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Standardization of Data QA/QC across Monitoring “Networks of Networks”

**National Water Quality Monitoring
Council Conference**

Chris Lochner and the National Water Quality
Monitoring Information Working Group -
National Water Quality Monitoring Office,
Environment Canada

**Wednesday, May 21st, 2008,
Atlantic City, NJ**



Overview



- Our “Network of Networks” program
- Program drivers and partners
- Data QA/QC considerations
- Differences in data QA/QC across the program
- Possible solutions and tools
- Tools that are helping – EnviroGrapher
- Next Steps



Principle program functions

- Characterize the health of waters - status
- Identify trends over time
- Identify emerging problems
- Evaluate the efficacy of management actions
- Respond to emergencies such as floods and spills



Program components

- National Status and Trends Program (FPT, Nutrients Trends, Real-time Automated Network)
- National Water Quality Surveillance Studies (*Pesticides, Waterborne Pathogens*)
- Canadian Aquatic Biomonitoring Program (CABIN)
- *Marine Monitoring (Shellfish Beds)*



Federal-Provincial-Territorial Agreements

Newfoundland & Labrador	Fed-Prov Agreement, signed in 1986
Prince Edward Island	Fed-Prov Agreement, signed in 1989
Nova Scotia	<i>(Under development)</i>
New Brunswick	Fed-Prov Agreement 1988; <i>(revision under development)</i>
Quebec	Fed-Prov Agreement on St. Lawrence River 2002; <i>(prov-wide under development)</i>
Ontario	Fed-Prov Agreement 2002
Manitoba	Fed-Prov Agreement 1988
Saskatchewan	<i>(Under development)</i> (Prairie Prov Water Board Agreement)
Alberta	(PPWB Agreement only)
British Columbia	Fed-Prov Agreement 1985; <i>(revision under development)</i>
Yukon	<i>(Under development)</i>
Northwest Territories	Fed-Terr Agreement 1995; <u>dormant</u>
Nunavut	<u>None</u>



