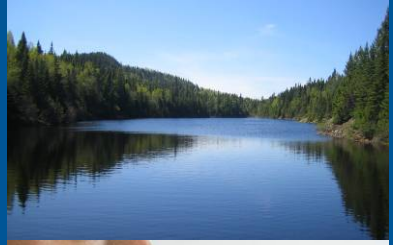
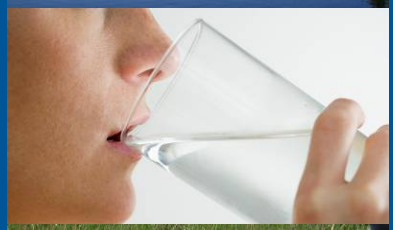






Real-Time Water Quality Report

Leary's Brook at Prince Philip Drive

Deployment Period
March 30, 2016 to May 12, 2016

Newfoundland Labrador

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

Leary's Brook, Newfoundland and Labrador

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General

- The Water Resources Management Division (WRMD), in partnership with Environment Canada, maintains a real-time water quality and water quantity monitoring station at Leary's Brook adjacent to Prince Phillip Parkway.
- The real-time station allows for assessment and management of the water body. This deployment report discusses water quality related events occurring at the Leary's Brook station.
- The purpose of this real-time station is to monitor, process and publish hydrometric (water quantity) and real-time water quality data at the real-time station. Leary's Brook is an urban stream that flows through industrial and commercial areas and adjacent to a major roadway.
- This report covers the period between the deployment on March 30, 2016 and removal on May 12, 2016.

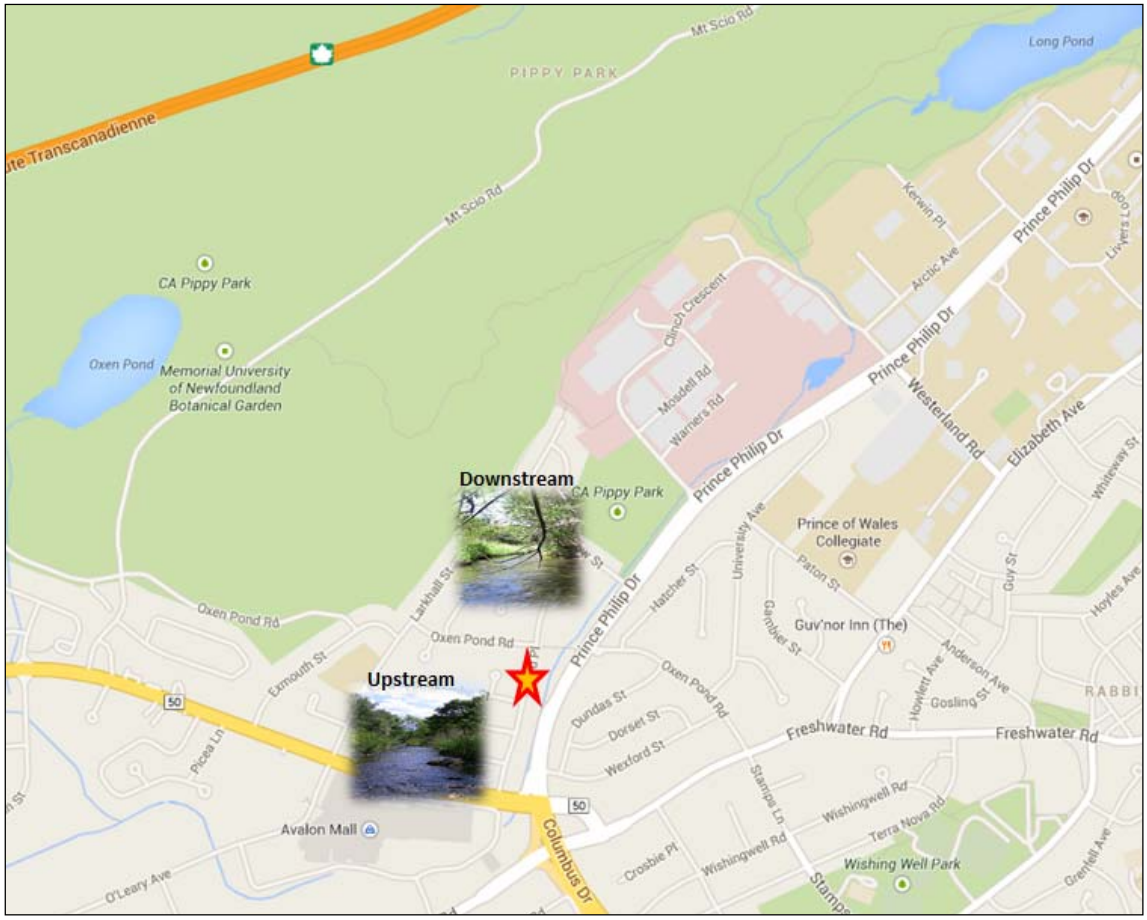

Figure 1: Leary's Brook Real-Time Water Quality and Quantity Station.

