AUTOMATED, RAPID MICROBIAL DETECTION SYSTEM FOR REMOTE TESTING OF *E.Coli*, COLIFORMS, AND ENTEROCOCCI BACTERIA

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Presented by: Douglas Wilton, P. Eng., President
www.tecta-pds.com
Formed in 2003 based on water monitoring technology developed at a major Canadian University - Queen’s University

Direct response to Walkerton, Ontario *E. coli* contamination drinking water disaster

Acquired by Veolia Water in 2009 and re-branded as ENDETEC

Management led buyout in 2016

Sales in over 25 countries
Our Mandate: To revolutionize the microbiological monitoring of water

The Problem: Inadequate microbiological testing – ancient methods lead to water quality and human health problems

We can and should do better.

The Solution: Lab equivalent, Fully automated, Rapid, EPA approved, microbial detection system
Why a revolution?

Boil water advisory issued for Picture Butte
Alberta Health Services says water should be boiled for at least a minute before consumed
CBC News  Posted: Feb 20, 2014 12:50 PM MT  |  Last Updated: Feb 20, 2014 12:50 PM MT

People in Picture Butte are being told to boil their water.

1.3 million Montrealers face boil water advisory
Residents should expect advisory to last a minimum of 24 hours

Doylestown - Water restrictions remained in place at Linden Elementary School in Doylestown Wednesday, a day after it was revealed that fecal coliform showed up in a water test at the school.

Coroner calls for stricter controls after E.coli death

There are a further 125 probable cases

Tap water warning in Copenhagen after E.coli found
Why a revolution?

Walkerton Report – Causes:

• Lack of technology
• Centralized testing
• Storage and transport of samples
• Long overall test time
• Manual test method
• opportunity for human error / human negligence
• Regulatory shortcomings

• INADEQUATE TESTING

7 Dead
2,300 People Sick
46% Population
**The Solution**

- **Walkerton Report – Solution / Government checklist:**
  - Automated test
  - Testing done on-site, on-line
  - No storage or shipping
  - Overall test turn-around at most one day
  - No visual estimation or judgment
  - Replace human sample manipulation/ intervention/decision making with Intelligent System using objective, pre-set criteria

**TECTA™ B16**

Rapid, Automated Microbial Detection System
Conventional methods

Limitations of current methods

• Based on ancient technology
• Require a microbiology lab
• Take too long
• Visual interpretation required
• Prone to errors
• There are no better options
• Everyone accepts this as “state of the art”
Conventional methods

• Test Tube Methods
  – Lactose fermenting bacteria
  – Presence of gas bubbles in positive tubes
  – P/A, or quantitative using multi-tubes & MPN
  – Originally developed: 1914
  – Still in use, though being replaced in most jurisdictions
Conventional methods

- Membrane Filtration (traditional “plate” method)
  - Culture bacteria on membrane filter
  - Metabolism to generate colored colonies
  - Lactose-fermenting colonies cause pH change (e.g. turn green)
  - P/A or quant by counting colonies
  - Early versions used around 1950
Membrane filtration

• Limitations for Quantitation

- dynamic range 0~80 CFU or sample dilutions required
- excess "general bacteria" can result in "over-grown" plate
Enzyme methods

• Defined substrate methods (or Enzyme methods)
  – Colour change and fluorescence
  – Two method styles
    • Broth Culture - media powder mixed into sample
    • MF Plates
  – IDEXX Colilert, Colitag; Colisure; ReadyCult; E*Colite
  – P/A or quant by MPN (Quantitray or tubes); plate counting
  – In use since 1980s, replacing older methods
Enzyme methods

- Limits for visual interpretation – subjective
Automated method

- TECTA™ B16 Bench Top Testing System
- TECTAlert™ Consumable Test Cartridges
Automated method

• Selective broth culture with detection of enzymes identical to conventional tests:
  - glucoronidase for *E. coli*
  - galactosidase for coliforms

• Opto-chemical sensor extracts and automatically detects enzyme product

• Complete test and sensor in a single-use cartridge with pre-measured reagents

• Simple instrument that can be operated in the field

• Continuous automated interpretation and reporting of sample result
Tecta cartridge

Enzyme-substrate / solution culture method

Detecting identical enzyme as conventional methods

Extracting fluorescent markers outside of sample into polymer

Automated detection of fluorescence in polymer triggers result

100mL Water Sample

Targeted Substrate

E. coli Bacteria

Fluorescent Product

Polymer Partition Element

Miniature Spectrometer

Fibre-optic Probe

U.V. LED

Detecting identical enzyme as conventional methods

Extracting fluorescent markers outside of sample into polymer

Automated detection of fluorescence in polymer triggers result
Quantitative analysis

