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Accuracy and Precision in Real-Time Water Quality Monitoring

How good is my data?

Robert Wight
Environmental Scientist

The Pollster

"This poll is accurate

within plus or minus five percentage points nineteen times out of twenty"

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Benchmarks

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Accuracy and Precision

Precise

(Not Accurate)

Accurate

(Not Precise)

Accurate And Precise

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Real-Time Water Quality Monitoring

QA/QC Protocols

- Trained Personnel
- Right Instrument for the Job
- Proper Instrument Set-up and Calibration Procedures
- Data Review and Analysis
- Tools to measure Accuracy and Precision

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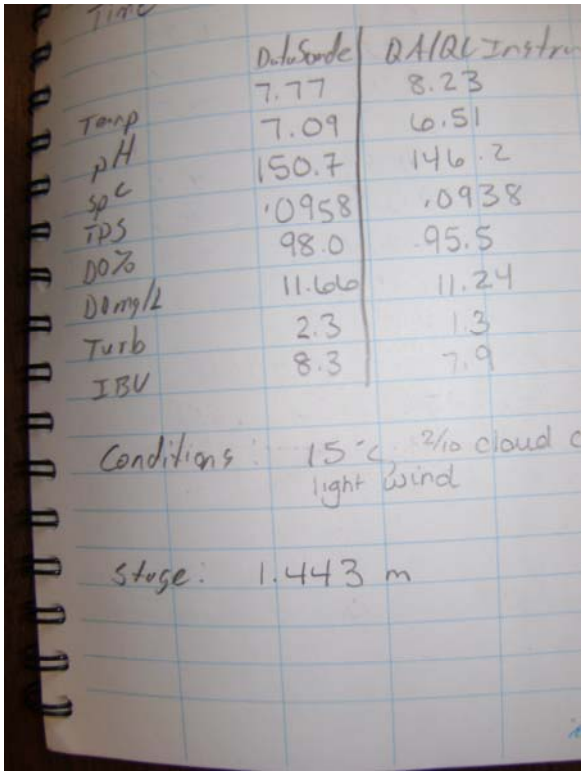
Side-by-Side Comparison



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Representative Grab Samples

- How and when the sample is taken
- Proper collection, preservation, handling, storage, shipping protocols
- CALA Accredited Labs
- Blanks, Spikes, Blind Duplicates
- No matter what you do, samples will change some en route to the lab.
- What about accuracy and precision?

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Monitoring Wells

- Typically 50 mm (2 inch) ID casing
- Is a Side-by-Side comparison possible?
- Can you get a representative sample?

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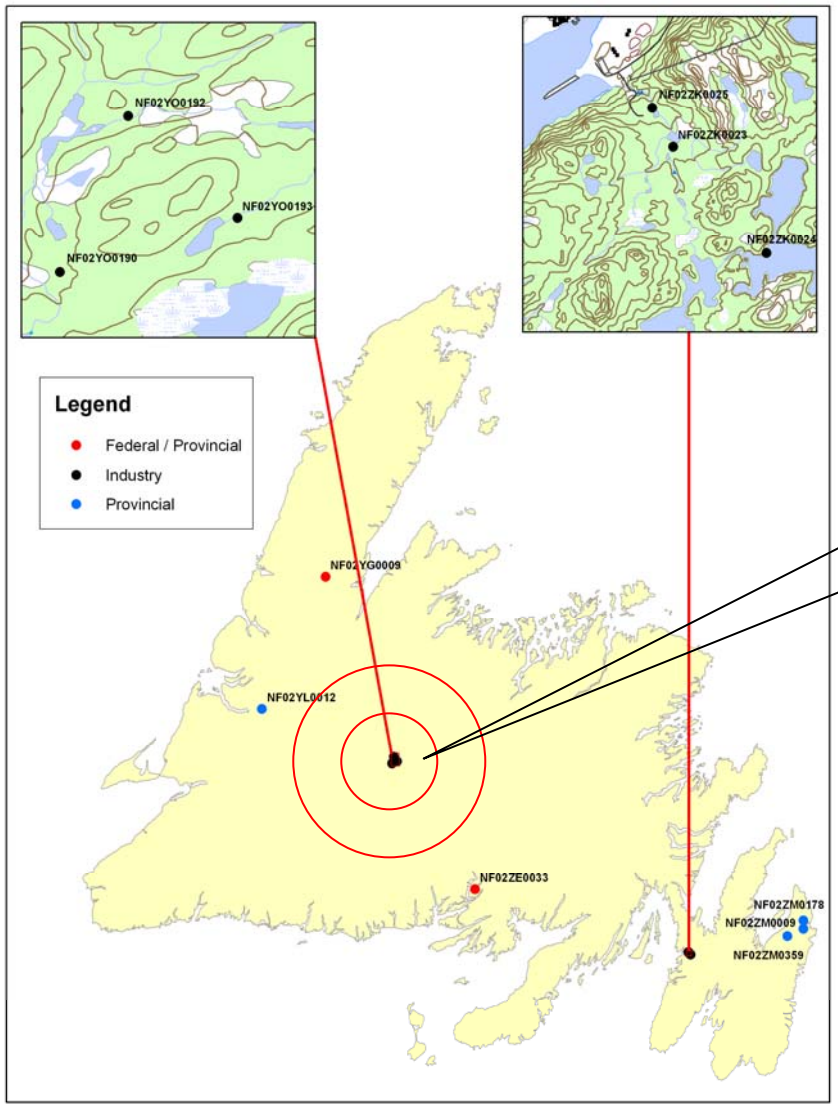
Location



Teck Duck Pond Operations

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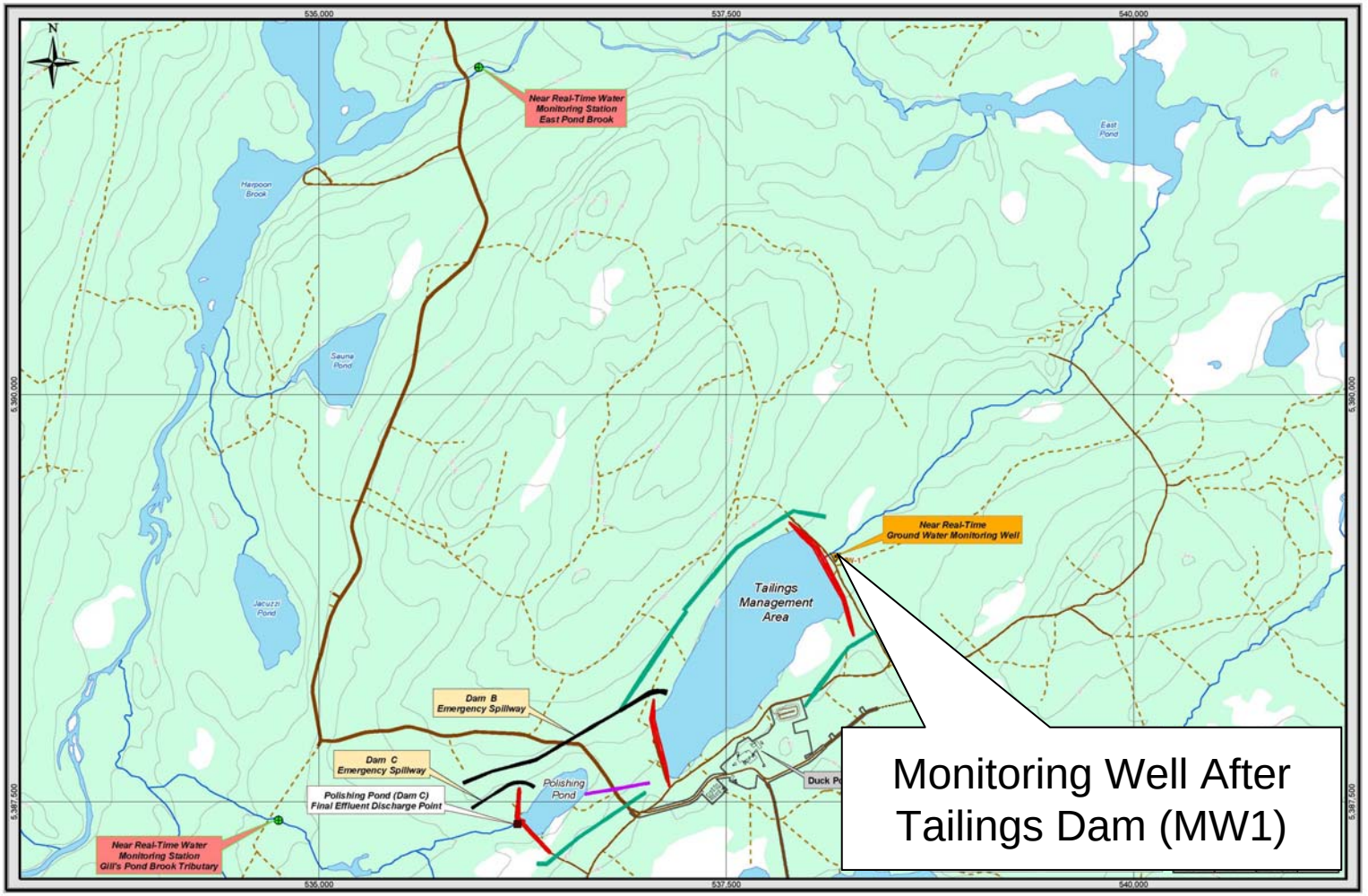
Location



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Monitoring Well after Tailing Dam (MW1) Duck Pond

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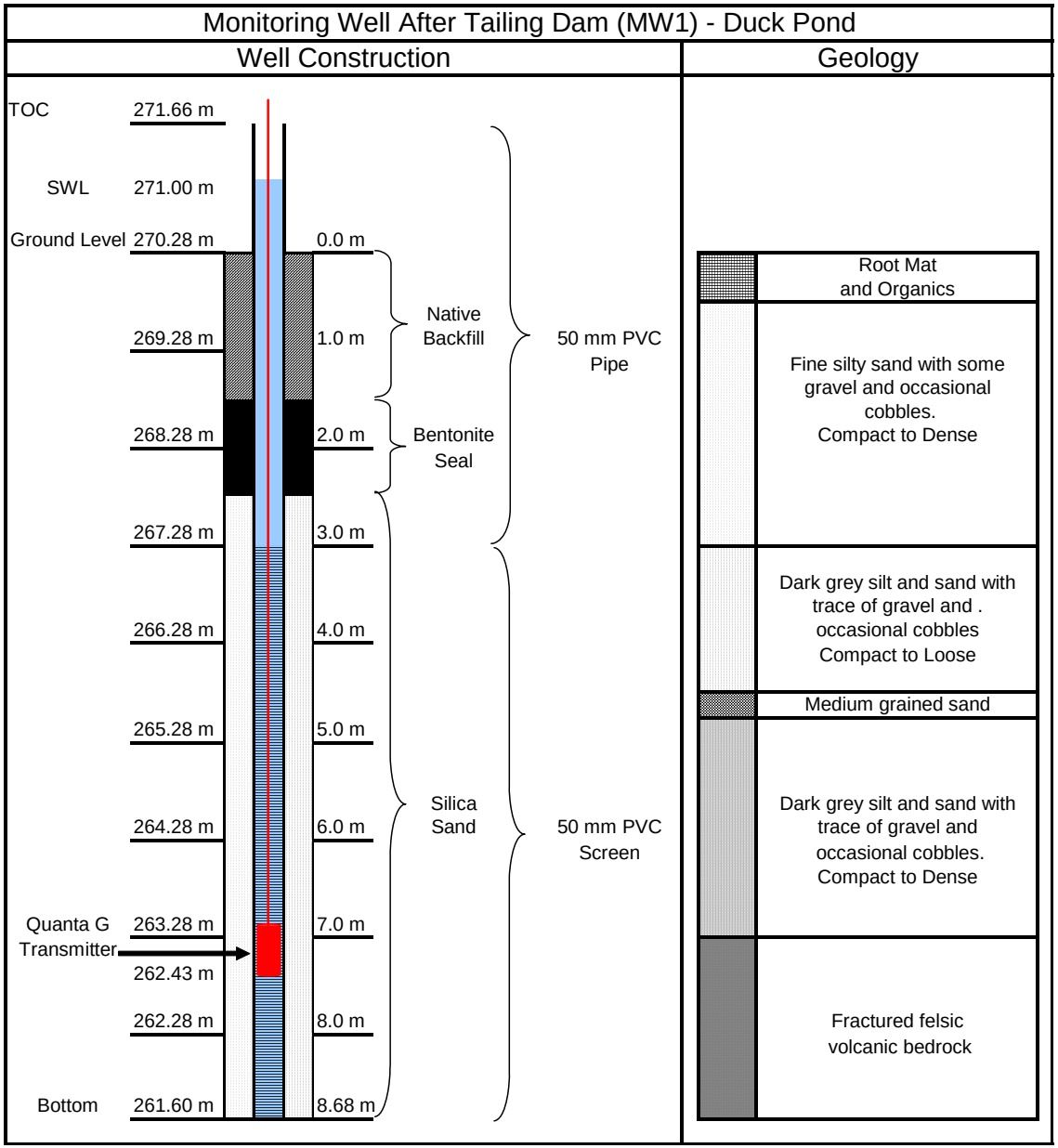

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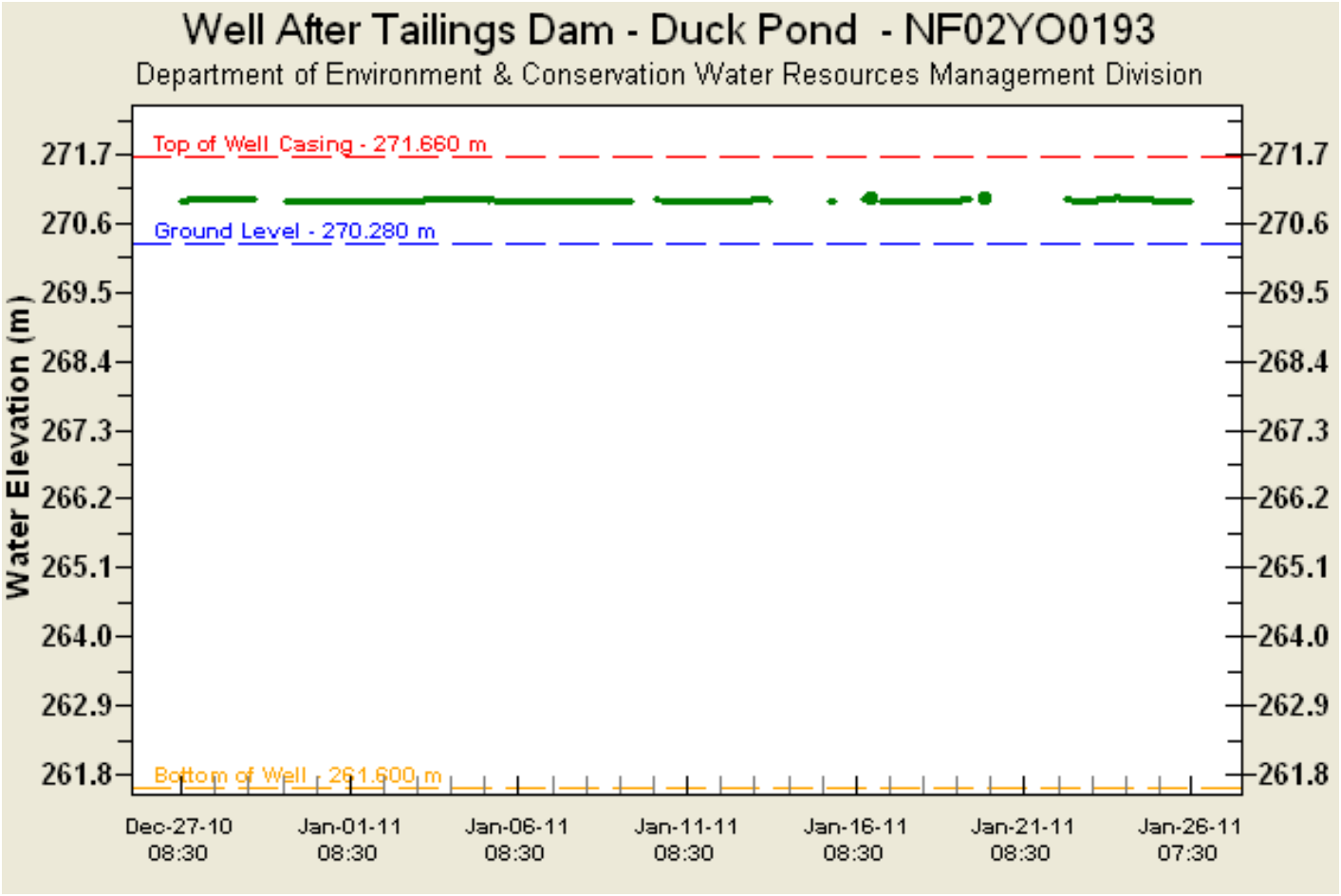
Water Elevation 30 Days