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 alongside 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 the parameters on 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: Instrument Performance 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

- The temperature sensor on any sonde is the most important. All other parameters can be divided into subgroups of: temperature dependent, temperature compensated and temperature independent. Due to the temperature sensor's location on the sonde, the entire sonde must be at a constant temperature before the temperature 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 instrument performance rankings for **Leary's Brook** for the period of March 30, 2016 to May 12, 2016 are summarized in Table 2.

Table 2: Instrument performance rankings for Leary's Brook

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Leary's Brook	**March 30, 2016**	**Deployment**	Good	Excellent	Excellent	Excellent	Excellent
	May 12, 2016	**Removal**	Good	Good	Excellent	Excellent	Fair

- At the Leary's Brook station at the time of deployment, the pH, dissolved oxygen, conductivity and turbidity readings ranked as "Excellent". The temperature ranked as 'Good' .

- At the time of removal, conductivity and dissolved oxygen ranked as "Excellent", temperature and pH ranked as good, while turbidity ranked as fair.
- Turbidity readings near the end of the deployment period are suspect because of increased biofouling on the sensor.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from March 30, 2016 to May 12, 2016 at the Leary's Brook station.
- Automatic data transmission was lost from 10:02 PM on April 29 to 6:17 AM on May 1. Flow and stage data is not available for that period as illustrated by the various graphs below. Water quality data for that period has been partially supplemented with data logged internally on the field sonde.
- 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. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected and finalized data may be retrieved from the Water Survey of Canada website (http://www.ec.gc.ca/rhc-wsc/)
- Precipitation data from the deployment period was retrieved from the Environment Canada weather station at St. John's International Airport.

Leary's Brook

Water Temperature

- Water temperature ranged from -0.06°C to 15.00°C during this deployment period (Figure 2).
- Water temperature at Leary's Brook displays a typical variation over the deployment period. Water temperature is influenced by air temperature.
- The water temperature data displayed on Figure 2 is typical of shallow streams and ponds. Shallow water bodies are highly influenced by variations in ambient air temperatures. Water temperature also falls overnight and rises during daylight hours.
- Unusually cold air temperatures on April 20 caused a noticeable dip in water temperature after several days of warmer temperatures.

