Teck

Newfoundland Labrador

Canada

Teck Duck Pond Operations
Real-Time Water Quality Monitoring Network
Annual Report
2009

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Acknowledgements

The Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations is successful in tracking emerging water quality issues due to the hard work and diligence of individuals from three different organizations. The management and staff of Teck Duck Pond Operations work in cooperation with the management and staff of the Department of Environment and Conservation (ENVC) as well as Environment Canada (EC) to ensure the protection of ambient water resources in the vicinity of the mine and mill.

At Teck Duck Pond Operations several staff members including General Manager Bob Kelly have assisted in ensuring that the real-time system is operating such that data are reliable and accurate. Boyd Gulliford, Jill Kelly, Gord Parsons and Tracy Winsor have provided valuable assistance with the stations and feedback from time to time.

Various individuals from the Department of Environment and Conservation under the management of Haseen Khan have been integral in ensuring the smooth operation of such a technologically advanced network. Renée Paterson and Robert Wight played the lead roles in coordinating and liaising between the major agencies involved, thus, ensuring open lines of communication at all times. Robert was responsible for the data management/reporting, troubleshooting, along with ensuring the quality assurance/quality control measures are satisfactory. Throughout the year, Robert travelled to Teck Duck Pond Operations sometimes twice monthly to maintain and service the equipment and troubleshoot any technical problems as they arose. Paul Neary, Leona Hyde and Amir Ali Khan have worked on the communication aspects of the network ensuring the data is being provided to the general public on a near real-time basis through the departmental web page.

Staff of Environment Canada (Meteorological Service of Canada - Water Survey Canada) under the management of Howie Wills play an essential role in the data logging/communication aspect of the network. Brent Ruth and Roger Ellsworth, visit the site often to ensure the data logging equipment is operating properly and transmitting the data efficiently. They play the lead role in dealing with hydrological quantity and flow issues.

All individuals from each agency are fully committed to maintaining and improving this network and ensuring it provides meaningful and accurate water quality/quantity data that can be used in the decision-making process. This network is only successful due to the open communication and high level of cooperation of all three agencies involved.

Cover Photo supplied by Teck Duck Pond Operations

Section 1.0 Introduction

The Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations began in 2006 when the property was being developed by Aur Resources Inc. This network forms part of a larger network of government run and government-industry partnership run real-time water quality stations throughout the Province. **Figure 1** depicts the Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations in relation to the others on the island portion of the Province.

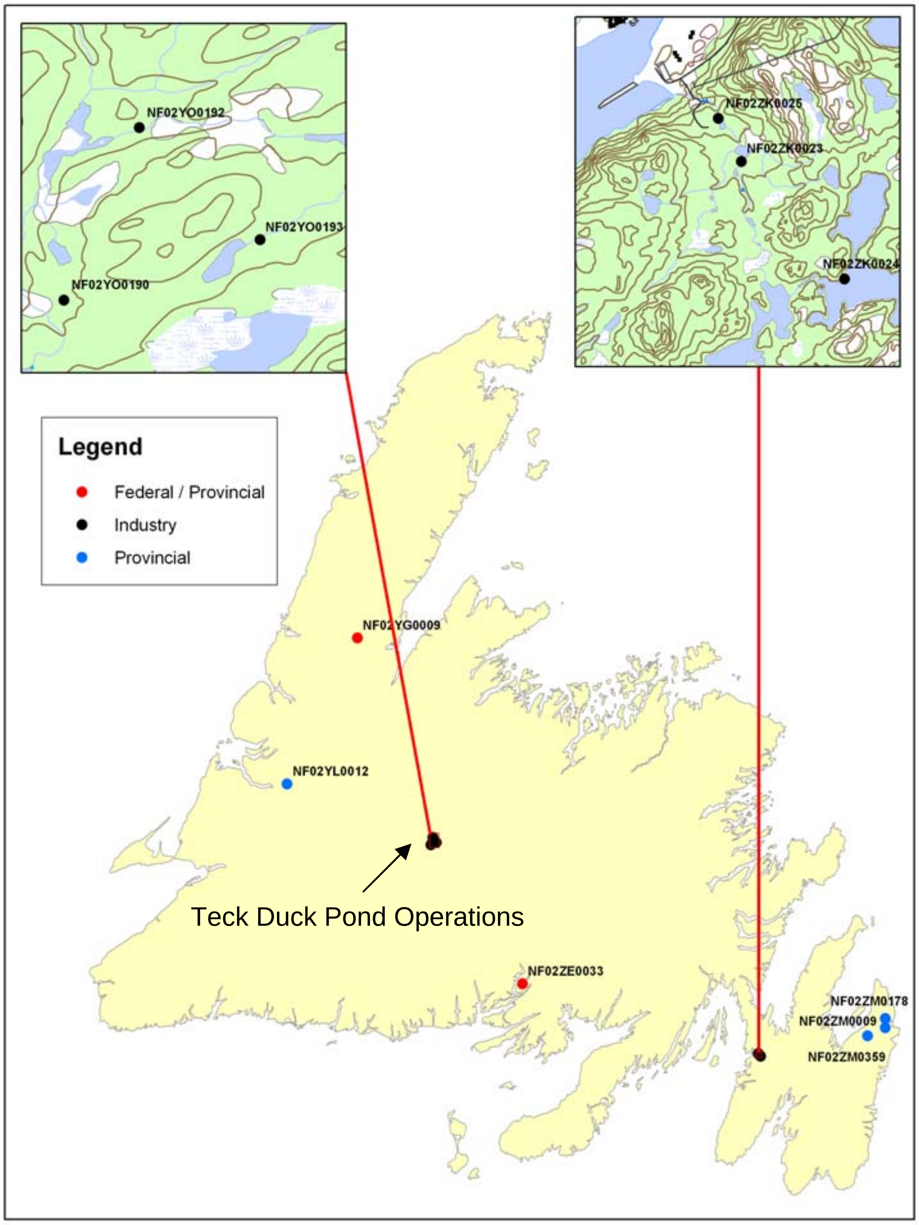

Figure 1: Real-Time Water Quality Monitoring Stations, Newfoundland

Three permanent stations (**Figure 2**) are established at Teck Duck Pond Operations; two in surface water streams and one in a ground water monitoring well:

- **Tributary to Gills Pond Brook Station (NF02YO0190**) is located 1700 m downstream of the final discharge point for the site's Tailings Management Area / Polishing Pond. This station is located such that any impacts from normal mine/mill discharge on receiving waters can be measured. This station has been fully operational since May 10, 2006 during the mine/mill construction phase.

- **East Pond Brook Station (NF02YO0192)** is located several kilometers downstream of the Tailings Management Area. This station is located such that any surface water impacts from the Tailing Management Area via seepage through Dam A may be measured. This station has been fully operational since September 7, 2006, during the mine/mill construction phase.

- **Monitoring Well After Tailings Dam Station (NF02YO0193)** is located approximately 100 meters below Tailings Dam A. This station is located such that any ground water impacts from the Tailing Management Area via seepage through Dam A may be measured. This station has also been fully operational since September 7, 2006.

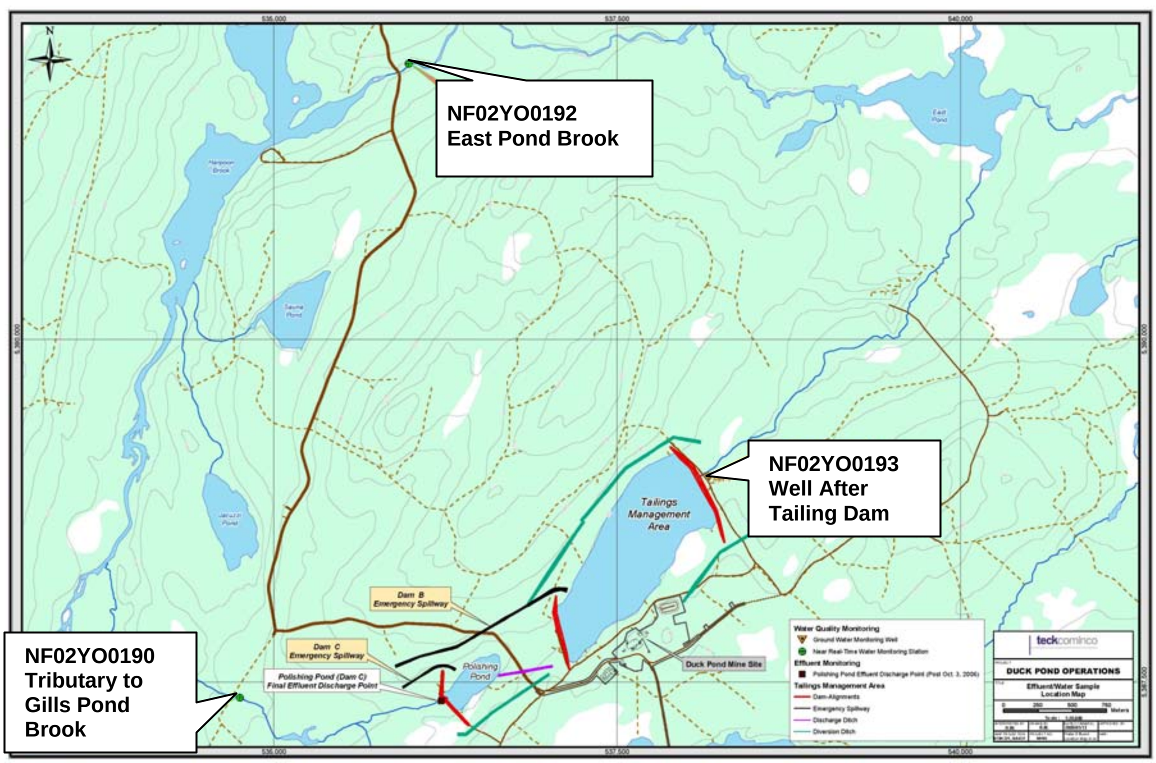

Figure 2: Real-Time Water Quality Monitoring Stations
Teck Duck Pond Operations

The two surface water stations (Tributary to Gills Pond Brook Station (NF02YO0190) and East Pond Brook Station (NF02YO0192)) are operated under a renewable cost-share agreement with Teck Duck Pond Operations. The operation of the ground water station (Monitoring Well After Tailings Dam Station (NF02YO0193)) is funded solely under the Canada-Newfoundland and Labrador Water Quality Agreement.

The objective of operating these stations is to provide an early warning of any potential or emerging water quality issues such that mitigative measures can be employed to ensure that discharge from Teck Duck Pond Operations meets all regulatory requirements and has minimal impact on the receiving waters and other water in proximity to the site.

It was initially intended to remove the instruments from the three stations during the winter months, as the instruments are prone to be damaged by freezing. Furthermore, initially, there was no discharge planned for the winter months. However, as the mine and mill have become operational, discharge from the site has been required outside the planned time frame of July through November. Accordingly, the instruments have been deployed continuously when ever possible throughout the year.

The instruments at Tributary to Gills Pond Brook Station (NF02YO0190) and East Pond Brook Station (NF02YO0192) were deployed nearly continuously throughout the year. During the winter months, they remained deployed for longer periods to minimize the risk of damage from freezing during deployment and removal. Up to this point in time no significant negative impacts on the instruments have been observed. During the remaining months, these instruments were removed approximately monthly for short periods, generally two days, to facilitate regular maintenance and calibration.

As Monitoring Well After Tailings Dam Station (NF02YO0193) freezes at surface, the instrument was remained deployed continuously from November 2008 until May 2009, and from May 2009 to end of October 2009, at which time it was removed and returned to the vendor for regular servicing. It will remain out over the winter 2009-2010 as the well is frozen at surface. Past experience has indicated that this probe is very stable over the long term, thus deployments up to six months have been recommended by the vendor.