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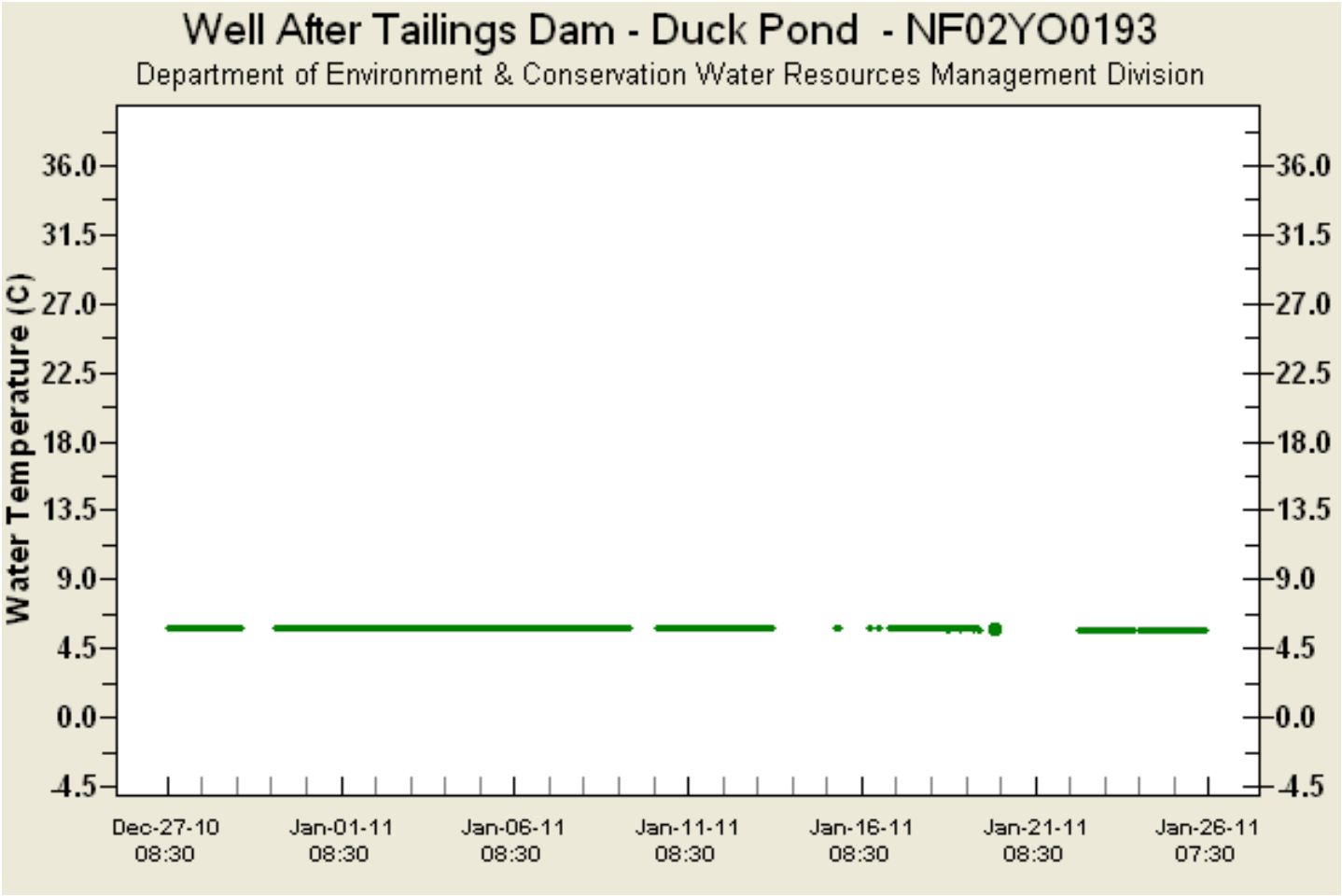
Temperature 30 Days



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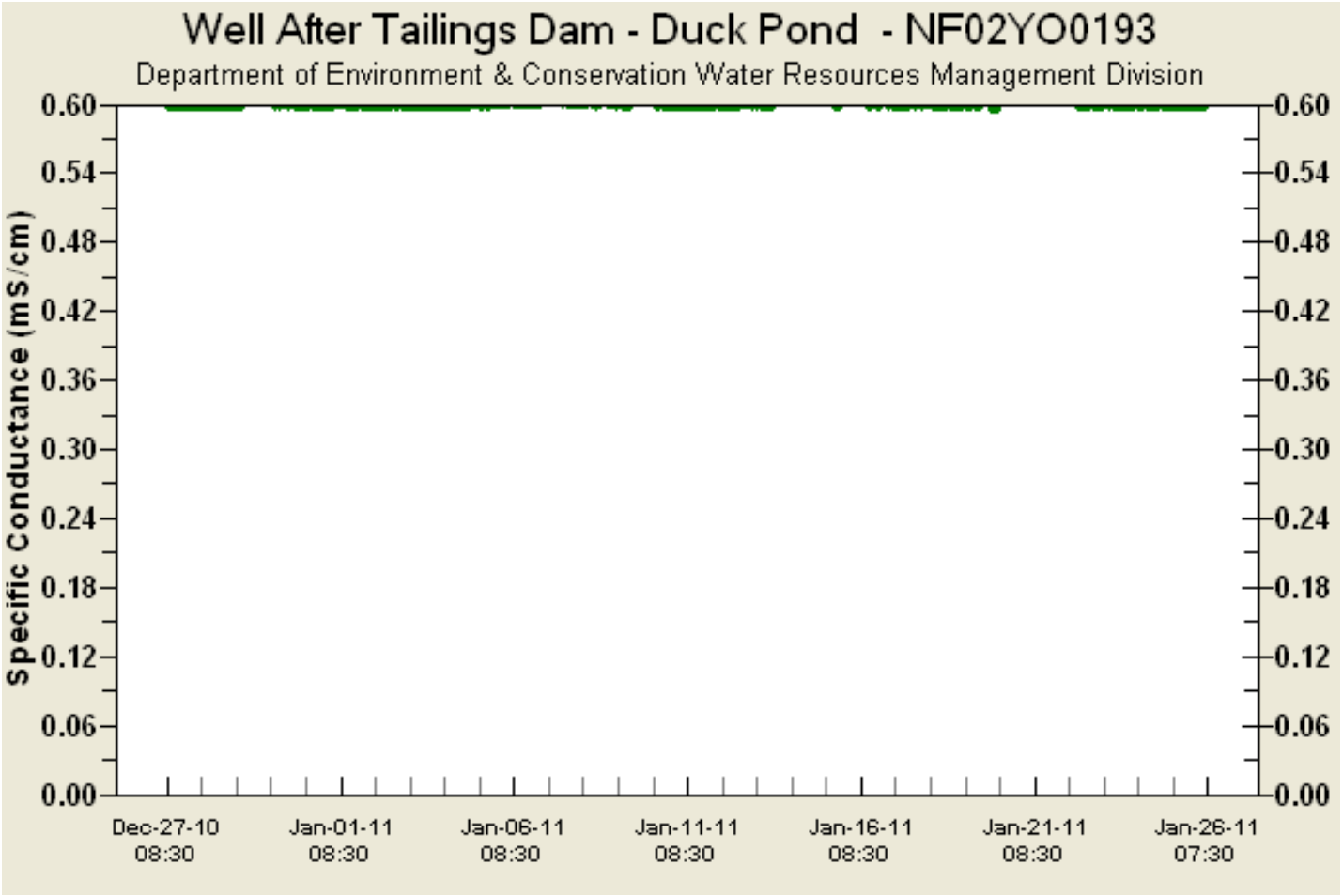
Specific Conductivity 30 Days



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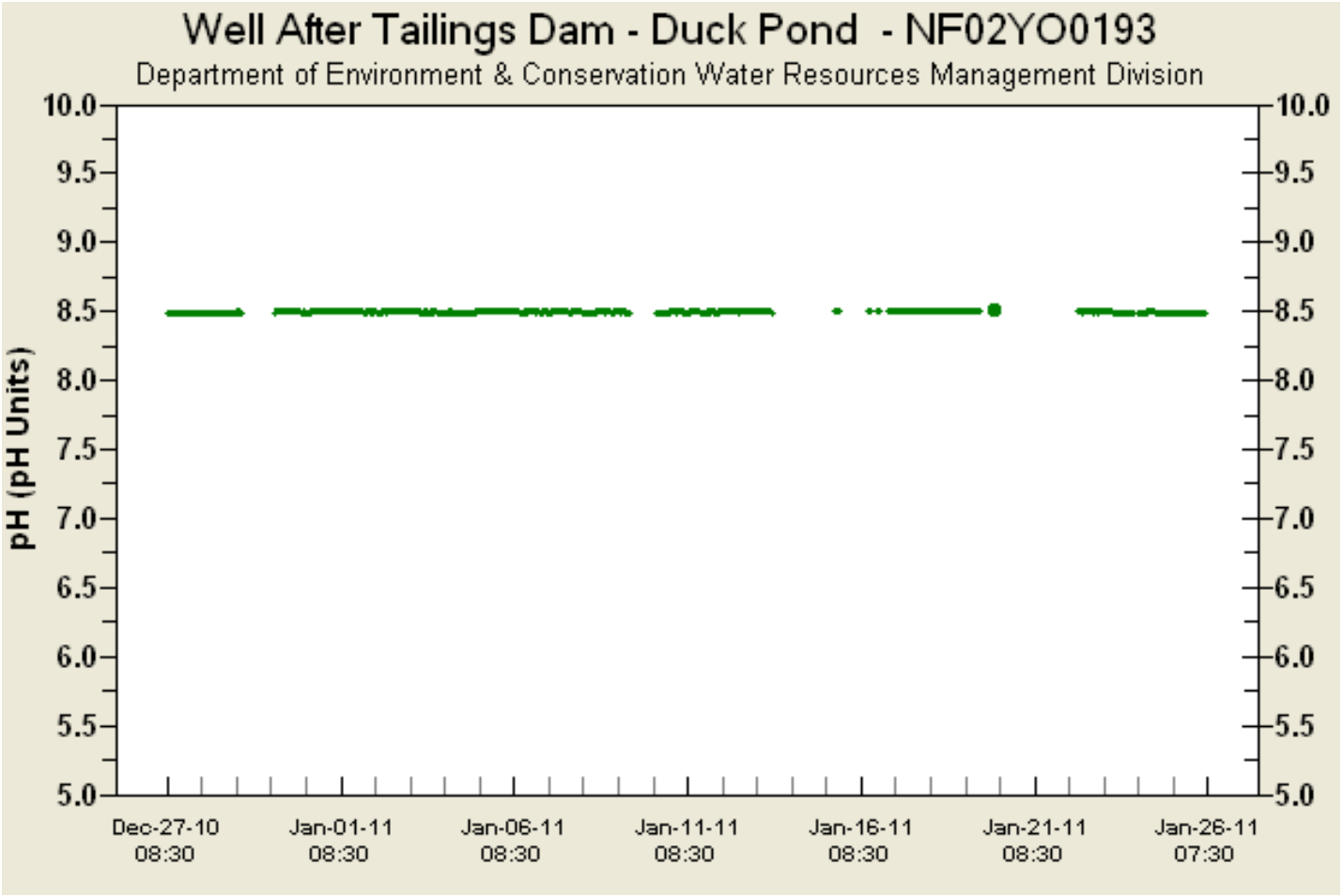
pH 30 Days



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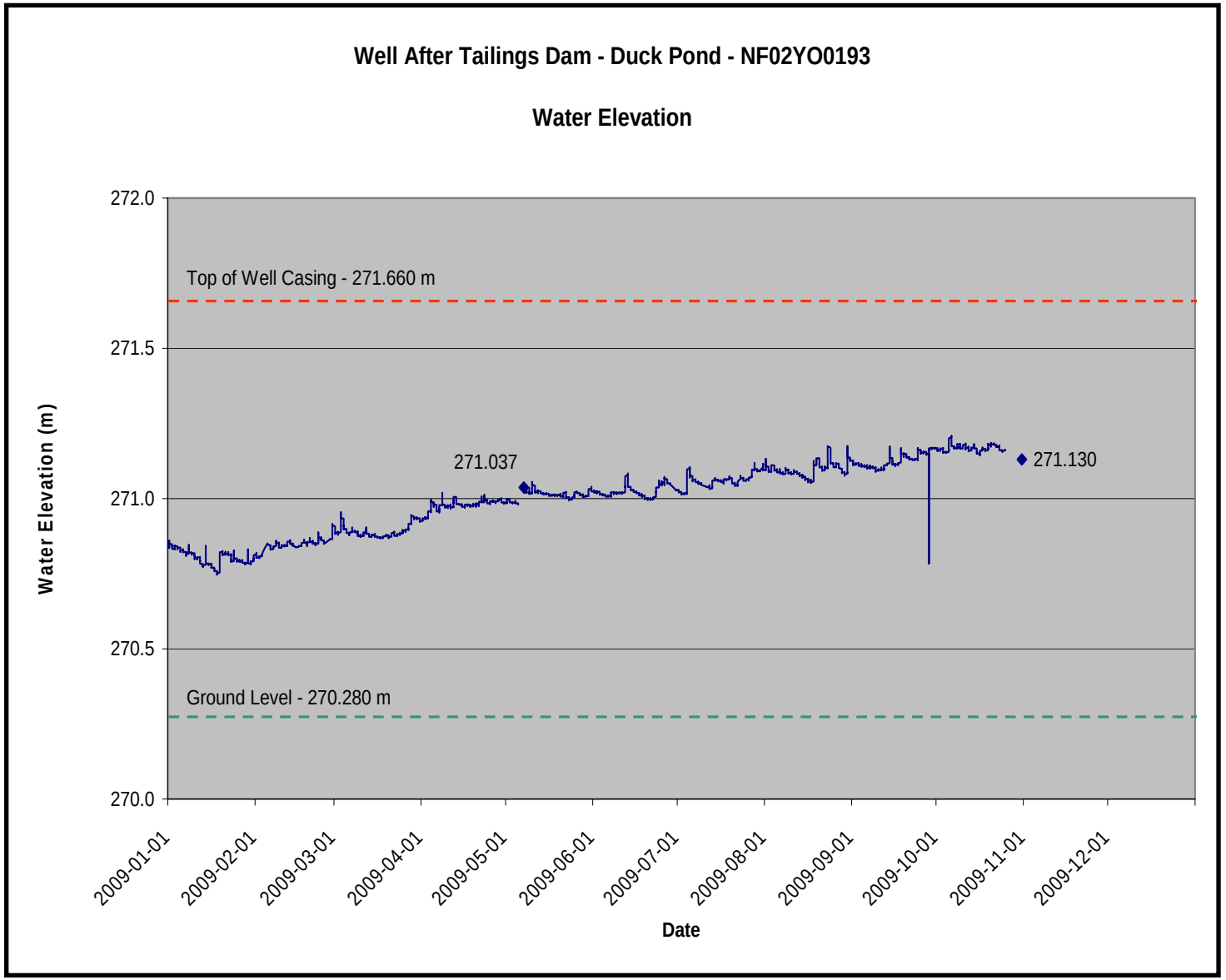
Water Elevation 2009