Where we monitor

Long-term status and trends network

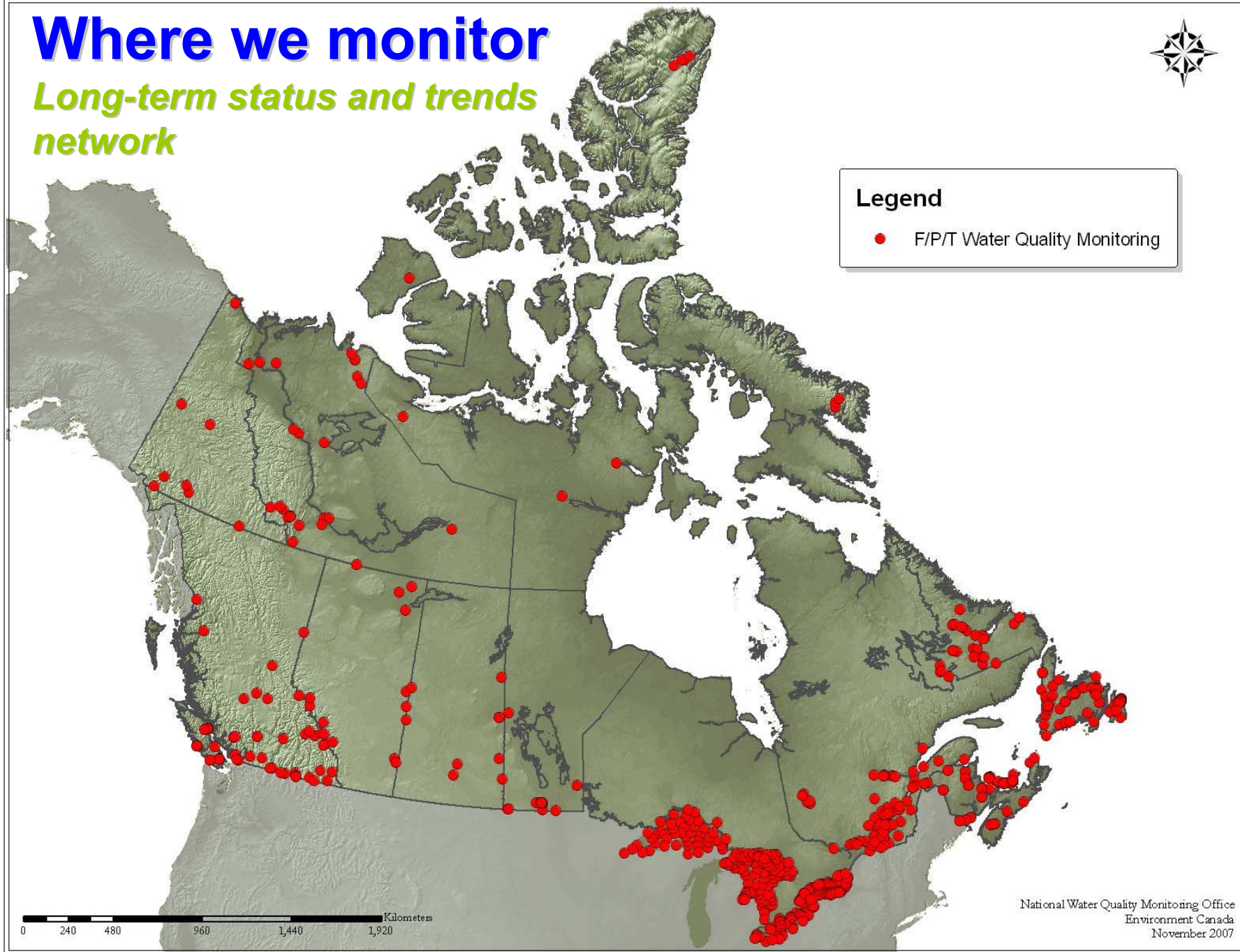


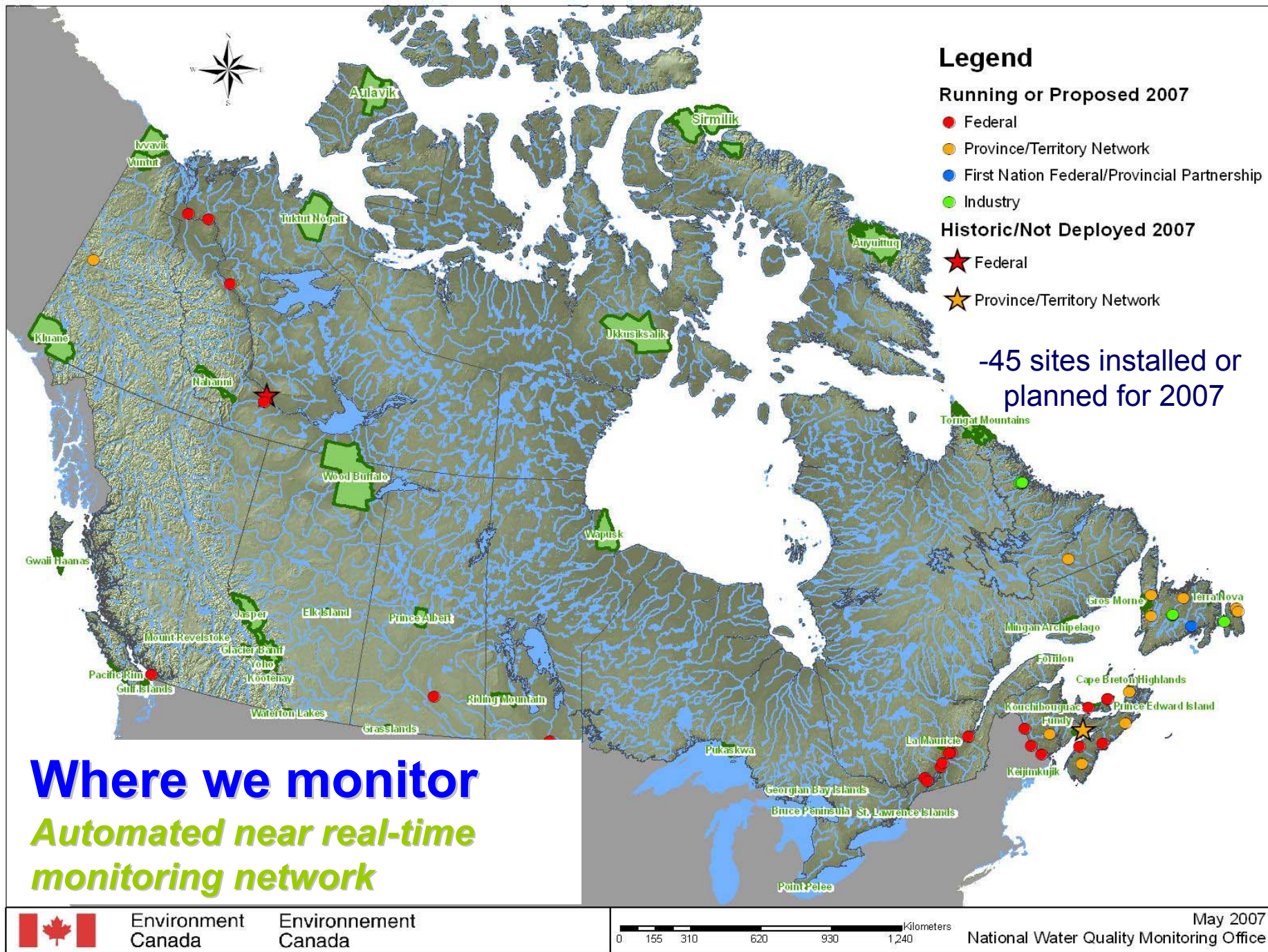
Legend

● F/P/T Water Quality Monitoring

0 240 480 960 1,440 1,920 Kilometers

National Water Quality Monitoring Office
Environment Canada
November 2007

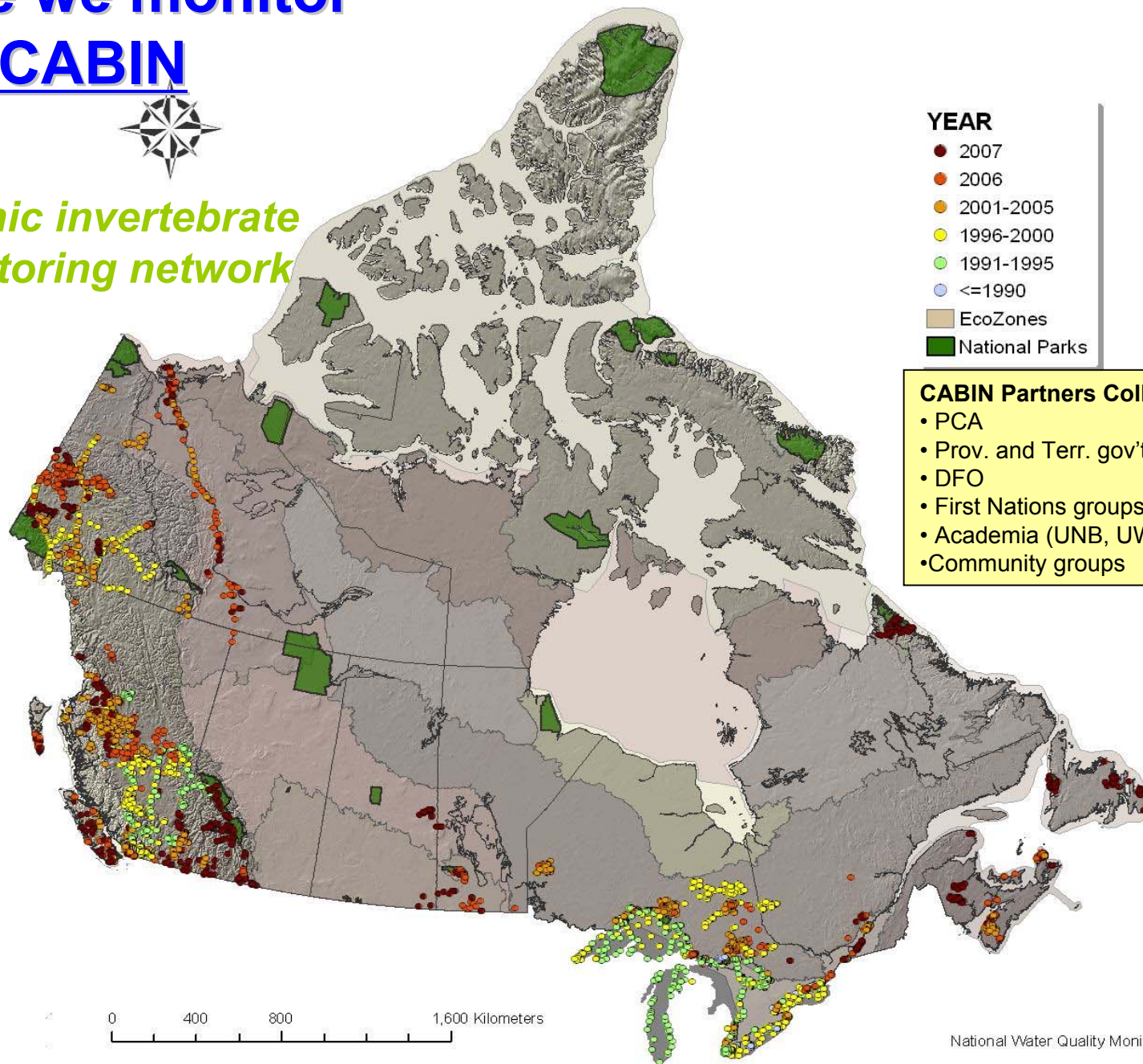




Where we monitor CABIN



Benthic invertebrate monitoring network



Data / Information Management

- Distributed network of regional databases (ENVIRODATs); national CABIN database
- Network of laboratories (LIMS linked to final data holdings)
- Objective: To facilitate national sharing, discovery, access and use of credible and comparable Water Quality data from EC's distributed monitoring networks
- ***Requisite component of regional/basin and national-scale reporting***



