QA/QC Practice for RTWQ Monitoring in NL

Paula Dawe

Dept of Environment & Conservation

Phone: 709-637-2542

Email: pauladawe@gov.nf.ca

Web: http://www.env.gov.nl.ca/env/Env/water_resources.asp

Real Time Water Quality Monitoring

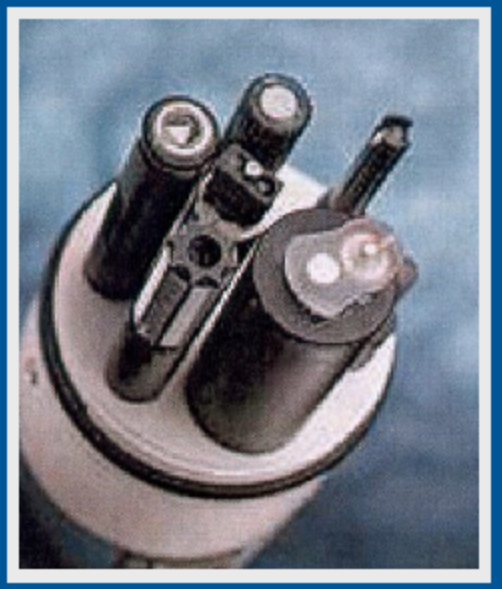
Newfoundland Labrador

The capability to detect and predict in real time adverse changes in water quantity and quality.

Instrumentation

Numerous parameters available:

- Temperature
- pH
- Turbidity
- Depth
- Chloride
- Ambient Light
- Barometric Pressure
- Ammonia
- Nitrate
- Redox
- Salinity
- Chlorophyll
- Specific Conductance
- Dissolved Oxygen
- Total Dissolved Gas



Newfoundland Labrador

What is QA/QC?

- QA/QC = Quality Assurance/ Quality Control
- QA/QC basically refers the things investigators do to make sure their measurements are:
  - Accurate (ie. the absolute *true* value)
  - Reproducible (ie. precise, consistent)
  - And that they have a good estimate of their uncertainty

Specifics of QA/QC

- It involves following established rules in the field and lab to assure everyone that the sample is:
  - representative of the site
  - free from outside contamination by the sample collector
  - and that it has been analyzed following standard QA/QC methods
- Typically involves comparing the sample to a set of known samples for estimating ***accuracy*** and by replicating the measurement to estimate its ***precision***

Why the Need for QA/QC?

- When deployed for continuous operation RTWQ sensors are colonized gradually by a biofilm of algae and less noticeably, by bacteria and fungi as well
- As this material builds up, the biofilm interferes with the sensor's ability to accurately sample the surrounding water

Quality Assurance (QA)

- Includes all high-level activities, structures and mechanisms used to ensure and document the accuracy, precision, completeness, effectiveness and representativeness of the RTWQ monitoring program
- Consists of two separate but interrelated activities:
  - Quality Control (QC)
  - Quality Assessment

Quality Assurance

- RTWQ monitoring program plan
- Purchasing control to ensure all instruments made from a sole manufacturer (ie. Hydrolab)
- Ensuring probe maintenance and warranty checks are carried out in compliance with manufacturer recommendations
- Personnel qualification and training
- Technical procedures for sampling and conducting field and analytical work

Quality Assurance

- Troubleshooting of instruments, recording equipment, installations, transmission of data and corrective action plans
- Record keeping including chain of custody for grab samples, logbooks and instrument calibration records
- Implementation of QA/QC procedures including data verification and validation
- Preparation of analytical reports, data packages and RTWQ web page

Quality Assurance

- Assessments to determine whether personnel are adhering to program requirements and following internal procedures
- Expert peer review of RTWQ program design, QA/QC procedures and data analysis
- Keep up to date on emerging RTWQ technology, QA/QC procedures, and analysis techniques
- Develop first hand knowledge of each individual watershed through observation and field visits

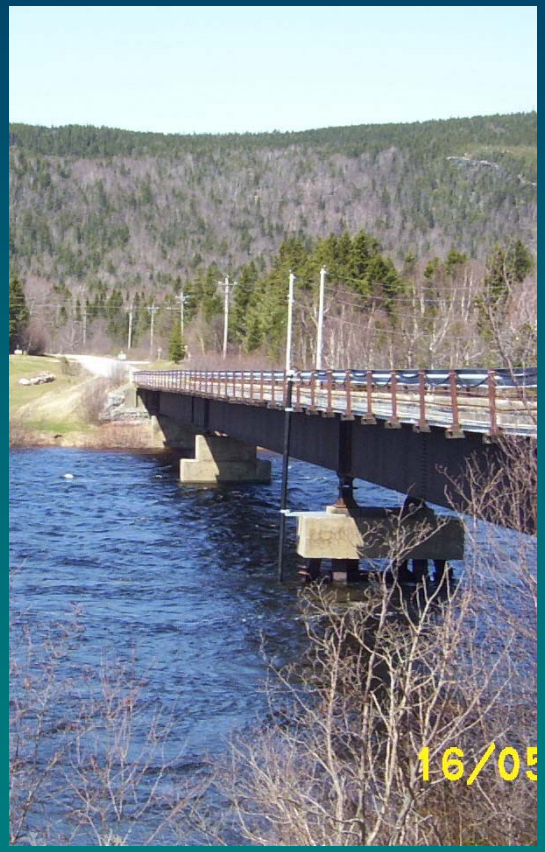
Quality Control (QC)