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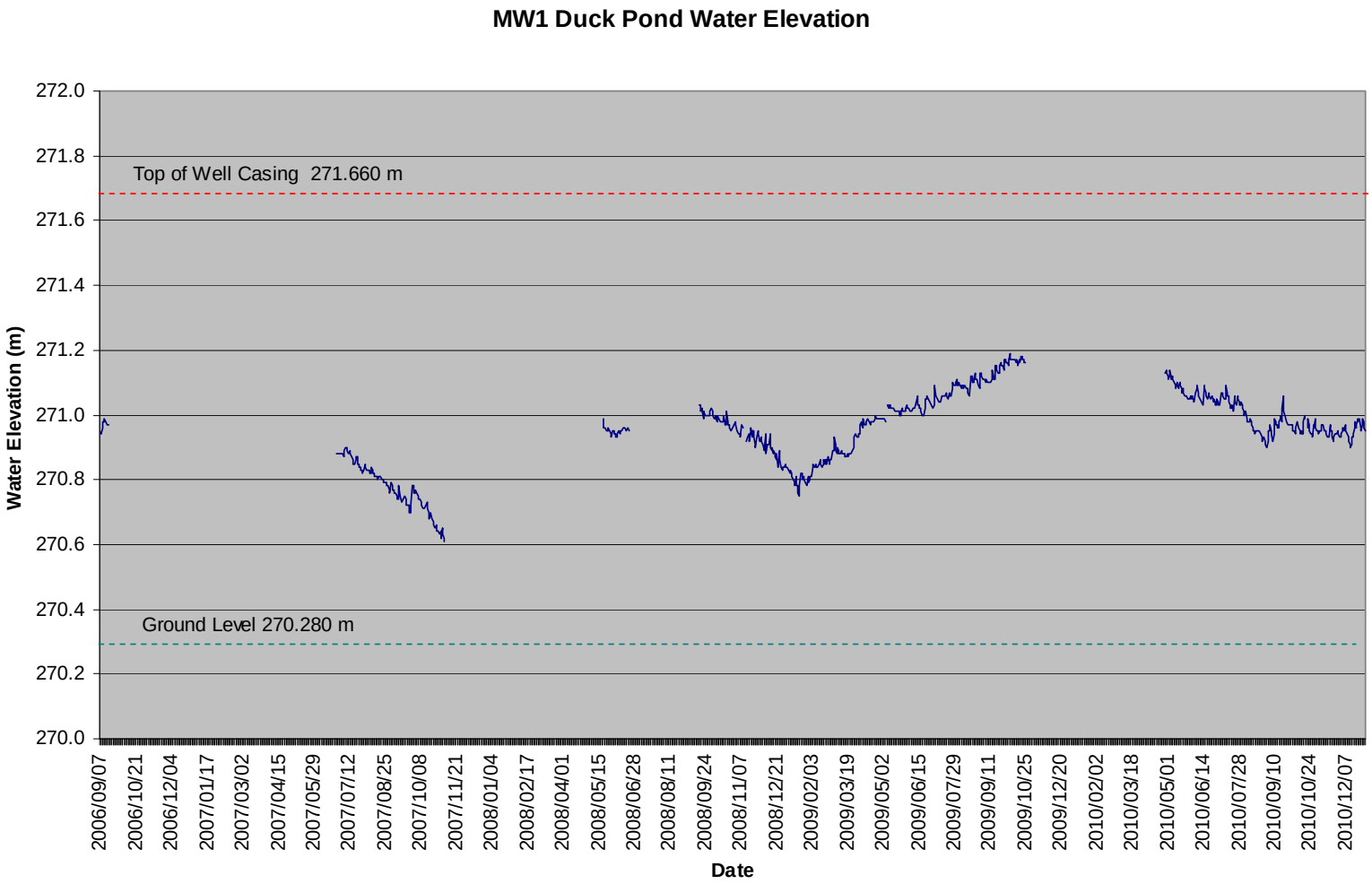
Water Elevation 2006-2010



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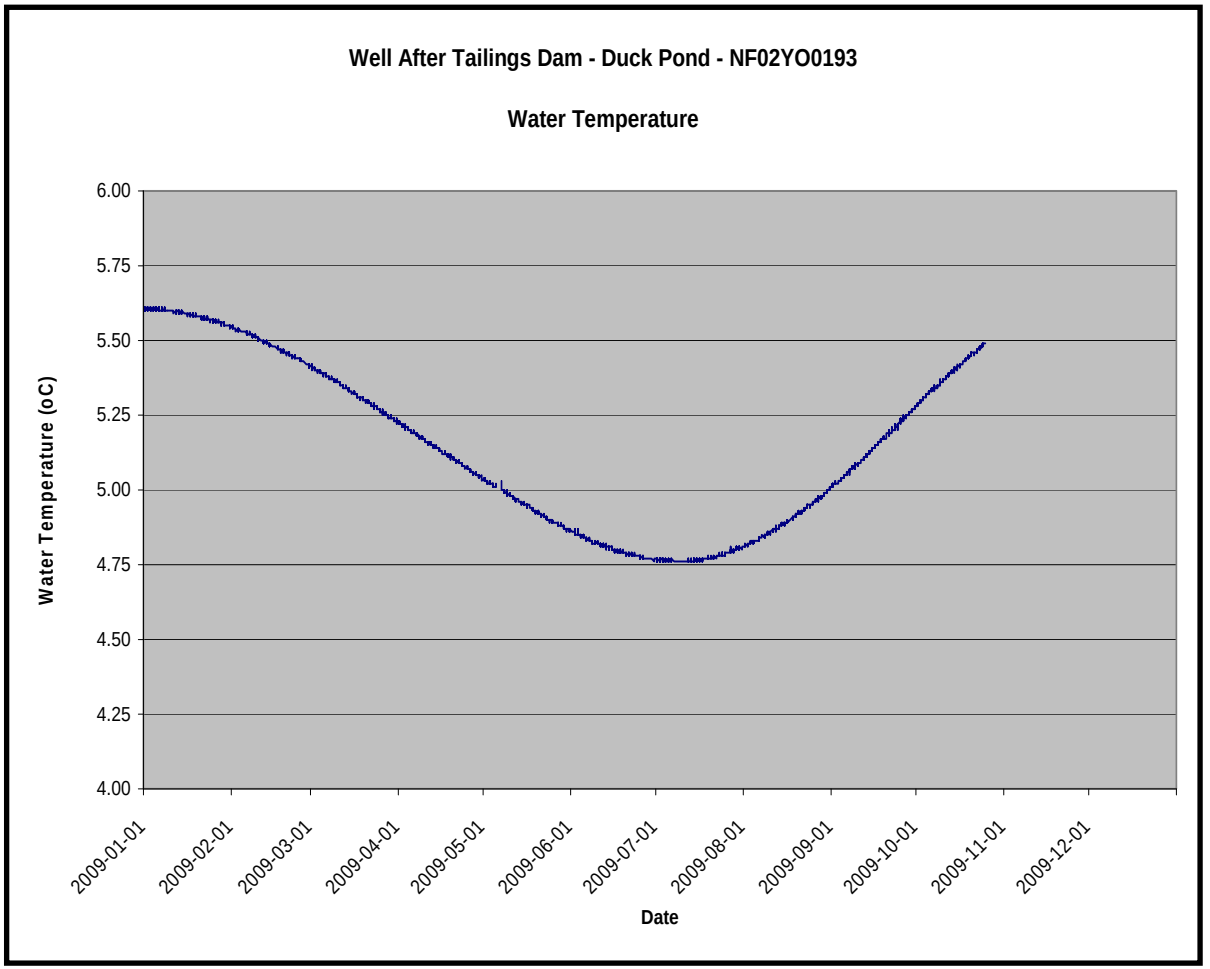
Water Temperature 2009



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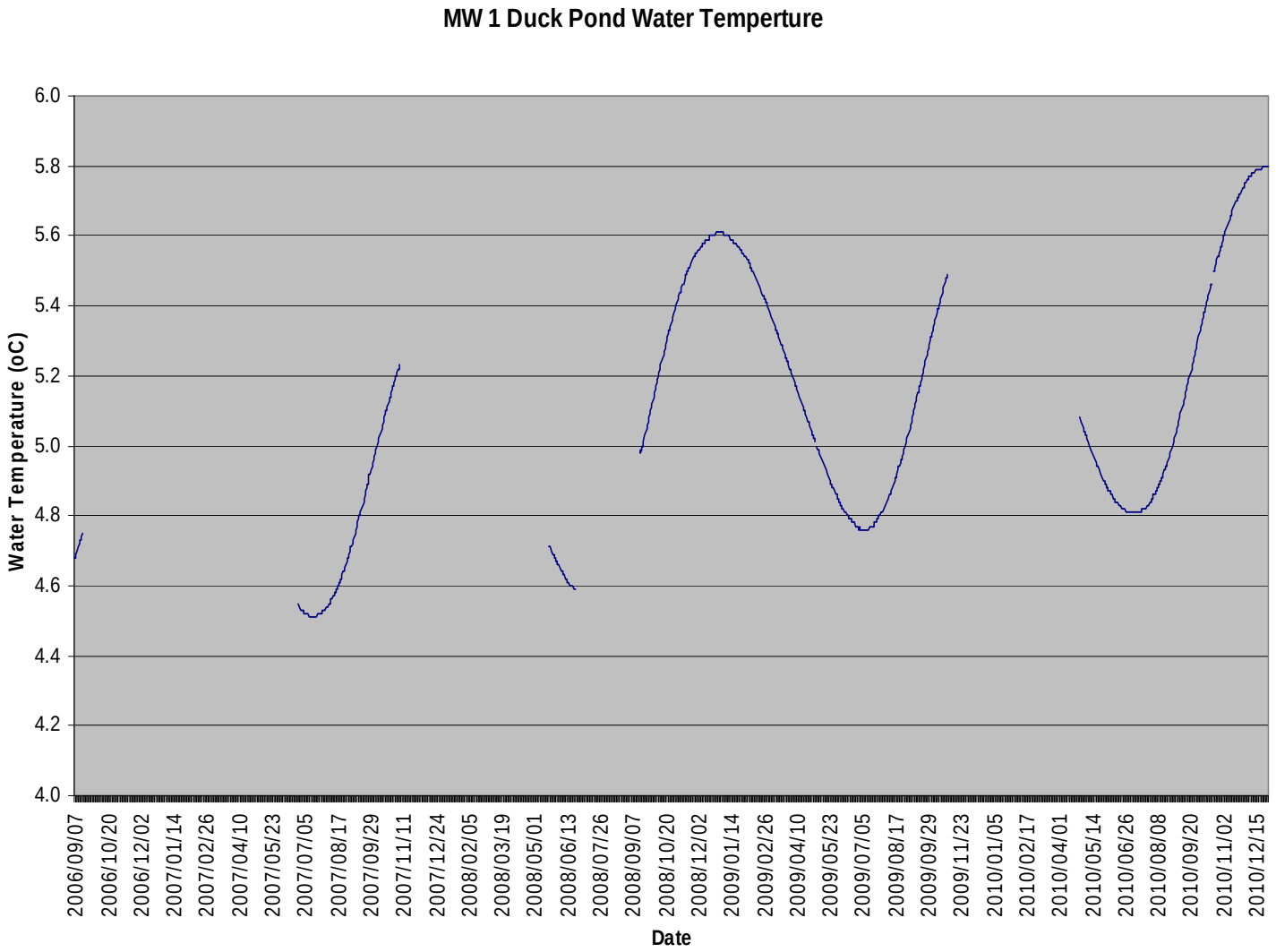
Water Temperature 2006-2010



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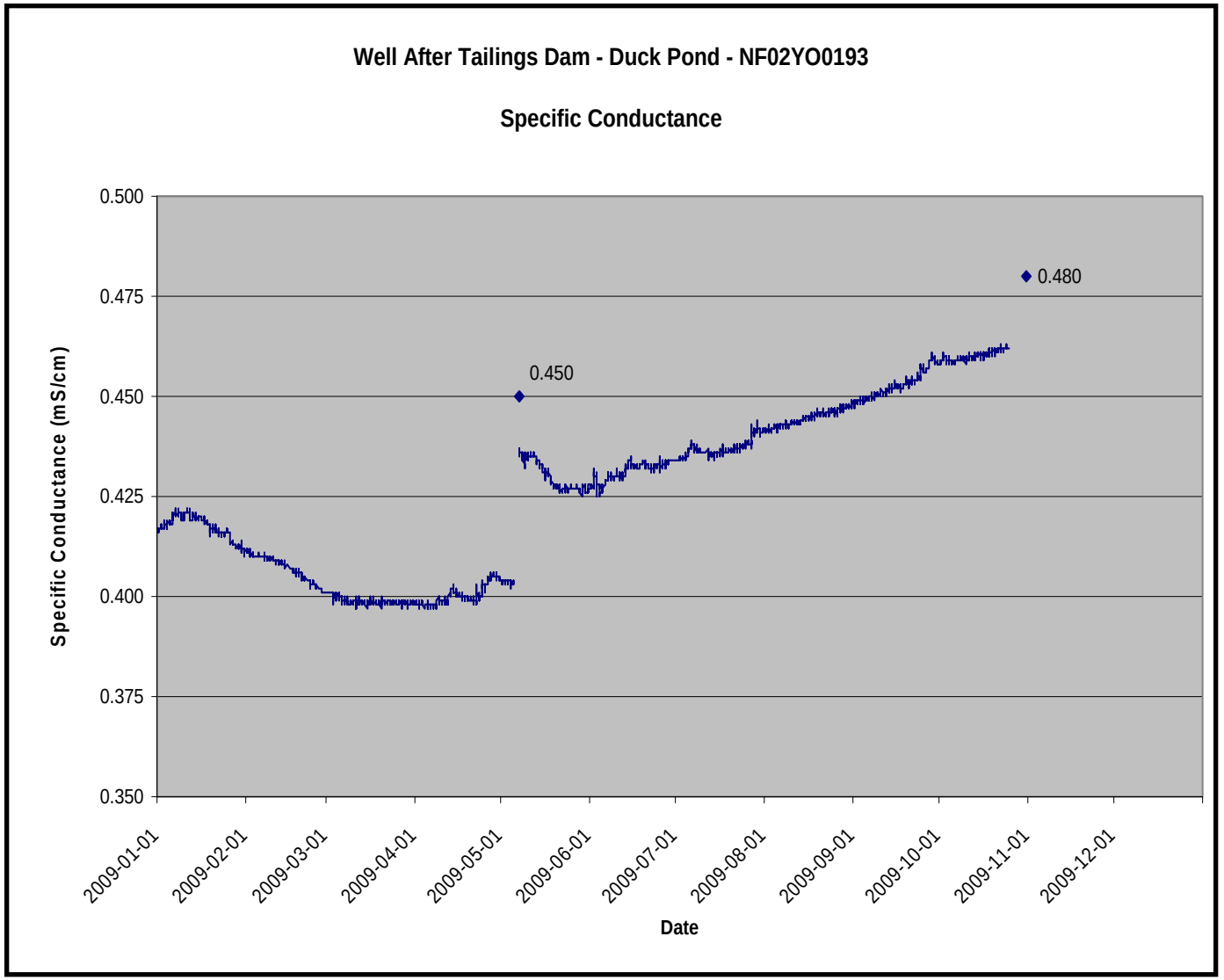
Specific Conductivity 2009



