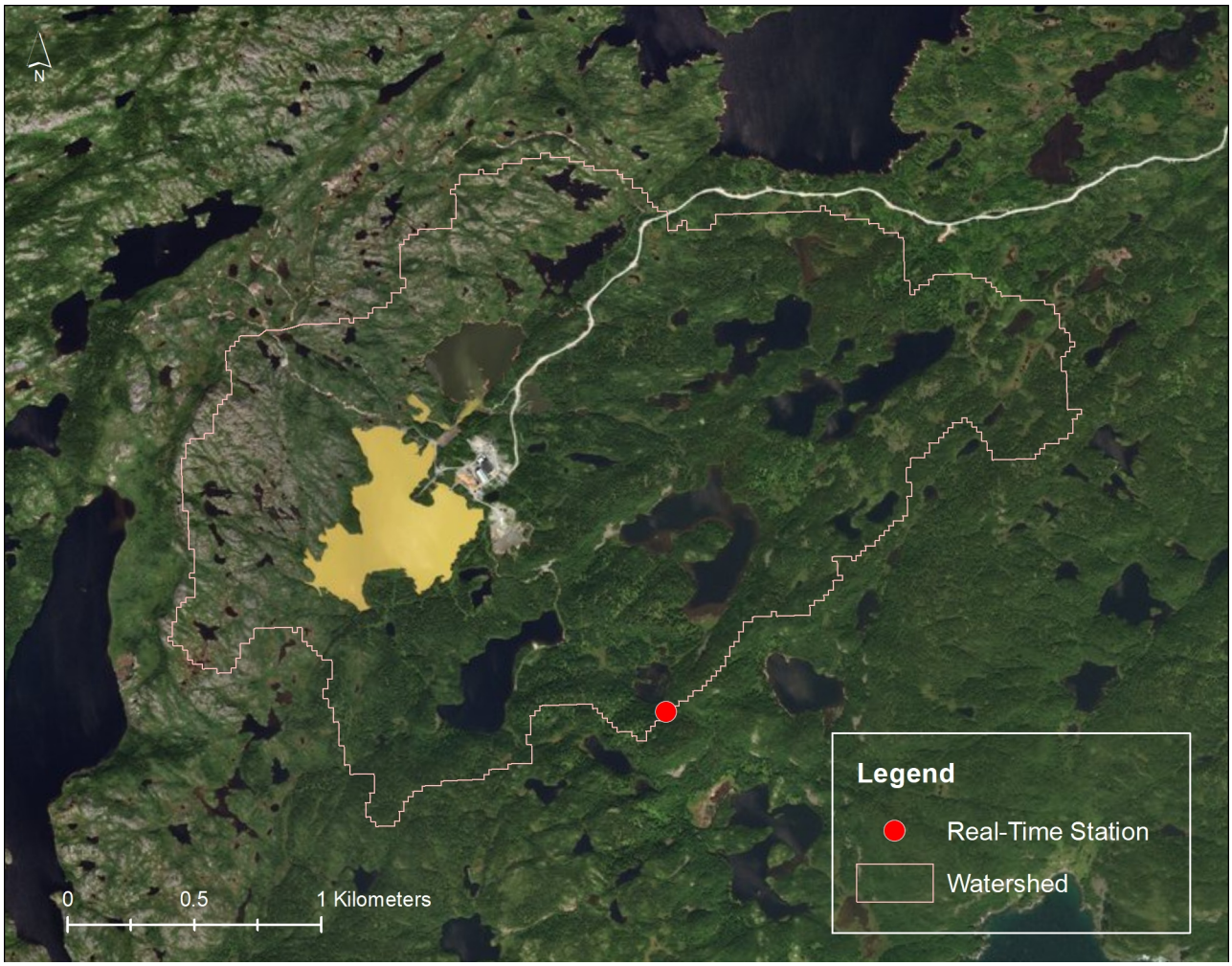

Figure 1: Location of the real-time station downstream of Rambler's Nugget Pond Mill tailings management facility

Quality Assurance and Quality Control

- As part of the Quality Assurance and Quality Control protocol (QA/QC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.
  - At deployment and removal, a QA/QC Sonde is temporarily deployed adjacent to the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments**.** Based on the degree of difference between parameters recorded by the Field Sonde and QA/QC Sonde at deployment and at removal, a qualitative statement is made on the data quality (Table 1).