Presently, all instruments are **Hydrolab®** brand **DataSonde®** probes in the surface water stations and a **Quanta G®** probe in the ground water station. Normally, the same probe is deployed consistently at a given station. However, from time to time, an alternate probe, having the same technical specifications, may temporarily be substituted. Portable **Hydrolab®** brand **MiniSonde®** probes are used for QA/QC purposes.

Section 2.0 Maintenance and Calibration

All staff involved in the installation, deployment, maintenance and calibration of these probes have undergone the training and certification by **Hydrolab®.**

Maintenance and calibration of these probes are undertaken in controlled conditions at the laboratory of the Department of Environment and Conservation in Grand Falls – Windsor. Maintenance and calibration procedures, specified by the equipment manufacturer are followed precisely, and all calibration values logged into a database. All replacement parts, reagents and calibration solutions used meet the manufacturer's specifications.

It is recommended that regular maintenance and calibration of the **DataSonde®** instruments take place on a monthly basis in order to ensure the accuracy of the data. Particularly during the warmer months, the sensors are prone to fouling from the accumulation of biofilm and other organic matter in the streams. **Quanta G®** instruments are intended for longer term deployments, with less frequent maintenance and calibration as they may not be as subject to fouling in the well where temperatures are colder and more stable.

Table 1 details the dates the instruments were installed and removed for maintenance and calibration in 2009. It is important to note that during the winter months instruments remained deployed for periods longer than a month to minimize the risk of damage from freezing during installation and removal. It has also been demonstrated that during the winter months, due to the colder temperatures, there is less fouling of the sensors, thus allowing them to remain accurate for longer periods of time.

Tributary to Gills Pond Brook Station (NF02YO0190)			
Deployment Period			
Installation Date (yyyy-mm-dd)	Removal Date (yyyy-mm-dd)	Days Deployed	Remarks
2008-12-17	2009-05-05	139	Winter deployment
2009-05-05	2009-06-24	50	
2009-06-24	2009-07-27	33	
2009-07-27	2009-09-01	34	
2009-09-01	2009-11-24	84	
2009-11-25			Ongoing winter deployment
East Pond Brook Station (NF02YO0192)			
Deployment Period			
Installation Date (yyyy-mm-dd)	Removal Date (yyyy-mm-dd)	Days Deployed	Remarks
2008-12-15	2009-05-05	141	Winter deployment
2009-05-05	2009-06-24	50	
2009-06-24	2009-07-27	33	
2009-07-29	2009-09-01	34	
2009-09-09	2009-11-24	75	
2009-11-25			Ongoing winter deployment
Monitoring Well After Tailings Dam Station (NF02YO0193)			
Deployment Period			
Installation Date (yyyy-mm-dd)	Removal Date (yyyy-mm-dd)	Days Deployed	Remarks
2008-11-14	2009-05-05	172	Winter Deployment
2009-05-07	2009-10-30	175	Removed prior to winter for Servicing

Table 1: Maintenance and Calibration Schedule

Section 3.0 Discharge from Polishing Pond

Under Provincial and Federal regulatory measurers, effluent from the mine's Tailings Management Area may be discharged through the Polishing Pond to receiving waters (Tributary to Gills Pond Brook) provided it meets stringent criteria. During 2009, there were 16 separate Discharge Periods as summarized in **Table 2** and depicted in **Figure 3**. It is important to note, that while meeting the discharge criteria, the physical and chemical characteristics of the discharge water will be different than the receiving water. This will be evident in some of the parameters reviewed in Section 4.1.

Discharge Period	Start Date (yyyy-mm-dd)	Stop Date (yyyy-mm-dd)	# of Days	Average Daily Discharge (m^3/day)
1	2009-01-01	2009-01-08	8	20505
2	2009-03-20	2009-03-24	5	14166
3	2009-04-03	2009-04-09	7	14292
4	2009-04-27	2009-05-01	5	14354
5	2009-05-12	2009-05-19	8	20234
6	2009-06-01	2009-06-10	10	19465
7	2009-06-24	2009-06-30	7	17883
8	2009-07-09	2009-07-16	8	19316
9	2009-07-25	2009-07-30	6	19259
10	2009-08-08	2009-08-13	6	16317
11	2009-08-20	2009-08-26	7	19936
12	2009-09-08	2009-09-11	4	20649
13	2009-09-19	2009-09-21	3	22010
14	2009-09-30	2009-10-01	2	16300
15	2009-10-23	2009-10-29	7	19528
16	2009-11-16	2009-12-31	46	20565

Note1: Discharge Period 1 began before the beginning of the Calendar Year
Note 2: Discharge Period 16 ended after the end of the Calendar Year

Table 2

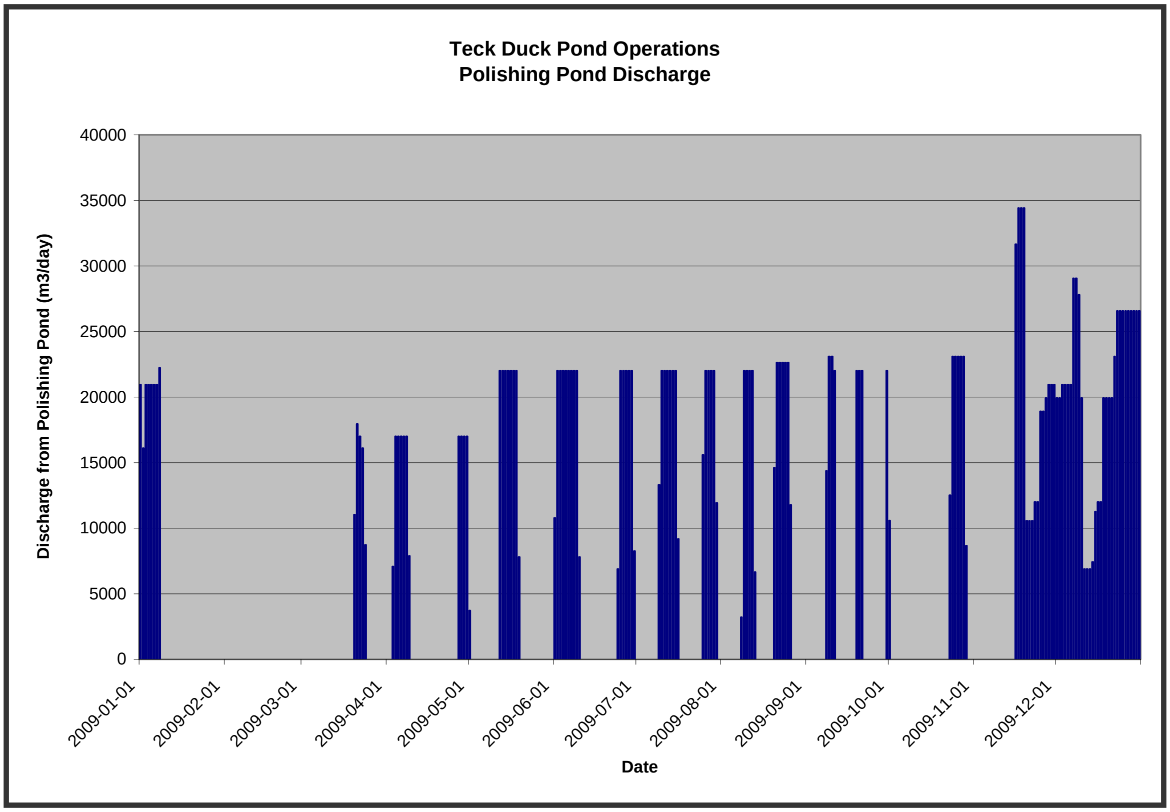
Teck Duck Pond Operations
Polishing Pond Discharge
Discharge from Polishing Pond (m3/day)
40000
35000
30000
25000
20000
15000
10000
5000
0
2009-01-01
2009-02-01
2009-03-01
2009-04-01
2009-05-01
2009-06-01
2009-07-01
2009-08-01
2009-09-01
2009-10-01
2009-11-01
2009-12-01
Date

Figure 3

Section 4.0 Data Interpretation

Section 4.1 Tributary to Gills Pond Brook Station (NF02YO0190)

Tributary to Gills Pond Brook Station is located 1700 m downstream of the final discharge point for the mine's Tailings Management Area - Polishing Pond. This station is located such that any impacts from the mine discharge on receiving waters can be measured.

The water temperature (**Figure 4**) ranged from a minimum of -0.38 ^{o}C to a maximum of 25.62 ^{o}C. In the winter months, under the cover of ice in the stream, temperatures were generally at or slightly below the freezing point. The highest temperatures were measured in June. The temperature profile for this stream is very similar to that of East Pond Brook (**Figure 10**). There are no obvious changes in temperature during discharge periods (**Figure 3**). Accordingly discharge from the Polishing Pond does not appear to have any significant impact on the water temperature at this station.

There is no recommended limit or range for water temperature.

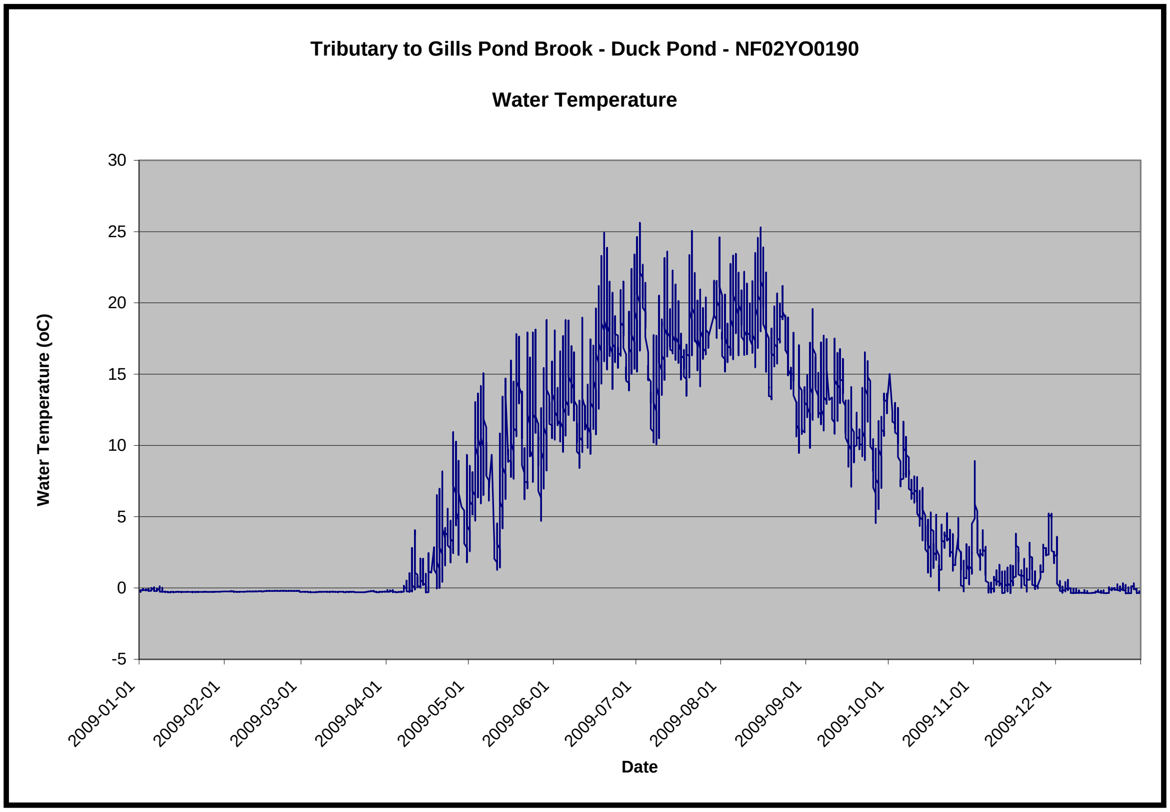

Figure 4

The pH (**Figure 5**) ranged from a minimum of 5.54 to a maximum of 8.02. The pH of this stream is naturally quite low, often being documented to be near or below the lower limit of the recommended range (6.5 – 9.0 – see colored lines on **Figure 5**) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (1). It should be noted however, that discharge from Polishing Pond often has a pH higher than the natural background pH of the receiving waters. Thus, when there is discharge from Polishing Pond (**Figure 3**), there is generally an increased pH in the stream at this station, which often brings the water within the pH range recommended by CCME. The pH profile throughout the year is similar to East Pond Brook (**Figure 11**), except during the discharge periods.

