Real-Time Water Quality Deployment Report

Outer Cove Brook Stations

April 6 to May 9, 2012

Newfoundland Labrador

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

Contents

General

- Department of Environment and Conservation staff monitors the real-time web pages regularly.
- This deployment report discusses water quality related events occurring at the stations: Outer Cove Brook below Airport and Outer Cove Brook at Clovelly Golf Course in St. John's.
- On April 6, 2012, 2 real-time water quality monitoring instruments were deployed for the first time in Outer Cove Brook located within the City of St. John's (see Figure 1). The instruments are scheduled to be deployed for 30 to 40 days.
- The purpose of these real-time stations is to monitor, process and publish hydrometric (water quantity) and real-time water quality data at the real-time stations. Outer Cove Brook is in the vicinity of the Torbay Road North Commercial Development Area and the real-time stations allow for assessment and management of the water body.
- This report covers the deployment period between April 6, 2012 until removal on May 8, 2012.

Figure 1. Outer Cove Brook Stations within the City of St. John's

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: 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 divided into subgroups of: temperature dependant, 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 comparison rankings for Outer Cove Brook below Airport for the period of April 6 through to May 8, 2012 is summarized in Table 2.

Table 2: Comparison rankings Outer Cove Brook below Airport April 6 – May 8, 2012

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Below Airport	April 6 2012	Deployment	Excellent	Excellent	Good	Excellent	Excellent
	May 8 2012	Removal	Excellent	Excellent	Poor	Excellent	Poor

Outer Cove Brook, Newfoundland and Labrador

- At the Outer Cove Brook below Airport station, temperature, pH, dissolved oxygen and turbidity ranked 'excellent' at deployment while conductivity ranked 'good'. For the first deployment of freshly calibrated instruments this is a very good overall ranking.

- At removal, temperature, pH and dissolved oxygen continued to rank 'excellent', while conductivity and turbidity ranked 'poor'. After 33 days deployment the sonde had become completely coated in a brown-red slime. On inspection, it was noticed that all of the probes were covered in the slime. The slime can interfere with the sensors ability to read water quality correctly. Turbidity is the most sensitive sensor for this type of interference. The conductivity probe has an opening in it that can also encourage the built up biofoul. This was noted to be the case for both sensors during removal.
- Deployment and removal comparison rankings for Outer Cove Brook at Clovelly Golf Course for the period of April 6 through to May 8, 2012 is summarized in Table 3.

Table 3: Comparison rankings Outer Cove Brook at Clovelly Golf Course April 6 – May 8, 2012

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Clovelly Golf Course	April 6 2012	Deployment	Excellent	Excellent	Good	Poor	Good
	May 8 2012	Removal	Good	Excellent	Fair	Poor	Good

- At the Outer Cove Brook Clovelly Golf Course station, temperature, pH and conductivity ranked within 'excellent' and 'good' at deployment while dissolved oxygen ranked 'poor'. The 'poor' reading for the dissolved oxygen was noted, though extremely unusual for a new instrument. It was assumed that were was an error with the QAQC instrument. We now know that it was actually a problem with the sensor on the newly purchased instrument.

- At removal, temperature, pH and turbidity ranked within 'excellent' and 'good', conductivity ranked at 'fair' and dissolved oxygen continued to rank as 'poor'. At the time of removal, it was clear that the dissolved oxygen probe was not functioning correctly, therefore the percent saturation and mg/L readings are inaccurate and cannot be included in the Data Interpretation section of this report.

- This brook has a large amount of algae growing and it was very hard to select a location for the sonde where the probes wouldn't be influenced by the large hair-like algae. The algae may cause issues periodically if it becomes tangled around the turbidity sensor or blocks the conductivity window.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from April 6 to May 8 at the Outer Cove Brook Stations.
- 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 data can be obtained upon request from Water Survey of Canada.
- There is no data for Dissolved Oxygen during this deployment period. The Dissolved Oxygen on both instruments had failed and the data provided was inaccurate and incorrect for that time. The decision was made to remove the incorrect data from the file; there will be no graph for dissolved oxygen.

Outer Cove Brook below Airport

Water Temperature

- Water temperature ranged from 1.80 °C to 13.50°C during this deployment period (Figure 2). The average temperature during this deployment period was 6.52 °C.
- There is a natural diurnal pattern to the water temperature data when graphed, this is the response to the air temperature around the water as day turns to night and night turns to day. Day temperatures are generally higher and night temperatures are generally lower. This pattern is visible on Figure 2.
- This time of year is the spring thaw from the winter, and the surrounding grounds and banks defrost pushing off excess melt water into the river. The water temperatures of surrounding brooks are directly influenced by the runoff and result in fluctuating water temperatures.
- Water Temperature is an important parameter as it influences other parameters.
- Towards the end of the deployment period there is some evidence with the display on the graph that water temperatures are starting to increase slightly as the climate adjusts towards warmer air temperatures.