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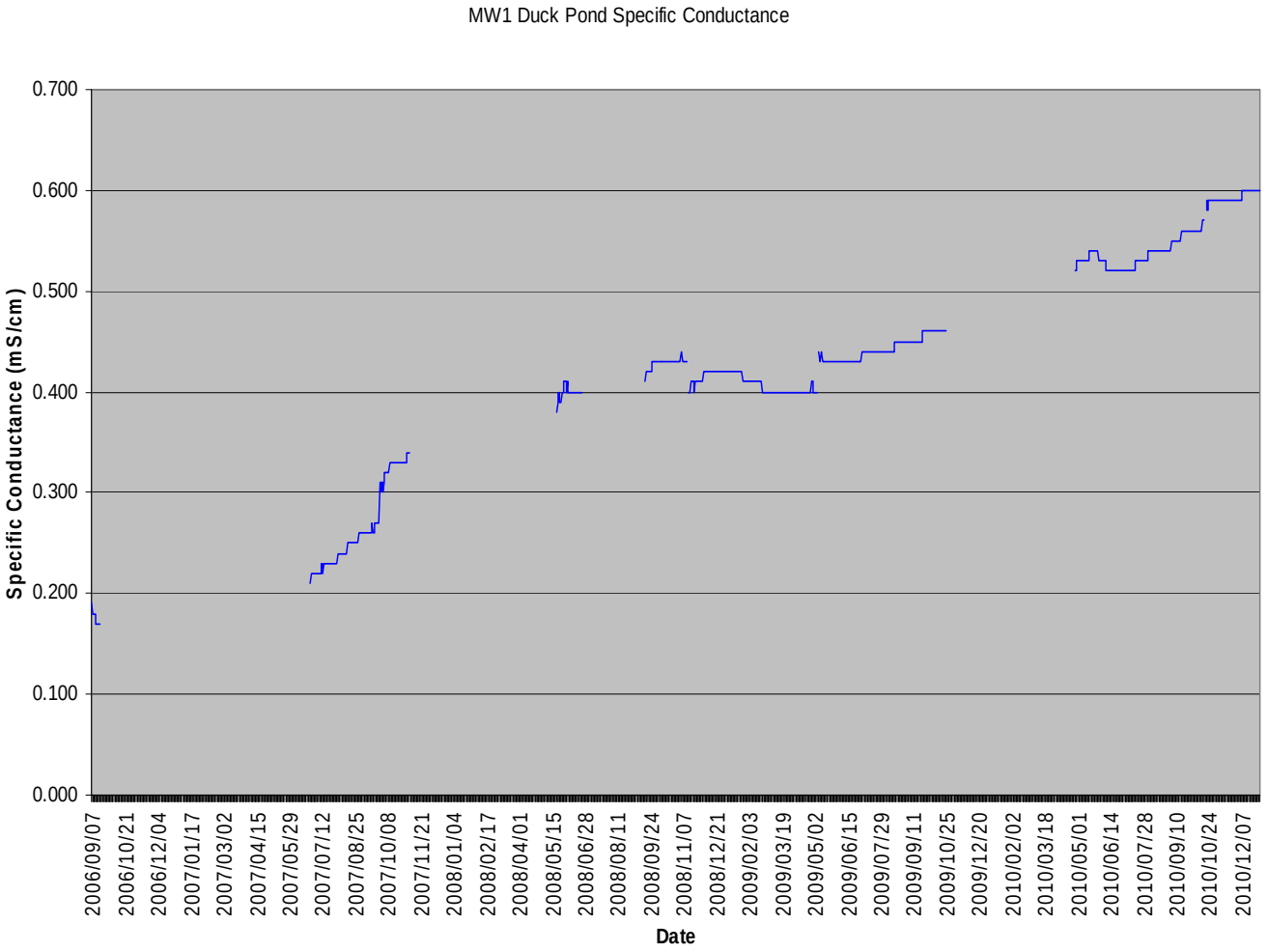
Specific Conductivity 2006-2010



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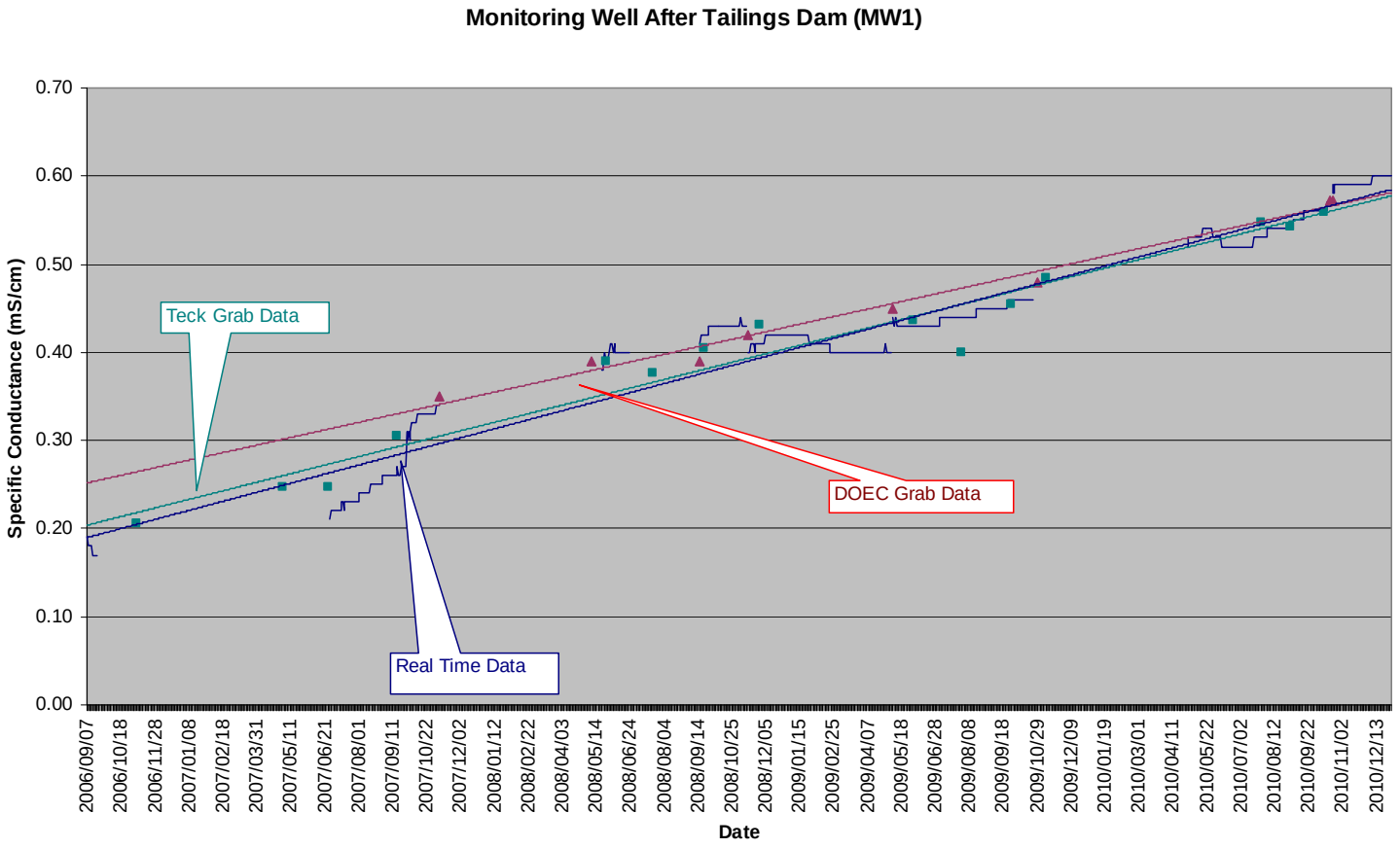
Specific Conductivity 2006 - 2010



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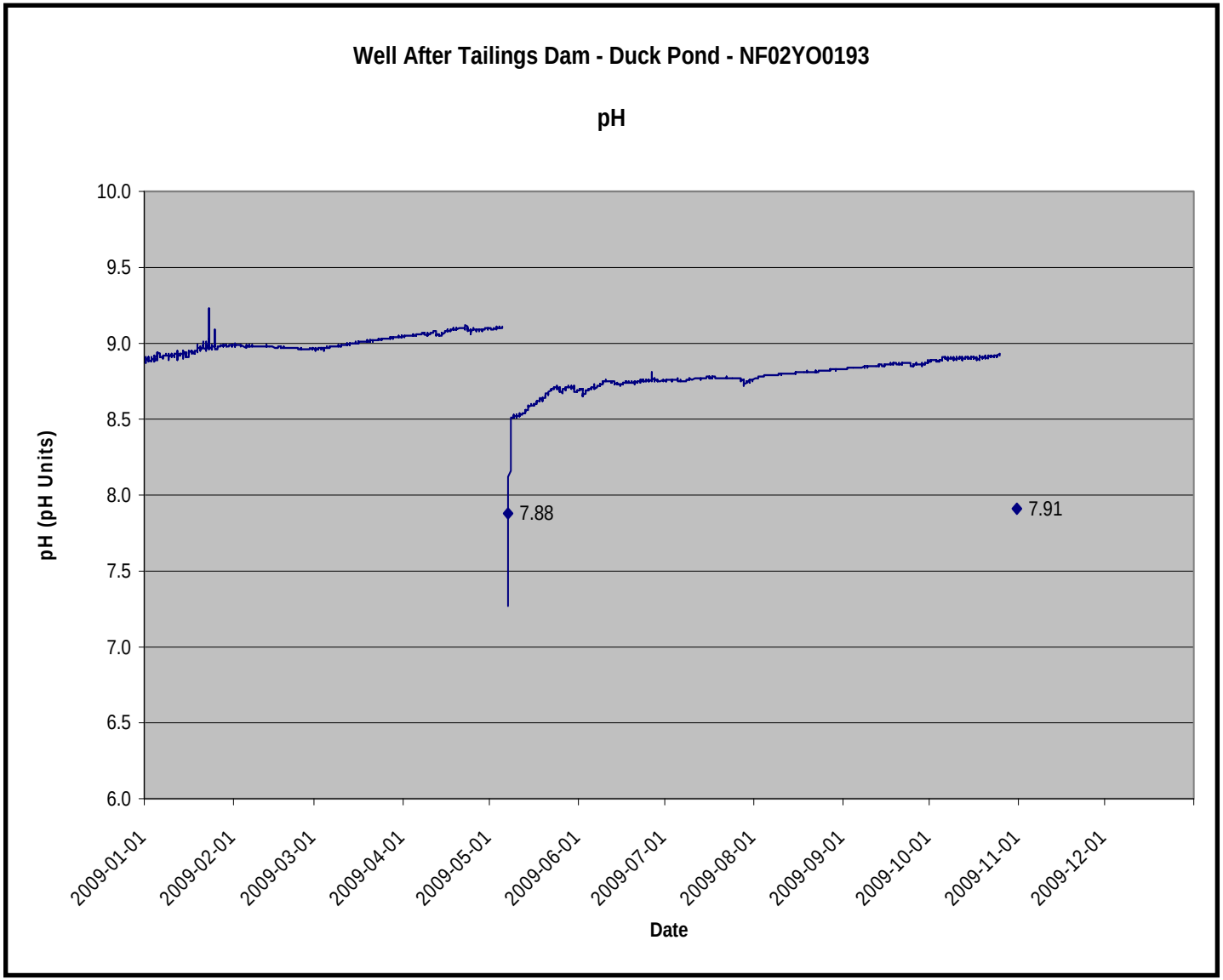
pH 2009



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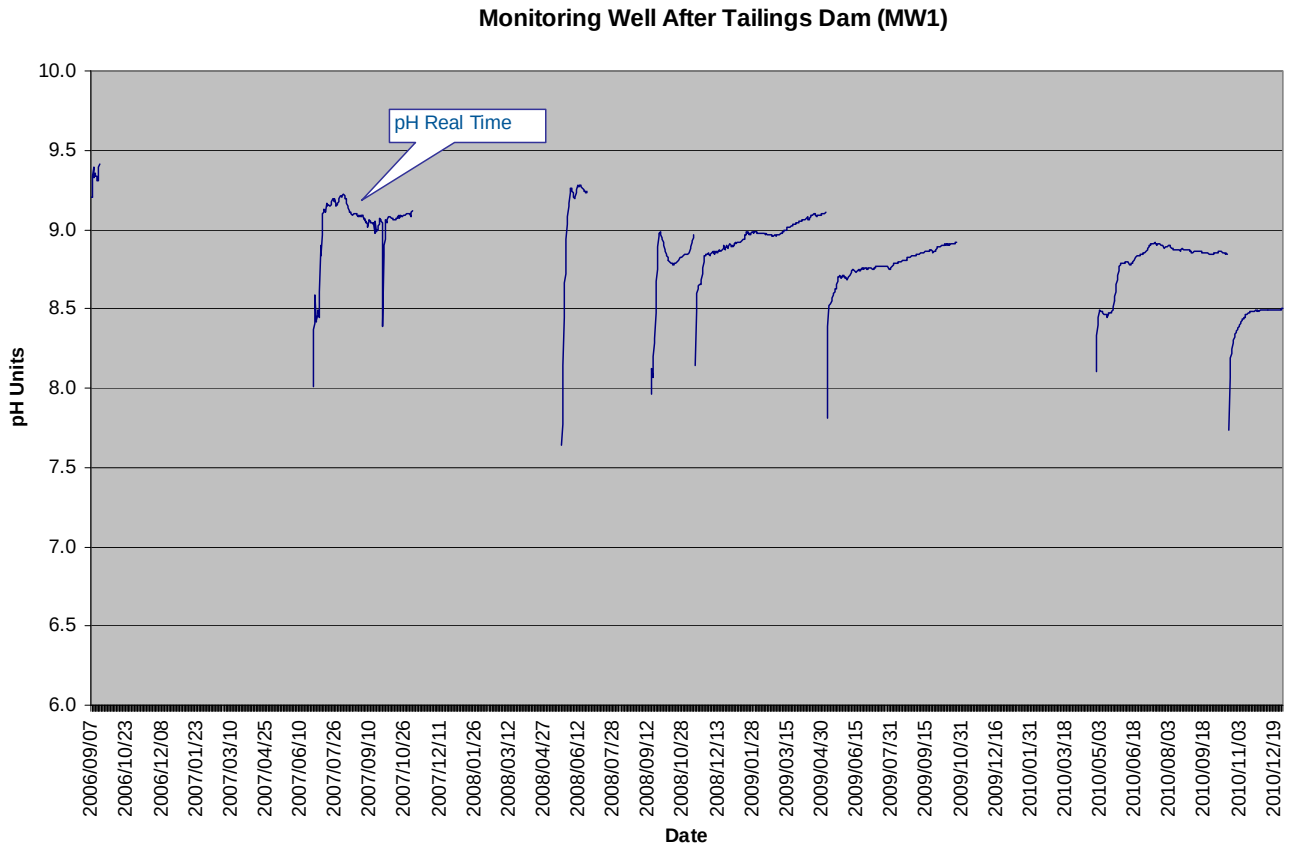
pH 2006 - 2010