The highest pH was recorded on January 5, 2009.

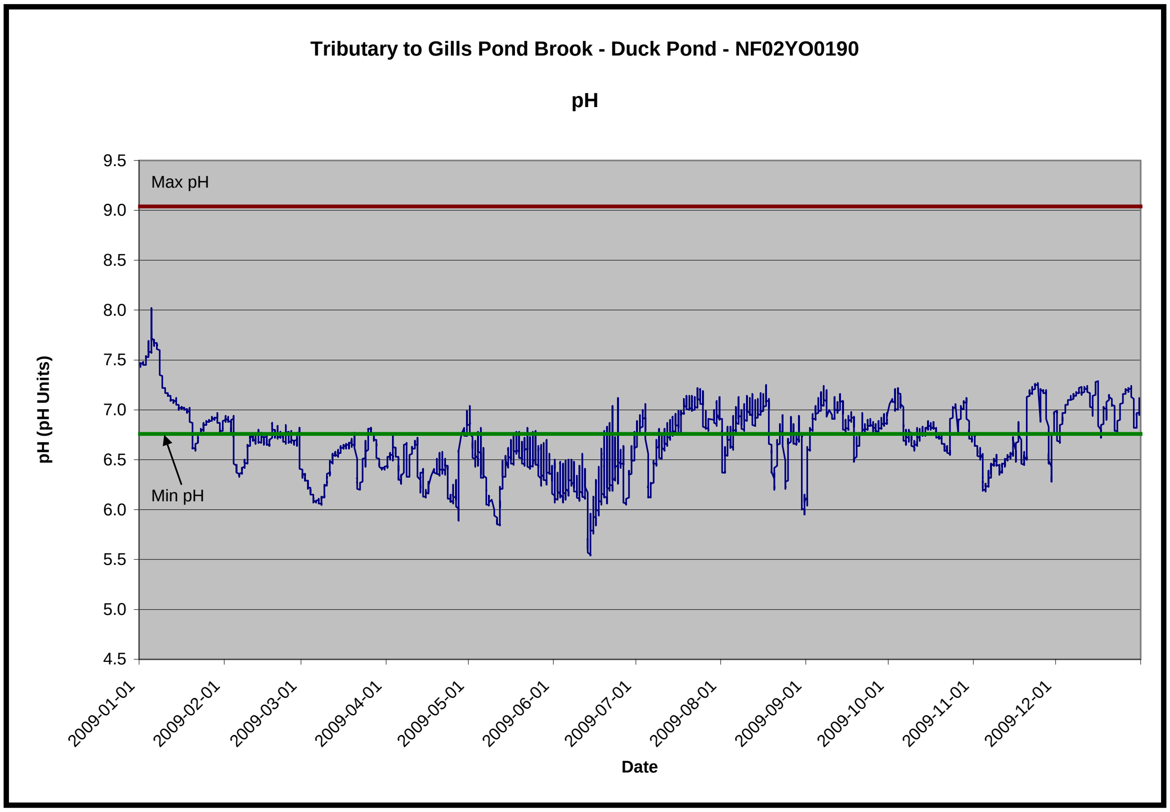

Figure 5

The specific conductivity (**Figure 6**) is affected by the amount of dissolved metals and salts in the water. Pristine waters in this part of the island generally have a specific conductance of less than 50 µmS/cm. Outside the periods when there is discharge from Polishing Pond (**Table 2**), the specific conductivity in this stream would generally be quite low. During the past year, the minimum specific conductivity was measured to be 22.2 µS/cm. When there is discharge from the Polishing Pond, conductivity increases significantly, the highest value being measured to be 808.0 µS/cm. The significant increases and decreases in specific conductivity correspond closely with the beginning and end of the discharge periods from polishing pond (**Figure 3**).

It is interesting to note, that specific conductivity dips, sometimes significantly, following periods of snowmelt or rainfall. Snowmelt and rainfall contributions to the stream's discharge would generally have an extremely low (approaching zero) background specific conductively and would effectively 'dilute' water in stream. This is particularly more evident when there is discharge from the Polishing Pond.

There is no recommended limit or range for specific conductance, although it is a key indicator to the potential effects of the discharge from Polishing Pond.

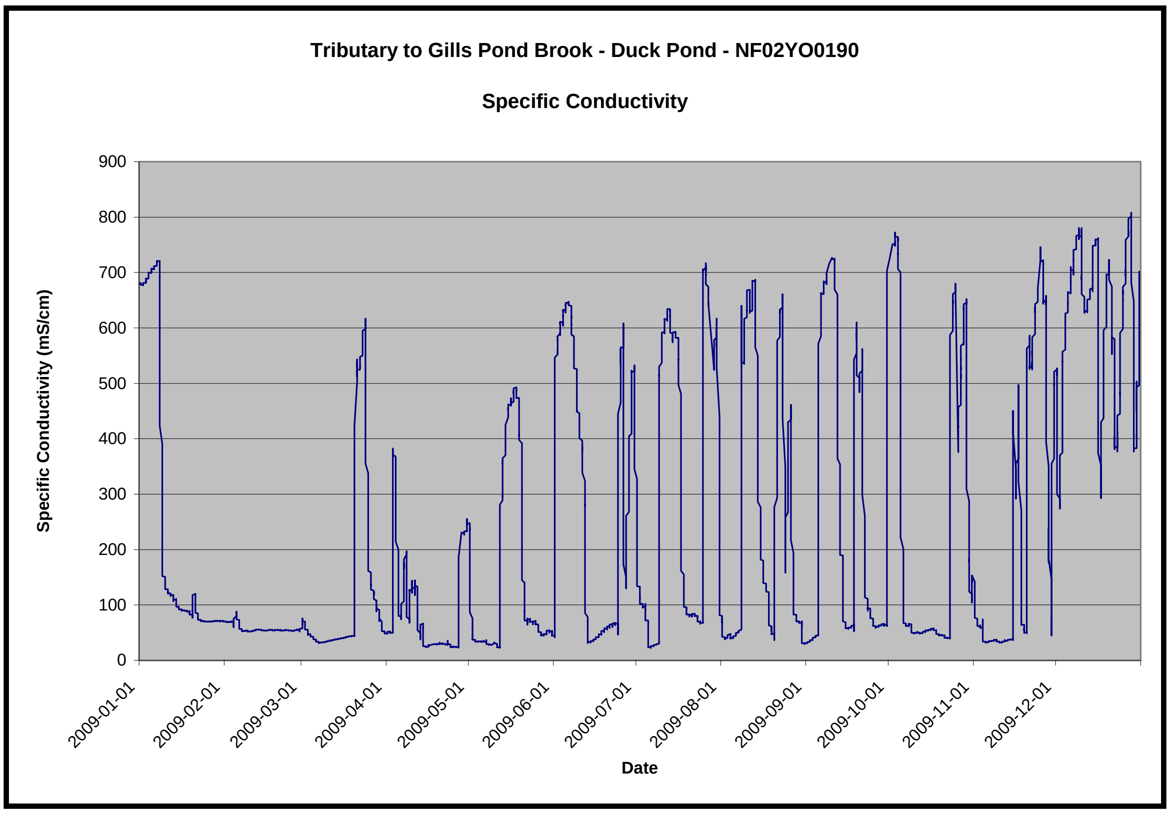

Figure 6

Dissolved oxygen (**Figure 7**) ranged from a minimum of 7.39 mg/L to a maximum of 14.28 mg/L. Generally, dissolved oxygen is inversely proportional to water temperature; this being evident in comparison to **Figure 4**.

The CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* [(1)] for dissolved oxygen establish two separate lower limits for cold water biota: other life stages – above 6.5 mg/L; and early life stages – above 9.5 mg/L. While dissolved oxygen consistently remained above 6.5 mg/L, in the warmer months, it did not remain above 9.5 mg/L, the recommended lower limit for early life stage cold water biota. This is a function of the inverse relationship to the warmer water temperatures. In fact, the dissolved oxygen in waters in East Pond Brook (**Figure 13**) has a very similar profile. There does not appear to be any appreciable change in dissolved oxygen resultant from discharge from Polishing Pond.

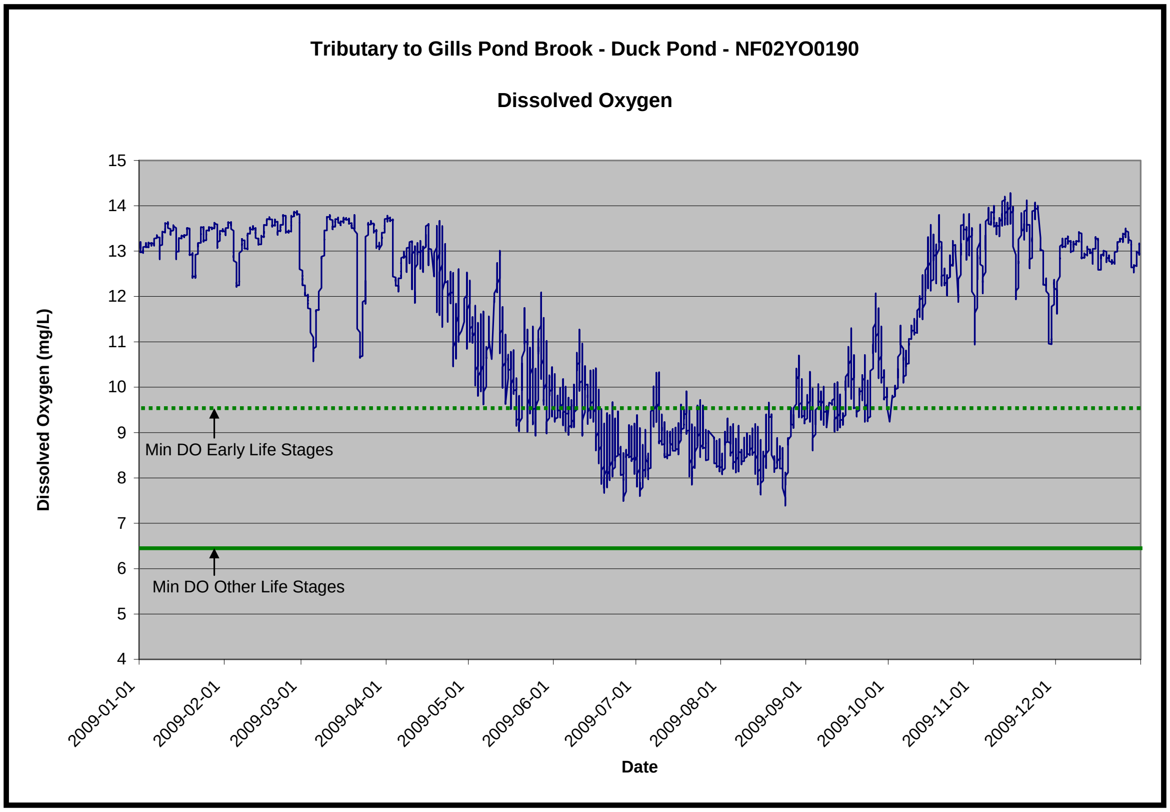

Figure 7

Turbidity (**Figure 8**) ranged from a minimum of 0.0 NTU to a maximum of 2993 NTU. Minor and un-sustained spikes are the usually the result of natural debris passing over the sensor.