Data QA/QC considerations

- ***Consistent, credible and comparable reporting on regional and national scales***
- Many different Provincial/Territorial agreements – partners may have different program objectives and requirements from one another
- 5 different labs
- Different analytical methods may have different resolutions and performances
- Manual vs automated QA/QC
- Some elements of data QA are done by the labs, some by the monitoring specialists
- Flagging systems
 - “verified”, “unverified” or “qualified”
 - Qualified – many different qualifications



Key driver is national reporting

- Pivotal meeting in 2007 to discuss different elements of data QA: findings
 - There are variations
 - Some areas have a significant backlog of data QA due to manual implementation
- Who automates their QA? Who doesn't?
- What tools are available to more effectively and efficiently QA data achieve the most credible, comparable and consistent data?



The EnviroGrapher QA tool - Background

- Began in 2006 as a QA/QC tool as a need to automate previous manual QA/QC process of requesting data into excel sheet, graph in graphing program (Grapher) and visually inspect and manually calculate data quality objectives
- First version created time savings of 70%, after data quality objectives were integrated savings increased to almost 90%
- Upgraded with AJAX elements, guidelines (objectives), flagging in early 2007
- Launched French version for Quebec region in July 2007
- Integrated data retrieval tool in January 2008, this created a "one-stop" website location to download data in Excel, CSV and to graph application
- Launched PNR in February 2008



The EnviroGrapher QA tool – Tech stuff

- Developed using ASP.NET 1.1 and C# in Visual Studio.NET 2003
- Upgraded to ASP.NET 2.0 and C# in Visual Studio.NET 2005 in 2007
- Introduced AJAX and Web 2.0 elements in 2007
- Initial database used SQL Server 2000, extended application to use SQL Server 2005 and Oracle 8 to 11



Snapshot of available WQ variables

EnviroGrapher v1.6 (Beta)

Select Water Quality Station:

Start Date: End Date:

Water Quality Data: An Environmental Water Quality Tool for EC-PNR

Show Envirographer

Measure Number: ☐ Value Type Code: ☐ Flags: ☒

NITROGEN: **Reveal Nitrogen**

- AMMONIA DISSOLVED ☐
- NITROGEN DISSOLVED NO3 & NO2 ☐
- NITROGEN PARTICULATE ☐
- NITROGEN TOTAL DISSOLVED ☐

PESTICIDES: **Reveal Pesticides**

METALS: **Reveal Metals**

OTHER: **Reveal Others**

CARBON: **Reveal Carbon**

- CARBON DISSOLVED ORGANIC ☐
- CARBON PARTICULATE ORGANIC ☐

PHYSICALS: **Reveal Physicals**

Get Data

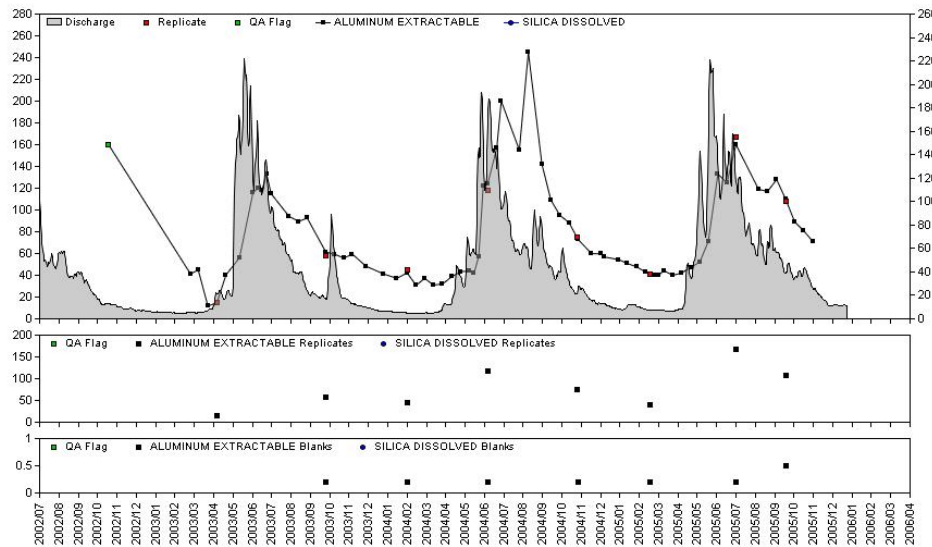


Graphing data from Fraser River

EnviroGrapher v1.6 (Beta)