Table 1: Ranking classifications for deployment and removal

	Rank				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (°C)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	<+/-1
pH (unit)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Sp. Conductance (µS/cm)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Sp. Conductance > 35 µS/cm (%)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Dissolved Oxygen (mg/L) (% Sat)	<=+/-0.3	>+/-0.3 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Turbidity <40 NTU (NTU)	<=+/-2	>+/-2 to 5	>+/-5 to 8	>+/-8 to 10	>+/-10
Turbidity > 40 NTU (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be broken down into three groups: temperature dependant, temperature compensated and temperature independent. Because the temperature sensor is not isolated from the rest of the sonde the entire sonde must be at the same temperature before the sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.

Deployment and removal comparison rankings for the station Outflow of the Steady deployed between July 16 and September 6, 2019 are summarized in Table 2.

Table 2: Comparison rankings for Outflow of the Steady station July 16 – September 6, 2019.

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Outflow of the Steady	July 16, 2019	Deployment	NA	NA	NA	NA	NA
	Sept 6, 2019	Removal	Excellent	Excellent	Good	Excellent	Excellent

- Deployment rankings are unavailable as the QA/QC sonde reading and grab sample were overlooked for this initial deployment.
- At removal, all parameters ranked either 'good' or 'excellent'.
- There are a few circumstances which may cause less than ideal QA/QC rankings to be obtained. These include: the placement of the QA/QC sonde in relation to the field sonde, the amount of time each sonde was given to stabilize before readings were recorded; and deteriorating performance of one of the sensors.

Data Interpretation

- The following graphs and discussion illustrate water quality related events from July 16 to September 6 at the station Outflow of the Steady.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

Outflow of the Steady

- Water temperature ranged from 14.25 to 23.85°C during this deployment period (Figure 2).
- Water temperature remained relatively steady during the summer months before dropping steadily in late August and into September. This decrease in water temperature corresponds with ambient air temperatures as summer changes into fall (Figure 2).

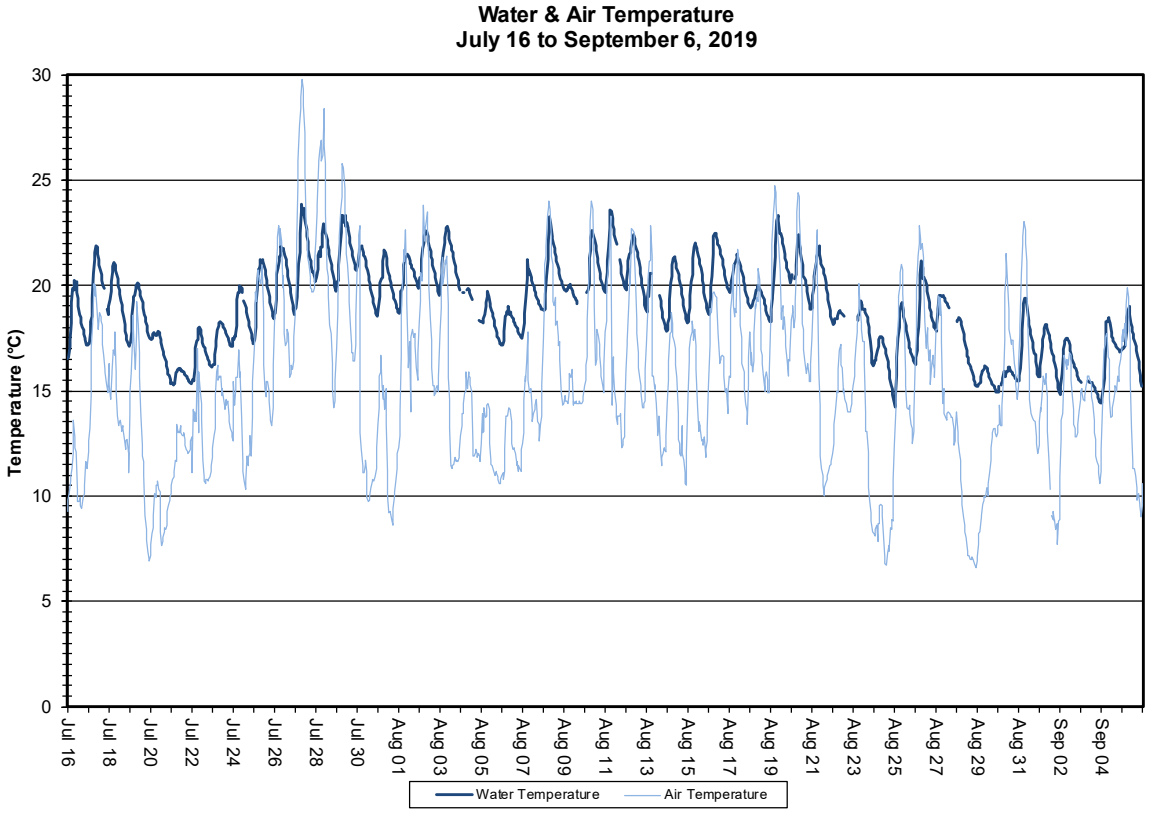

Figure 2: Water and Air Temperature – Outflow of the Steady

(Weather data collected at La Scie)