On occasion turbidity values were reported to be 3000 NTU. This number represents a system error in data transmission. Accordingly, these values have been removed. Additionally, there was a sustained period (July 29, 2009 through September 1, 2009) where transmitted turbidity values were erroneous. For this period internally (**DataSonde®**) logged turbidity values were substituted.

During periods when there was no discharge from Polishing Pond, turbidity values were generally at or close to zero. The frequency and intensity of turbidity spikes was generally greater during discharge periods (**Figure 3**).

The highest turbidity values were reported during April following a particularly long (139 day) over-winter deployment period when there was some fouling of the sensor. Accordingly, it is believed that the values toward the end of this deployment period are incorrect. Turbidity values returned to normal values following maintenance and calibration of the instrument.

It has also been documented in the *Real Time Water Quality Report Duck Pond Operations (Teck Cominco Limited) Deployment Period 2008-10-16 to 2008-11-12* (2) that at this location, air entrainment due to higher water velocities, and turbulent flow at higher stream discharges results in false-positive turbidity values. Accordingly, the on-line real time turbidity graph is annotated with the following comment: '*Turbidity values may be exaggerated due to air entrainment (turbulent flow)'.* Efforts are made to place the probe in a location in the stream which is least impacted by turbulent flow. Other solutions continue to be investigated.

Throughout the year, high turbidity was not visible in the stream nor documented in the any *in situ* measurements or water sample results (0.0 NTU to 2.18 NTU). Accordingly, the higher turbidity values (frequency and intensity) during the periods of discharge from Polishing Pond are attributed to air entrainment due to high flows as opposed to actual water quality impairment. Any unusual turbidity measurements will continue to be investigated by staff of the Department of Environment and Conservation and/or Teck Duck Pond Operations.

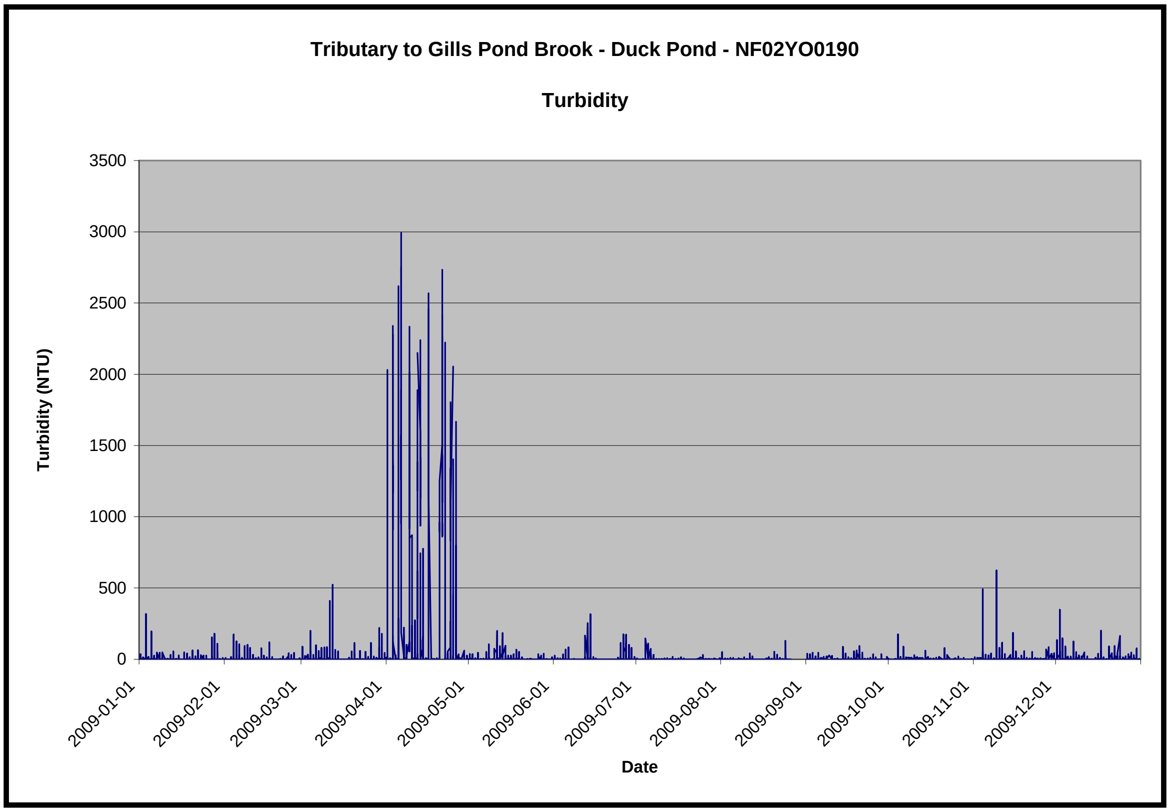
Tributary to Gills Pond Brook - Duck Pond - NF02YO0190
Turbidity
Turbidity (NTU)
3500
3000
2500
2000
1500
1000
500
0
2009-01-01
2009-02-01
2009-03-01
2009-04-01
2009-05-01
2009-06-01
2009-07-01
2009-08-01
2009-09-01
2009-10-01
2009-11-01
2009-12-01
Date

Figure 8

The stage or water level (**Figure 9**) was recorded to be between 1.21 m and 1.96 m. At this location, stage is referenced to an arbitrary bench mark. The highest stage was recorded on December 31, 2009, presumably due to the backwater effect from ice formation.

For the remainder of the year, however, stage varied between 1.21 m and 1.70 m, with the higher levels corresponding to periods of discharge from Polishing Pond (**Figure 3**) and following snow melt and rainfall events.

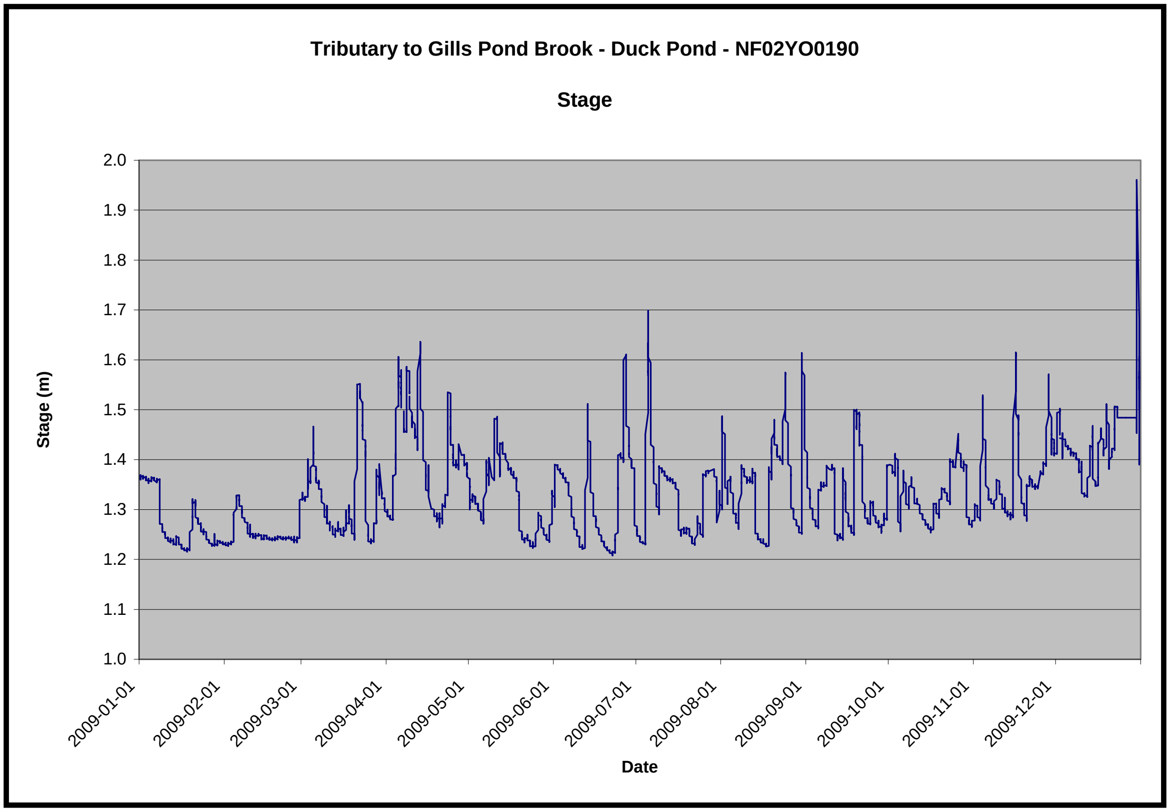

Figure 9

Section 4.2 East Pond Brook Station (NF02YO0192)

East Pond Brook Station is located several kilometers downstream of the Tailings Management Area. This station is located such that any surface water impacts from the Tailing Management Area via seepage through Dam A may be measured.

The water temperature (**Figure 10**) ranged from a minimum of -0.14 ^{o}C to a maximum of 26.6 ^{o}C. In the winter months, under the cover of ice in the stream, temperatures were generally at or slightly below the freezing point. The highest temperatures were measured in June. The temperature profile for this stream is very similar to that of Tributary to Gills Pond Brook (**Figure 4**).

There is no recommended limit or range for water temperature.

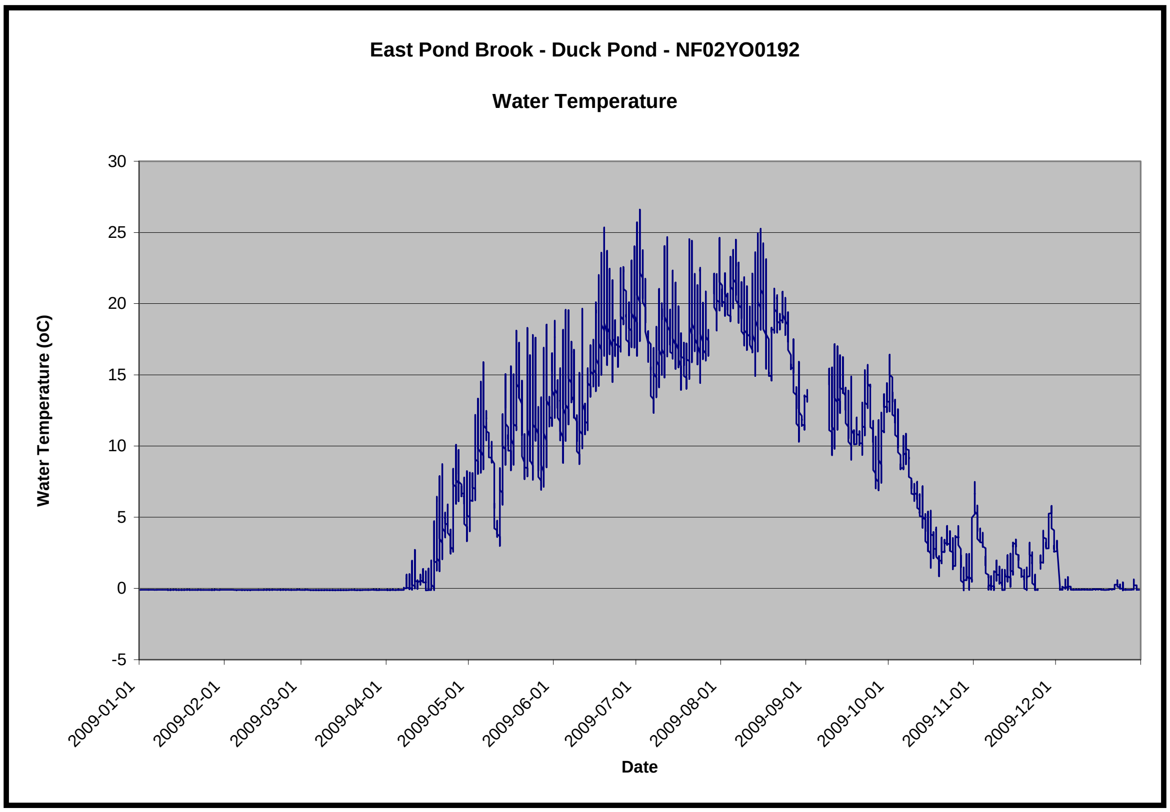

Figure 10

The pH (**Figure 11**) ranged from a minimum of 5.65 to a maximum of 7.19. The pH of this stream is naturally quite low, often being documented to be near or below the lower limit of the recommended range (6.5 – 9.0 – see colored lines on **Figure 11**) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (1).