- Technical activities employed to ensure that the data collected are adequate for quality assessment purposes
- Maintenance and calibration of the probe and its sensors
- Inspection and maintenance of RTWQ station installation
- Field readings taken at the time of removal and reinstallation of the probe for maintenance and calibration purposes using a calibrated field instrument

Quality Control (QC)

- Collection of a water quality grab sample at the time of reinstallation of the probe to be sent to a laboratory for analysis
- Updating maintenance forms with collected field instrument readings after reinstallation
- Using field results taken during removal of the probe with the field instrument, data from the preceding period is corrected for drift
- Storing corrected data in a separate database
- Updating spreadsheet with grab sample results once laboratory analysis is complete

RTWQ Monitoring Sites



Maintenance and Calibration

- Occurs once a week to every 2 months typically
- Follow the Instrument Manuals for calibration and maintenance procedures
- Regular maintenance depends on conditions at the monitoring location
- Use Hydras 3LT or HyperTerminal/ ProComm for calibrating

Maintenance and Calibration

Manual Field Sampling

- Field readings taken at the time of removal and reinstallation of the probe for maintenance and calibration purposes using a calibrated field instrument

Grab Sampling

- Collection of a water quality grab sample at the time of reinstallation of the probe to be sent to a laboratory for analysis

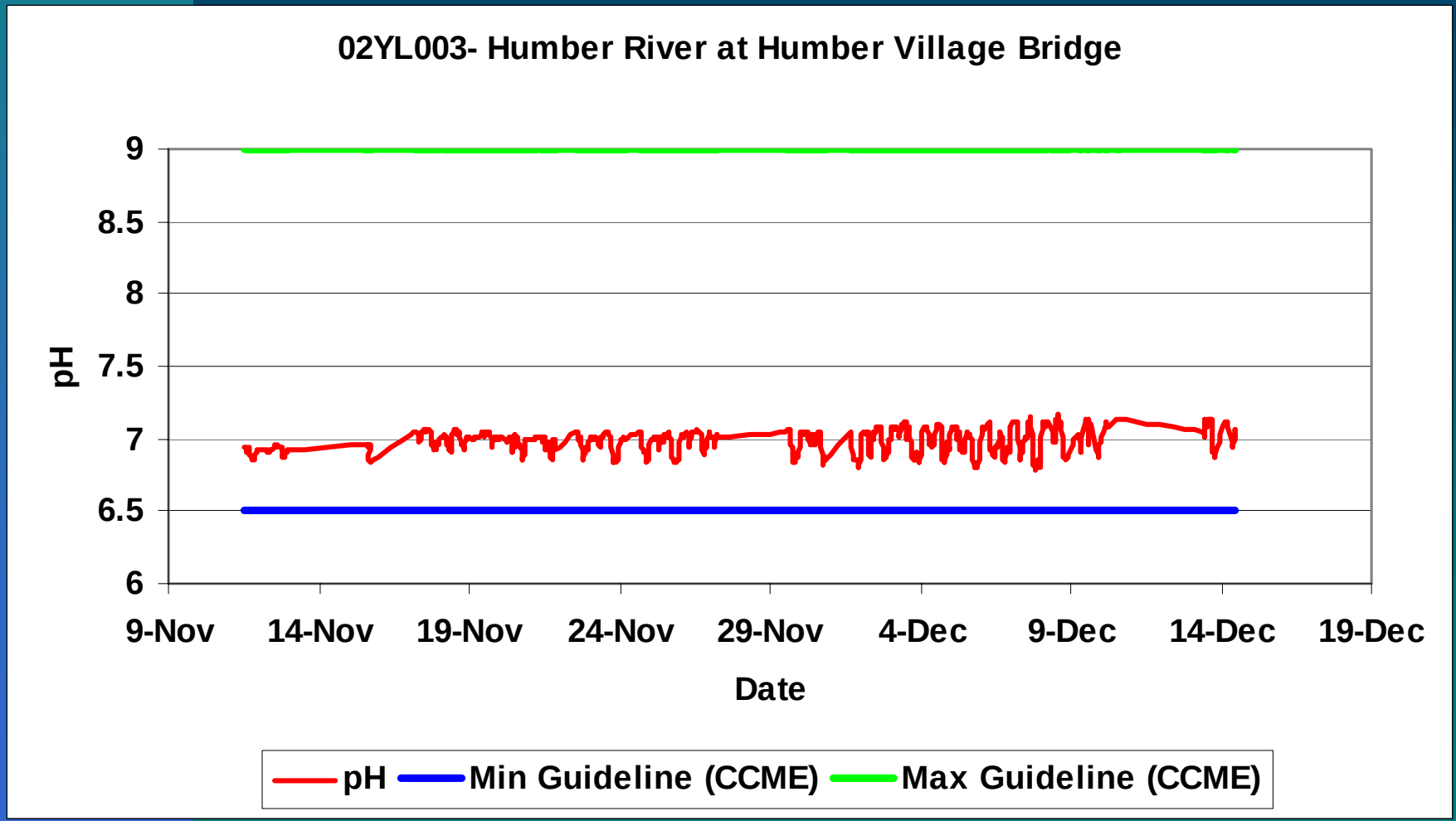
Quality Assessment

- To quantify the effectiveness of the quality control procedures
- Comparison of field results with RTWQ probe results to evaluate amount of drift observed in water quality parameters over that period
- Evaluate if field and actual readings are within acceptable ranges, by how much the reading is off, and reasons why the parameter reading may be off
- Calculate long-term and monthly period summary statistics using the corrected data

Quality Assessment

- Daily updates of RTWQ data on the Water Resources Division web page for review
- Produce time series graphs for each parameter and evaluate for gaps, data errors, and guideline exceedances
- Preparation of auxiliary information to aid in the review of water quality records
- Produce a monthly report for each station
- Produce an annual report for each RTWQ station at the end of each calendar year
- Archiving of RTWQ monitoring data records

Data Drift


02YL003- Humber River at Humber Village Bridge
9
8.5
8
7.5
7
6.5
6
pH
9-Nov
14-Nov
19-Nov
24-Nov
29-Nov
4-Dec
9-Dec
14-Dec
19-Dec
Date
pH
Min Guideline (CCME)
Max Guideline (CCME)

What is Allowable Error?