- pH ranged between 6.84 and 7.41 pH units throughout the deployment period, with a median value of 7.11 units (Figure 3).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units). pH fluctuates slightly during the day and night.
- Significant rainfall on August 13th (evident as a rise in stage levels) caused a slight dip in pH levels. This is a common occurrence in freshwater as the slightly acidic rain influences the overall pH of the river for a short period of time.
- Overall, pH was stable for the first portion of the deployment, but was trending upward late August into September.

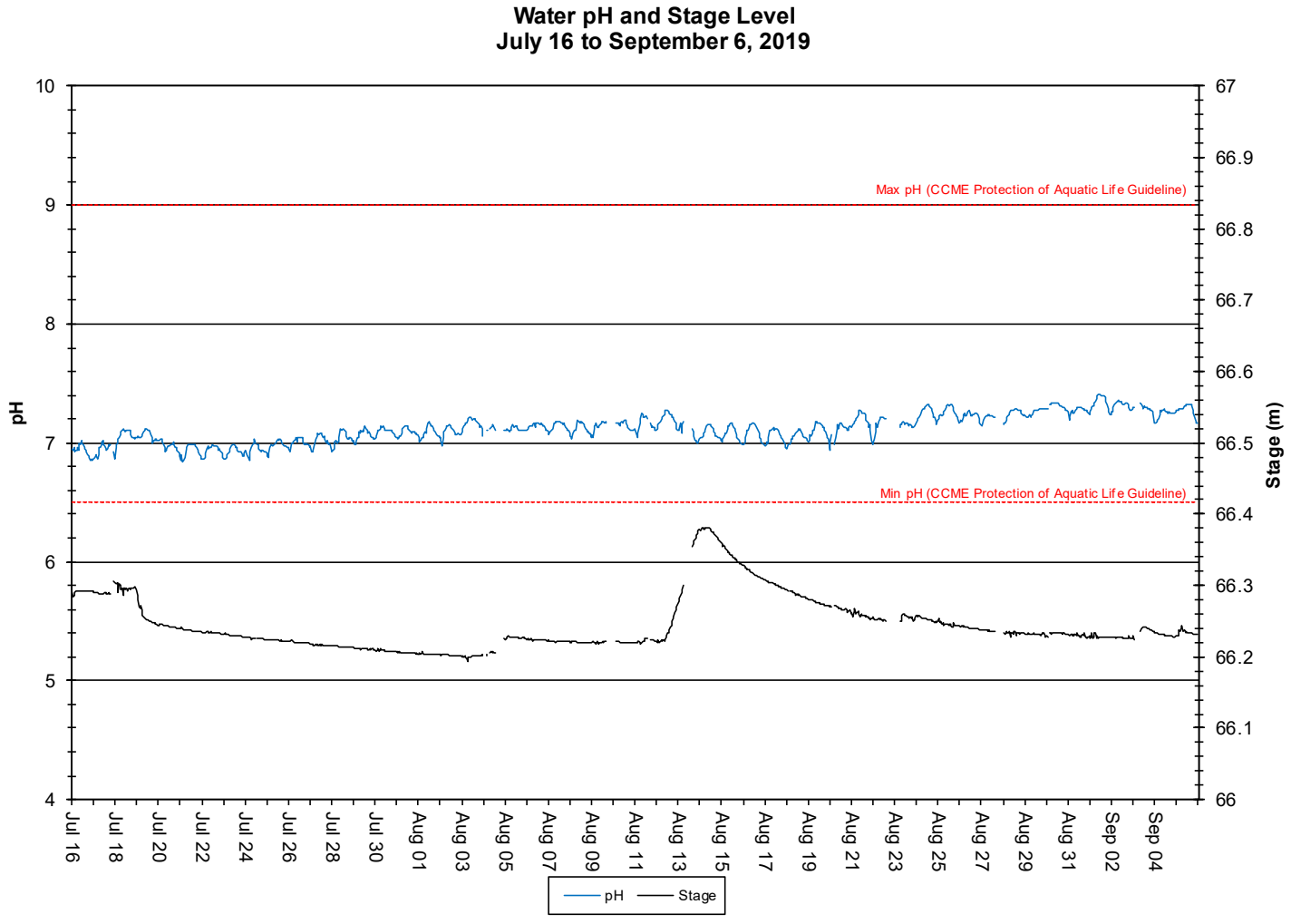

Figure 3: Water pH and Stage – Outflow of the Steady

- Specific conductivity ranged from 124.1 to 206.8 µs/cm (Figure 4).
- Specific conductivity steadily increased over the course of this deployment period.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