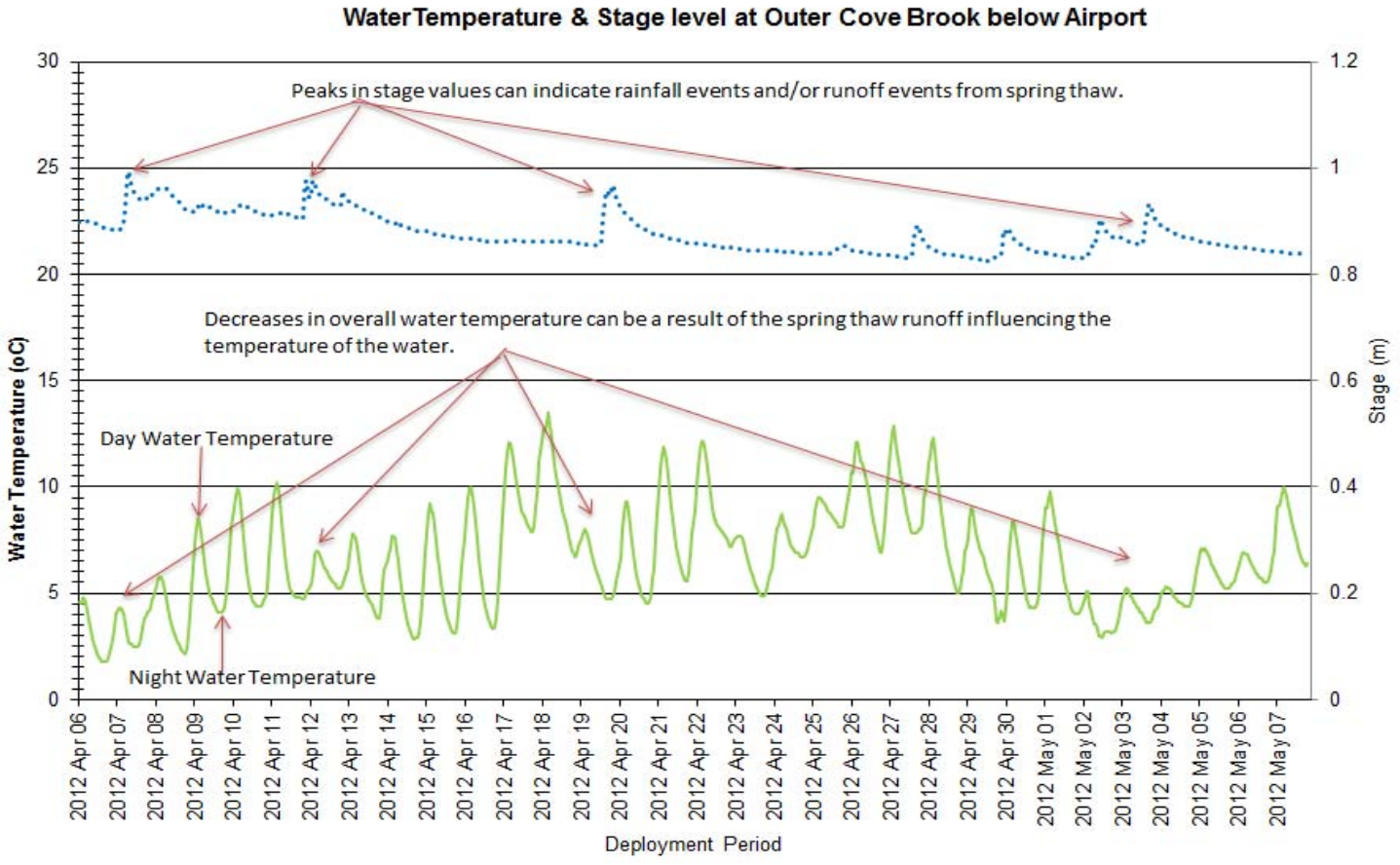

Figure 2: Water temperature and Stage Level at Outer Cove Brook below Airport

pH

- pH ranges between 6.59 and 6.21 pH units throughout this deployment period (Figure 3). The average pH reading during this time was 6.45
- During the deployment, the pH values at this station sit just below the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 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, as in the case of Outer Cove Brook below Airport's natural slightly acidic pH levels.
- The pH values at this station remain constant during the deployment period.
- Stage levels indicate increases in stream level during the deployment period; it is unclear whether it is due to rainfall or runoff from the surrounding banks. Sometimes rainfall and/or runoff can influence the pH values to a lower pH level, hence slightly increasing the acidity of the stream for a short time.

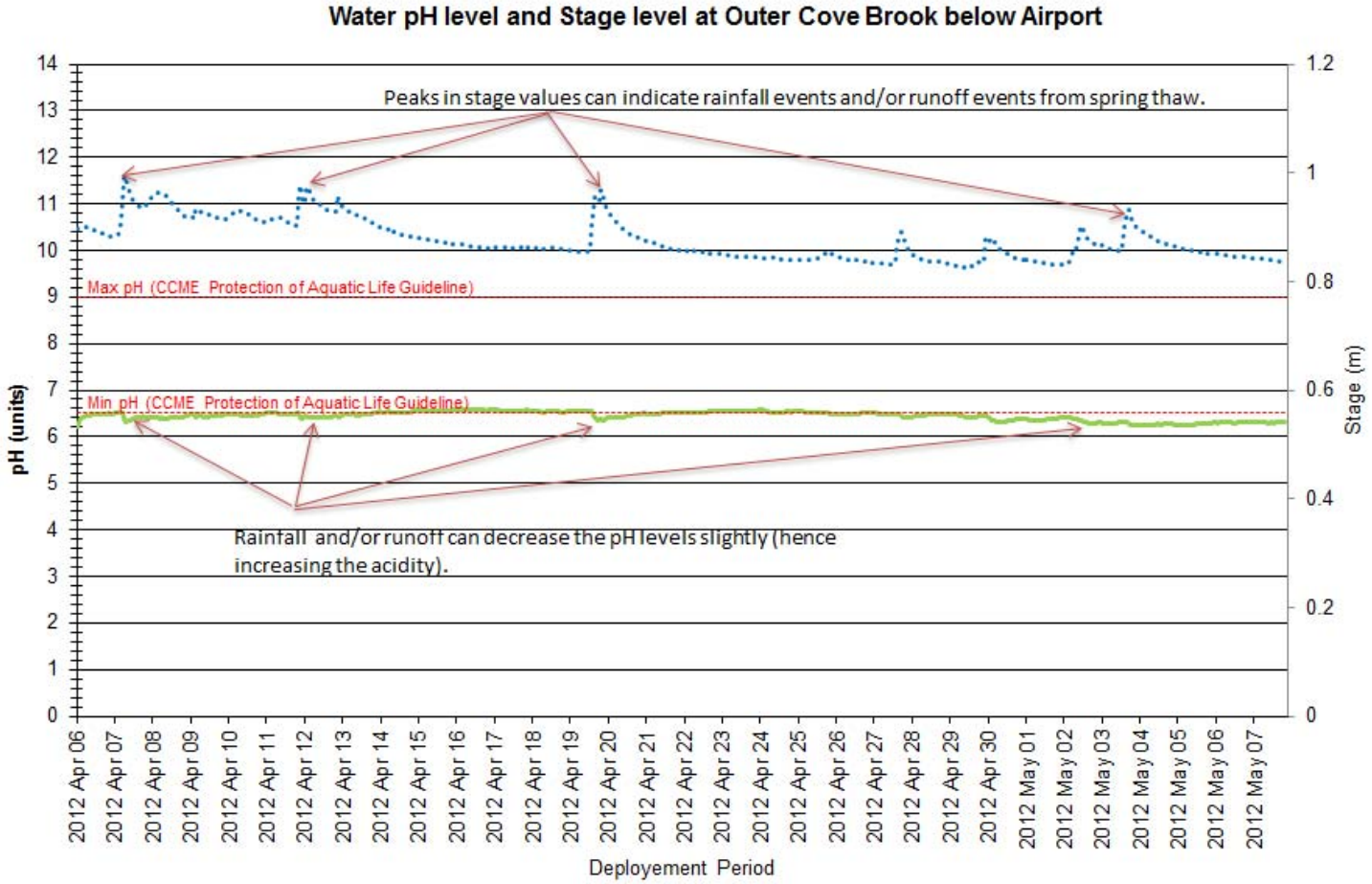

Figure 3: pH & stage level at Outer Cove Brook below Airport

Specific Conductivity & TDS

- The conductivity levels were within 246.0µS/cm and 536.0µS/cm during this deployment period. The average conductivity level was ~ 391.8µS/cm.
- The graph below (Figure 4) indicates several dips in the conductivity level during the deployment period. When compared to the stage values it is evident that the dips occur during higher stage levels. Increased stage levels can be related to rainfall events and/or runoff events after spring thaw.
- Rainfall events & spring thaw can have the effect of lowering conductance levels, which is evident on Figure 4 as the stage increases the conductance decreases.
- Total Dissolved Solids (TDS), is a calculated parameter that the instrument populates. TDS is calculated by an algothrim that utilizes the data from Specific Conductivity and Water Temperature to produce a TDS.