An Environmental Water Quality Graphing Tool for EC-PYR

BC08KA0007 - Fraser River at Red Pass



ALUMINUM EXTRACTABLE and SILICA DISSOLVED

ALUMINUM EXTRACTABLE

Mean: 77.6794
Median: 59.5
SD1: 45.4873 SD2: 11.0323 SD3: 16.5484
Min: 11.8 Max: 245
Samples: 68

SILICA DISSOLVED

Mean: 0
Median: 0
SD1: 0 SD2: 0 SD3: 0
Min: 0 Max: 0
Samples: 0

Re-Draw Graph

Start Date: 2002/07/28

End Date: 2006/04/09

Flags: ☒

Re-Draw

Guidelines

ALUMINUM EXTRACTABLE

None

Re-Draw

Rechecks & DQOs

Check for Duplicates

DQOs



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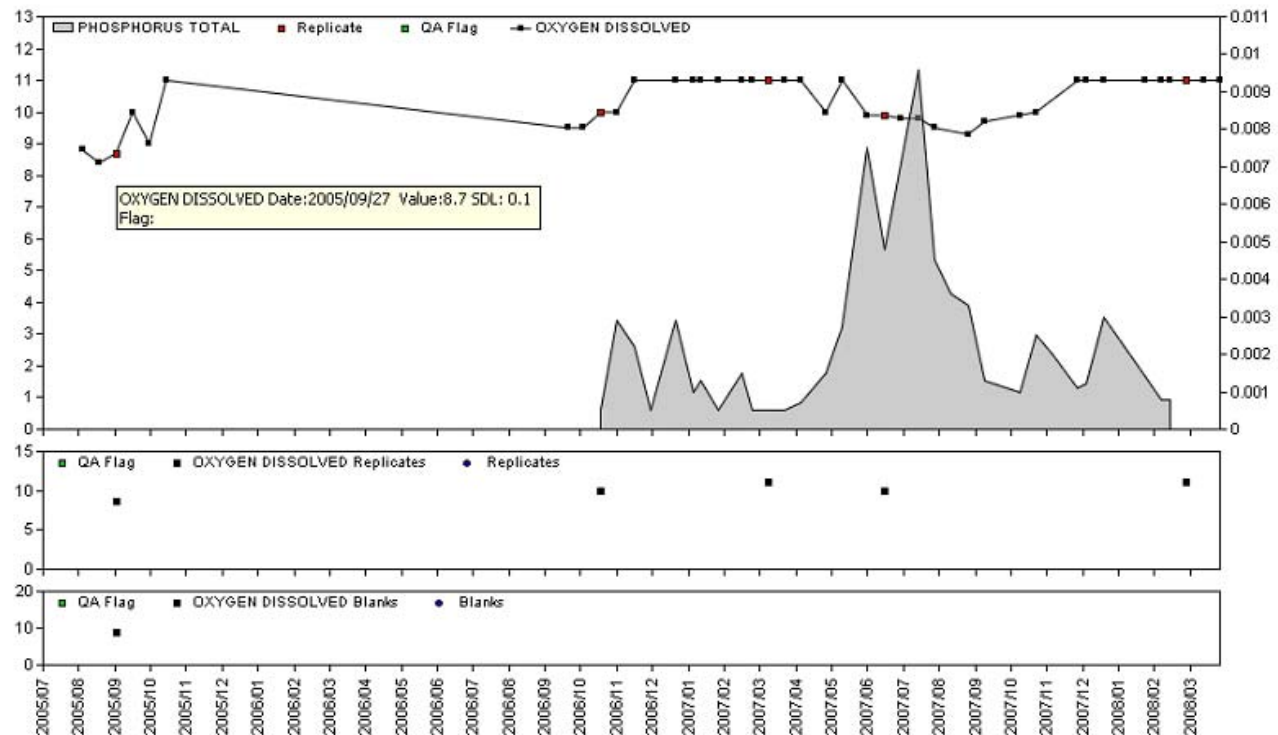
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Look at data for individual points

EnviroGrapher v1.6 (Beta)

An Environmental Water Quality Graphing Tool for EC-PYR

BC08KA0007 - Fraser River at Red Pass



Retrieving data from graphs

Water Quality Data Retrieval v0.2

An Environmental Water Quality Tool for EC-PYR

Station: Yukon River at Eagle, Alaska (AK09ED0001)

Description: Yukon River at Eagle, Alaska. Boat/plane access only. Samples taken on left bank.