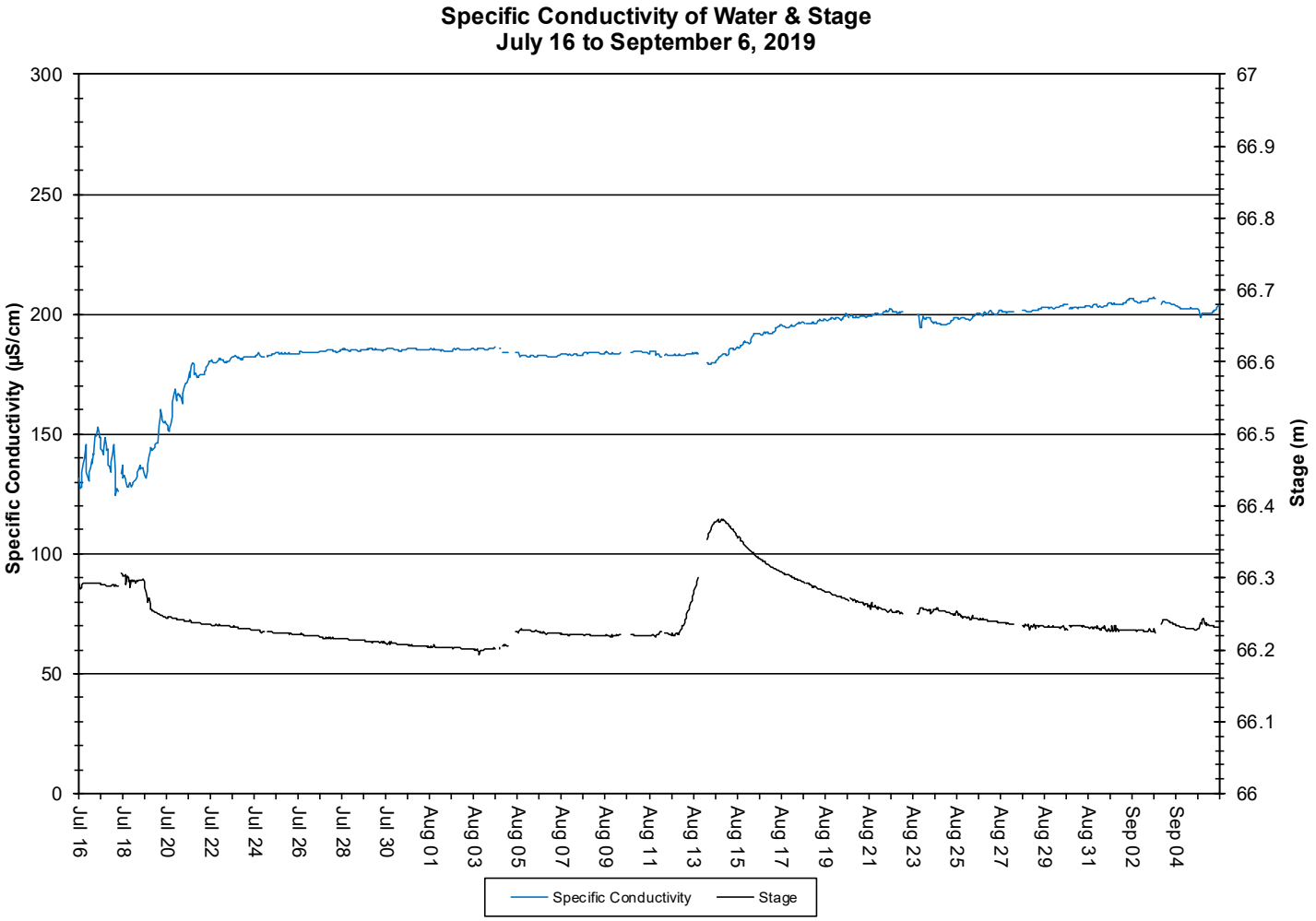

Figure 4: Specific Conductivity of Water and Stage - Outflow of the Steady

- The saturation of dissolved oxygen ranged from 89.3% to 110.8% and a range of 8.10 to 10.20 mg/l was found for the concentration of dissolved oxygen with a median value of 9.28 mg/l (Figure 5).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stages of Cold Water Biota of 6.5 mg/l. The majority of values were below the minimum CCME Guideline for the Protection of Early Life Stages of Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in red on Figure 5.
- Dissolved oxygen content fluctuates diurnally, displaying the inverse relationship to water temperature. Dissolved oxygen decreased during the first portion of this deployment period as water temperatures warmed, before increasing again in the later portion of the deployment as water temperatures cooled into early fall.