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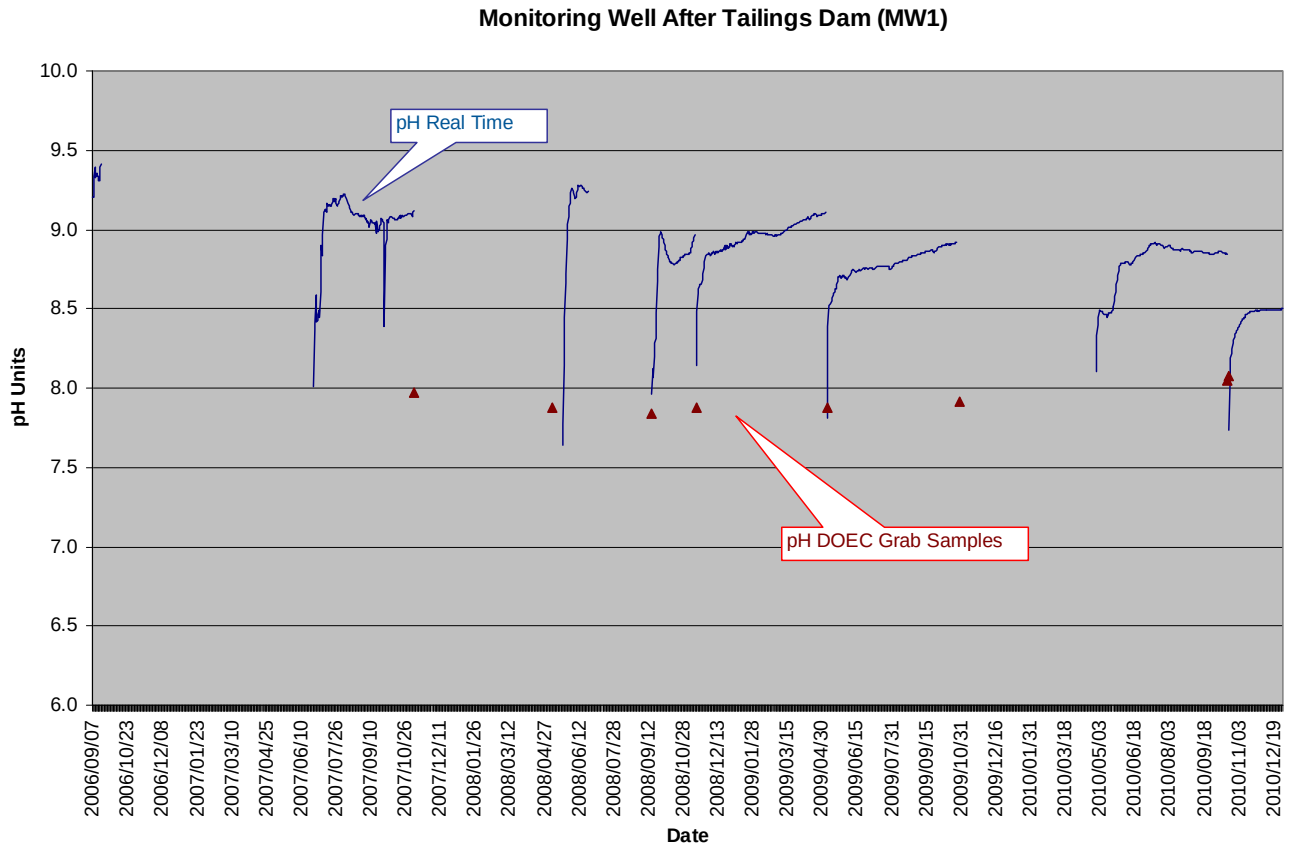
pH 2006 - 2010



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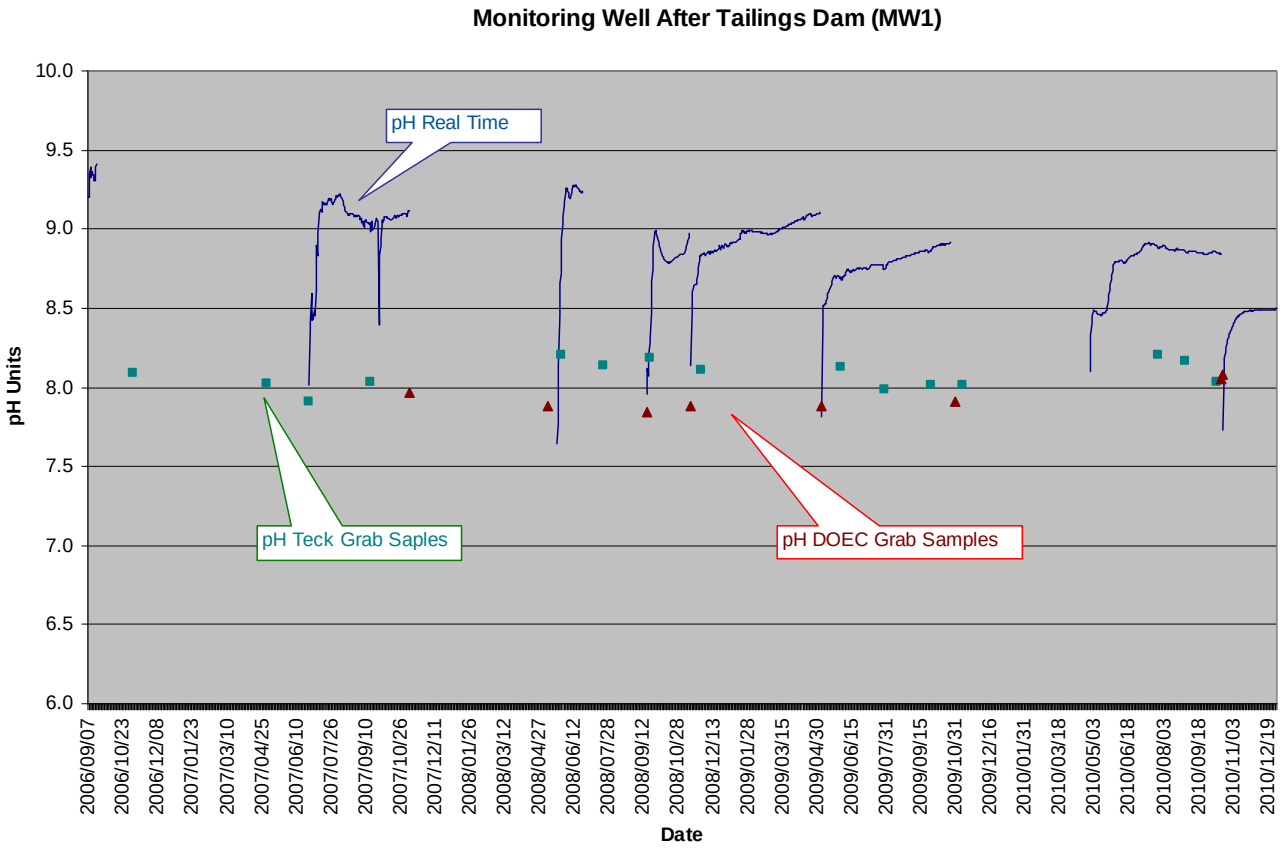
pH 2006 - 2010



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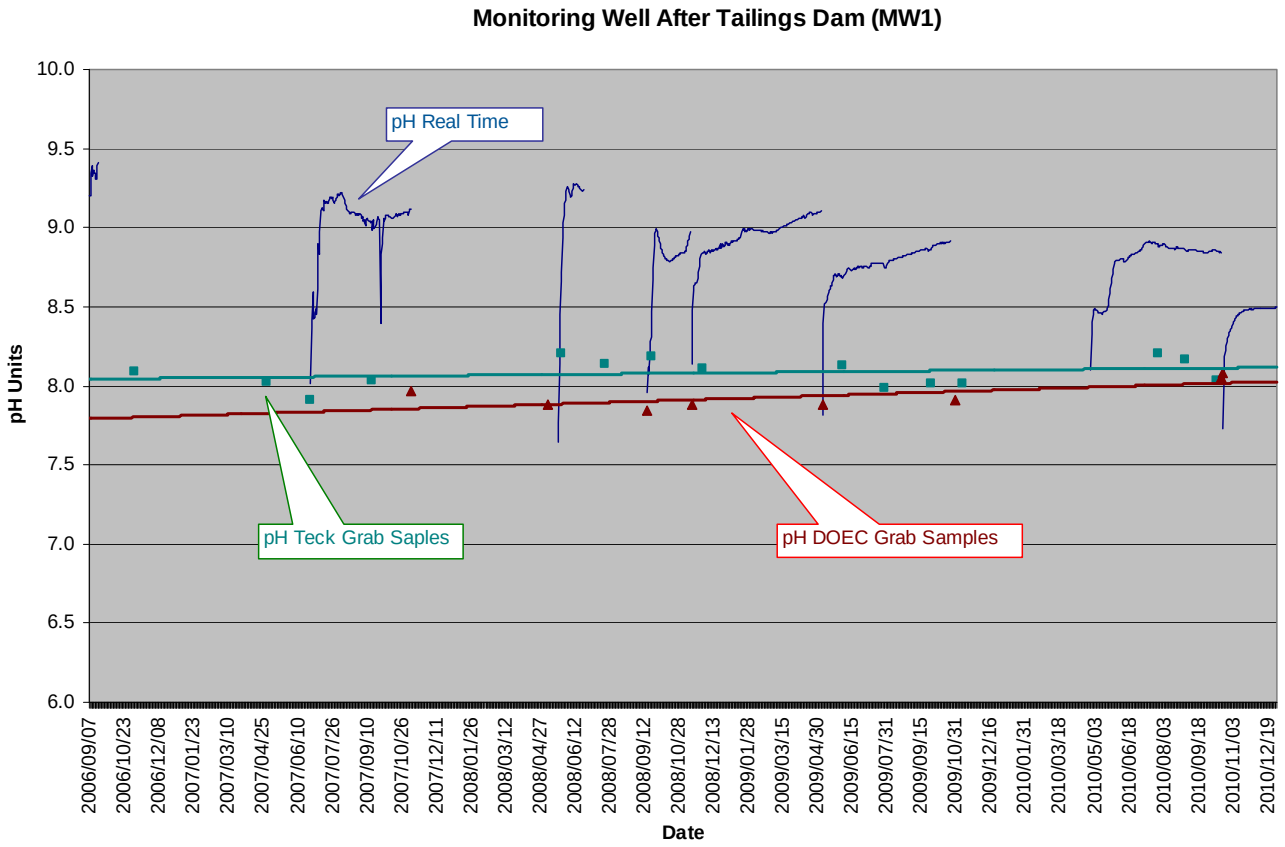
pH 2006 - 2010



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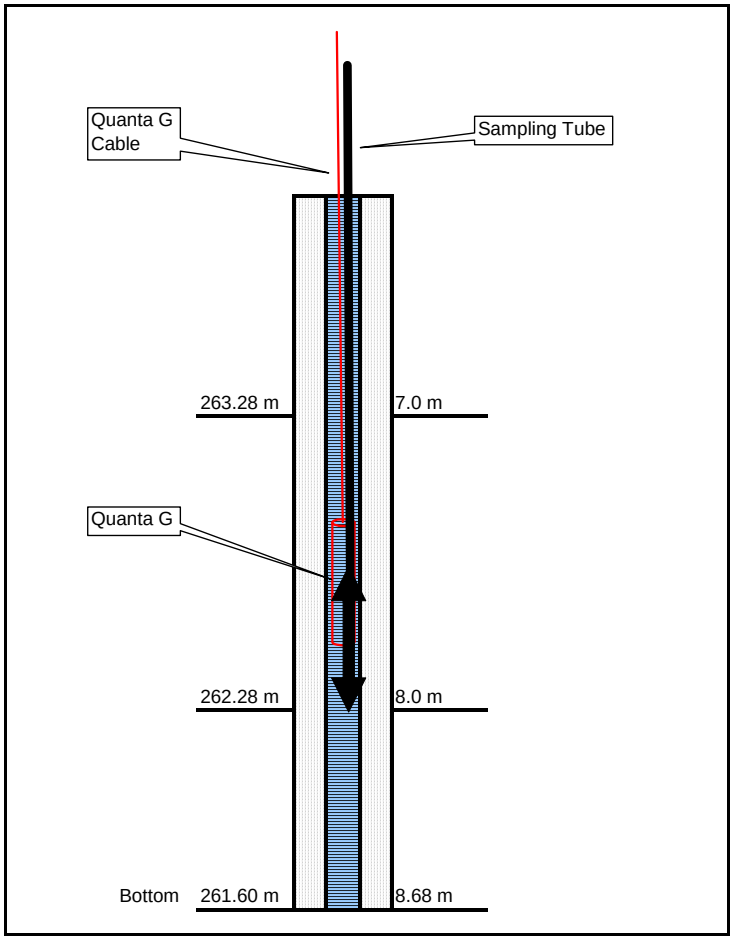
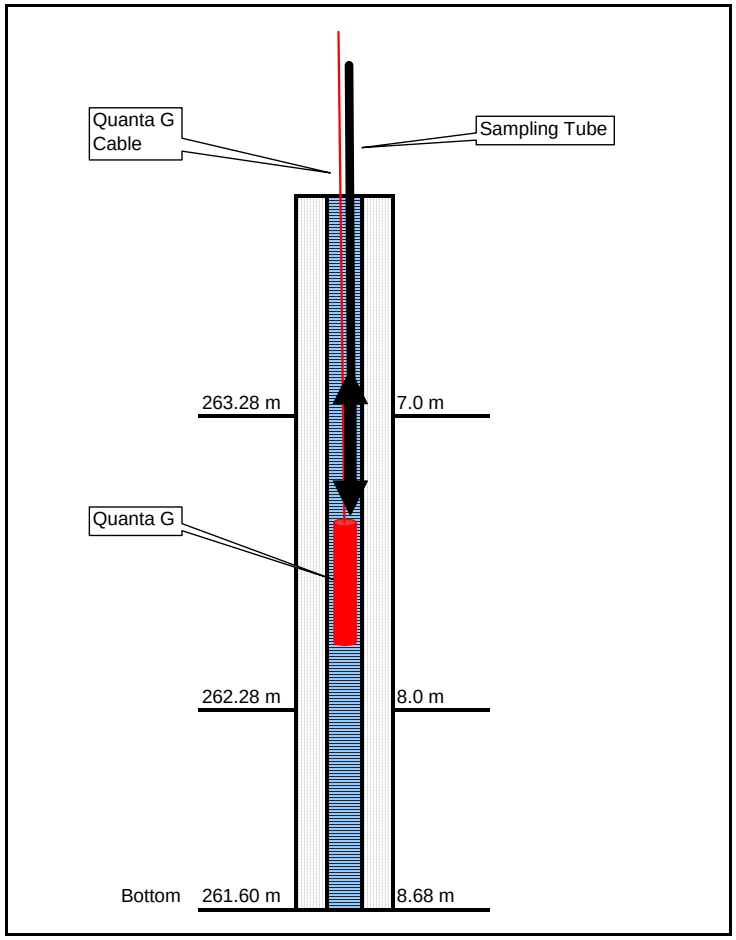
Why the Difference in Grab Samples?