Latitude: 64.788890 Longitude: -141.196670

Start Date: 1989/07/22 0:00

End Date: 1994/09/29 0:00

[Download Data](#)

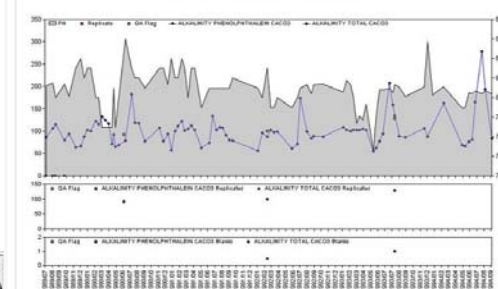
[Back to Envirographer](#)

Sample Time	Sample No	Project No	ALKALINITY TOTAL CACO3 (10101) Lab: 36	Flag	OA Flag	ALKALINITY TOTAL CACO3 (10111) Lab: 1	Flag	OA Flag	ALKALINITY PHENOLPHTHALEIN CACO3 (10151) Lab: 36	Flag	OA Flag	PH (10301) Lab: 1	Flag	OA Flag	PH (10301) Lab: 36
07/27/1989 12:20:00 PM	89PY000902	PY0331	85.70						0			8.12			
08/23/1989 01:50:00 PM	89PY001032	PY0331	106						0			8.15			
09/06/1989 03:20:00 PM	89PY001084	PY0331	115						0			8			
10/12/1989 05:00:00 PM	89PY001267	PY0331	79.90						0			8.14			
11/01/1989 09:30:00 AM	89PY001368	PY0331	93.70									8.01			
11/29/1989 11:00:00 AM	89PY001428	PY0331	64.30									8.30			
12/20/1989 02:10:00 AM	90PY000090	PY0331	65.90									8.40			
01/04/1990 09:30:00 AM	90PY000163	PY0331	87.10									8.20			

EnviroGrapher v1.6 (Beta)

An Environmental Water Quality Graphing Tool for EC-PYR

AK09ED0001 - Yukon River at Eagle, Alaska



ALKALINITY PHENOLPHTHALEIN CACO3	ALKALINITY TOTAL CACO3
Mean: 0	Mean: 102.1259
Median: 0	Median: 99
SD: 0 SD2: 0 SD3: 0	SD: 35.7208 SD2: 7.7489 SD3: 11.6234
Min: 0 Max: 0	Min: 55 Max: 279
Samples: 4	Samples: 65



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Data retrieval

EnviroGrapher Water Quality Data Retrieval v1.8

Select Water Quality Station:

Start Date: End Date:

Water Quality Data: An Environmental Water Quality Tool for EC-PYR

[Show Envirographer](#)

Measure Number: ☐

Value Type Code: ☐

BIOTA:

COLIFORMS FECAL ☐

CALCULATED QUANTITIES:

HARDNESS TOTAL (CALCD.) CACO3 ☐

MAGNESIUM DISSOLVED (CALCD.) ☐

CARBON:

CARBON DISSOLVED INORGANIC ☐

CARBON DISSOLVED ORGANIC ☐

CARBON TOTAL INORGANIC ☐

CARBON TOTAL ORGANIC ☐

CYANIDE TOTAL ☐

DESCRIPTIVE:

TEMPERATURE AIR ☐

HALIDES, ORGANIC:

ADSORBABLE ORGANIC HALIDE - AOX ☐

IONS, ANIONS AND CATIONS:

BROMIDE DISSOLVED ☐

IONS, MAJOR IONS:

ALKALINITY GRAN CACO3 ☐

ALKALINITY PHENOLPHTHALEIN CACO3 ☐

ALKALINITY TOTAL CACO3 ☐

CALCIUM DISSOLVED ☐

CALCIUM EXTRACTABLE ☐

METALS, EXTRACTABLE:

ALUMINUM EXTRACTABLE ☐

ANTIMONY EXTRACTABLE ☐

ARSENIC EXTRACTABLE ☐

BARIUM EXTRACTABLE ☐

BERYLLIUM EXTRACTABLE ☐

BISMUTH EXTRACTABLE ☐

BORON EXTRACTABLE ☐

CADMIUM EXTRACTABLE ☐

CERIUM EXTRACTABLE ☐

CESIUM EXTRACTABLE ☐

CHROMIUM EXTRACTABLE ☐

COBALT EXTRACTABLE ☐

COPPER EXTRACTABLE ☐

GALLIUM EXTRACTABLE - GA ☐

IRON EXTRACTABLE ☐

LANTHANUM EXTRACTABLE - LA ☐

LEAD EXTRACTABLE ☐

LITHIUM EXTRACTABLE ☐

MANGANESE EXTRACTABLE ☐

MERCURY EXTRACTABLE ☐

MOLYBDENUM EXTRACTABLE ☐

NICKEL EXTRACTABLE ☐

NIوبيUM EXTRACTABLE ☐

PLATINUM EXTRACTABLE ☐

POTASSIUM EXTRACTABLE ☐

RUBIDIUM EXTRACTABLE - RB ☐

SELENIUM EXTRACTABLE ☐

SILVER EXTRACTABLE ☐



View metadata for individual samples

Water Quality Data Retrieval v0.2

An Environmental Water Quality Tool for EC-PYR

Station: Fraser River at Red Pass (BC08KA0007)