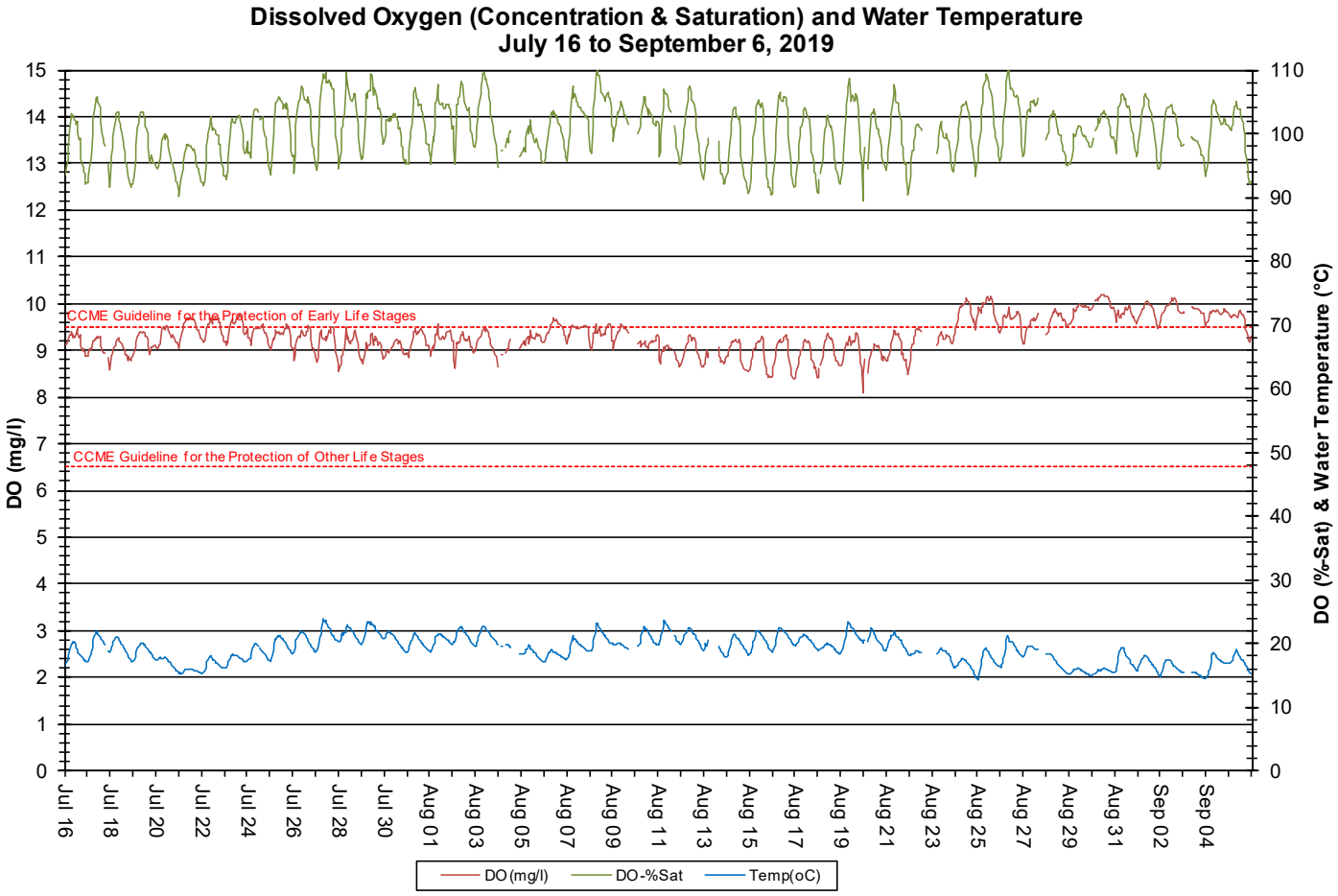

Figure 5: Dissolved Oxygen and Water Temperature – Outflow of the Steady

- Turbidity values range from 0.0 NTU to 1.4 NTU with a median of 0.3, indicating very clear background turbidity.
- Turbidity increased when water levels were dropping and decreased when stage increased due to precipitation (Figure 6). This indicates rainfall may assist in flushing out sediment from the brook.