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What Has Changed?

- Why the big swings in pH?
- Why is Grab pH lower than static pH?
- Why is the well in flux, then ~ static?
- What did I do that was different?
- How does this affect my data?
- Is my data accurate and precise?
- Is my data reliable?
- What happens to the parameters that I don't monitor real-time?

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Demonstration

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What is Different at the Beginning of Each Deployment

1. Purging with Inertia Pump

2. Deployment of the Instrument

Both ‘may’ introduce flux into a reasonably static system

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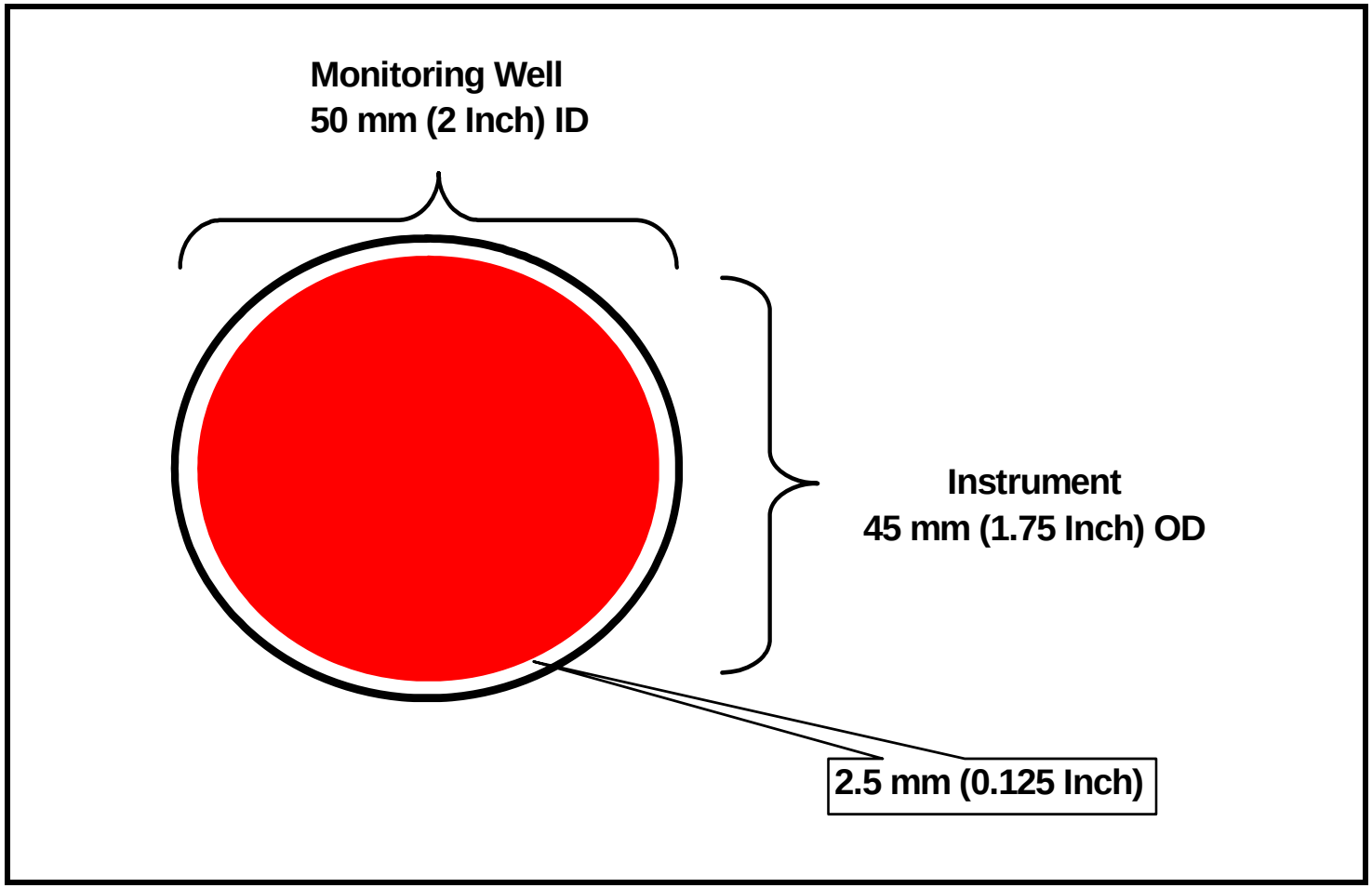
It Fits!



But Should it?

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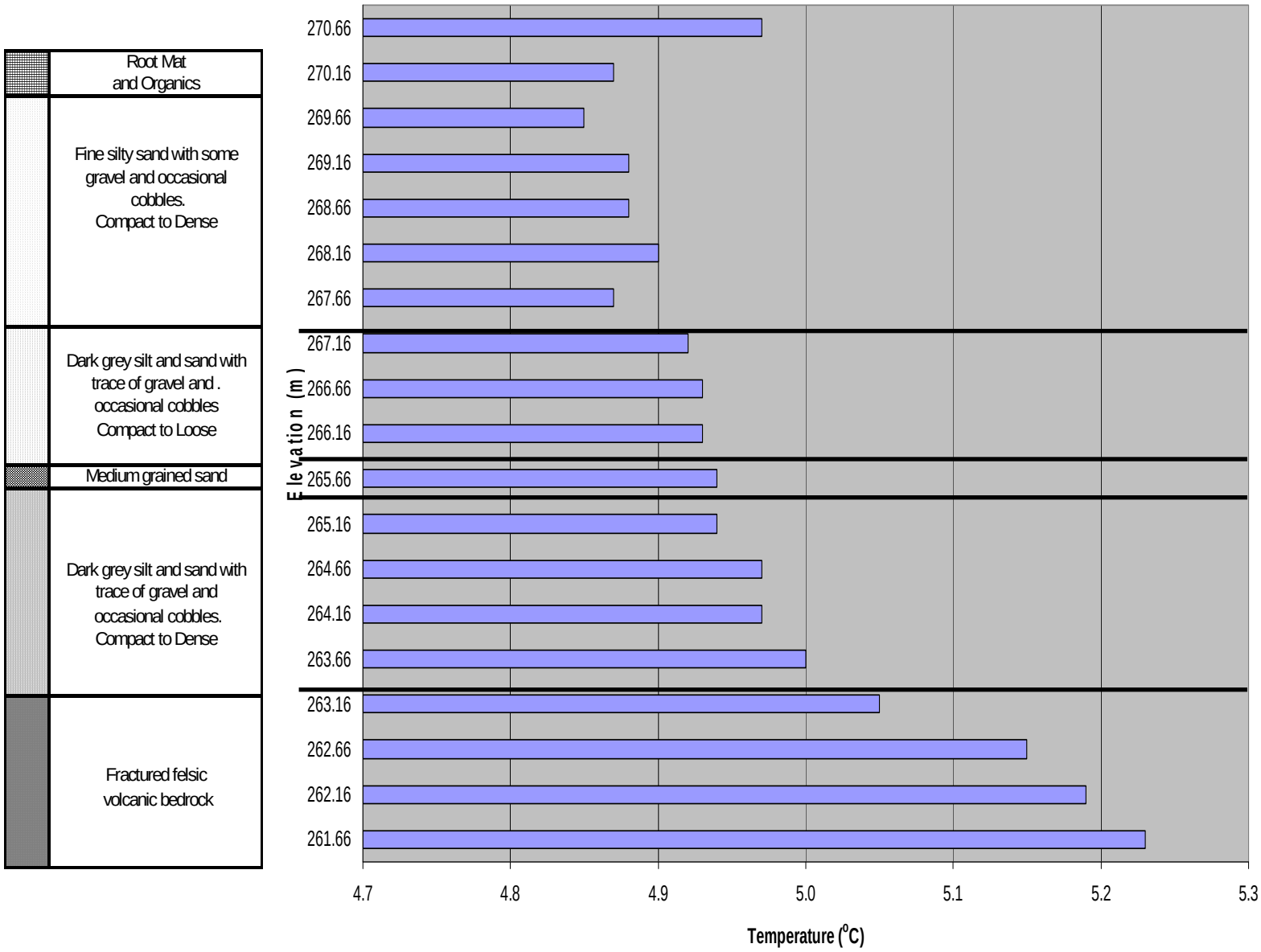
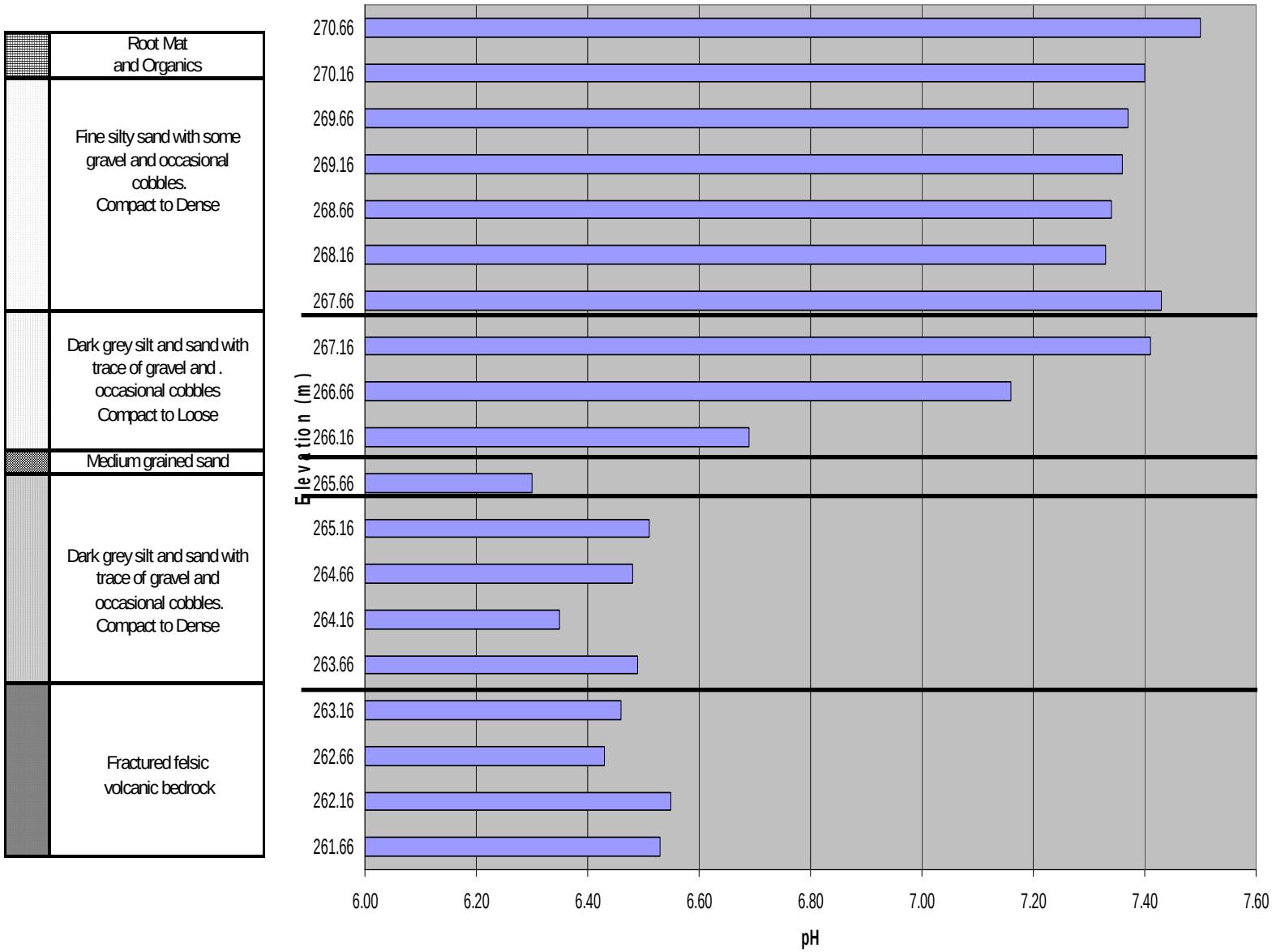
Temperature Profile