There is a notable decrease in pH leading up to removal of the probe for cleaning and calibration on September 1, 2009. This decrease is due to fouling of the sensor during the deployment during the warmest part of the summer. Note the normal pH values following the September 9, 2009 deployment.

Variation in pH is influenced by a number of factors. For example, there is an inverse relationship with stage (**Figure 15**) which is influenced by snowmelt and precipitation, and a positive relationship with specific conductivity (**Figure 12**). All variations in pH appear to be due to natural influences.

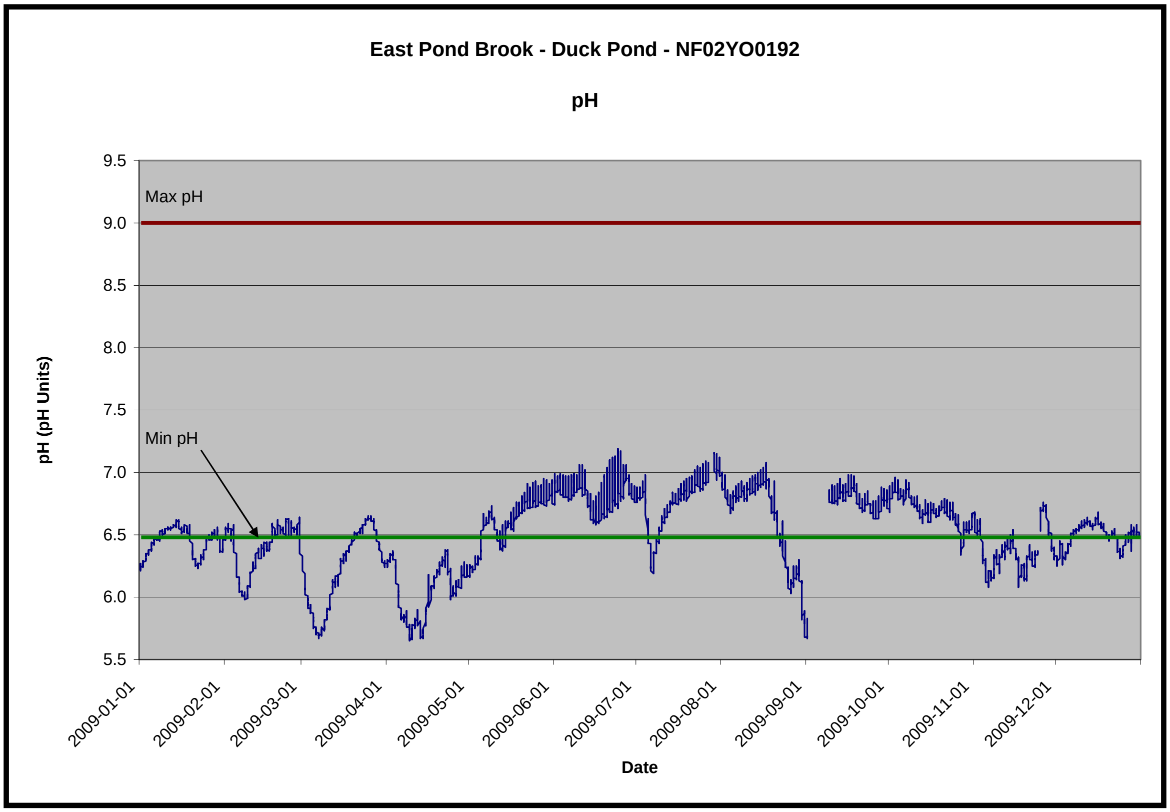

Figure 11

The specific conductivity (**Figure 12**) is affected by the amount of dissolved metals and salts in the water. Pristine waters in this part of the island generally have a specific conductance of less than 50 µS/cm.

During the past year, the specific conductivity ranged between 9.3 µS/cm and 37.4 µS/cm. Specific conductivity shows a similar profile to pH (**Figure 11**) and an inverse relation to stage (**Figure 15**).

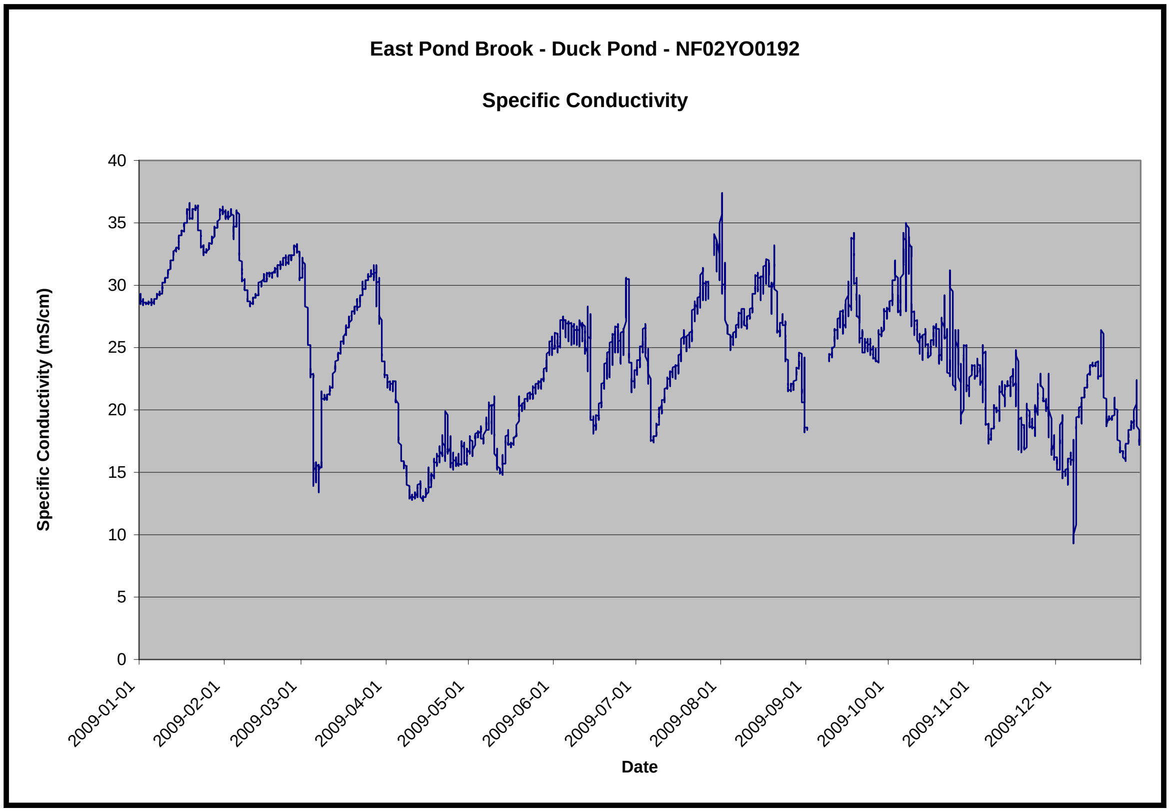

Figure 12

Dissolved oxygen (**Figure 13**) ranged from a minimum of 7.82 mg/L to a maximum of 14.56 mg/L. Generally, dissolved oxygen is inversely proportional to water temperature; this being evident in comparison to **Figure 10**.

The CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* [1] for dissolved oxygen establish two separate lower limits for cold water biota: other life stages – above 6.5 mg/L; and early life stages – above 9.5 mg/L. While dissolved oxygen consistently remained above 6.5 mg/L, in the warmer months, it did not remain above 9.5 mg/L, the recommended lower limit for early life stage cold water biota. This is a natural function of the inverse relationship to the warmer water temperatures.

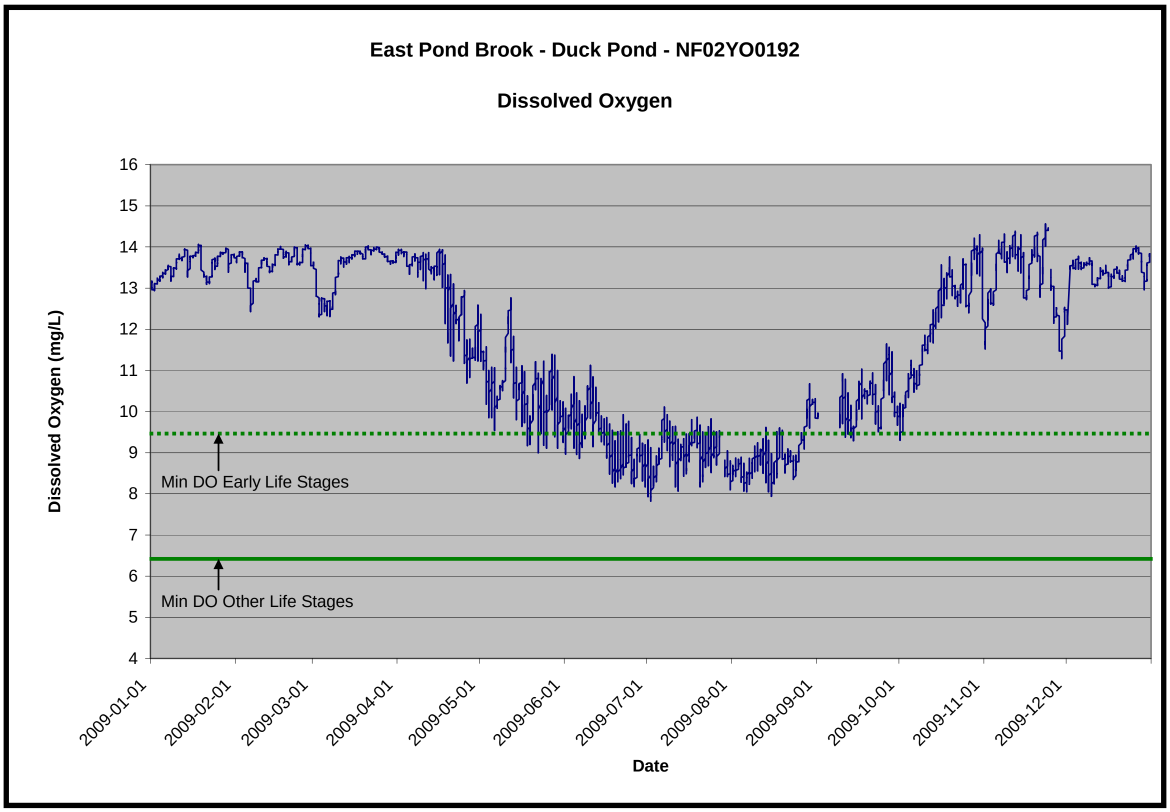

Figure 13

Turbidity (**Figure 14**) ranged from a minimum of 0.0 NTU to a maximum of 1448.0 NTU. Generally, turbidity values in this stream are at or close to zero. Minor and un-sustained spikes are the result of natural debris passing over the sensor. There was a sustained period of higher than normal turbidity in late August, at the end of a deployment period when it was noted that leaves were caught on the sensor. Turbidity values returned to normal values following maintenance and calibration of the instrument.

On occasion turbidity values were reported to be 3000 NTU. This number represents a system error in data transmission. Accordingly, these values have been removed. Additionally, there was a sustained period (May 5, 2009 through June 24, 2009) where transmitted turbidity values were erroneous. For this period internally (**DataSonde®**) logged turbidity values were substituted.