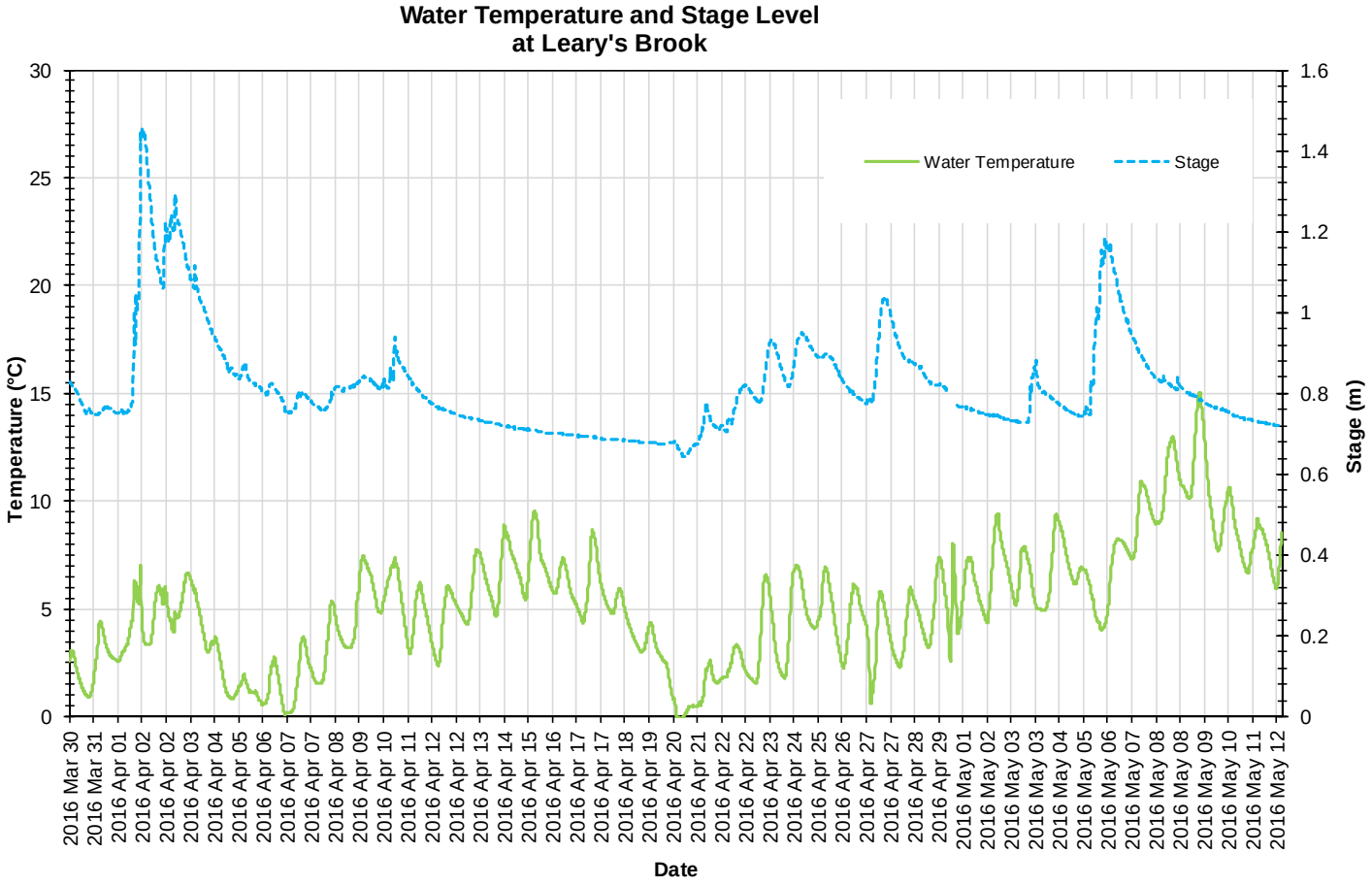

Figure 2: Water Temperature and Stage Level at Leary's Brook

pH

- Throughout this deployment period pH values ranged between 6.02 pH units and 6.80 pH units (Figure 3).
- For most of the deployment, pH values were near the minimum CCME Guidelines for the Protection of Aquatic Life (6.5 pH units).
- The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different. Leary's Brook pH median was 6.55 (pH units) for this deployment period.
- As illustrated below, pH typically falls slightly in Leary's Brook (the water becomes more acidic) at the same time as stage and flow are increasing (see inside ovals). In general, precipitation entering Leary's Brook has a lower pH than local surface water and this causes a reduction in the pH of the brook.