Monitoring Well After Tailings Dam (MW1) - Duck Pond



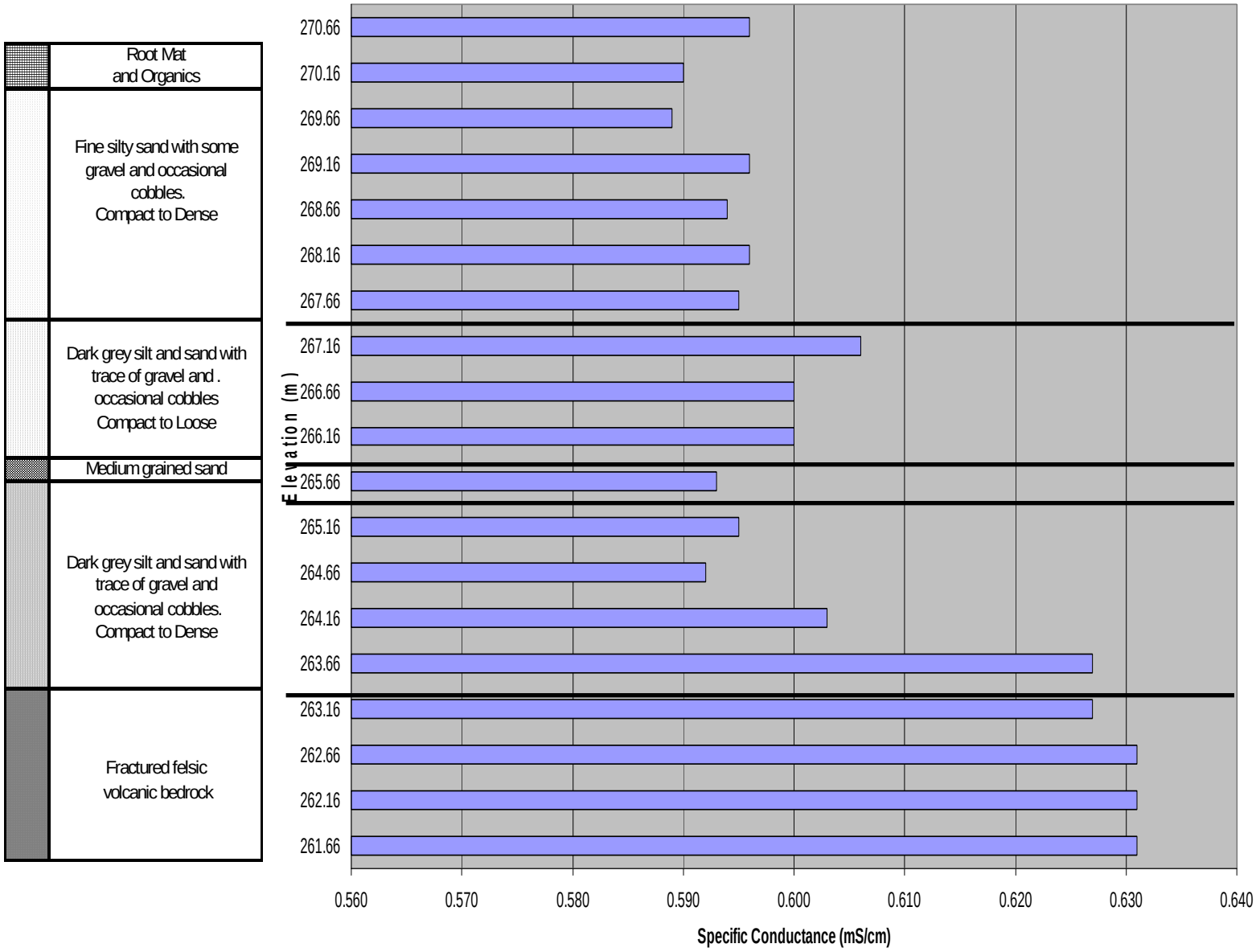
pH Profile

Monditoring Well After Tailings Dam (MW1) - Duck Pond



Specific Conductance Profile

Monditoring Well After Tailings Dam (MW1) - Duck Pond



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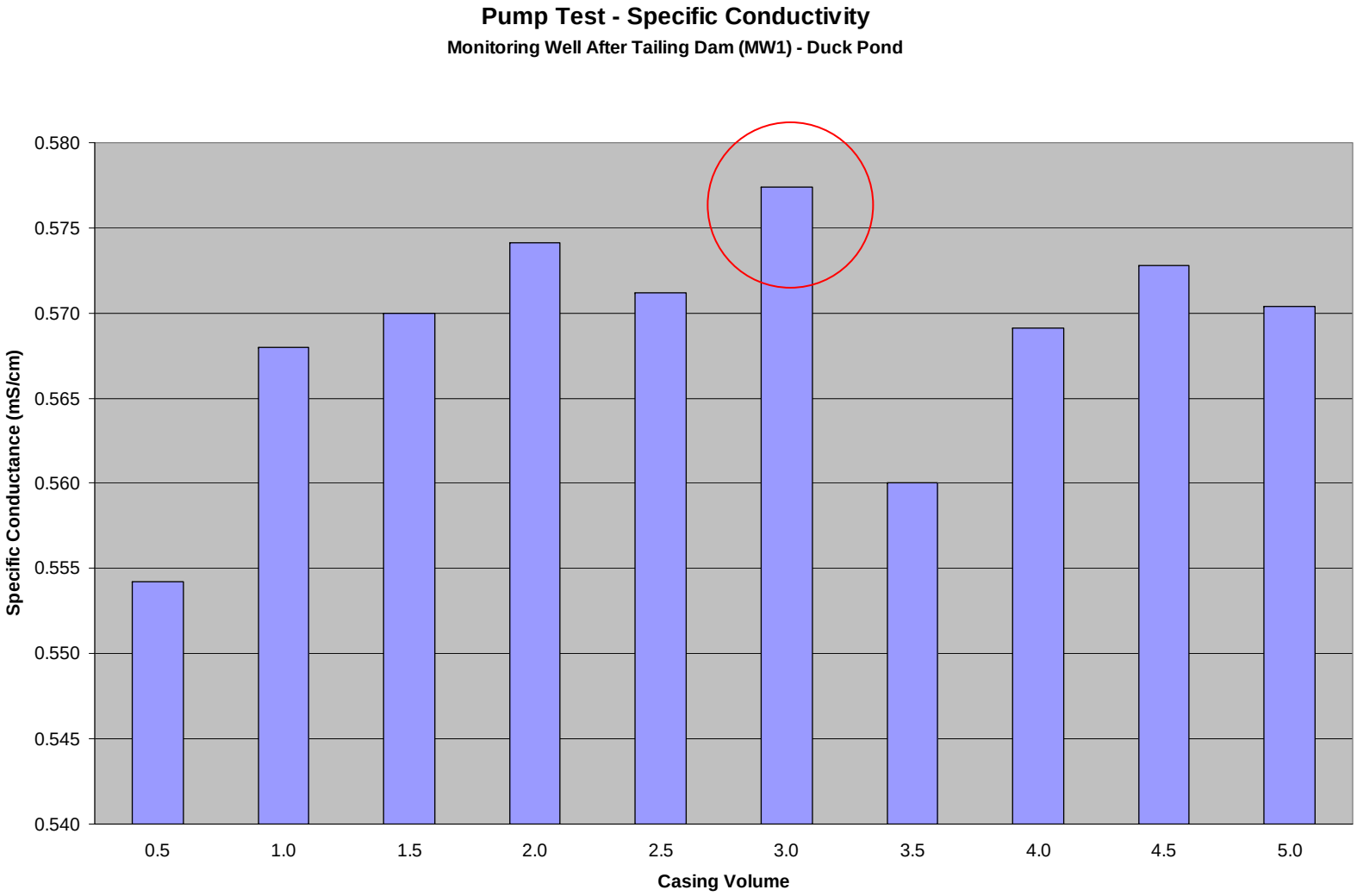
Pump Test
Specific Conductivity



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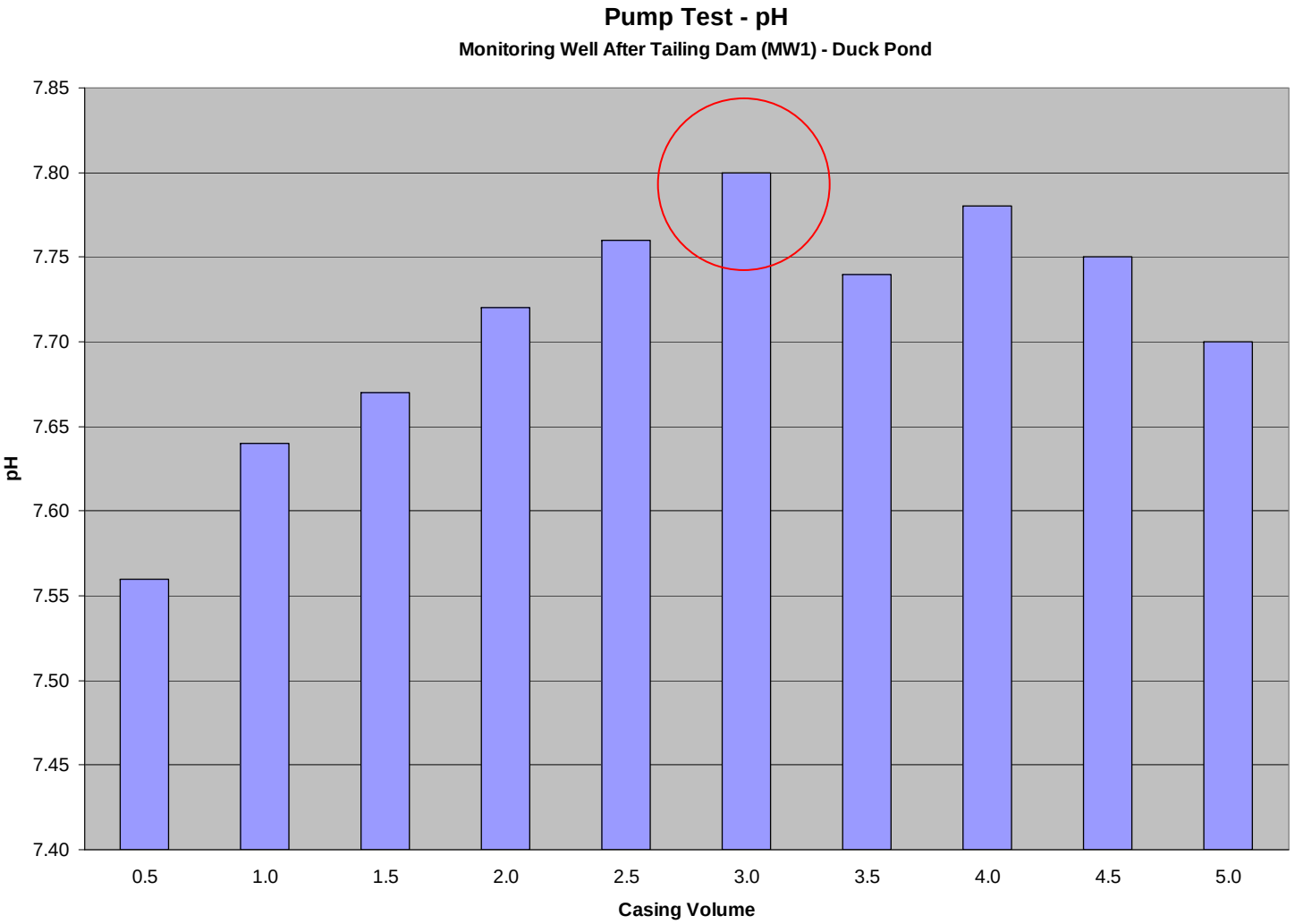
Pump Test
pH



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In Terms of Accuracy and Precision

- How close are my data to the actual environmental conditions?
- Would another researcher replicate my results?
- Is my data within + or - 5 %, 19 times out of 20?
- Is my data above or below the benchmark? By how much?
- Is my data grouped together away from the bulls eye?
- ……..Scattered around the bulls eye?
- ……..Grouped right on the bulls eye?
- Is my data reliable and are my conclusions defensible?
- What decisions are being made based upon my data?

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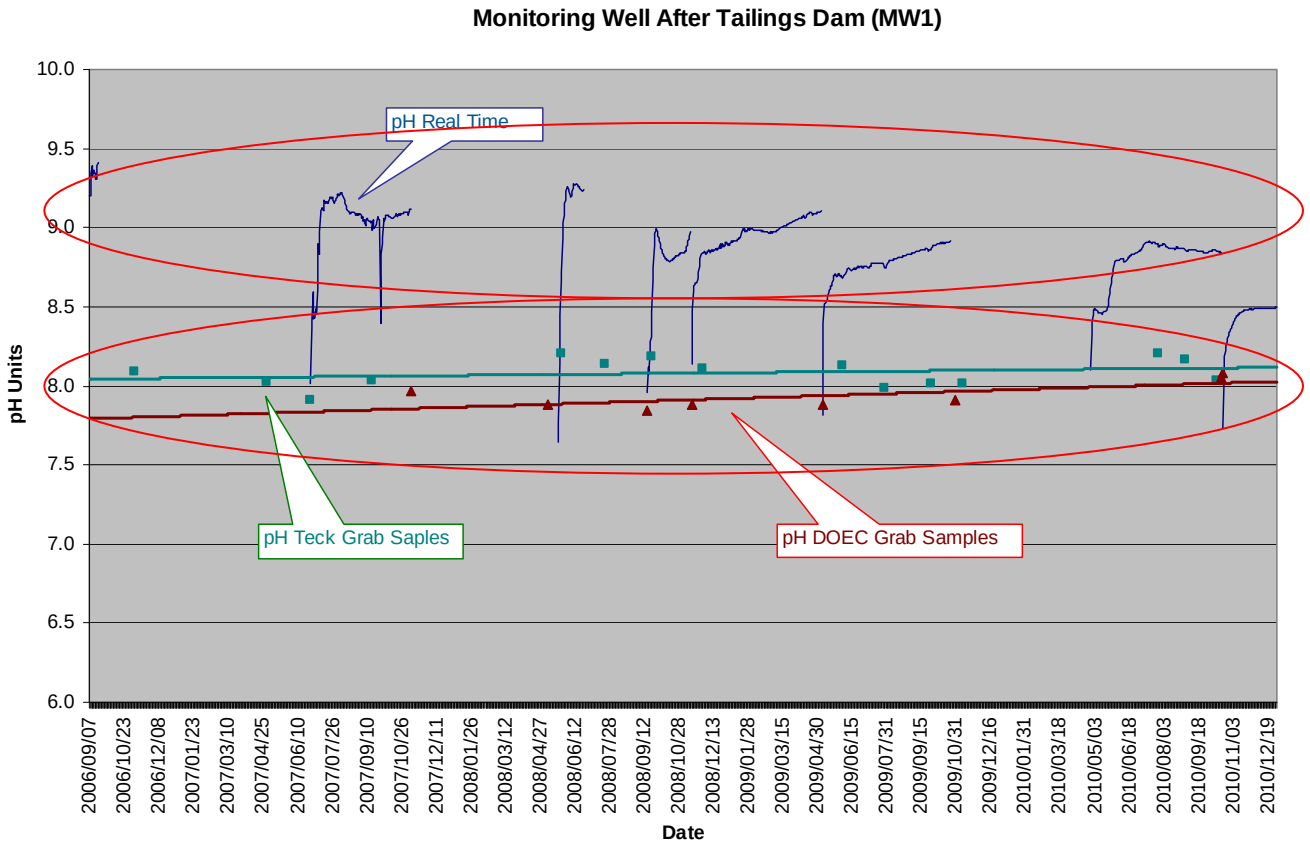
pH 2006 - 2010



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How good is my data?

- Sensors have negligible fouling or instrument drift over 6 month deployments
- Grab sample data are very close to Real-Time data – When they are taken – Flux State
- I am measuring what is happening in the environment at that instant in time

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How good is my data?

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Am I measuring what I want to measure?

- NO!
- I need to minimize my influence on the well

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What Can I Do To Reduce Flux?

- No more Inertia Pump
- Use Peristaltic Pump
- Slowly deploy instrument ???
- Standardized purging and sampling protocol – In this case 3 volumes
- Will this help make my data more accurate and precise?