- The difference in value between automatic RTWQ data and data collected manually (ie. drift)
- Automatic RTWQ data is considered suspect when the allowable % error is exceeded
- Error associated with drift and fouling

How is Error Measured?

- Ability to qualify data as valid, suspect or invalid
- Use either:
  - % Error
  - Difference

$$\%Error = \frac{|Manual - Automatic|}{Automatic} \times 100$$

$$Difference = |Manual - Automatic|$$

Allowable Error Ranges

	Ratings (Used in NL)				
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
Conductance (%)	<=+/-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 (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

Measured physical	**Ratings (From the USGS 2000)**			
property	**Excellent**	**Good**	**Fair**	**Poor**
Water temperature	0.2 °C	> 0.2 to 0.5 °C	> 0.5 to 0.8 °C	> 0.8 °C
Specific conductance	3%	> 3 to 10%	> 10 to 15%	> 15 %
Dissolved oxygen	> 0.3 mg/L	> 0.3 to 0.5 mg/L	> 0.5 to 0.8 mg/L	> 0.8 mg/L
pH	0.2 unit	> 0.2 to 0.5 unit	> 0.5 to 0.8 unit	> 0.8 unit
Turbidity	5%	> 5 to 10%	10 to 15%	> 15 %

Typical QA/QC Ratings: NL

Parameter	Typical Rating
Temperature	Excellent
pH	Fair/Good/Excellent
Conductance	Fair/Good
Dissolved Oxygen	Poor
Turbidity	Poor

Data anomalies are mostly associated with DO and/or turbidity data, sometimes with pH.

Correction Factors

- Adjust data by calculating correction factors when there is accurate calibration data spanning the period in question and when the results estimated by interpolation are consistent with the rest of the data set
- In other cases data is simply rejected
- Be careful not to delete anomalous data that may simply reveal real dynamic changes

How is Correction Factor Measured?

- Automatic RTWQ value is adjusted by the difference between the Automatic and Manual reading at probe extraction, spread over the entire data count

$$CorrectionFactor = Automatic_{t_x} + \frac{Automatic_{t_{final}} - Manual}{DataCount} \times DataCount_{t_x}$$

RTWQ Summary Statistics

	Temp-Water	pH	Conductance	Percent-Satur	Diss-Oxy
max	20.7	7.7	44.9	148.10	20.01
min	-0.1	5.4	25.3	87.71	7.78
average	7.8	6.8	36.7	99.00	11.73
standard diviation	5.7	0.3	3.6	8.14	2.10