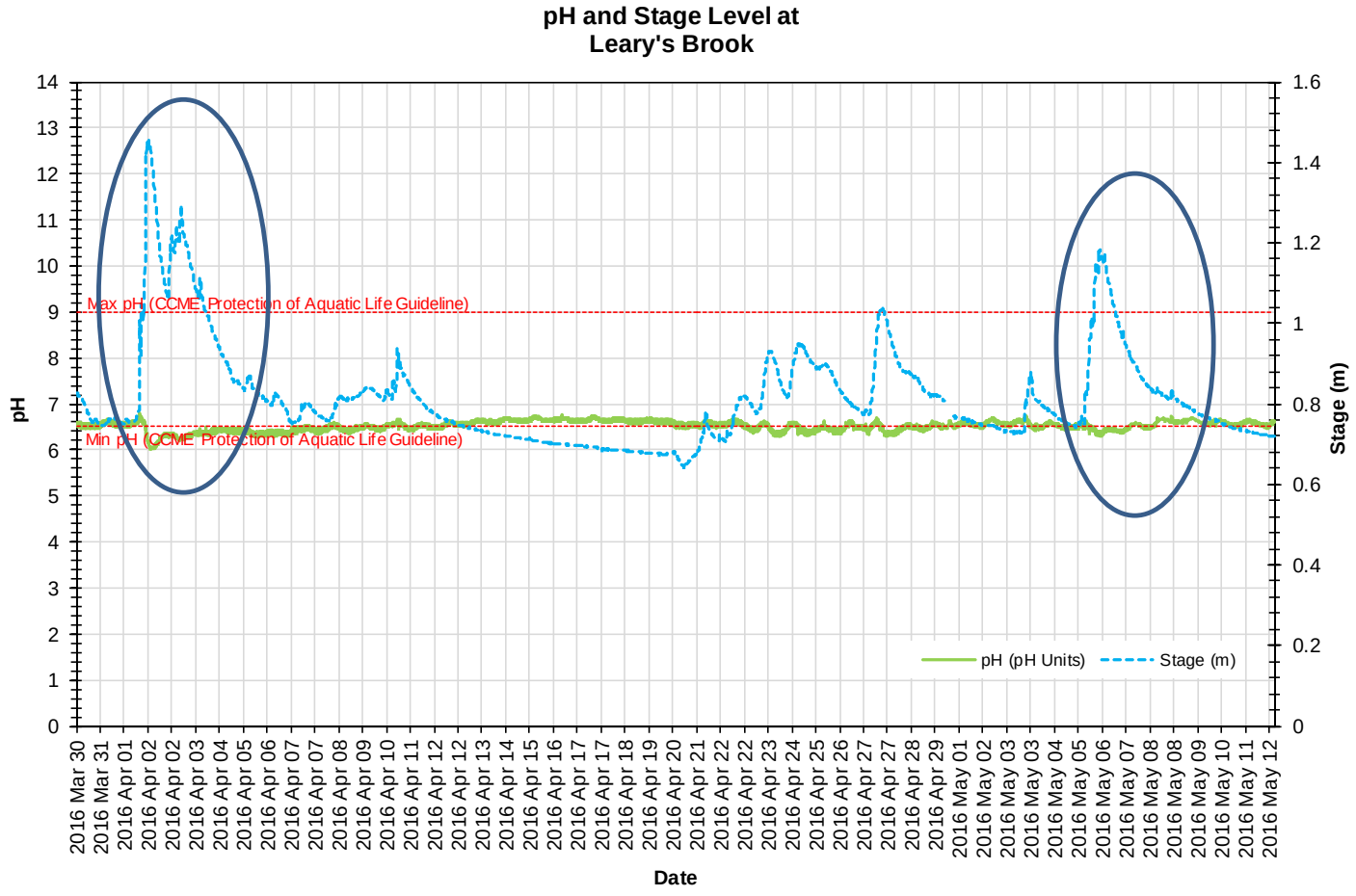

Figure 3: pH (pH units) values at Leary's Brook Station

Specific Conductivity

- The conductivity levels ranged between 346.0 µS/cm and 5418.0 µS/cm during this deployment period. The median was 805.0 µS/cm. TDS ranged from 0.2220 g/ml to 3.4700 g/ml. (Figure 4)
- Peaks in conductivity seen during this deployment period are believed to be associated with road and parking lot salting upstream of the Leary's Brook station due to below freezing temperatures overnight. The highest conductivity and TDS occurred during the late morning and early afternoon of April 6 as road salts were applied in response to a significant snowfall. Another significant peak in conductivity, likely as a result of road salting and runoff, occurred on the morning of April 21 following a record breaking snowfall of 49 cm.
- Peaks in conductivity recorded during the remainder of this deployment period are also believed to be associated with snowfall and road salting during the overnight period and runoff during the day.

  The graph below shows that increasing stage at this time of year can be associated with both increasing and decreasing conductivity. When runoff follows cold weather and road salting, conductivity increases with stage. When runoff occurs during warmer weather when roads are not salted, conductivity typically decreases with an increase in stage.