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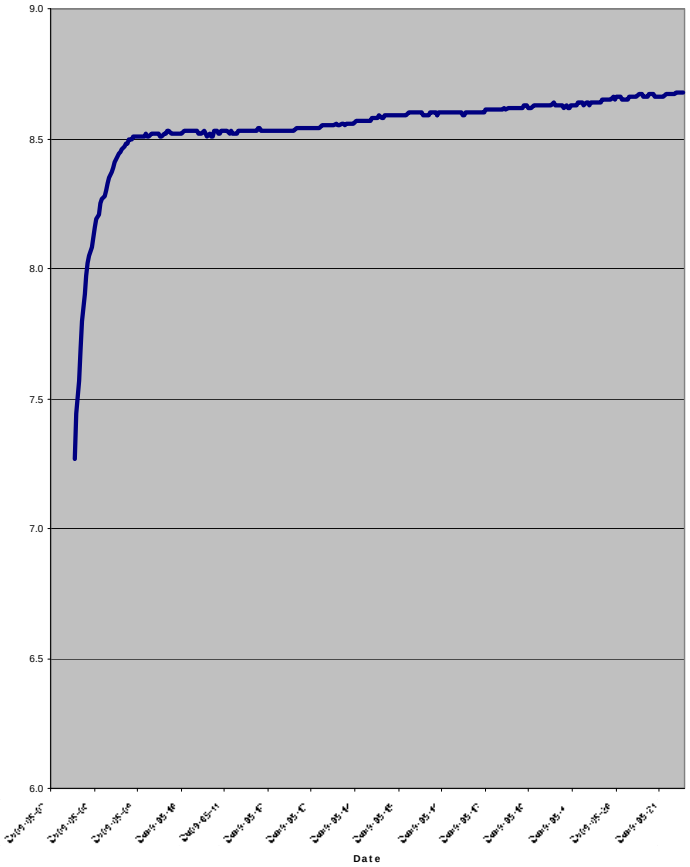
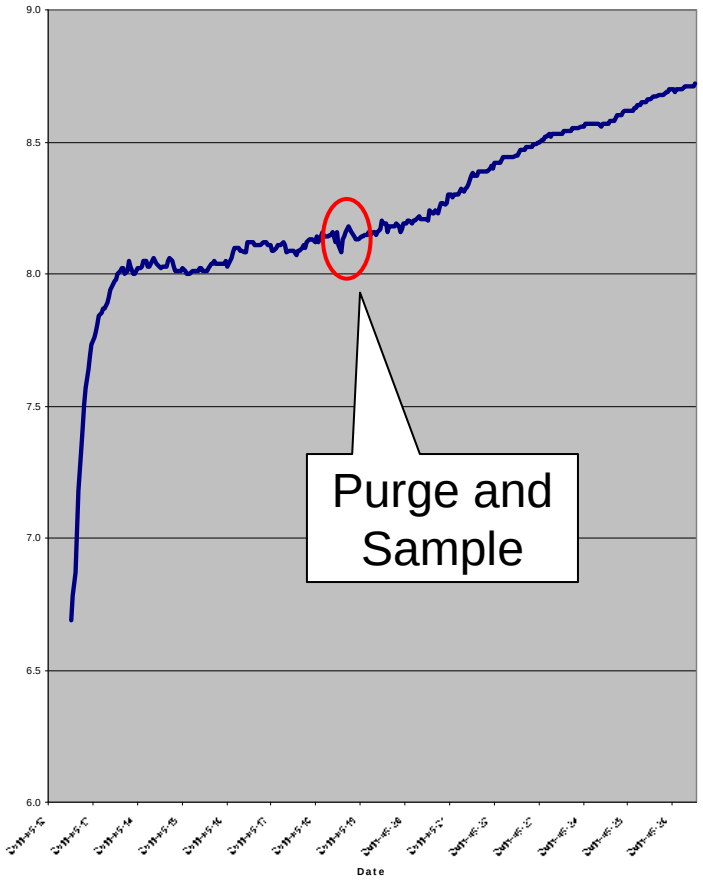
What Causes the Flux ?

2009



2011



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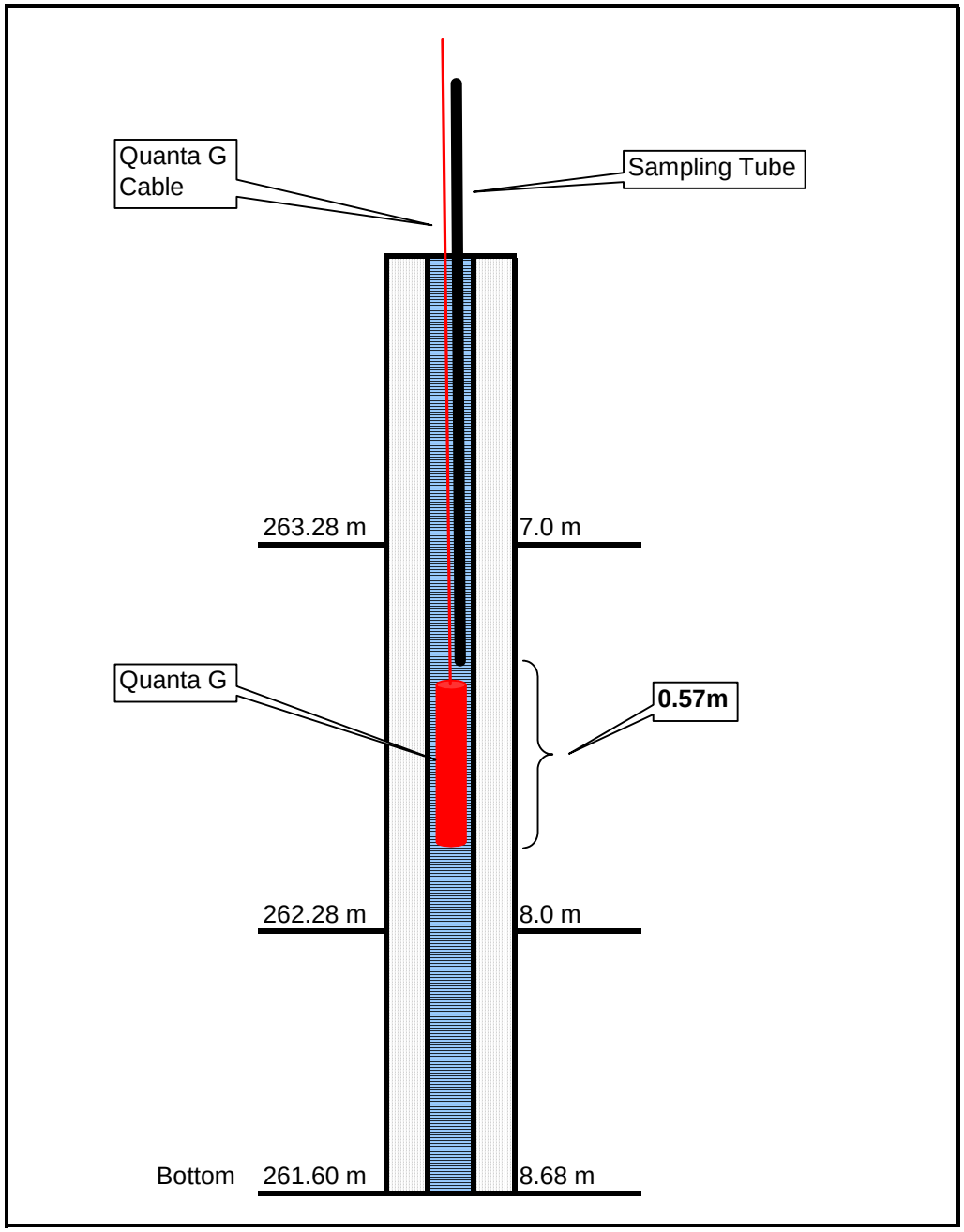

The Current Set-Up

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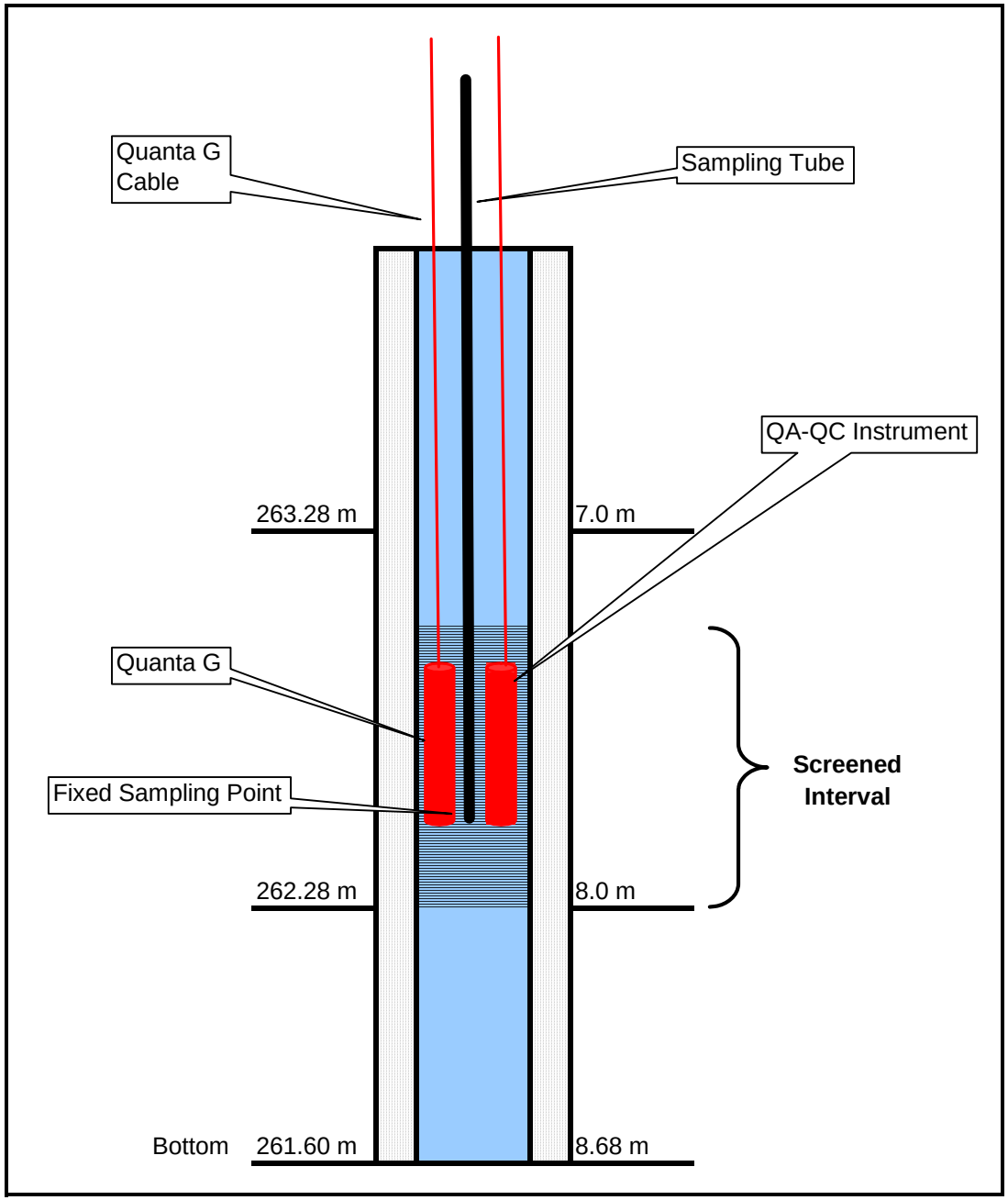

The Ideal Set-Up

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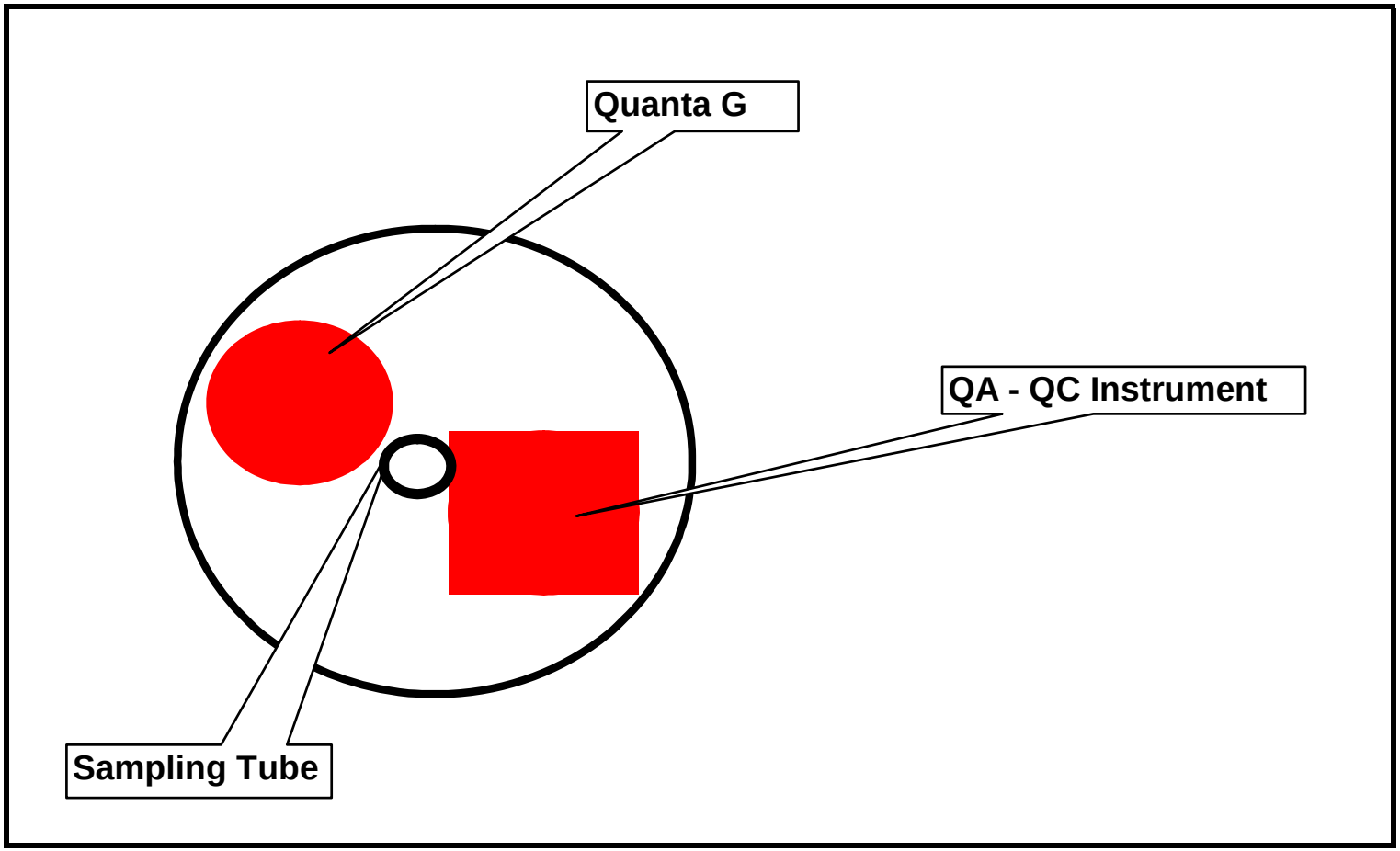
The Ideal Set-Up



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Recommendations for Future Monitoring Well Projects

1. Larger well diameter – At least 100 mm or 4 Inch
   - Will allow side by side comparisons
   - Will allow sampling tube to be near sensor tips
2. Design and construct a dedicated monitoring well based upon nearby drill holes
3. Target the geologic (hydro-geologic) zone of interest – screen only the zone of interest
4. Place instrument (tips) in the target zone
5. After well is developed, do a water quality profile and pump test
6. Develop a standardized well purging and sampling protocol – use peristaltic pump
7. Leave the instrument in Long Term
8. Look at your data regularly. Modify the plan if you have to.

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Questions ?