Throughout the year, high turbidity was not visible in the stream nor documented in any water sample results (less than 1.0 NTU).

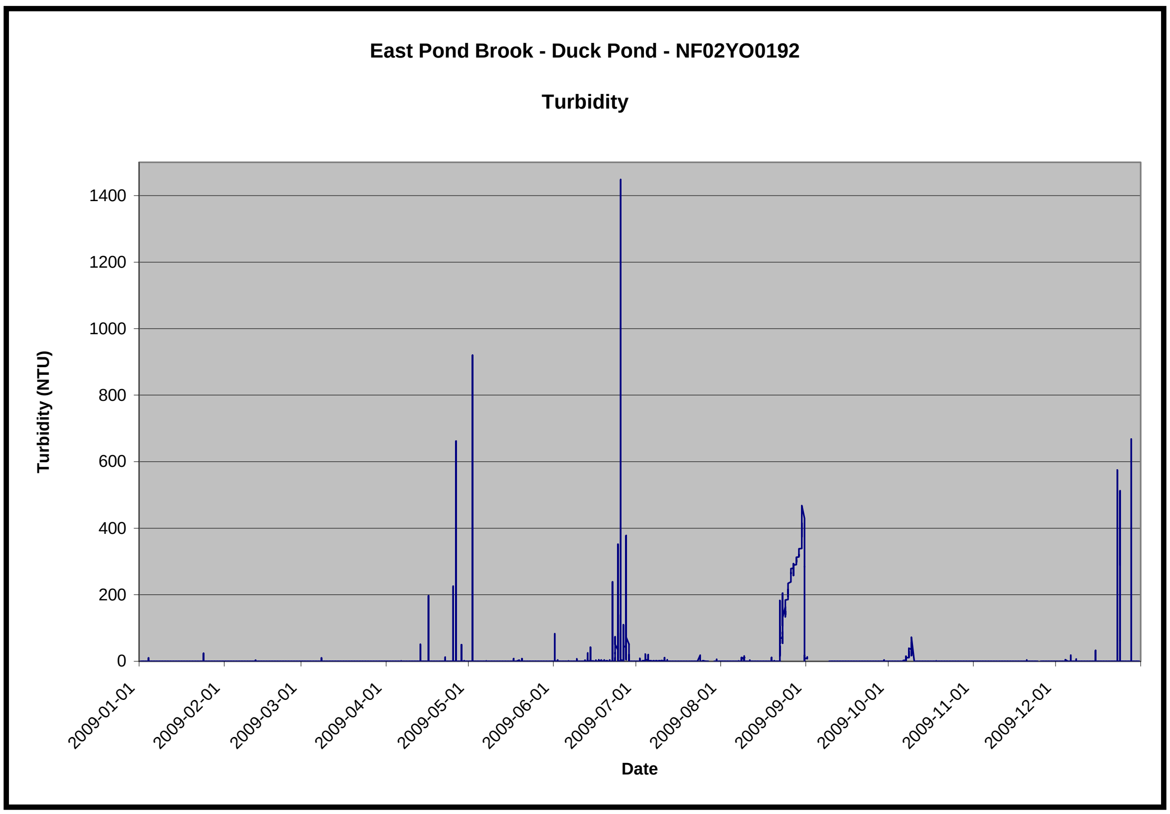

Figure 14

The stage or water level (**Figure 15**) was recorded to be between 0.94 m and 3.37 m. At this location, stage is referenced to an arbitrary bench mark. The lowest levels were recorded in June. The highest stage was recorded in early March and in December. High values are attributed to the backwater effect caused by ice in the stream as it would be highly unlikely that stage would ever go that high.

For the remainder of the year, however, stage varied between 0.94 m and 2.0 m, with the higher levels following snow melt and rainfall events.

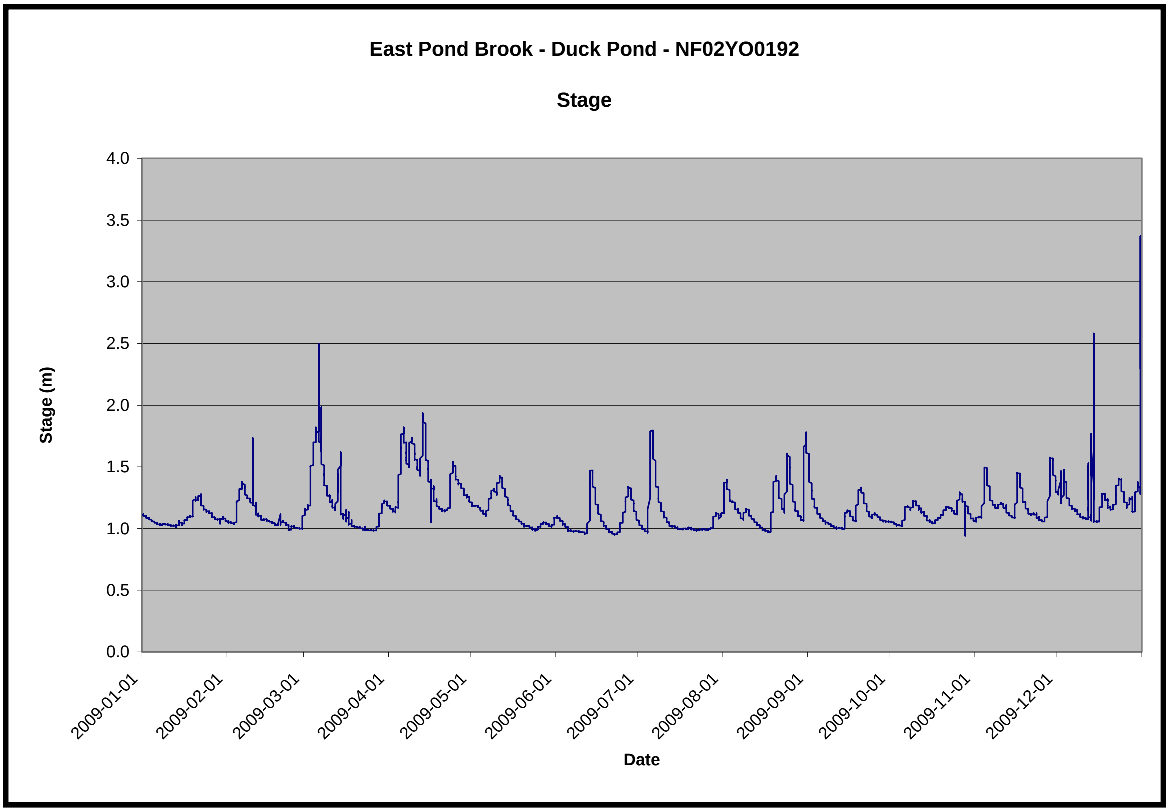

Figure 15

Section 4.3 Monitoring Well After Tailings Dam Station (NF02YO0193)

Monitoring Well After Tailings Dam Station is located near Tailings Dam A. This station is located such that any ground water impacts from the Tailing Management Area via seepage through Dam A may be measured.

There is continuous data from January 1, 2009 through October 25, 2009, apart from a 2 day period in early May when the instrument was removed for cleaning and calibration. It should be noted as well that the well was purged of at least one volume on May 5, 2009. Water samples were collected on May 7, 2009 and October, 30, 2009 at the beginning and end of the second deployment period. There is a loss of data transmission from October 25, 2009 through October 30, 2009, although the instrument was recording normally upon removal from the well. Subsequently, the instrument was sent to the vendor for performance and evaluation testing to ensure its accuracy.

Water temperature (**Figure 16**) ranged from a minimum of 4.76 °C to a maximum of 5.61 °C. Lower temperatures were recorded in the summer months, while the higher temperatures were recorded in late December. The temperature profile is very similar to 2008.

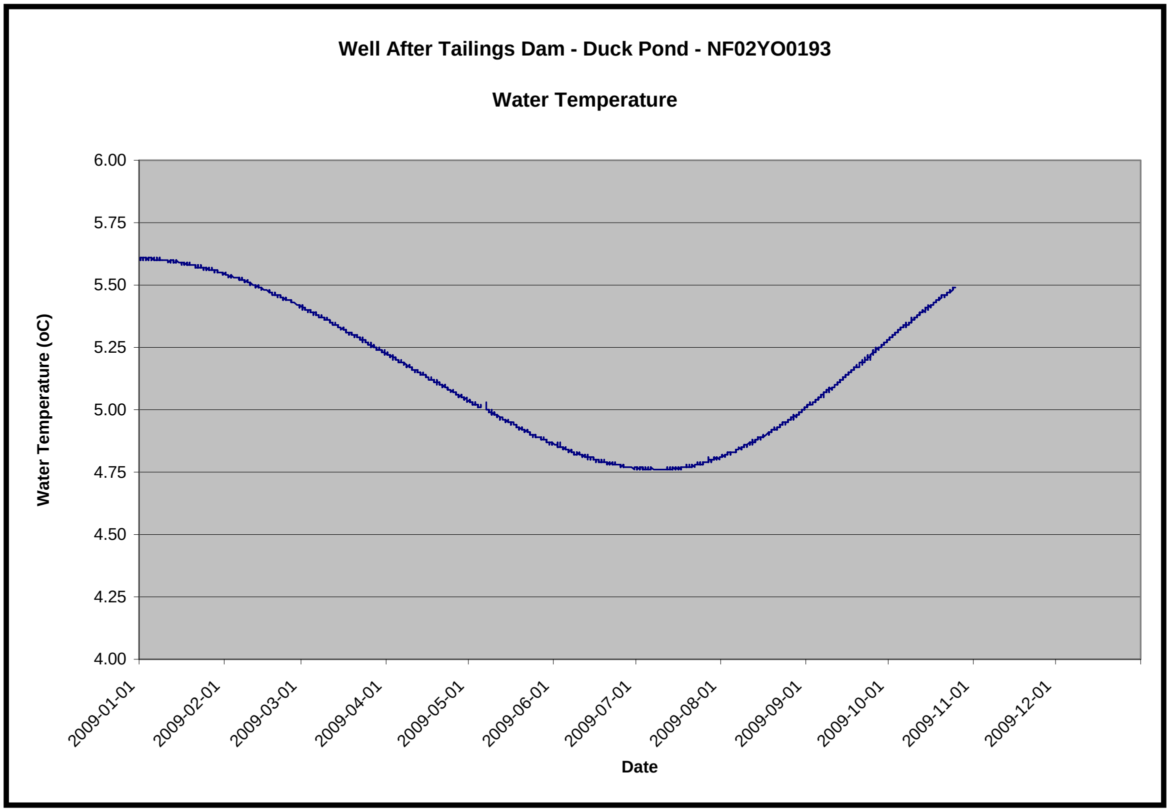

Figure 16

The pH measurements for this well are depicted in **Figure 17**. Values ranged from a minimum of 7.27 to maximum of 9.23. This range is similar to 2008 data.

At the beginning of the second deployment period, there is a significant increase in pH which essentially 'levels off' for the remainder of that period. This response in pH is typical of previous deployments. It is believed that this is a function of the well being purged.

The pH of grab samples collected at the beginning and end of the deployment period are indicated as points with the values tagged on the figure below. The discrepancy (0.35) at the beginning is likely the result of the well recently being purged. The discrepancy (0.80) at the end may be a combination of instrument drift over time, and the fact that the well had to be purged a little in order to collect the grab sample. We will continue to investigate the variance in pH.