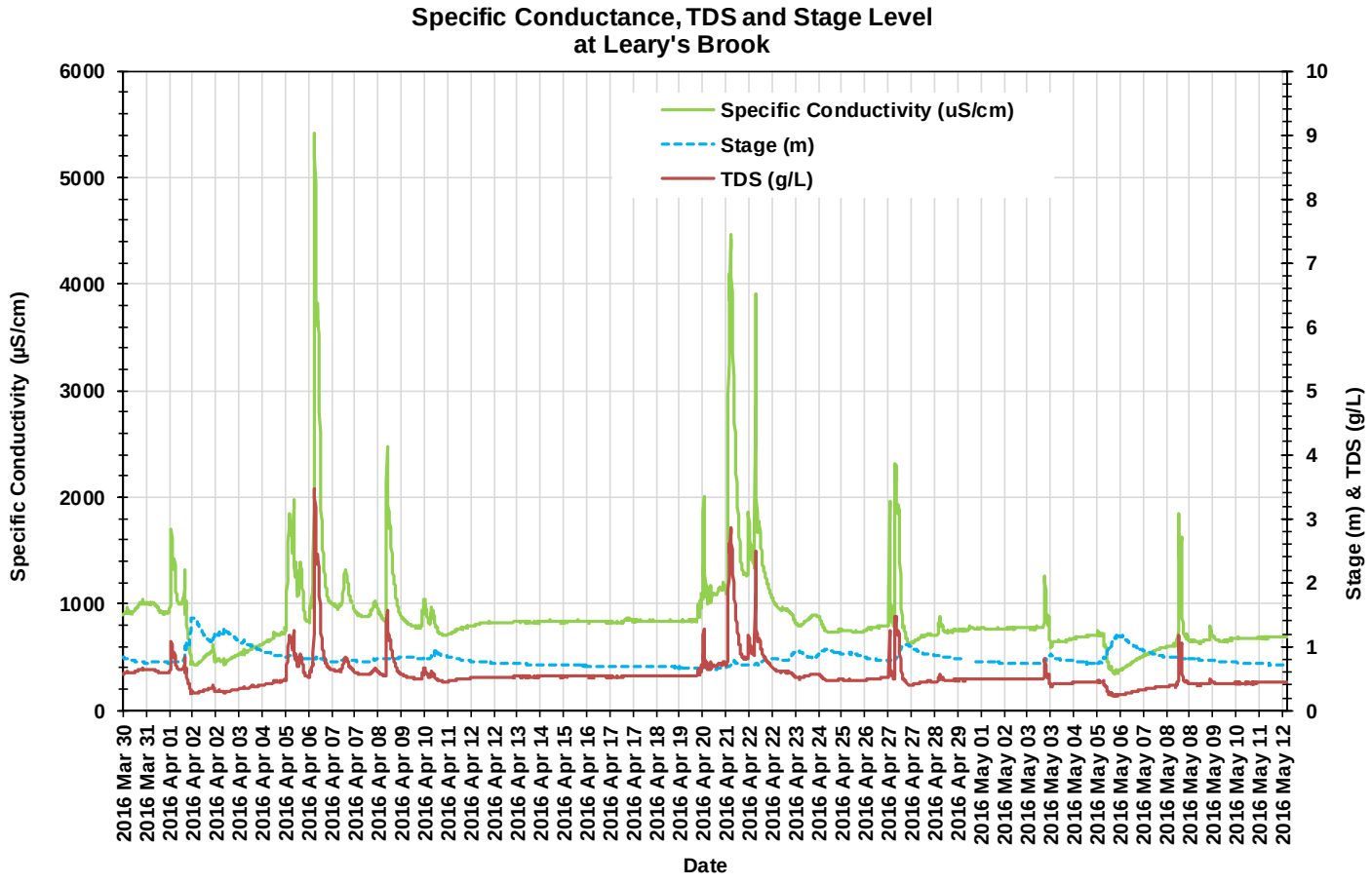

Figure 4: Specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Leary's Brook Station

Dissolved Oxygen

- The instrument measures dissolved oxygen (mg/L) directly then calculates percent saturation (% Sat.).
- The Dissolved Oxygen % Sat levels within this deployment period were between 92.6 % Sat and 100.6 % Sat. Dissolved Oxygen (mg/L) measured between 9.93 mg/L and 14.34 mg/L. (Figure 5)
- Dissolved oxygen is often above 100% saturation in natural systems as pure oxygen is produced by photosynthesizing aquatic plants and because equilibrium between air and water is not instantaneous
- The DO mg/L values are consistently above the minimum DO CCME guideline for early life stages for this deployment period (Figure 5).
- Small dips in mg/L values are associated with increases in water temperature. Cool water can hold more dissolved oxygen than warmer water.