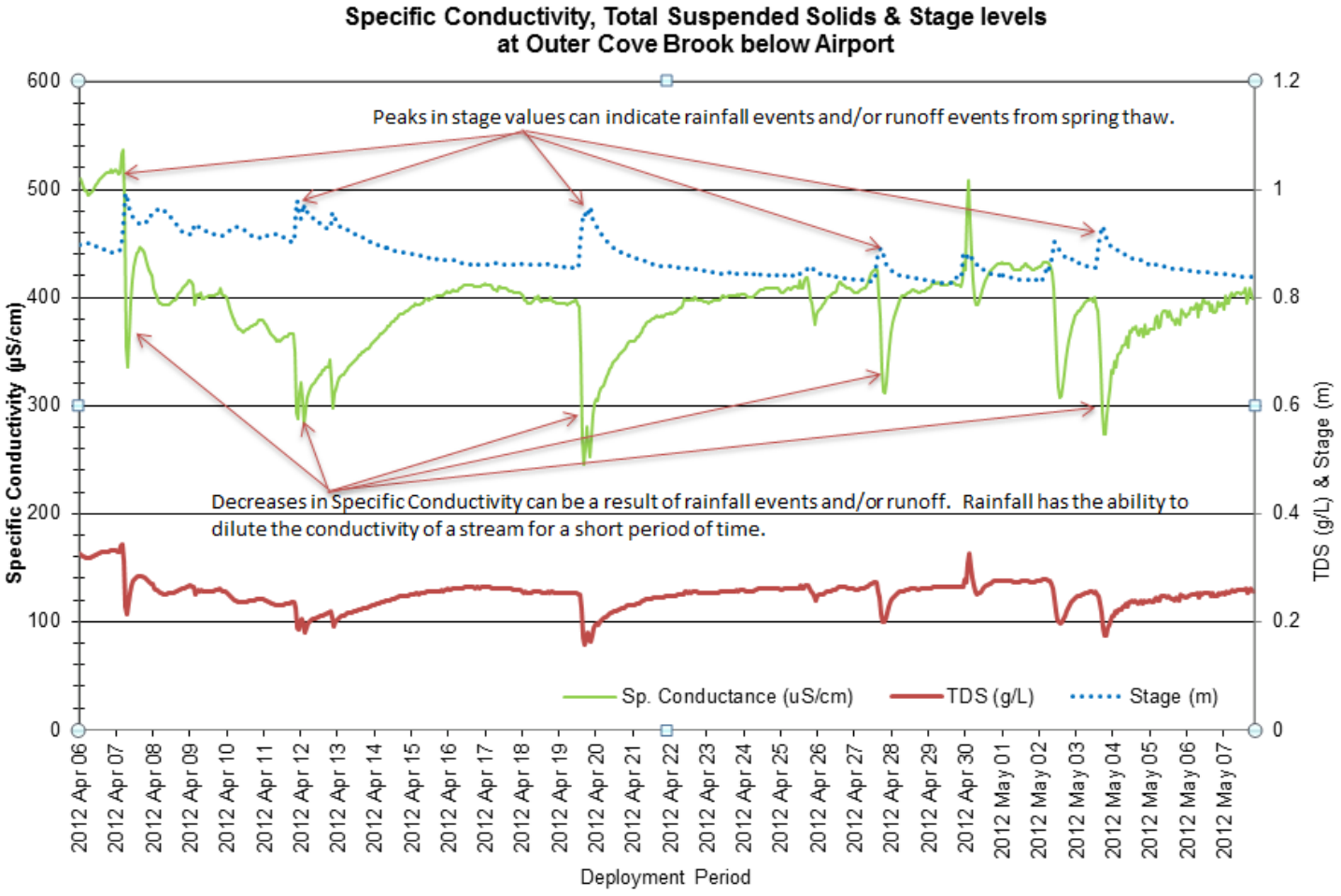

Figure 4: Specific conductivity, TDS and stage levels at Outer Cove Brook below Airport

Dissolved Oxygen

- The instrument calculates two individual dissolved oxygen readings; percent saturation dissolved oxygen and dissolved oxygen in mg/L. Dissolved Oxygen in mg/L is calculated by taking into consideration the dissolved oxygen % sat and the temperature of the water body.
- The DO values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and maximum guideline for Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in red on the graph in Figure 5.
- Dissolved Oxygen percent saturation remains constant during the deployment period. Dissolved oxygen mg/L content fluctuates with the water temperature changes. As temperature increases the DO mg/L levels decrease and vs. versa.

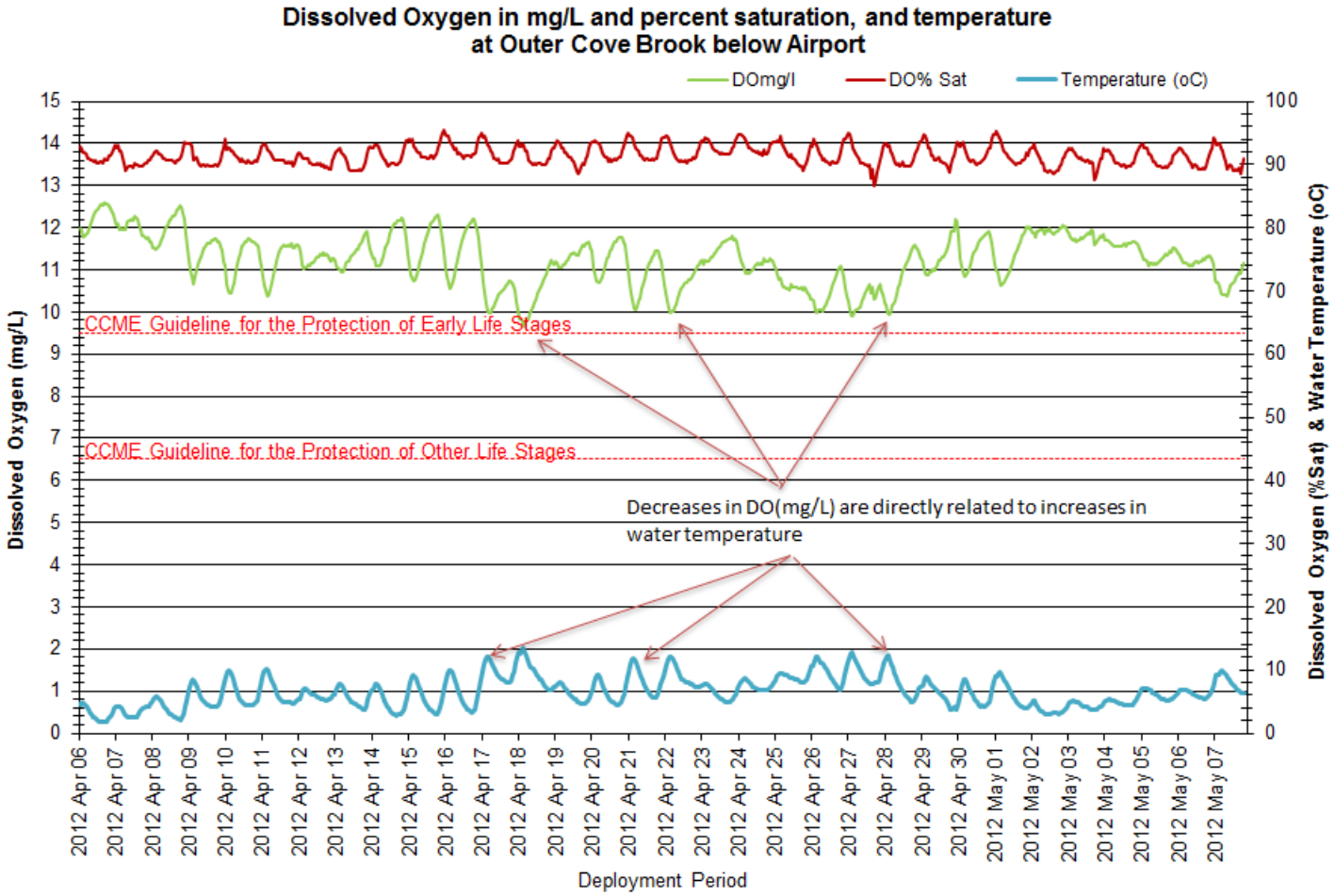

Figure 5: Dissolved Oxygen (mg/L & % sat) and Water Temperature at Outer Cove Brook below Airport