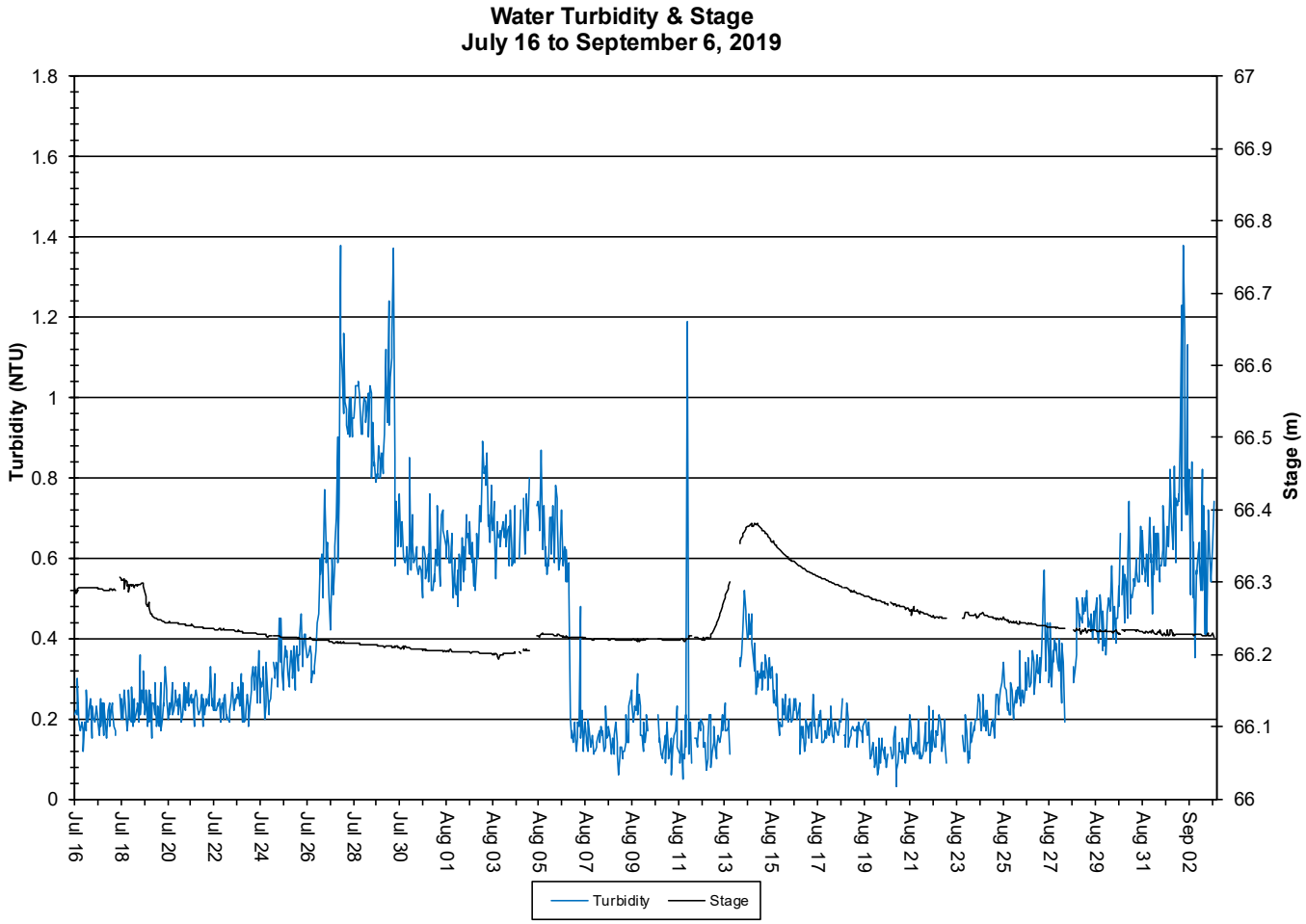

Figure 6: Turbidity and Stage – Outflow of the Steady

- Precipitation and stage during the deployment period are graphed below (Figure 7). Stage was decreasing in the first portion of the deployment before a significant rainfall event of 22mm on August 13 caused the stage to rise rapidly. Stage then decreased steadily in the later portion of the deployment.
- It is notable from the data that precipitation did not always lead to an increase in stage at this location.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