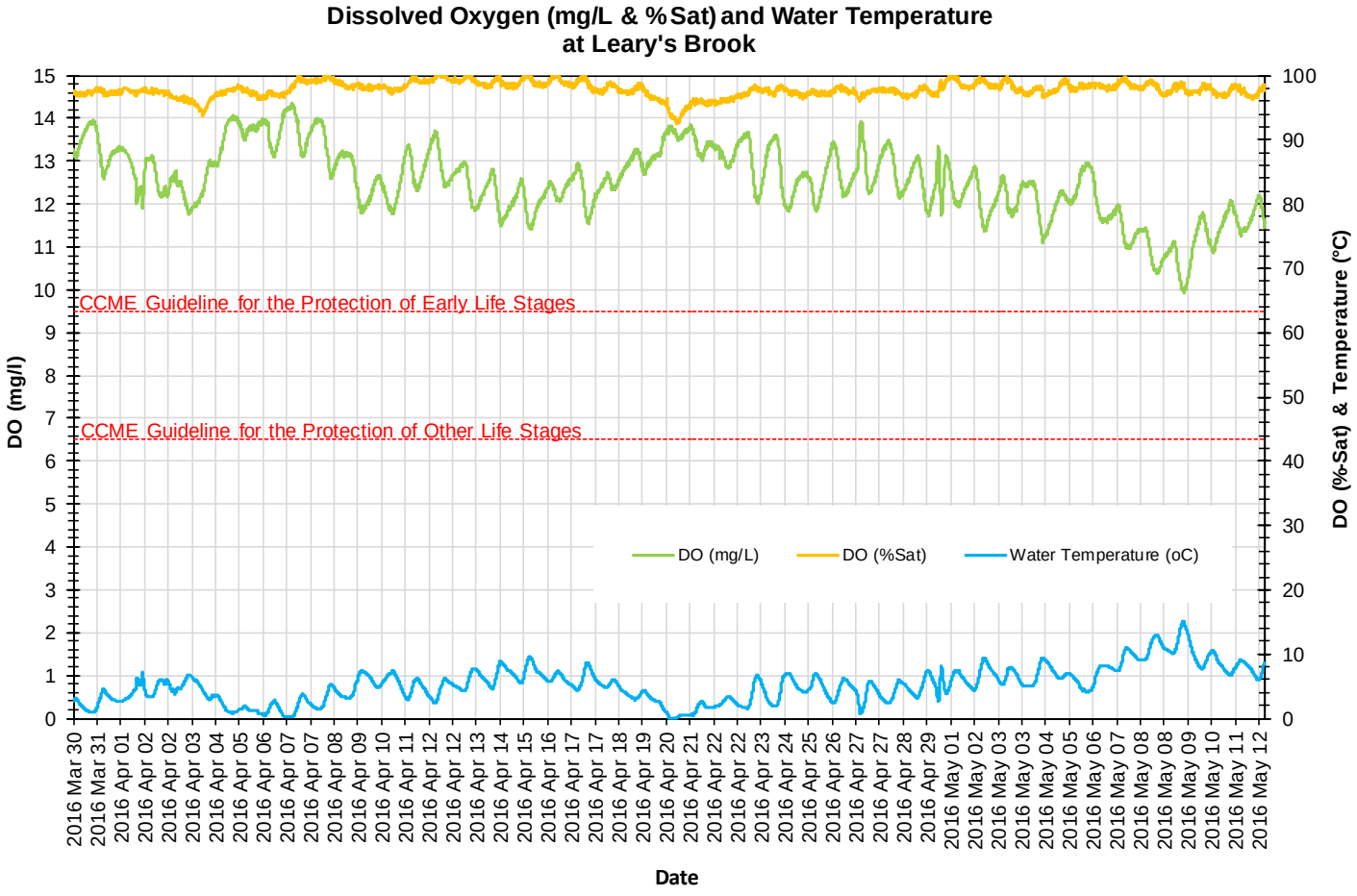

Figure 5: Dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Leary's Brook Station

Turbidity

- The turbidity sensor records values between 0 NTU and 3000 NTU. A turbidity reading of 3000 NTU is identified as an error and is not a true value. Readings of 3000 NTU should not be included in any statistical analysis.
- The turbidity readings during this deployment ranged between 0.0 NTU to 515.0 NTU (Figure 6).
- Higher turbidity values closely correspond with precipitation events and elevated river stage and runoff (Figure 7). Rainfall and subsequent runoff along with increased flow carries road and bank sediment and other material into the brook which is captured by the turbidity sensor. This is typical of an urban stream where significant sediment loading is associated with even minor precipitation events.