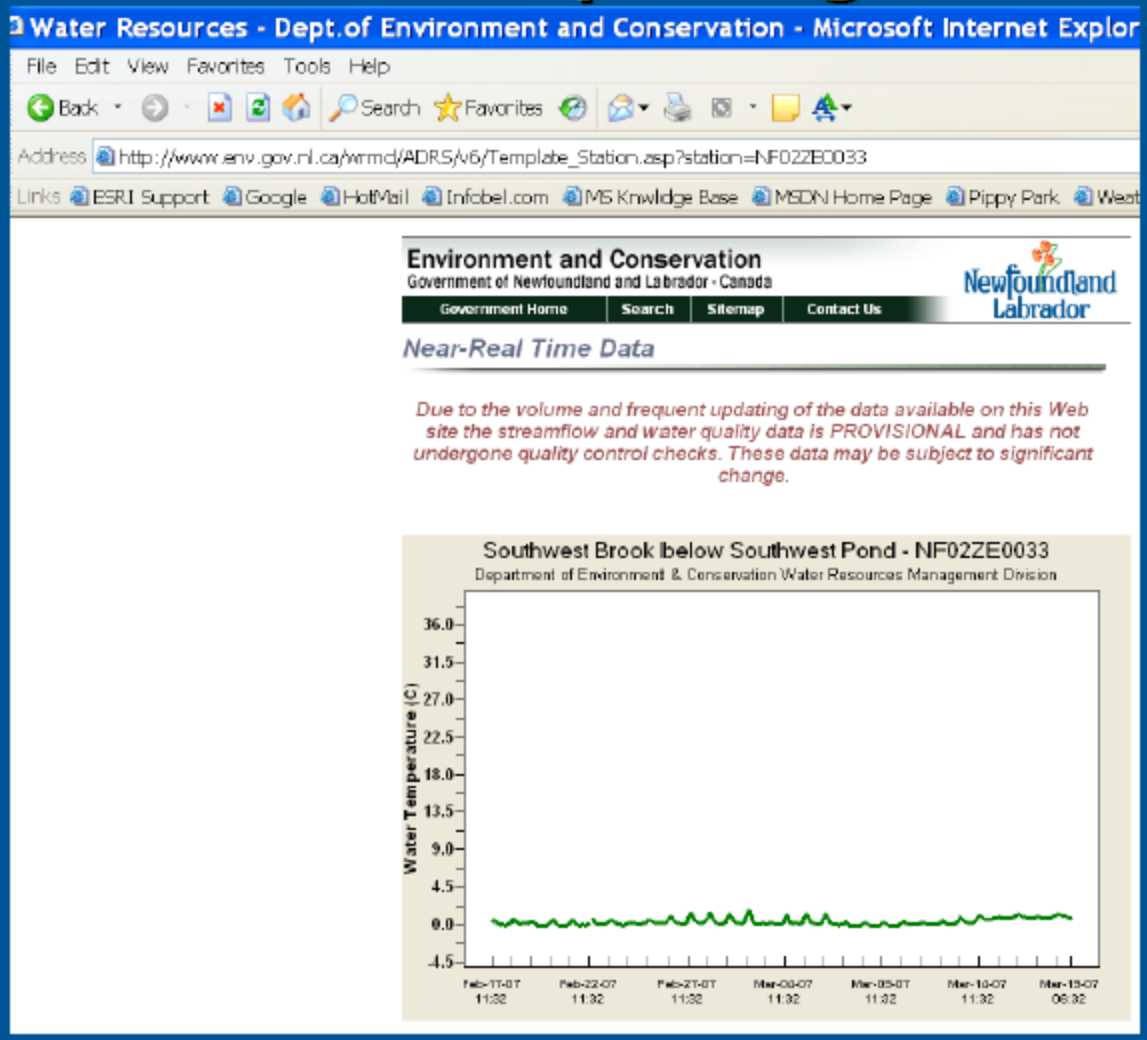
From Humber River Station

Web Based Reporting

Real-Time Data Reporting

NF02ZE0033 - Southwest Brook below Southwest Pond

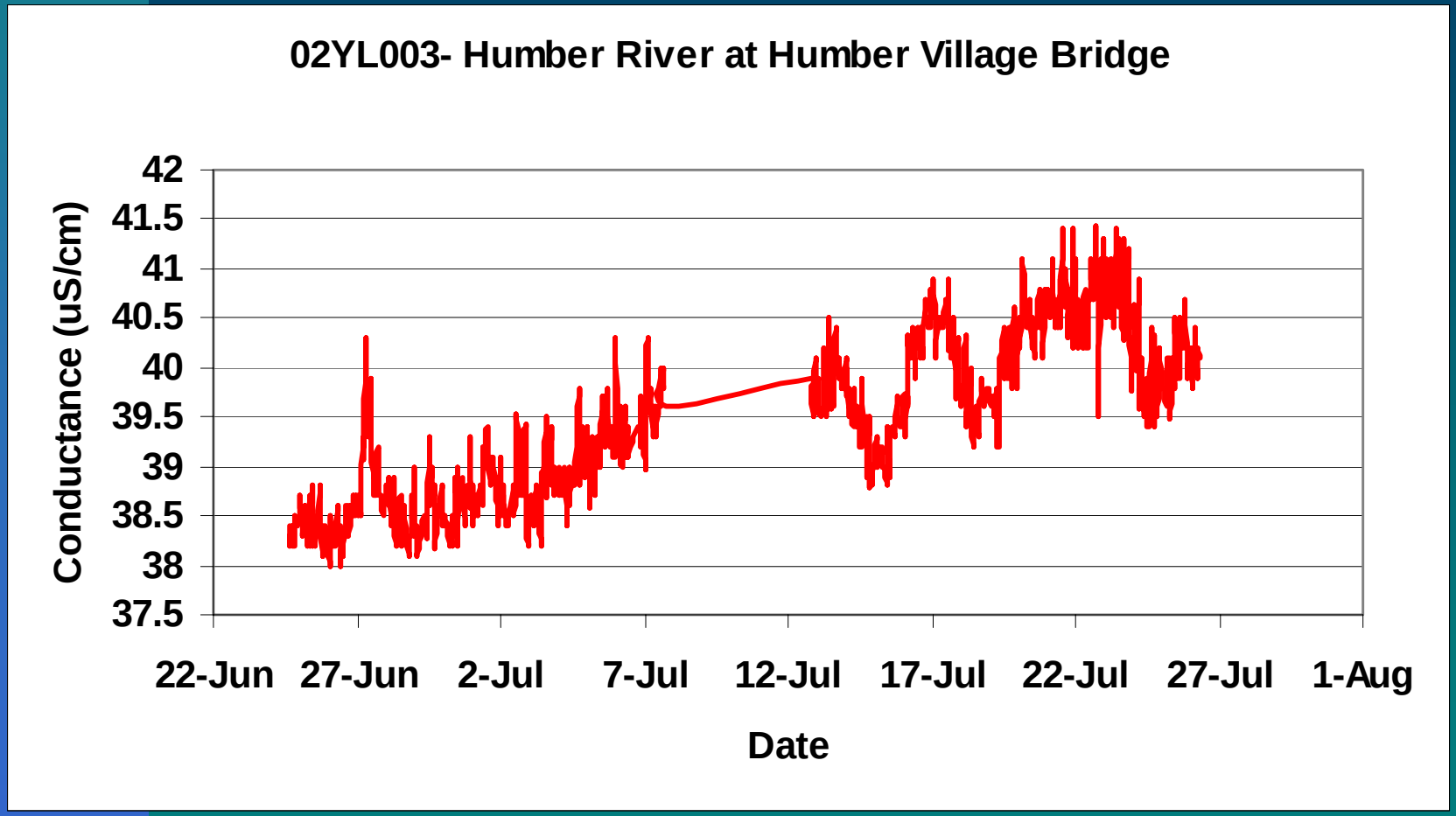
(Miawapukek First Nation Pilot Project)