Description: At CN Railway bridge at Red Pass, near outlet of Moose Lake. Sampled from downstream side of bridge. Water Survey 08KA007

Latitude: 52.9878 Longitude: -119.0101

Start Date: 2006/07/28 0:00

End Date: 2008/04/09 0:00

[Download Data](#)

[Back to Envirographer](#)

Sample Time	Sample No	Project No	OXYGEN DISSOLVED (-91006) Lab: 80	Flag	QA Flag	PHOSPHORUS TOTAL (15413) Lab: 1	Flag	QA Flag
10/10/2006 09:48:00 AM	06PY001279	PY0331	9.50					
10/23/2006 09:38:00 AM	06PY001324	PY0331	5.50					
11/07/2006 08:40:00 AM	06PY001383	PY0337				0.0005	L	
11/07/2006 08:56:00 AM	06PY001382	PY0331	10			0.0005	L	
11/07/2006 09:08:00 AM	06PY001381	PY0334	10			0.0005	L	
11/20/2006 09:27:00 AM	06PY001432	PY0331	10			0.0029		
12/05/2006 09:47:00 AM	07PY000014	PY0331	11			0.0022		
12/18/2006 09:04:00 AM	07PY000045	PY0331				0.0005	L	

01/08/2007 10:07:00

Water Quality Data Retrieval v0.2

An Environmental Water Quality Tool for EC-PYR

Station: Fraser River at Red Pass (BC08KA0007)

Description: At CN Railway bridge at Red Pass, near outlet of Moose Lake. Sampled from downstream side of bridge. Water Survey 08KA007

Latitude: 52.9878 Longitude: -119.0101

Meta Data: SUNNY, COOL. SLIGHT NW WIND. WATER LEVEL LOW-LOTS OF SMALL DEBRIS (LEAVES ETC.).



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View WQ variable information

Water Quality Data Retrieval v0.2

An Environmental Water Quality Tool for EC-PYR

Station: Fraser River at Red Pass (BC08KA0007)

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Latitude: 52.9878 Longitude: -119.0101

Start Date: 2006/07/28 0:00

End Date: 2008/04/09 0:00

[Download Data](#)[Back to Envirographer](#)

Sample Time	Sample No	Project No	OXYGEN DISSOLVED (-91006) Lab: 80	Flag	QA Flag	PHOSPHORUS TOTAL (15413) Lab: 1	Flag	QA Flag
10/10/2006 09:48:00 AM	06PYD01279	PY0331	9.50					
10/23/2006 09:38:00 AM	06PYD01324	PY0331	9.50					
11/07/2006 08:40:00 AM	06PYD01383	PY0337				0.0005	L	
11/07/2006 08:56:00 AM	06PYD01382	PY0331	10			0.0005	L	
11/07/2006 09:08:00 AM	06PYD01381	PY0334	10			0.0005	L	
11/20/2006 09:27:00 AM	06PYD01432	PY0331	10			0.0029		
12/05/2006 09:47:00 AM	07PYD00014	PY0331	11			0.0022		
12/18/2006 09:04:00 AM	07PYD00045	PY0331				0.0005	L	

Water Quality Data Retrieval v0.2

An Environmental Water Quality Tool for EC-PYR

VMV Code	Variable Code	Variable Name	Variable Group	Method Code	Units	Detect Limit
15413	730	PHOSPHORUS TOTAL	PHOSPHORUS	566	MG/L	.0002