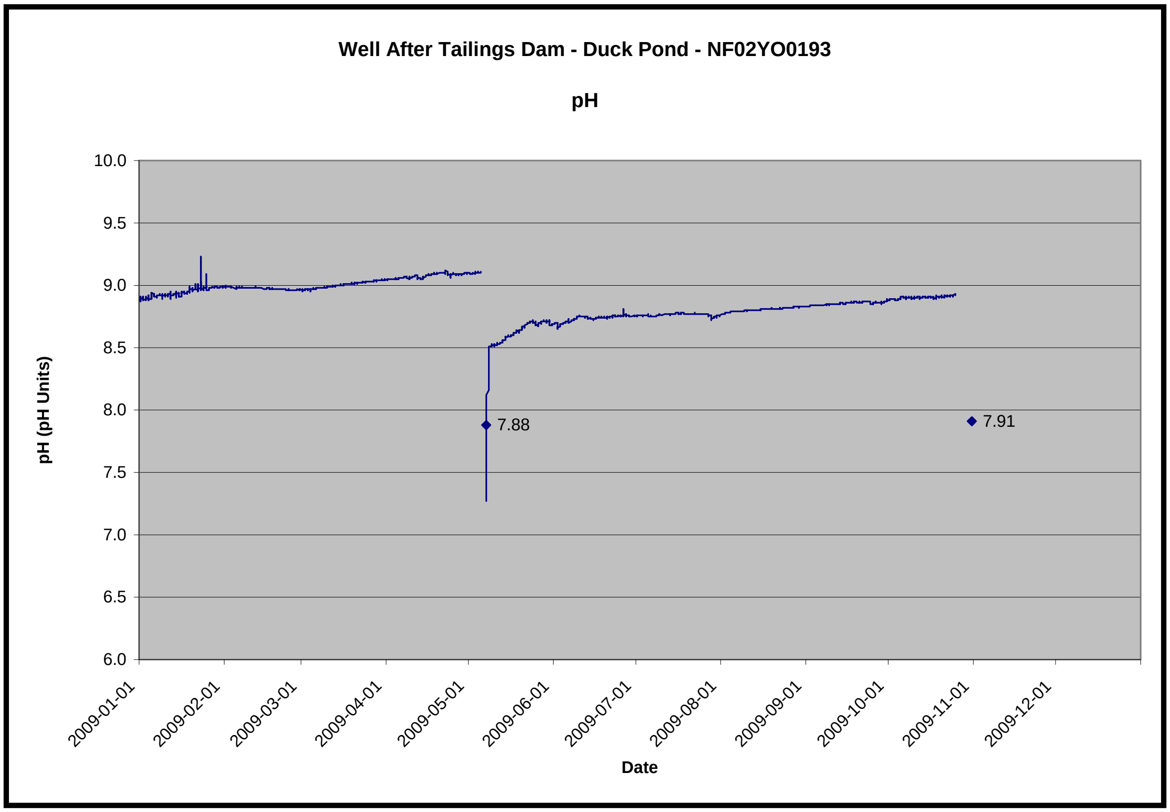

Figure 17

Specific conductance in this well (**Figure 18**) ranged from a minimum of 0.397 mS/cm to a maximum of 0.463 mS/cm. The range is similar to that measured in 2008. Conductivity in this well is higher than surrounding surface waters due to the highly mineralized nature of the material through which it is drilled.

There is a difference of 0.034 mS/cm following the cleaning, calibration and deployment on May 7, 2009, indicating that the instrument had drifted only slightly over the previous winter's extended deployment period. There is excellent agreement (0.013 mS/cm, in both cases) between grab samples at beginning and end of the deployment period and the data recorded by the instrument. Grab sample data are indicated by points with the values tagged on the graph below.

While it appears that conductivity is increasing, we are presently unable to determine if this is a long term trend, is related to changes in the Tailings Management Area, or simply a seasonal fluctuation. Longer term monitoring of this well, may lead to a better understanding of the variability of the specific conductance in this well.

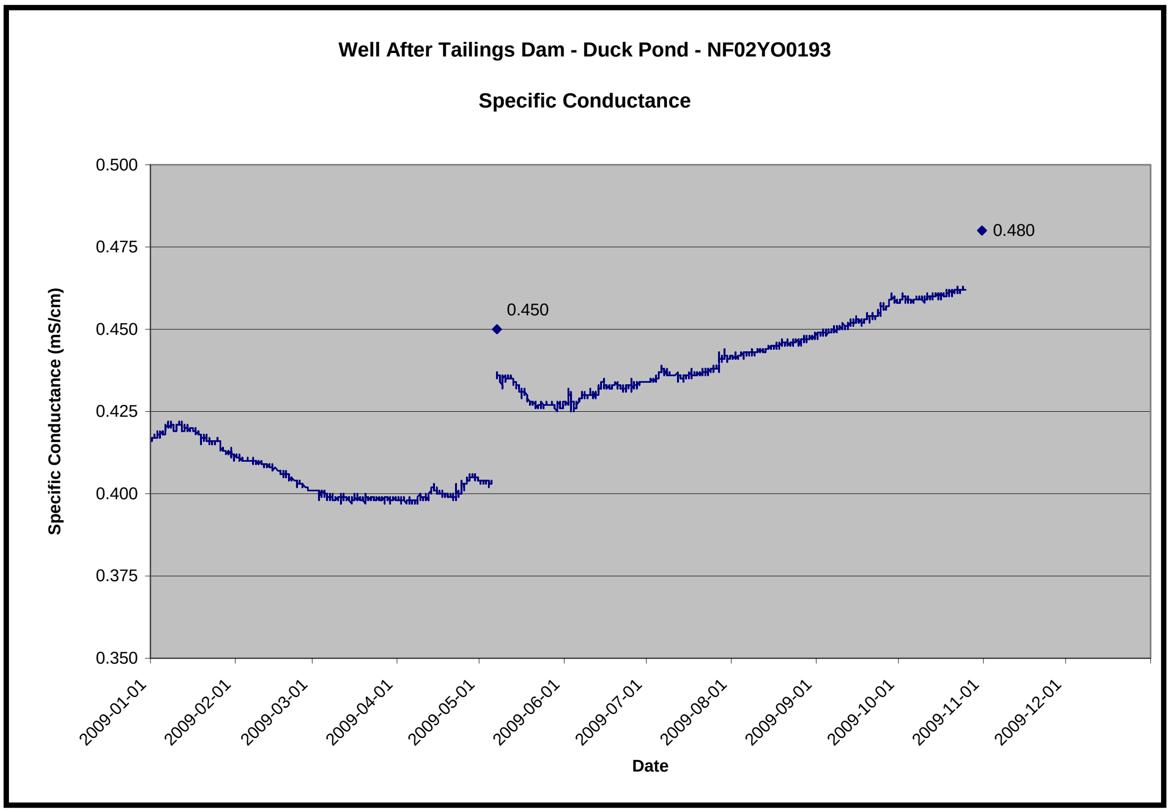

Figure 18

The water elevation (**Figure 19**) ranged between a minimum of 270.75 m and maximum of 271.20 m. This shallow well is located in a glacial till, less than 50 meters from a small stream (Trout Brook). The water elevation in this well is influenced by periods of snow melt and precipitation, showing elevation peaks which correspond closely with monitored streams in the area (Tributary to Gills Pond Brook and East Pond Brook). This is not surprising given its proximity to the stream.

On September 28, 2009, there is a significant decrease in water elevation in this well. This decrease corresponds with the same date and time that a water sample was collected from this well by staff of Teck Duck Pond Operations. There is excellent agreement between recorded and measured water elevations at the beginning (0.003 m) and end (0.002 m) of the second deployment period. This indicates that the water elevation is being logged accurately. Actual water level measurements are indicated by points with the values tagged on the graph below.

There appears to be a slight increase in water elevation throughout the year. However, having no data for November and December, we are unable to determine the profile as winter approached. In 2008, there was an overall decrease in water level from mid September to the end of the year. We are presently unable to determine if this is a long term trend, is related to changes in the Tailings Management Area, or simply a seasonal fluctuation. This relationship will be investigated further as more data is acquired.

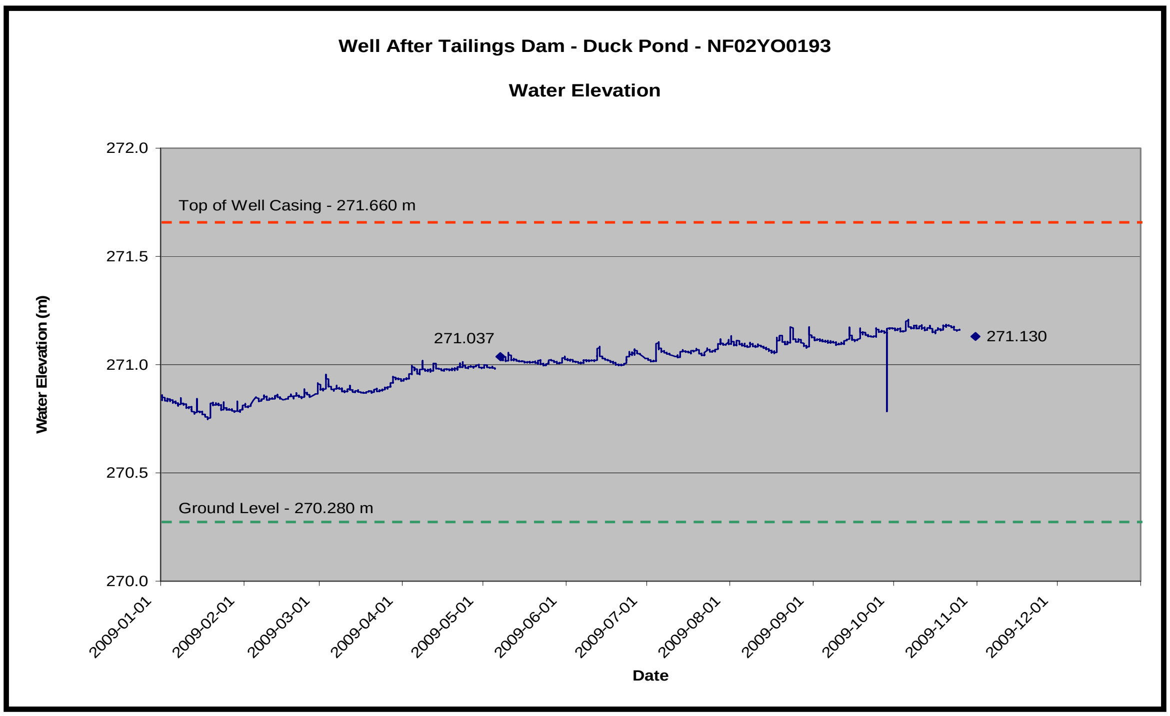

Figure 19

Section 5 Quality Assurance / Quality Control (QA/QC) Measures

Quality Assurance/Quality Control (QA/QC) measures are a very important aspect of the Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations. These measures are put in place to ensure that the instruments are reading data accurately. The QA/QC procedures established by Department of Environment and Conservation are two-fold:

1) Data from the water quality monitoring instrument *in situ* (**DataSonde®**) are compared to data from a portable instrument *in situ* (**MiniSonde®**) at the time of redeployment after maintenance and calibration procedures have been performed; ideally, data should fall within a specified range. **Table 4 (a & b)** summarizes the QA/QC results comparing the **DataSonde®** readings against the **MiniSonde®** readings for each surface water real-time water quality station. No *in situ* **MiniSonde®** readings are possible in the ground water well, thus this comparison is not possible for Monitoring Well After Tailings Dam Station (NF02YO0193).

2) Grab water samples are taken from each surface water station at the time of deployment (beginning and end of deployment period for groundwater station) and sent to a laboratory for analysis; the results are then compared to those of the water quality monitoring instrument *in situ*; ideally data should fall within a specified range. **Table 5 (a, b & c)** summarizes the QA/QC results comparing the **DataSonde®** (surface water stations) and **Quanta G®** (ground water station) readings against the laboratory readings. Only three parameters are available from the lab for comparison (pH, conductivity and turbidity) for surface water stations, while only two (pH and conductivity) are available for the groundwater station.