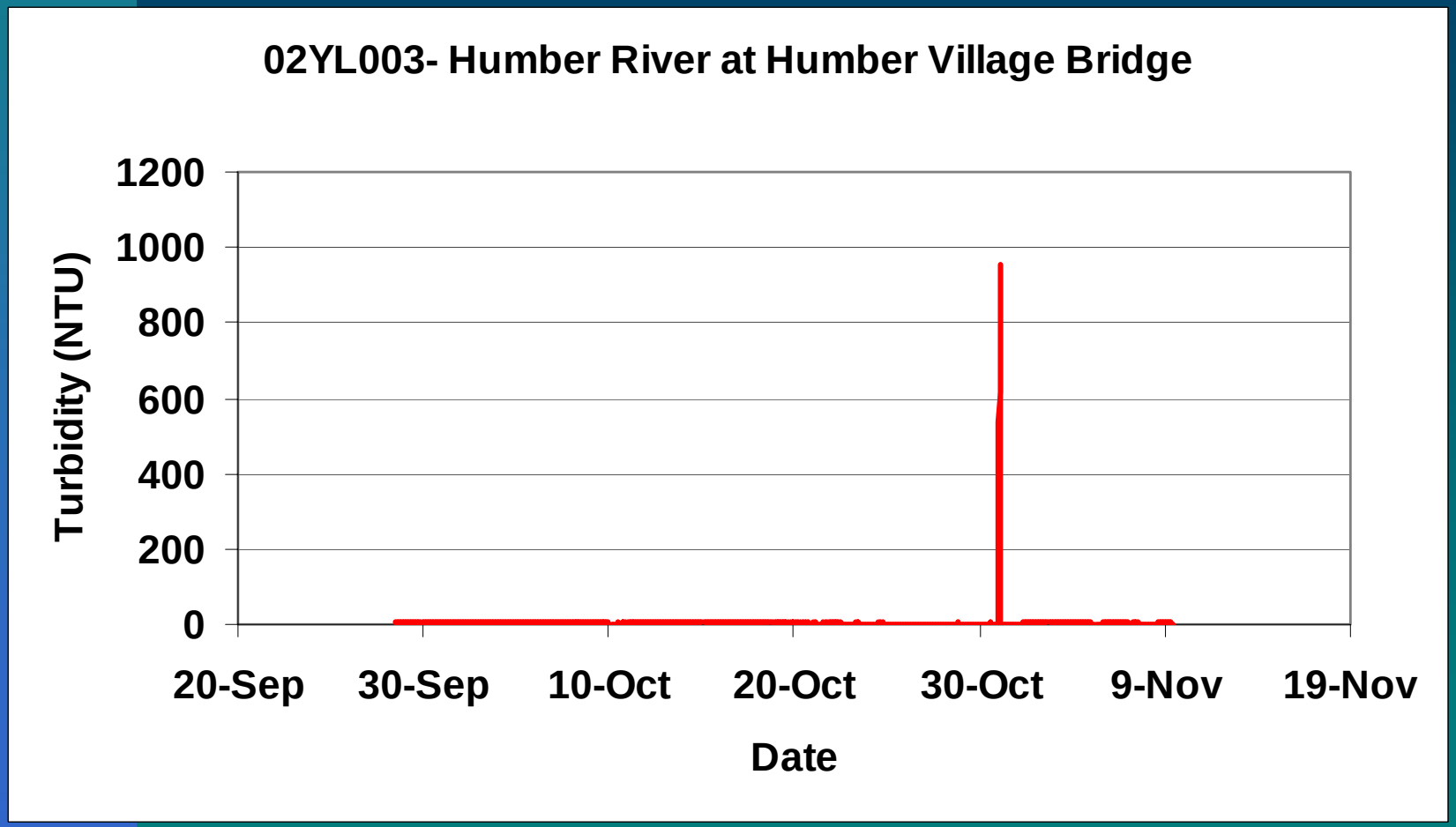
http://www.env.gov.nl.ca/wrmd/ADRS/v6/Template_Station.asp?station=NF02ZE0033