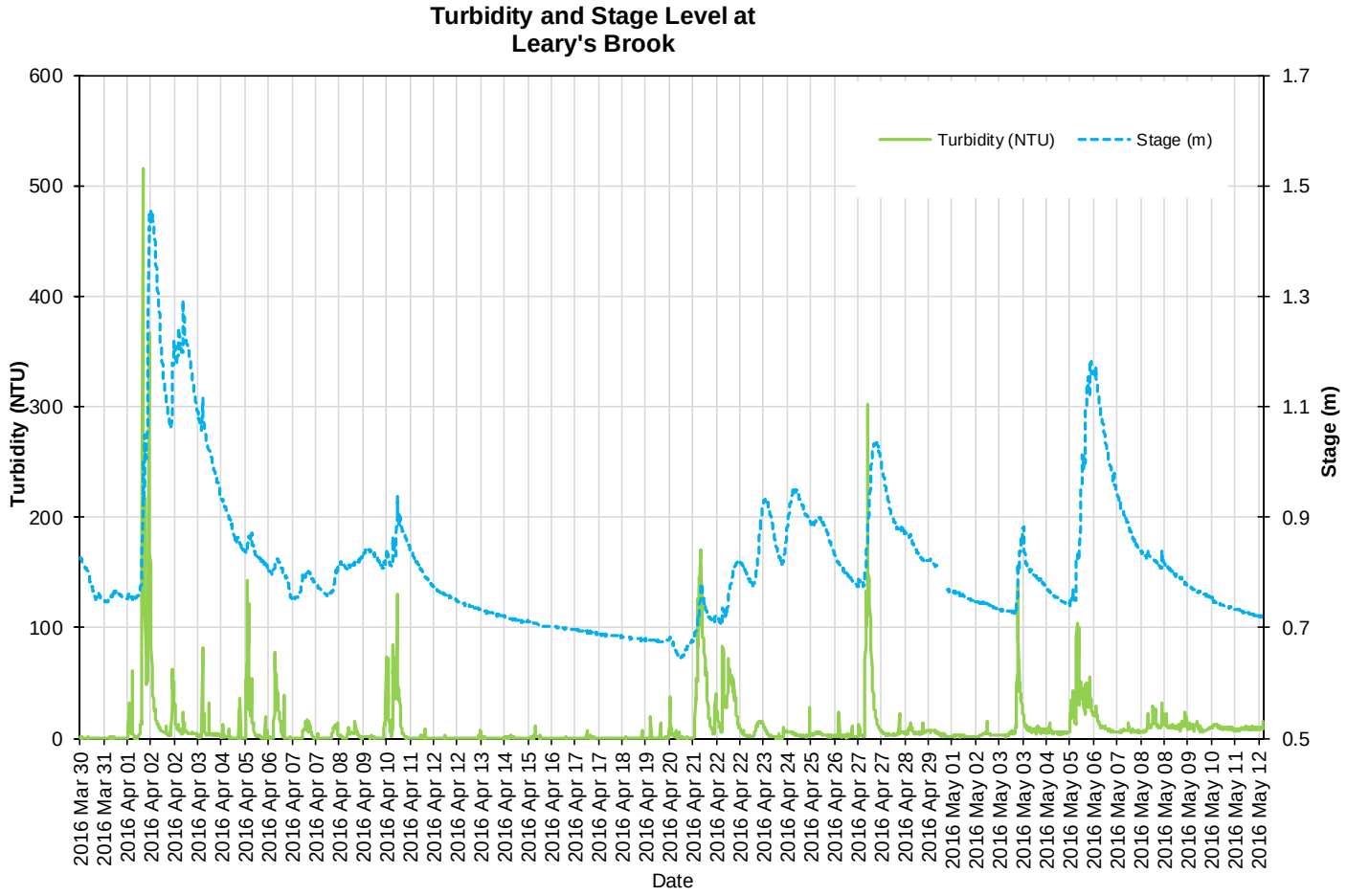

Figure 6: Turbidity (NTU) values at Leary's Brook Station

Stage and Total Precipitation

- The below graph includes daily total precipitation data from St. John's International Airport weather station and the daily average stage. Please note that the stage data in this report is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.
- Stage (and streamflow) usually varies significantly throughout the deployment period in Leary's Brook. Stage is directly influenced by rainfall and subsequent runoff from the surrounding environment. Precipitation runoff impacts urban streams relatively quickly as rainfall flows across impervious surfaces such as roads and parking lots and then into storm drains.
- Precipitation occurring as snow or mostly snow does not cause an immediate significant increase in stage or flow. This can be clearly seen on April 20 when a heavy snowfall did not cause an increase in stage in Leary's Brook.
- Precipitation in the form of rain falling on April 1 caused an immediate and rapid increase in stage.