Turbidity

- When selecting a location for deployment of the instrument, it is imperative that there is minimal influence from the surrounding natural environment. For example, one would want to select a site that is away from high algal areas that can block the turbidity sensor and interfere with the turbidity readings.
- This location was the best site along the brook for the station, however there is still a significant amount of algae present in the water body. As the water temperatures increase, the algae buildup also increases, the influence of algae on a turbidity sensor is demonstrated in Figure 6.
- The turbidity sensor can read a turbidity value between 0 NTU and 3000 NTU. If a reading hits 3000NTU it is identified as an error reading, not a valid turbidity reading.
- The turbidity readings during this deployment ranged within 0.0 NTU to 1112.0 NTU, with a median value of 12.6 NTU (Figure 6).
- The turbidity readings from April 22 onwards during deployment are likely a result of a buildup of algae on the turbidity sensor. The climbing turbidity readings are generally a clear indication of interference from something blocking the sensor. These values are inaccurate and should not be used in any statistical analysis.

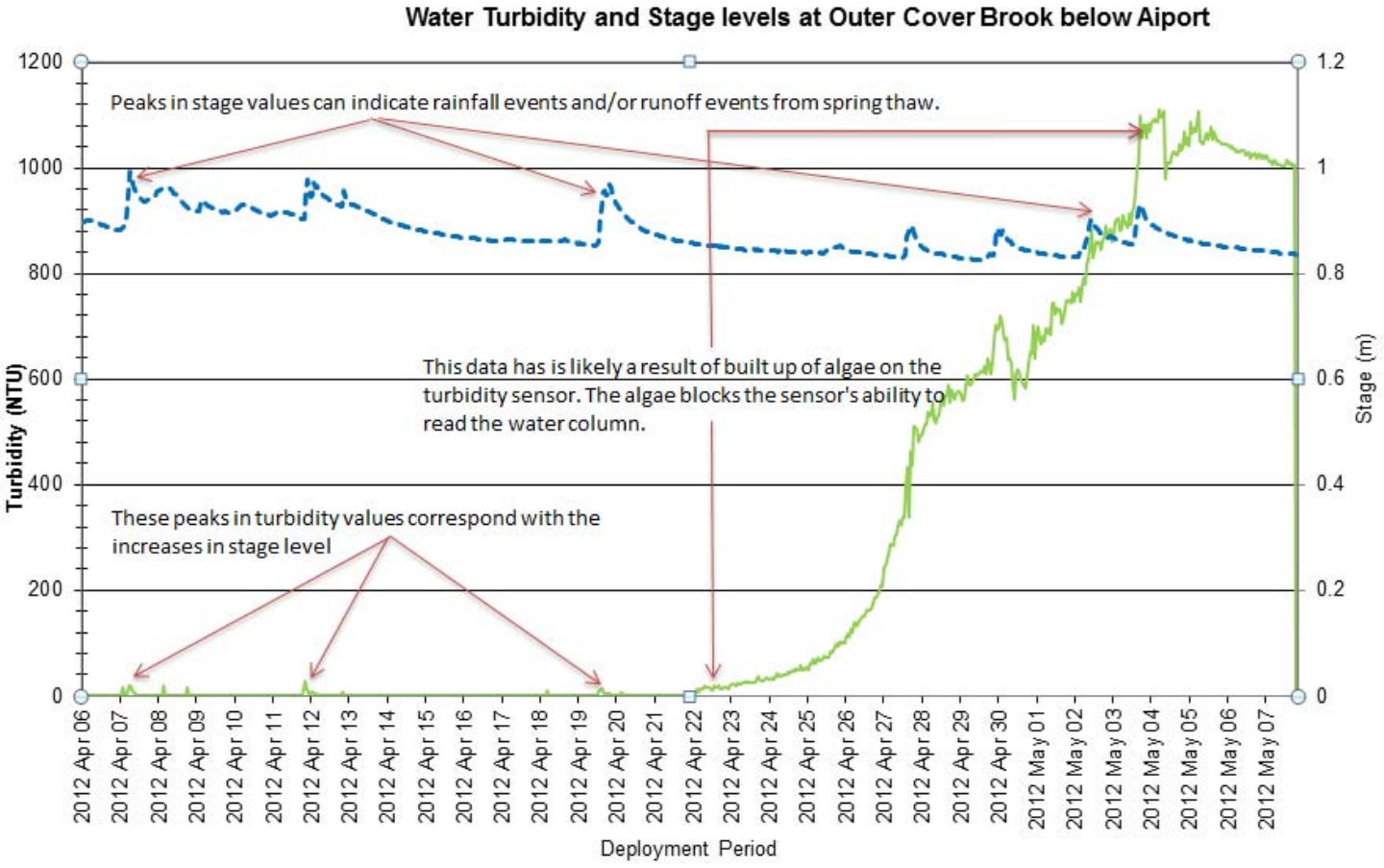

Figure 6: Turbidity and stage level at Outer Cove Brook below Airport

Stage

- Generally in this section of the report there is reference to the approximate precipitation that may occur near or at this station (St. John's International Airport). However at this time, Environment Canada has not released the precipitation data for April 2012 at St. John's International Airport.
- Stage can be defined as the height or elevation of the stream's water surface above a reference elevation (sea level, gage level)**.** Stage is important to display as it provides an estimation of water level at the station and can explain some of the events that are occurring with other parameters (i.e. Specific Conductivity, DO, turbidity).
- It is not unusual to see Stage vary throughout the deployment period (Figure 6). Stage is directly influenced by rainfall and any runoff from the surrounding environment.
- The peaks in Stage in Figure 7 were more than likely a response to a rainfall event or from spring thaw at that time of year.