The ranking system is based upon methodology developed by the U.S. Geological Survey [3], and uses the formulae in **Table 3** to qualify or rank the accuracy of the instruments.

	Ratings				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (oC)	<=+/-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 < 35 µS/cm (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)	<=+/-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

Table 3

Tributary to Gills Pond Brook Station (NF02YO0190)				
Installation Date (yyyy-mm-dd)	**Parameter**	**MiniSonde® Data**	**DataSonde® Data**	**Rating**
2009-05-05	Temp (°C)	12.37	12.47	Excellent
	pH (units)	6.71	6.11	Fair
	Sp. Conductivity (uS/cm)	32.1	33.3	Excellent
	Dissolved Oxygen (mg/L)	10.53	10.53	Excellent
	Turbidity (NTU)	0.0	0.0	Excellent
2009-06-24	Temp (°C)	15.74	15.63	Excellent
	pH (units)	6.98	7.06	Excellent
	Sp. Conductivity (uS/cm)	56.4	57.9	Excellent
	Dissolved Oxygen (mg/L)	9.44	9.48	Excellent
	Turbidity (NTU)	0.5	0.2	Excellent
2009-07-29	Temp (°C)	19.05	19.08	Excellent
	pH (units)	6.81	6.85	Excellent
	Sp. Conductivity (uS/cm)	522.1	523.6	Excellent
	Dissolved Oxygen (mg/L)	8.92	8.90	Excellent
	Turbidity (NTU)	0.0	1.6	Excellent
2009-09-01	Temp (°C)	13.35	13.36	Excellent
	pH (units)	6.36	6.42	Excellent
	Sp. Conductivity (uS/cm)	31.3	31.4	Excellent
	Dissolved Oxygen (mg/L)	9.77	9.74	Excellent
	Turbidity (NTU)	0.6	0.0	Excellent
2009-11-25	Temp (°C)	0.96	0.58	Good
	pH (units)	7.00	6.60	Good
	Sp. Conductivity (uS/cm)	726.4	726.5	Excellent
	Dissolved Oxygen (mg/L)	13.15	13.33	Excellent
	Turbidity (NTU)	0.0	0.7	Excellent

Table 4 a

East Pond Brook Station (NF02YO0192)				
Installation Date (yyyy-mm-dd)	**Parameter**	**MiniSonde® Data**	**DataSonde® Data**	**Rating**
2009-05-05	Temp (°C)	14.18	14.31	Excellent
	pH (units)	6.56	6.21	Good
	Sp. Conductivity (uS/cm)	17.40	18.00	Excellent
	Dissolved Oxygen (mg/L)	9.99	9.98	Excellent
	Turbidity (NTU)	0.0	0.0	Excellent
2009-06-24	Temp (°C)	16.49	16.60	Excellent
	pH (units)	7.05	7.13	Excellent
	Sp. Conductivity (uS/cm)	24.60	25.00	Excellent
	Dissolved Oxygen (mg/L)	9.70	9.74	Excellent
	Turbidity (NTU)	0.0	0.0	Excellent
2009-07-29	Temp (°C)	20.02	20.25	Good
	pH (units)	7.04	7.00	Excellent
	Sp. Conductivity (uS/cm)	32.10	32.20	Excellent
	Dissolved Oxygen (mg/L)	8.99	8.94	Excellent
	Turbidity (NTU)	0.0	0.0	Excellent
2009-09-09	Temp (°C)	14.14	14.09	Excellent
	pH (units)	6.65	6.75	Excellent
	Sp. Conductivity (uS/cm)	22.70	24.10	Excellent
	Dissolved Oxygen (mg/L)	9.95	9.97	Excellent
	Turbidity (NTU)	0.0	0.0	Excellent
2009-11-25	Temp (°C)	1.14	1.02	Excellent
	pH (units)	6.24	6.00	Good
	Sp. Conductivity (uS/cm)	22.00	21.70	Excellent
	Dissolved Oxygen (mg/L)	13.46	13.54	Excellent
	Turbidity (NTU)	0.0	0.0	Excellent

Table 4 b

Tributary to Gills Pond Brook Station (NF02YO0190)				
Installation Date (yyyy-mm-dd)	**Parameter**	**Laboratory Data**	**DataSonde® Data**	**Rating**
2009-05-05	pH (units)	6.89	6.11	Fair
	Sp. Conductivity (uS/cm)	37.0	33.3	Fair
	Turbidity (NTU)	0.6	0.0	Excellent
2009-06-24	pH (units)	7.11	7.06	Excellent
	Sp. Conductivity (uS/cm)	58.0	57.9	Excellent
	Turbidity (NTU)	1.7	0.2	Excellent
2009-07-29	pH (units)	7.04	6.85	Excellent
	Sp. Conductivity (uS/cm)	530.0	523.6	Excellent
	Turbidity (NTU)	1.1	1.6	Excellent
2009-09-01	pH (units)	6.45	6.42	Excellent
	Sp. Conductivity (uS/cm)	33.0	31.4	Excellent
	Turbidity (NTU)	0.6	0.0	Excellent
2009-11-25	pH (units)	6.88	6.60	Good
	Sp. Conductivity (uS/cm)	740.0	726.5	Excellent
	Turbidity (NTU)	0.7	0.7	Excellent

Table 5 a

East Pond Brook Station (NF02YO0192)				
Installation Date (yyyy-mm-dd)	**Parameter**	**Laboratory Data**	**DataSonde® Data**	**Rating**
2009-05-05	pH (units)	6.60	6.21	Good
	Sp. Conductivity (uS/cm)	20.00	18.00	Excellent
	Turbidity (NTU)	0.0	0.0	Excellent
2009-06-24	pH (units)	6.90	7.13	Good
	Sp. Conductivity (uS/cm)	26.00	25.00	Excellent
	Turbidity (NTU)	0.6	0.0	Excellent
2009-07-29	pH (units)	7.10	7.00	Excellent
	Sp. Conductivity (uS/cm)	35.00	32.20	Excellent
	Turbidity (NTU)	0.9	0.0	Excellent
2009-09-09	pH (units)	6.90	6.75	Excellent
	Sp. Conductivity (uS/cm)	26.00	24.10	Excellent
	Turbidity (NTU)	0.4	0.0	Excellent
2009-11-25	pH (units)	6.30	6.00	Good
	Sp. Conductivity (uS/cm)	24.00	21.70	Excellent
	Turbidity (NTU)	0.6	0.0	Excellent

Table 5 b

Monitoring Well After Tailings Dam Station (NF02YO0193)				
Installation Date (yyyy-mm-dd)	**Parameter**	**Laboratory Data**	**Quanta G® Data**	**Rating**
2009-05-07	pH (units)	7.88	7.32	Fair
	Sp. Conductivity (mS/cm)	0.450	0.439	Excellent
2009-10-30	pH (units)	7.91	8.71	Marginal
	Sp. Conductivity (mS/cm)	0.480	0.467	Excellent

Table 5 c

For Tributary to Gills Pond Brook Station (NF02YO0190) the monitoring instrument performed very well. Compared to a portable **MiniSonde®,** the *in situ* **DataSonde®** ranked Excellent or Good in 24 of 25 measurements over five events. Compared to Laboratory Data, the *in situ* **DataSonde®** ranked Excellent or Good in 13 of 15 measurements over five events.

For East Pond Brook Station (NF02YO0192) the monitoring instrument performed very well. Compared to a portable **MiniSonde®,** the *in situ* **DataSonde®** ranked Excellent or Good in 25 of 25 measurements over five events. Compared to Laboratory Data, the *in situ* **DataSonde®** ranked Excellent or Good in 15 of 15 measurements over five events.

For the two surface water stations, the occasional ranking below Excellent could not be attributed to any one particular event or parameter. They are considered to be random errors within the tolerances and limitations of the equipment and procedures.

For Monitoring Well After Tailings Dam Station (NF02YO0193) the monitoring instrument performed reasonably well. Compared to Laboratory Data, the *in situ* **Quanta G ®** ranked Excellent in 2 of 4 measurements over two events. There is discussion on the variance in pH in Section 4.3.

This confirms that the measurements recorded by each of these instruments are very accurate first when they are deployed. It is understood that this accuracy may drift over time should the sensors foul. Accordingly, when conditions and accessibility permit, the instruments will continue to be maintained and calibrated at the intervals recommended by the manufacturer.

Maintenance and calibration are always undertaken by trained staff in accordance with protocols prescribed by the manufacturer. All replaceable parts, reagents and calibration solutions used meet the specifications of the manufacturer. All work is undertaken in a controlled laboratory environment.

In order to ensure long term accuracy for the instruments, they are returned to the vendor periodically (approximately every two years, or when problems or issues are observed) for replacement of sensors (if required) and factory maintenance and calibration.

Section 6.0 Conclusions

The Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations has again this year proven to be quite useful. The data derived from this network has been used by Teck management and staff to monitor their performance. Government has reviewed the data daily to ensure that equipment is functioning properly, and that discharge from the site remains within the regulated discharge criteria. The public, who have access to this data through the web, have undoubtedly been diligent in monitoring the water quality data as well.

While changes to water quality have been observed throughout the year, not one incident has been identified which has raised any cause for concern. No mitigative measures have needed to be employed to address any problems or issues resultant from this monitoring.

Based upon the parameters monitored by this network, we are confident, that in 2009, Teck Duck Pond Operation has had minimal impact on the receiving waters and other water in proximity to the site.

Continued operation of the Real-Time Water Quality Monitoring Network at Teck Duck Pond Operations is planned for the life of the operation.

Section 7.0 Path Forward

In order for this program to remain successful, it is essential to continually evaluate, improve and move forward. The following is a list of initiatives and activities to be carried out in the upcoming year:

1) The **DataSonde®** instruments owned by Teck Duck Pond Operations will be monitored closely to ensure their accuracy and reliability. Should any issues be identified, they will be returned to the vendor for factory servicing and calibration. Instruments owned by the province will be used during this period.
2) Work will continue to overcome challenges with false-positive turbidity measurements at Tributary to Gills Pond Brook Station (NF02YO0190).
3) Efforts will continue to monitor and evaluate water elevation at Monitoring Well After Tailings Dam Station (NF02YO0193) and the possible relationship with Tailings Management Area water elevation.
4) Evaluation of water quality in Monitoring Well After Tailings Dam will continue to determine whether or not purging the well prior to instrument deployment should continue.
5) Work will continue to obtain weather data from on-site weather station operated by Teck Duck Pond Operations, and possibly incorporate it into the real-time reporting systems. Weather data can be used to more precisely assess the changes in water quality/quantity, as presently there is no automatic weather station nearby.
6) Improvements will be made to the pathways leading to the Real-Time Water Quality Monitoring stations.
7) Work will continue to optimize sensor performance, data transmission, and information transfer. Any emerging issues will be addressed in a timely manner.
8) Work will continue to automate the data handling and reporting processes. New processes are currently being developed by ENVC, which will quantify drift (fouling and instrument) over individual deployment periods. In subsequent deployment reports we hope to be able to document this drift numerically and graphically. This will enhance our confidence in the accuracy and reliability of the real-time monitoring network.
9) ENVC is working on extrapolation of other water quality parameters using regression analysis.

Section 8.0 References

1. *Canadian Water Quality Guidelines for the Protection of Aquatic Life,* Canadian Council of Environment Ministers, 1999, Update 7.1, December 2007.

2. *Real Time Water Quality Report, Duck Pond Operations (Teck Cominco Limited), Deployment Period 2008-10-16 to 2008-11-12*, Department of Environment and Conservation, 2009.

3. *Guidelines and standard procedures for continuous water-quality monitors – Station operation, record computation and data reporting: U.S. Geological Survey Techniques and Methods 1-D3*, U.S Geological Survey, 2006.