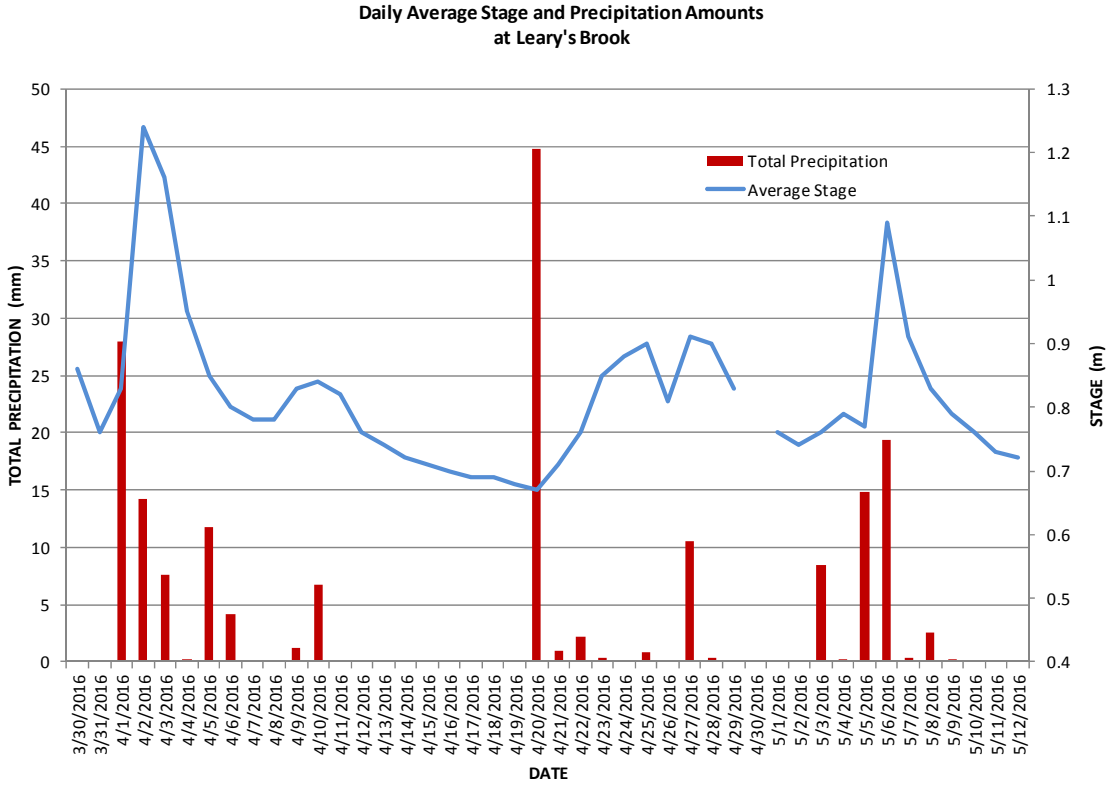

Figure 7: Daily average stage values (m) from Leary's Brook Station and daily total precipitation values (mm) from St. John's International Airport.

Conclusions

Generally in both natural and urban environments, climate and weather conditions can contribute in large part to variations in water quality. During this deployment it was evident that many of the changes in Leary's Brook water quality are related to intermittent precipitation events and small climatic changes of the seasons. The impact of road salting and relatively high sediment loads in urban runoff was also evident during this deployment period.

Rainfall and snowmelt events during the deployment period led to related increases in stage, which thus influenced the values of turbidity, pH, specific conductance, and TDS. Also, when ambient air temperatures increased there were correspondingly warmer water temperatures, which in turn slightly decreased the amount of dissolved oxygen in the water.

During this deployment period the median water temperature at the Leary's Brook station was 5.08°C.

The median pH value for Leary's Brook Station was 6.55 (pH units). The pH level for the most part, falls at this station during rainfall events and increases during dry periods.

Dissolved Oxygen at Leary's Brook had a median of 97.8 %Sat and 12.53 mg/L during the deployment period. Small reductions in DO (mg/L and % Sat) correspond with increases in water temperatures.

The turbidity median value at Leary's Brook during deployment was 2.9 NTU. Increases in stage level can explain most of the peaks in the turbidity values during the deployment period. As organic matter and sediments are washed into the brook, the suspended matter in the water column will increase and the turbidity sensor will detect an increase in water cloudiness.