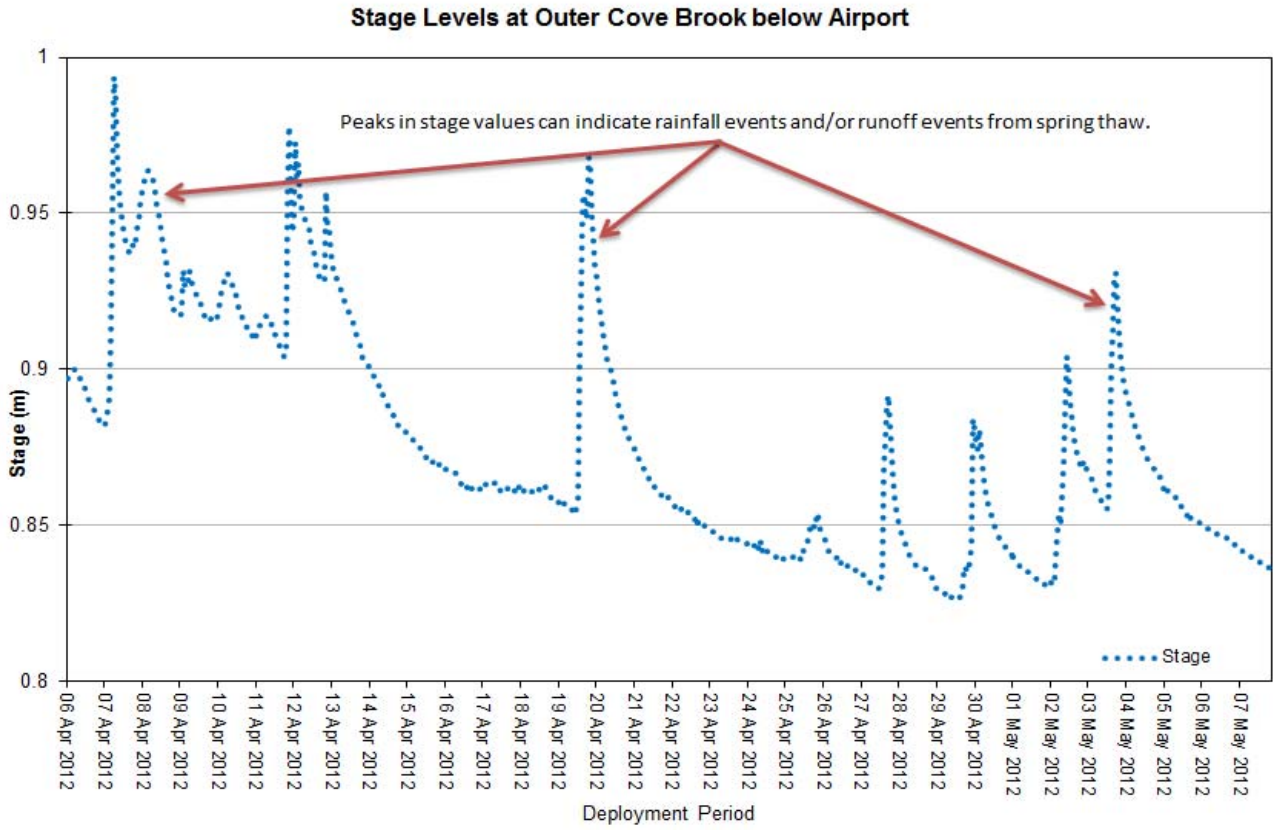

Figure 7: Stage Levels at Outer Cove Brook below Airport

Conclusions

- This was the initial deployment of this newly purchased instrument, as with many new field deployments, there is a period needed for trial and error to work toward problem resolution. During this new deployment, it was identified that the new instrument (DS 5X 62277) had moisture under the lens of the dissolved oxygen probe and although the instrument provided readings for the deployment period we needed to return the instrument for repair.
- At removal at the end of the deployment period (May 8, 2012), this instrument was returned to the manufacturer for a complete review of all the sensors and a new dissolved oxygen sensor was installed.
- Generally in natural environments, climate and weather conditions contribute to a large part to the variation in water quality parameters. During this deployment it can be assumed that many of the events that occurred were related to the natural spring thaw at that time of year and the intermittent precipitation events.
- Water Temperature continues to increase during the deployment period, which would be expected during this period. pH remains constant without any large events. Specific Conductivity displays several drops in the concentration of the readings which can also be explained by increases in stage (i.e. precipitation and runoff). The Dissolved Oxygen values remain at a constant, expected level with DO %Sat and DO mg/L staying above both CCME guidelines. The turbidity probe displayed interference and likely incorrect data, the increasing readings from April 22 onward are a result of a build-up of organic matter on the sensor reducing the sensors ability to perform. The turbidity data should not be used in any statistical analysis.

Outer Cove Brook at Clovelly Golf Course

Water Temperature

- Water temperature ranged from 1.66 to 14.22°C during this deployment period (Figure 8). The average temperature during this deployment period was 6.78 °C.
- There is a natural diurnal pattern to the water temperature data when graphed, this is the response to the air temperature around the water as day turns to night and night turns to day. Day temperatures are generally higher and night temperatures are generally lower. This pattern is visible on Figure 8.
- This time of year is the spring thaw from the winter, and the surrounding grounds and banks defrost pushing off excess melt water into the river. The water temperature of brooks is directly influenced by the runoff and can result in fluctuating temperatures as noted in Figure 8.
- Water Temperature is an important factor as it influences other parameters; some of the sensors on the instrument are temperature dependent.
- Water temperature during this deployment period remains constant.

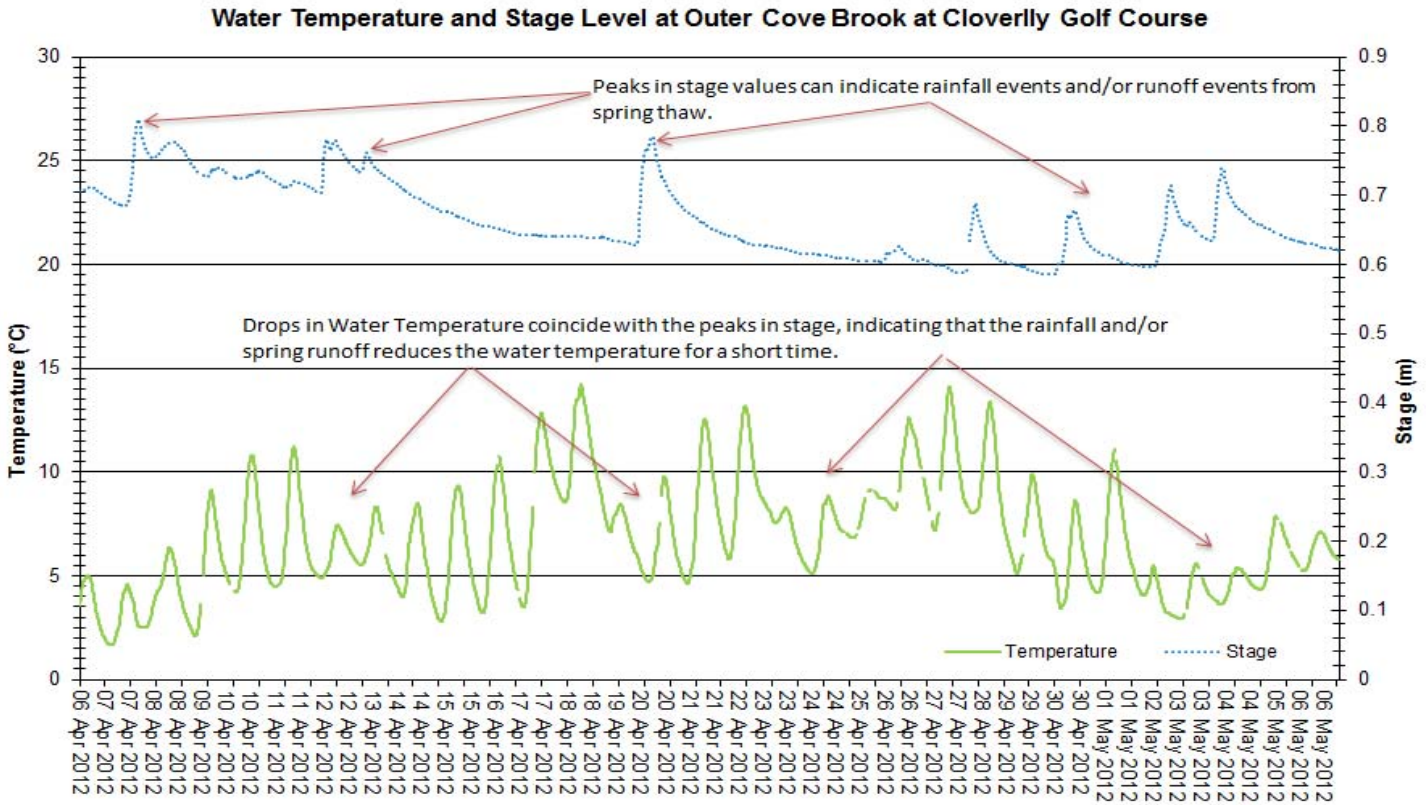

Figure 8: Water temperature and stage level at Outer Cove Brook at Clovelly Golf Course