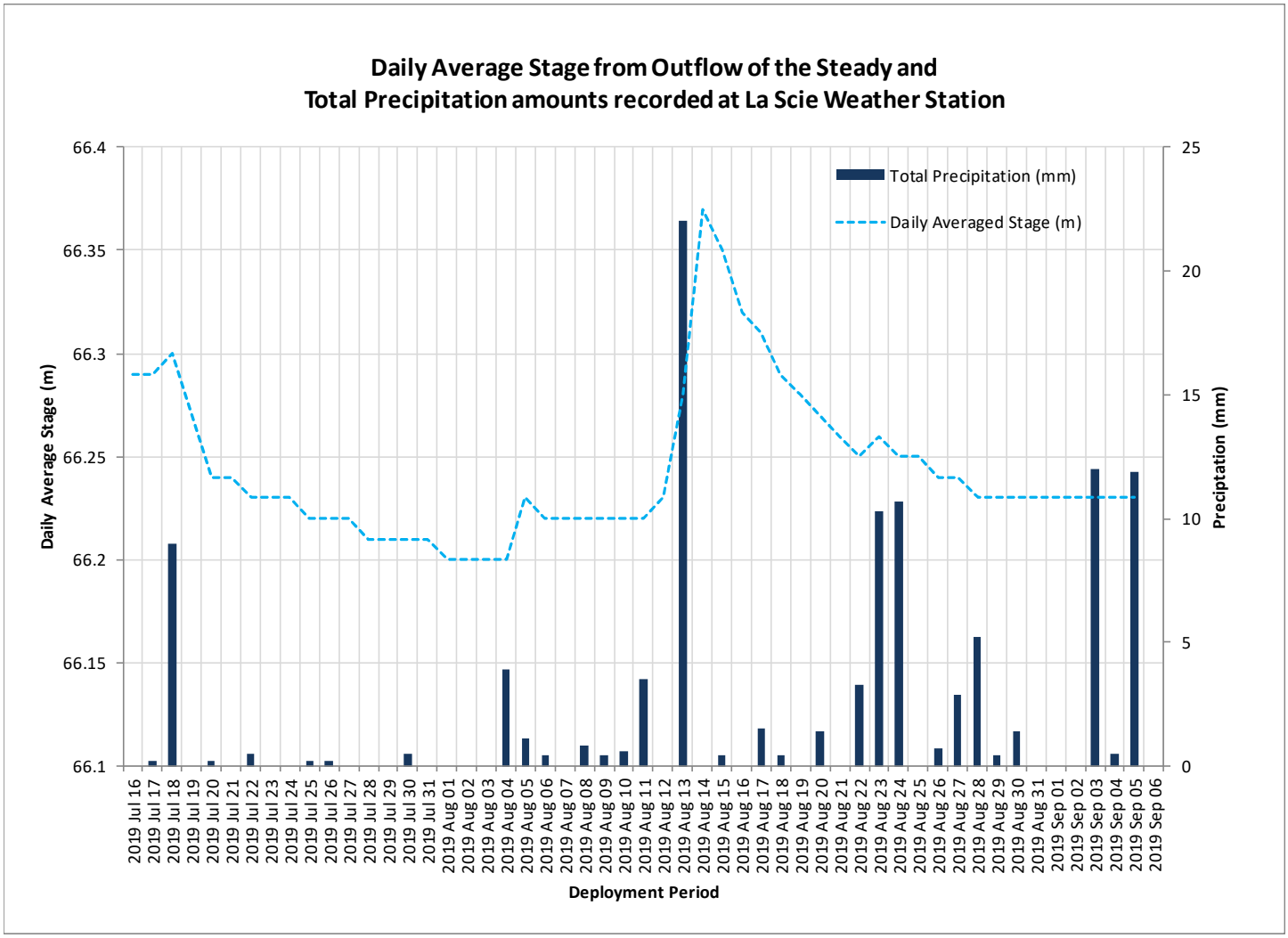

Figure 7: Precipitation and Stage – Outflow of the Steady

Conclusions

- An instrument was deployed at the Outflow of the Steady water quality monitoring station on July 16 and removed on September 6, 2019. This was the first deployment of the 2019 season.
- In most cases, weather related events or increases/decreases in water level explain parameter fluctuations.
- Water temperature increased during the early portion of the deployment period before cooling as fall approached, ranging from 23.85 down to 14.25^{o}C. This is expected due to the influence of the ambient air temperature as it changes between seasons.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 6.84 and 7.41. The brook is influenced by large precipitation events which decrease pH values for a short time.
- Specific conductivity ranged from 124.1 to 206.8 µs/cm, showing a slight increasing trend during the deployment.
- Dissolved oxygen values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. The majority of values were below the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l as water temperatures were warm in the summer months.
- Turbidity values of 0.0 NTU to 1.4NTU indicated low background turbidity. Increasing turbidity during periods of low water levels followed by decreased turbidity after significant stage increase indicate the instrument and river may be prone to biofouling or sediment buildup.
- Stage fluctuated during this deployment period, decreasing during the first half, before increasing after high precipitation and then decreasing again as fall approached.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