Newfoundland Labrador

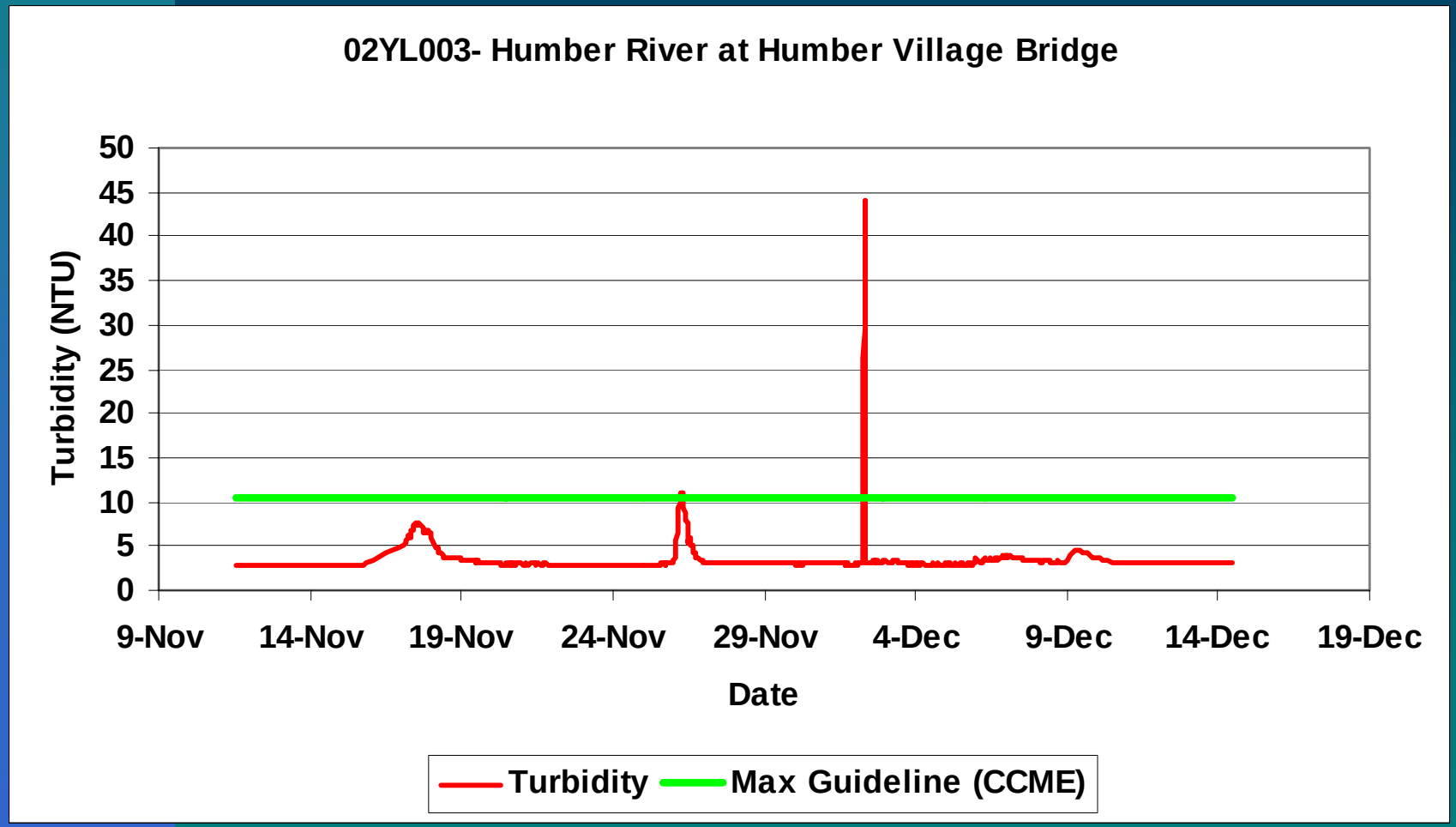
Data Gaps


02YL003- Humber River at Humber Village Bridge
Conductance (uS/cm)
42
41.5
41
40.5
40
39.5
39
38.5
38
37.5
22-Jun
27-Jun
2-Jul
7-Jul
12-Jul
17-Jul
22-Jul
27-Jul
1-Aug
Date