pH

- pH ranges between 6.31 and 6.71 pH units throughout this deployment period (Figure 9). The average pH reading during this time was 6.57
- During the deployment, the pH values at this station sit on the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 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, as in the case of Outer Cove Brook at Clovelly Golf Course's natural slightly acidic pH levels.
- The pH values at this station remain steady and constant during the deployment period.
- Stage levels indicate rises in the level of the brook during the deployment period; stage increases are generally related to rainfall or runoff from the surrounding banks. Sometimes rainfall and/or runoff can impact the pH values to drop to a lower pH, hence slightly increasing the acidity of the stream for a short time.

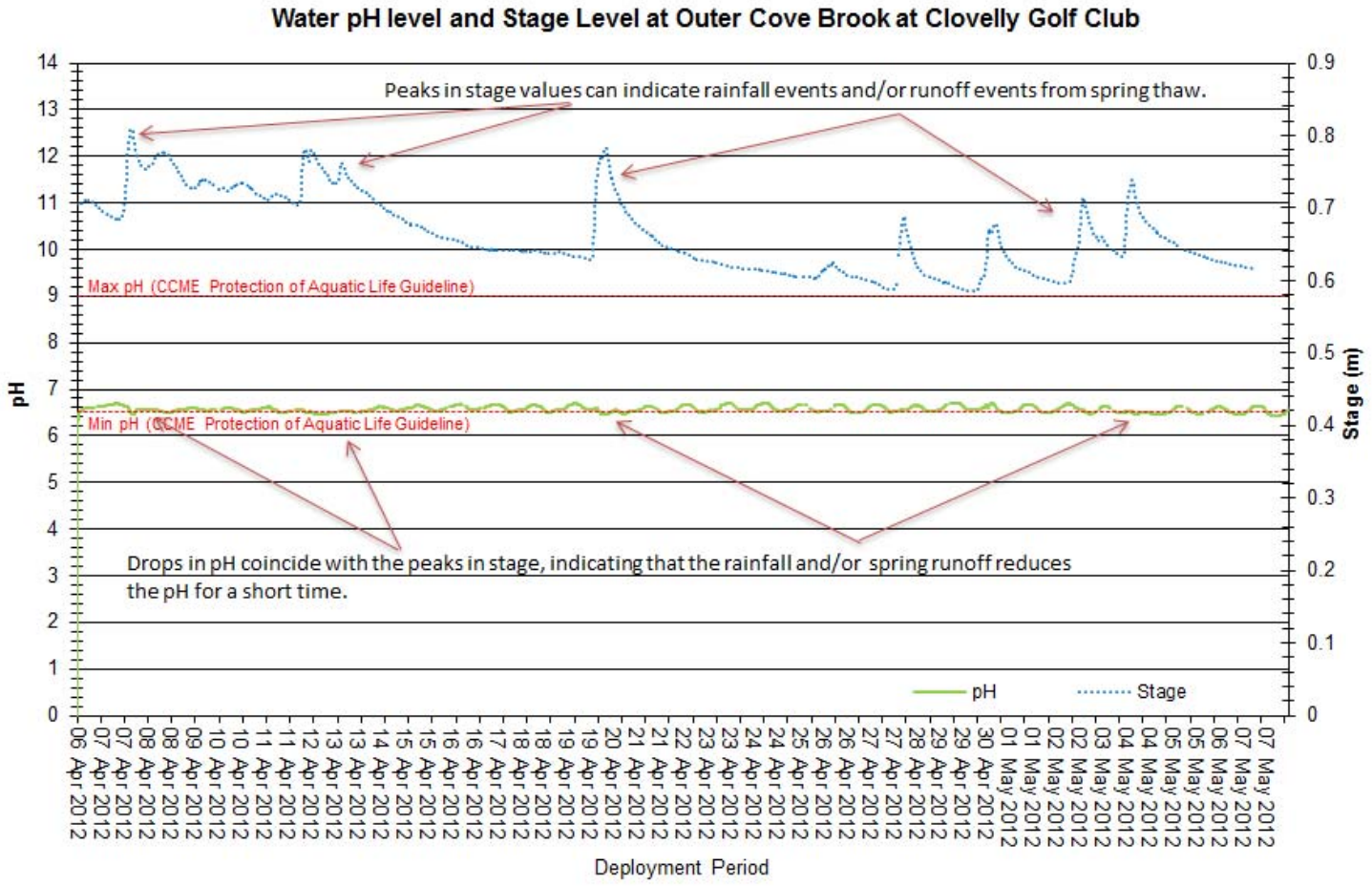

Figure 9: pH and stage level at Outer Cove Brook at Clovelly Golf Course

Specific Conductivity

- The conductivity levels were within 270.0µS/cm and 1345.0µS/cm during this deployment period. The average conductivity level was ~ 420.7µS/cm.
- The graph below (Figure 10) indicates several dips in the conductivity level during the deployment period. When compared to the stage values it is evident that the dips occur during higher stage levels. Increased stage levels can be related to rainfall events and/or runoff events after spring thaw.
- Rainfall events & spring thaw can have the effect of lowering conductance levels, which is evident on Figure 10 as the stage increases the conductance decreases.
- The two high peaks in Specific Conductivity, one on April 7 & the other on May 1, indicate an increase in material passing through the conductivity sensor. This can be a result of natural organic material runoff from the surrounding marsh areas.
- Total Dissolved Solids (TDS), is a calculated parameter that the instrument populates. TDS is calculated by an algothrim that utilizes the data from Specific Conductivity and Water Temperature to produce a TDS value.