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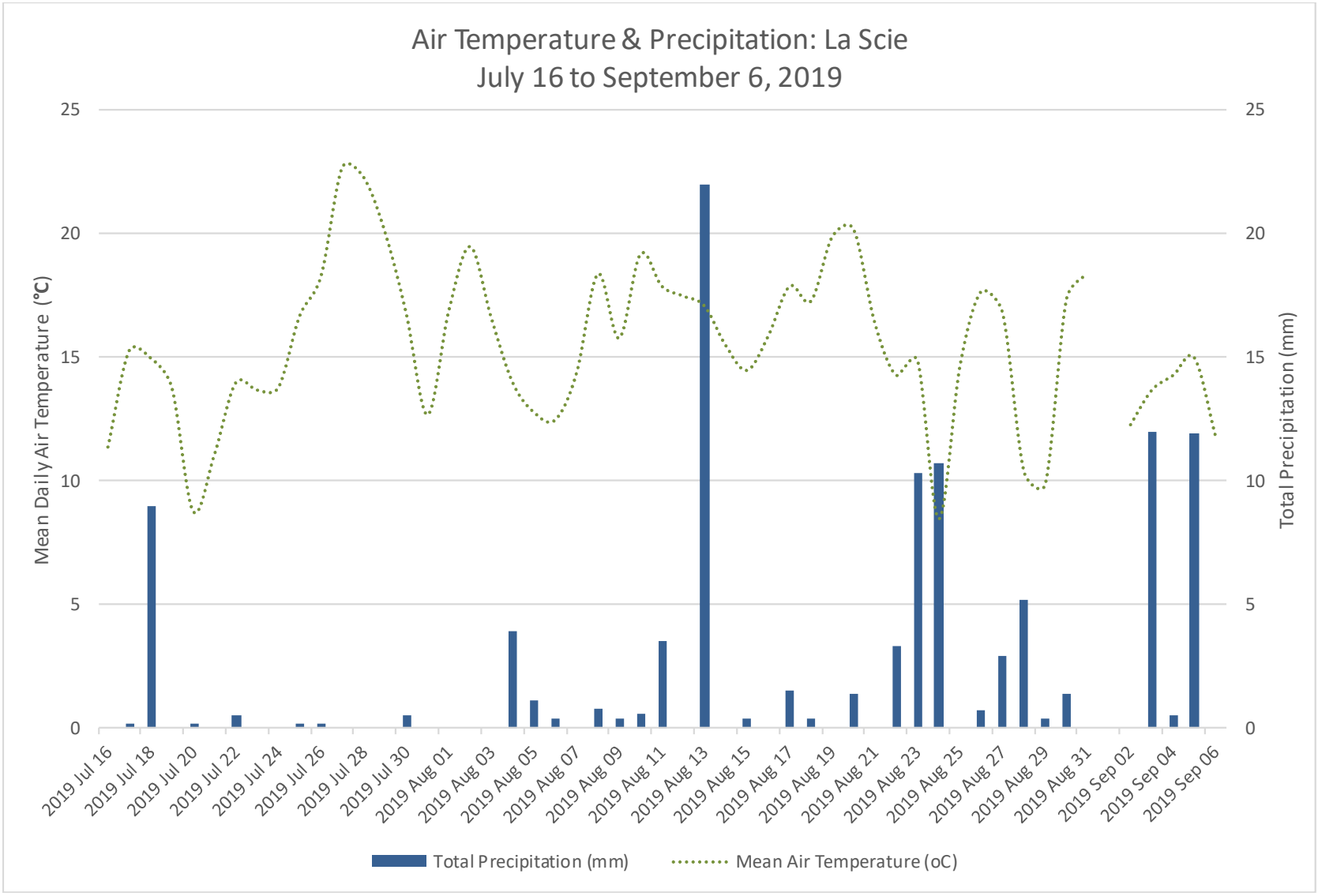
Appendix 1


Air Temperature & Precipitation: La Scie
July 16 to September 6, 2019
Mean Daily Air Temperature (°C)
Total Precipitation (mm)
25
20
15
10
5
0
2019 Jul 16
2019 Jul 18
2019 Jul 20
2019 Jul 22
2019 Jul 24
2019 Jul 26
2019 Jul 28
2019 Jul 30
2019 Aug 01
2019 Aug 03
2019 Aug 05
2019 Aug 07
2019 Aug 09
2019 Aug 11
2019 Aug 13
2019 Aug 15
2019 Aug 17
2019 Aug 19
2019 Aug 21
2019 Aug 23
2019 Aug 25
2019 Aug 27
2019 Aug 29
2019 Aug 31
2019 Sep 02
2019 Sep 04
2019 Sep 06
Total Precipitation (mm)
Mean Air Temperature (oC)