Data Error: Unusual Data Spikes

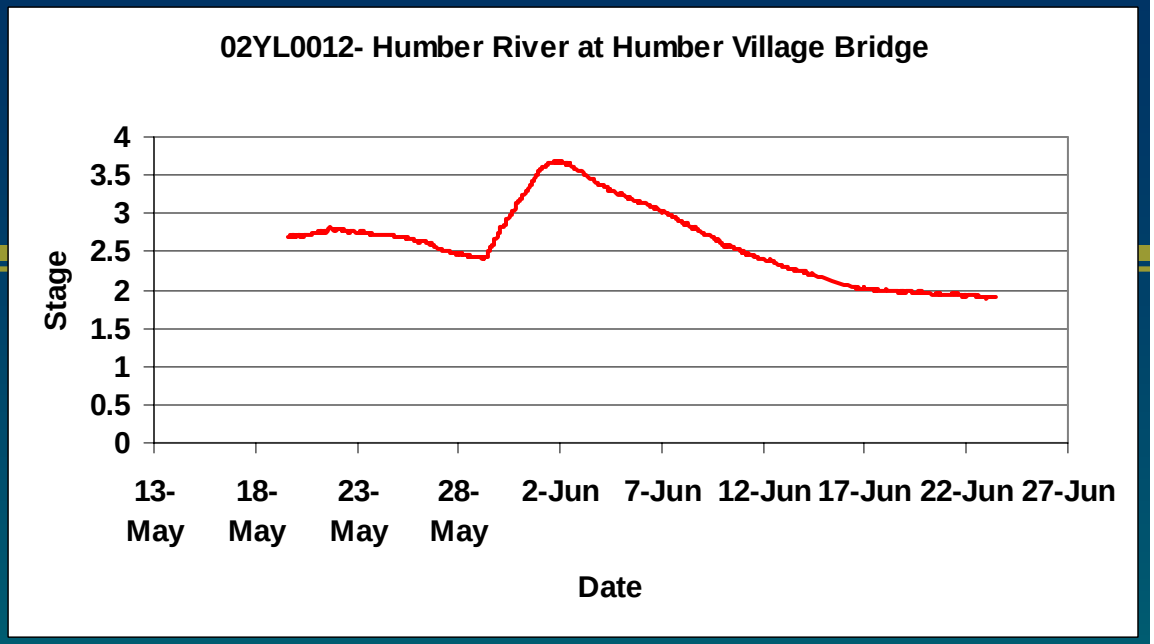


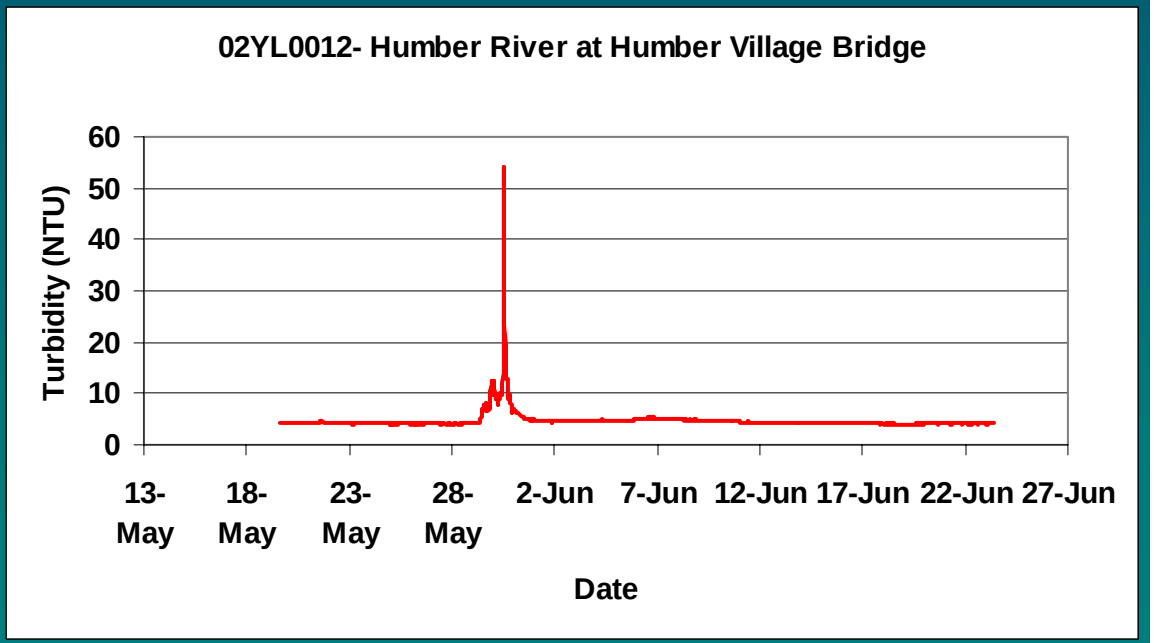
Guideline Exceedences



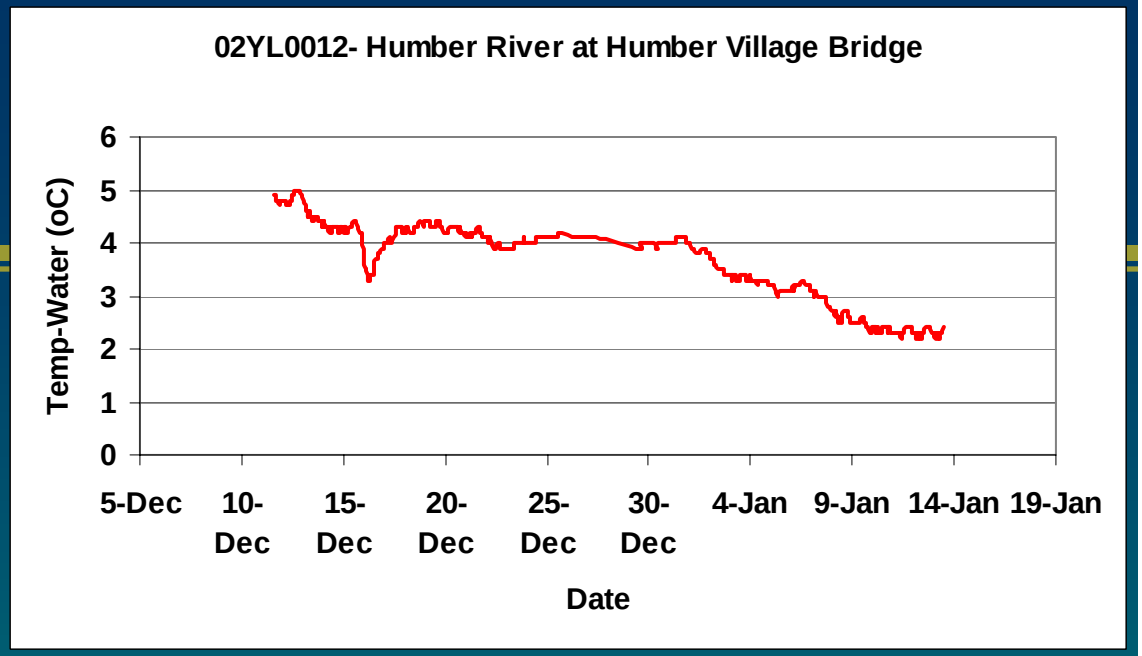
Data Interpretation: Natural Conditions

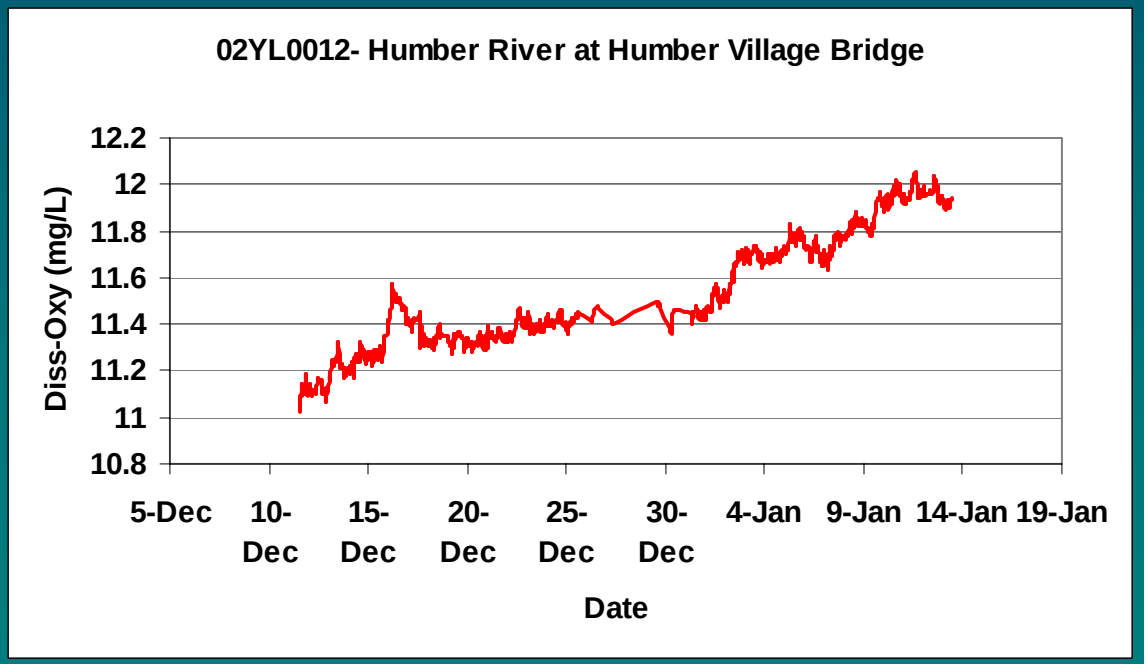
Examine data in context of our understanding of natural conditions and other data





Data Interpretation: Seasonal Effects





QA/QC Logistics: Time and Money

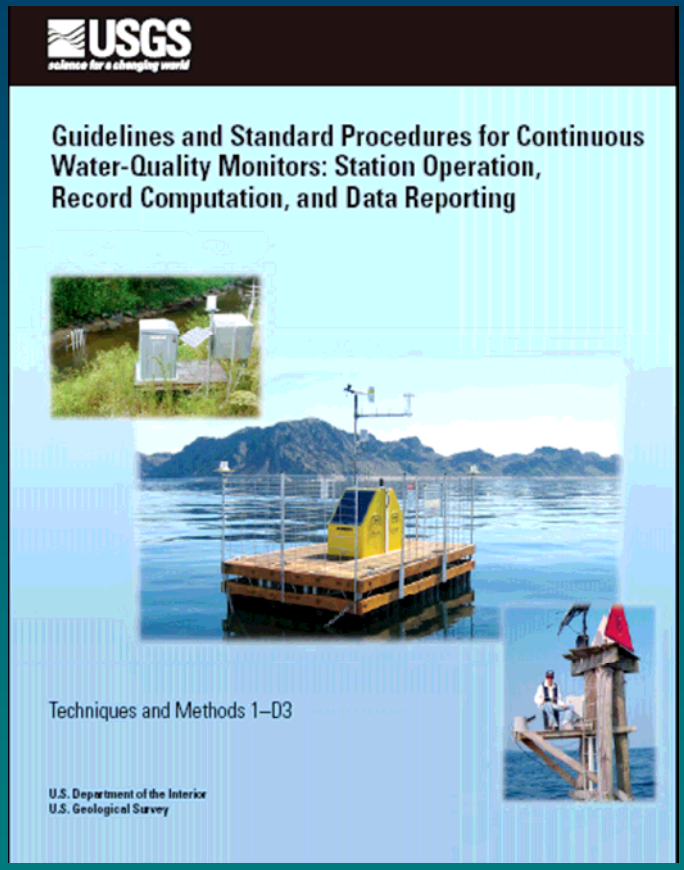
- Optimal number of RTWQ Monitoring locations assigned per person: 3-5
- QA/QC of data generally takes 30-60 days after collection
- QA/QC requirements must be incorporated into the long term budgeting for any RTWQ monitoring program
- No standard costs available but would include:
  - Instruments
  - Staff time
  - Grab sample analysis
  - Calibration solution and maintenance supplies
  - Installation site upkeep
  - Transportation
  - Training
  - Other

RTWQ Monitoring QA/QC Innovations

- Data Visualization Tools (DVTs) to rapidly display data in a variety of formats to help identify anomalous data
- Data processing programs to profile data readings to look for data outside of expected ranges
  - Temp: < -1 or > 35 ^{o}C, pH: < 4 or > 10
- On-site calibration cube van (USGS)

USGS Guidance Manual

- Provides basic guidelines and procedures in:
  - site and water-quality monitor selection
  - field procedures
  - calibration of continuous water quality monitors
  - record computation and review
  - data reporting



http://pubs.usgs.gov/tm/2006/tm1D3//

QA/QC Conclusions

- The QA/QC of near-real time remotely collected sensor data has provided challenges that were not present under traditional sampling regimes
- New rigorous protocols for each step of the data acquisition effort have been developed
- As RTWQ technologies become more common in resource management, future efforts must be directed toward the unique problems posed by real-time data collection

Questions?