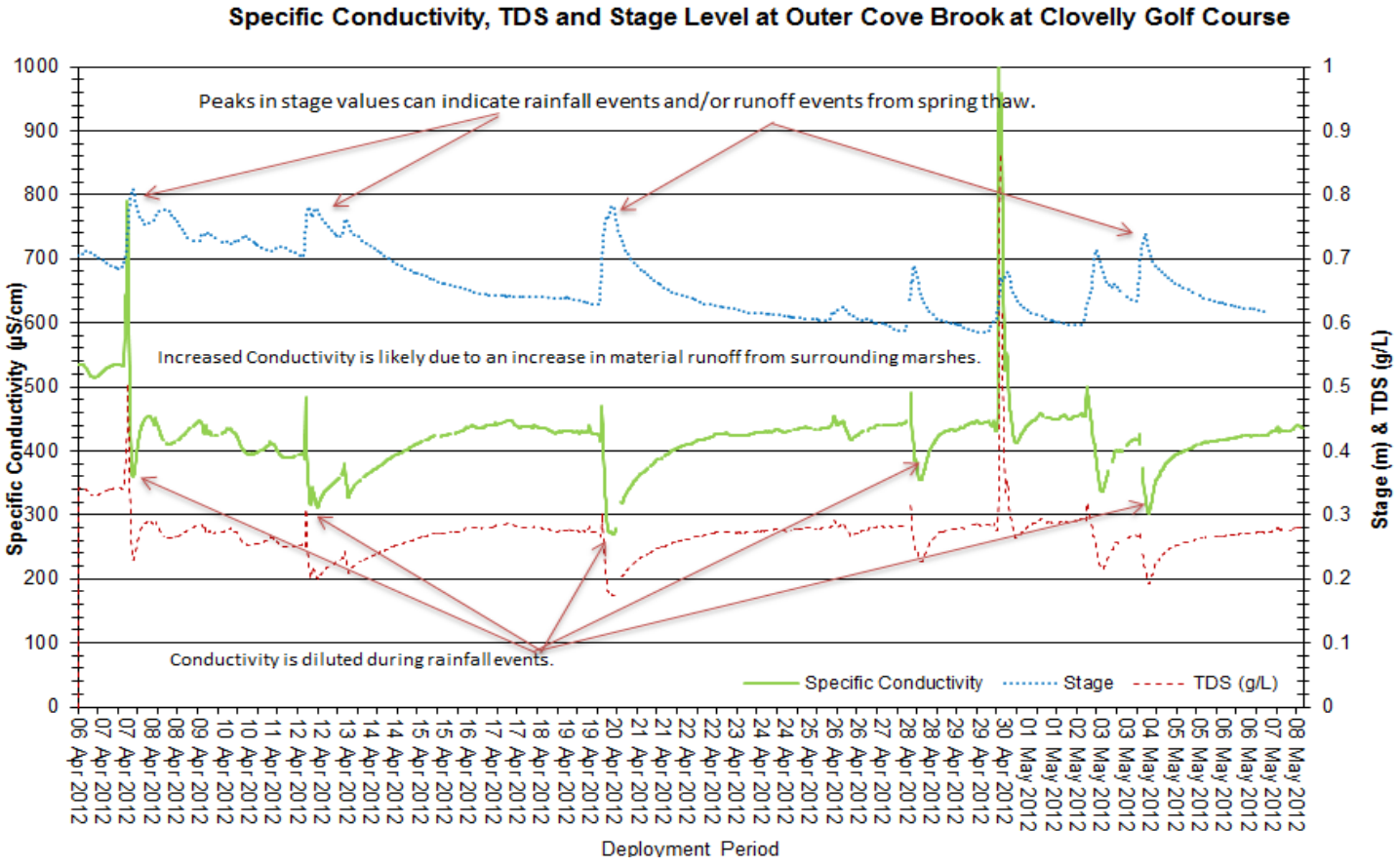

Figure 10: Specific conductivity, TDS and stage levels at Outer Cove Brook at Clovelly Golf Course

Dissolved Oxygen

- Unfortunately during this deployment period the instrument failed to record dissolved oxygen readings. During the calibration & maintenance at the end of deployment it was identified that the DO probe had moisture under the lens of the sensor. Moisture sufficiently reduces the sensors ability to provide accurate DO readings and even, as in this case, causes the sensor to fail.
- There is no Dissolved Oxygen data for this deployment period for Outer Cove Brook at Clovelly Golf Course.

NO GRAPH for Dissolved Oxygen (mg/L & % sat) at Outer Cove Brook at Clovelly Golf Course

Turbidity

- When selecting a location for deployment of the instrument, it is imperative that there is minimal influence from the surrounding natural environment. For example, one would want to select a site that is away from high algal growth that can block the turbidity sensor and interfere with the accuracy of the turbidity readings.
- This location was the best site for water level; unfortunately the brook streambed is completely covered by algae. As the water temperatures increase and water levels drop, there may be more evidence of algae interference at this station. During this deployment period there was no known interference.
- The turbidity sensor can read turbidity values between 0 NTU and 3000 NTU. If a turbidity reading hits 3000NTU it is always identified as an error reading, this is not a valid turbidity reading.
- The turbidity readings during this deployment ranged within 2.0 NTU to 114.9 NTU, with a turbidity average of 6.3 NTU (Figure 11).
- The turbidity peaks during this deployment period are likely a result of precipitation or spring melt. Each turbidity peak displayed in Figure 11 corresponds with an increase in stage level. As organic matter and natural minerals are washed into the brook, the suspended matter in the water column will increase.