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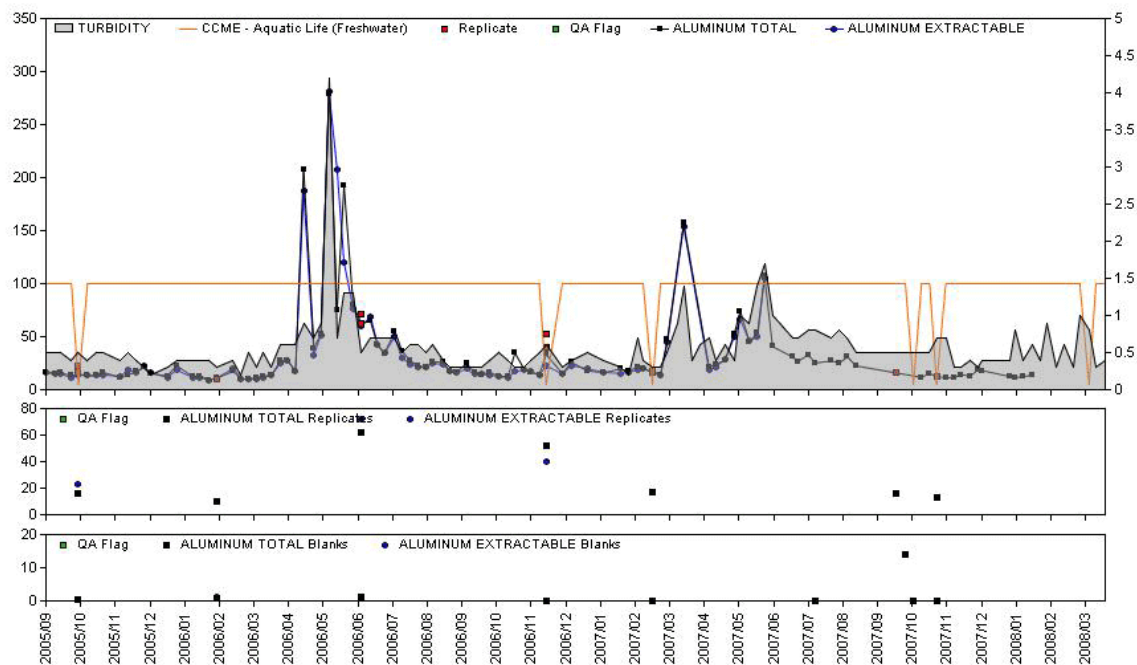
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Data viewing

EnviroGrapher v1.6 (Beta)

An Environmental Water Quality Graphing Tool for EC-PYR

BC08NE0001 - Columbia River at Waneta



ALUMINUM TOTAL and ALUMINUM EXTRACTABLE

ChartDirector (unregistered) from www.advsofteng.com

ALUMINUM TOTAL

- Mean: 32.1426
- Median: 18.1
- SD1: 40.7611 SD2: 8.1118 SD3: 12.1677
- Min: 9.1 Max: 279
- Samples: 101

ALUMINUM EXTRACTABLE

- Mean: 34.7215
- Median: 18.3
- SD1: 45.97 SD2: 10.3441 SD3: 15.5161
- Min: 8.9 Max: 281
- Samples: 79

Re-Draw Graph

Start Date: 2005/09/20

End Date: 2008/03/26

Flags: ☒

Re-Draw

Guidelines

ALUMINUM TOTAL

CCME - Aquatic Life (Freshwater) ▼

Re-Draw

Rechecks & DQOs

Check for Duplicates

DQOs



Flags for QA/QC

Water Quality Data Retrieval v0.2

An Environmental Water Quality Tool for EC-PYR

Station: Fraser River at Red Pass (BC08KA0007)

Description: At CN Railway bridge at Red Pass, near outlet of Moose Lake. Sampled from downstream side of bridge. Water Survey 08KA007

Latitude: 52.9878 Longitude: -119.0101

Start Date: 2006/07/28 0:00

End Date: 2008/04/09 0:00

[Download Data](#)

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Sample Time	Sample No	Project No	OXYGEN DISSOLVED (-91006) Lab: 80	Flag	QA Flag	PHOSPHORUS TOTAL (15413) Lab: 1	Flag	QA Flag
10/10/2006 09:48:00 AM	06PY001279	PY0331	9.50					
10/23/2006 09:38:00 AM	06PY001324	PY0331	9.50					
11/07/2006 08:40:00 AM	06PY001383	PY0337				0.0005	L	
11/07/2006 08:56:00 AM	06PY001382	PY0331	10			0.0005	L	
11/07/2006 09:08:00 AM	06PY001381	PY0334	10			0.0005	L	
11/20/2006 09:27:00 AM	06PY001432	PY0331	10			5.0000		
12/05/2006 09:47:00 AM	07PY000014	PY0331	11					
12/18/2006 09:04:00 AM	07PY000045	PY0331						
01/08/2007 10:07:00 AM	07PY000082	PY0331	11					

Measurement Flag color descriptions:

No Flag Code

Measurement Has A Systematic Bias - Check Meta Information

Greater Than The Reported Value

Less Than The Reported Value

Value Is Questionable - Check Meta Measurements

"Trace" Value; i.e. Less Than Reported Value But Presence Was Detected

Value Is Contaminated - Check Meta Measurements



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Next steps

- Continue talking about it
- Have the EnviroGrapher applied to the rest of our offices
 - There are variations
 - Some areas have a significant backlog of data QA due to manual implementation
- Build in additional statistical functionality
 - Total minus dissolved = >0
 - Ionic balances
- Consistent flagging system that fits our objectives and will allow more complete and consistent data sets
- Continue working together with the labs to:
 - improve the consistency of data transfers
 - Reconcile differences in who does what data QA



Thank you!



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