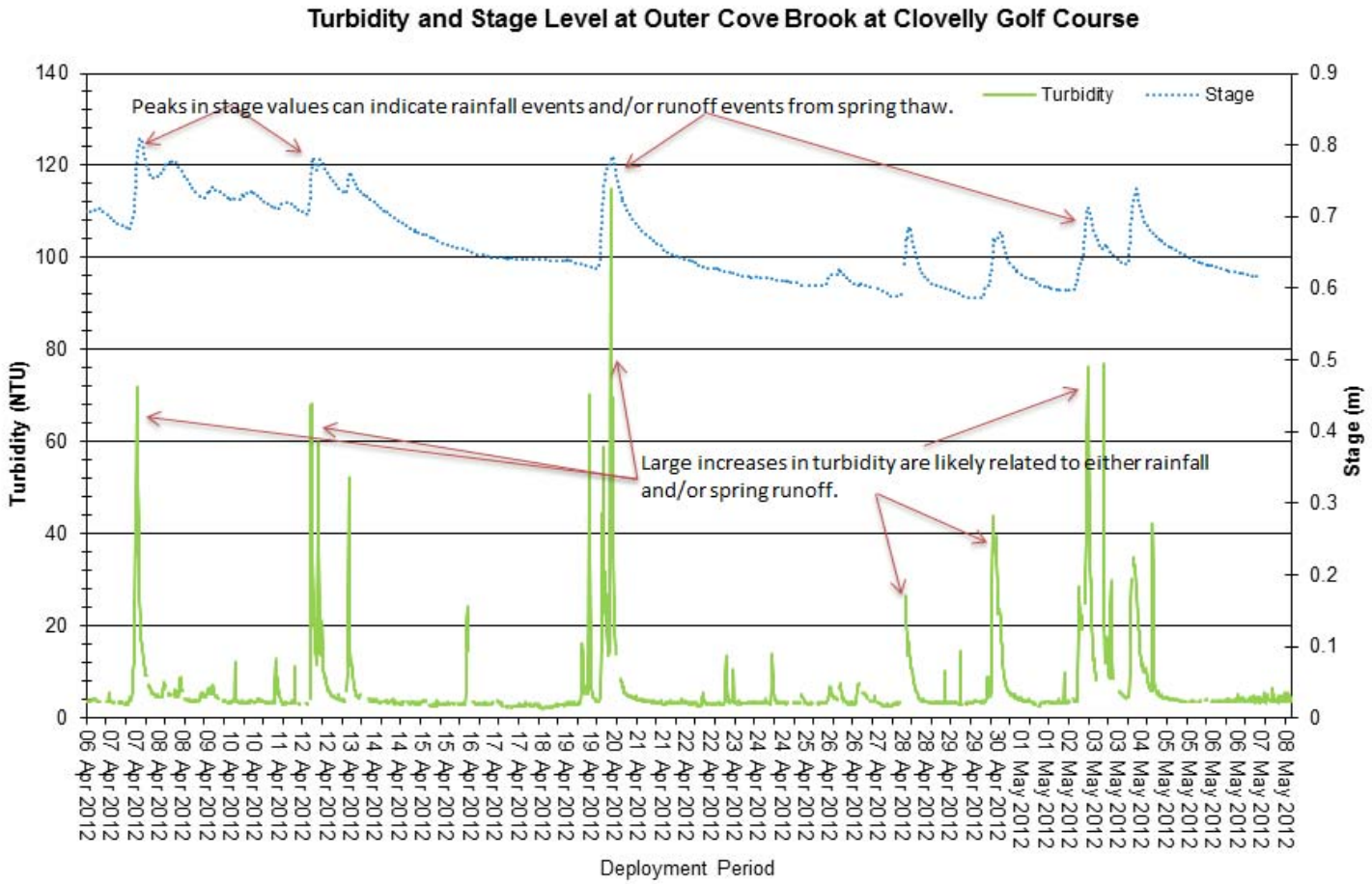

Figure 11: Turbidity and stage level at Outer Cove Brook at Clovelly Golf Course

Stage

- Generally in this section of the report there is reference to the approximate precipitation that may occur near or at this station (St. John's International Airport). However at this time, Environment Canada has not released the precipitation data for April 2012 at St. John's International Airport.
- Stage can be defined as the height or elevation of the stream's water surface above a reference elevation (sea level, gage level)**.** Stage is important to display as it provides an estimation of water level at the station and can explain some of the events that are occurring with other parameters (i.e. Specific Conductivity, DO, turbidity).
- It is not unusual to see Stage vary throughout the deployment period (Figure 12). Stage is directly influenced by rainfall and any runoff from the surrounding environment.
- The peaks in Stage in Figure 12 were more than likely a response to a rainfall event or from spring thaw at that time of year.

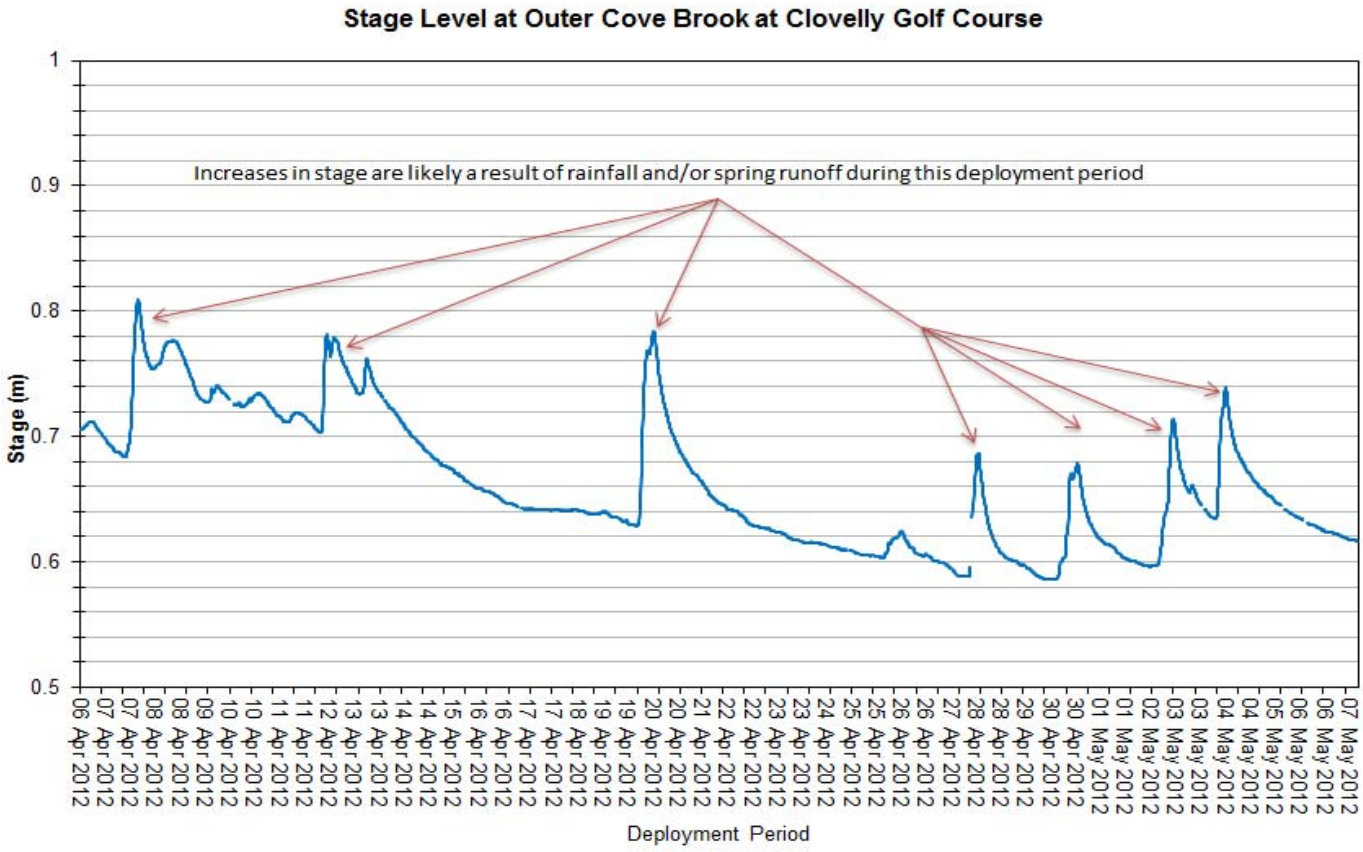

Figure 12: Stage Levels at Outer Cove at Clovelly Golf Course

Conclusions

- This was the initial deployment of this newly purchased instrument, as with many new field deployments, there is a period needed for trial and error to work toward problem resolution. During this new deployment, it was identified that the new instrument (DS 5X 62278) had moisture under the lens of the dissolved oxygen probe and we needed to return the instrument for repair.
- At removal at the end of the deployment period (May 8, 2012), this instrument was returned to the manufacturer for a complete review of all the sensors and a new dissolved oxygen sensor was installed.
- Generally in natural environments, climate and weather conditions contribute to a large part to the variation in water quality parameters. During this deployment it can be assumed that many of the events that occurred were related to the natural spring thaw at that time of year and the intermittent precipitation events.
- Water Temperature continues to increase during the deployment period, which would be expected during this period. pH remains constant without any significant events. Specific Conductivity displays several drops in the concentration of the readings which can also be explained by an increase in stage (i.e. due to precipitation and runoff). Increases in stage can also explain the peaks in the turbidity values during the deployment period. As organic matter and natural minerals are washed into the brook the suspended matter in the water column will increase and the turbidity sensor and the specific conductivity sensor will pick up these additional changes in the water body.

Prepared by:
Tara Clinton
Department of Environment and Conservation
Water Resources Management Division
Phone: 709.729.5925