• Signal onset gives Time-to-Detection (TTD)
  – TTD linearly related to log CFU bacteria
  – Indicates time for growth and enzyme expression
  – Calibrate response of TECTA system

Detection of *E. coli* at various levels in TECTA B16

- 10,000 cfu/100mL
- 1,000 cfu/100mL
- 100 cfu/100mL
- 10 cfu/100mL
Quantitative analysis

- Calibration using natural samples
  - Large sample carefully mixed and split into replicates
  - Also depends on reference method
    - various alternate methods give different results!

\[ R^2 = 0.8427 \]
Quantitative analysis

• Validation using separate sample set
  – *E. coli* and Total Coliforms tested simultaneously
  – 95% of results within 0.7 log of reference results
    - comparable to inter-lab studies using different methods
Quantitative analysis

• Validation of calibration at alternate site
  – McCarthy group, Monash U.

The Solution

TECTA™ B16
Rapid, Automated Microbial Detection System

- Fully automated bacterial test – *E. coli* and Total Coliform
- Lab-in-a-box - On-site analysis; zero transport, zero storage; zero prep, sample on-test with no delay
- No visual estimation or judgment
- No human sample manipulation or intervention
- Fully automated test monitoring, interpretation and reporting via email; networkable
- Major approvals in place including USEPA
The Solution

TECTA™ B16
Rapid, Automated Microbial Detection System

- Not affected by turbidity or sample color
  - Applicable to a wide range of matrices
- High dynamic range: <1 CFU - 10⁸ CFU / 100mL
- Installed & operated anywhere, by anyone, at any time
- Single-cell sensitivity
- Ready-to-use, pre-sterilized test cartridge
- Fastest test on market
  - only method available with early alerting
  - results in 2-18 hours depending on contamination level

Detection Times
CFU / 100mL v TTD value
< 1 (absent)......18 hours
1 CFU...............10h 40m
100 CFU..........8h 40m
1000 CFU.........7h 30m
10,000 CFU.......6h 30m
10⁶ CFU..........4h 20m

***default calibration – E. coli-only test
The Solution

TECTA™ B16
Rapid, Automated Microbial Detection System

- Secure storage of test reports for QA/QC protection
- Networkable
- Automated reporting via email

TECTA-B16 (1.2.5) Report

Sample ID:
Collection Time: 2013-11-12 14:50:08
Stored: Unknown
Target Temperature (C): 35.63 | Actual Temperature (C): 35.46
Data File: XPDS00046.2013-11-12_14.50.08_Chamber1_TIME.pds

Test Result

E. coli Result: Present
EC Detect Time: 10h4m6s || Quantity: 140 CFU/100 ml
[EC-35.5 Default Calibration rev. 1.0]

Total Coliform Result: Present
Total Coliform Detect Time: 10h17m23s || Quantity: 3000 CFU/100 ml
[TC-35.5 Default Calibration rev. 2.0]
The Opportunities

Conventional Methods / labs:

36 – 72 hours plus…. 

TECTA B-16:

2 – 18 hours

What opportunities exist for your operation if you had a rapid, on-site, easy to use micro system?

Drinking water

• Distribution compliance samples
• Raw, pre/post filtration, pre/post chlorination, post clear well
• Customer hand off
• Broken/replacement pipe

Waste / Reuse water

• Raw, pre/post MBR, pre/post RO, pre/post UV

Remote/challenging locations

Recreational water
Approvals & Validations

• **US EPA Approved** *(drinking water)*
  – Only EPA approved method with “early-alerting”
  – Better recovery of stressed cells

• **Ministry of Environment, Ontario, Canada** *(published in Journal of Microbiological Methods, 2009)*
  – 100% detection by non-micro operator under field conditions
  – Better accuracy than reference method

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<th>MF-DC</th>
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Approvals & Validations

- New Zealand Ministry of Health Approval
  - Received March 2016
  - “MOH is satisfied that TECTA-B16 can be used for bacterial compliance monitoring”

- National Institute of Environmental Research (NIER), South Korea

- AOAC Certified
  - “Performance identical to reference methods at detection limit of one viable organism in 100mL sample”

- US EPA ETV Study and Report
  - “Method very user friendly and eliminates need for technician”
Monash University Research Project, Australia

**TECTA Results**

*Test prep-time* .......... T-1<sup>st</sup>

*Results interpretation time* ................. 1<sup>st</sup>

*Incubation time* ................. 2<sup>nd</sup>

*Cost per test* ................. 1<sup>st</sup>

*** Was run inside lab with samples ready to test

*** Does not consider:

1. Cost / time for transportation to lab
2. Cost for trained lab tech or microbiologist

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### Approvals & Validations

Remote locations - Indigenous Communities

- **Challenges**
  - Significant delays transporting samples from highly remote sites; not well served by existing lab infrastructure
  - High overall cost due to transportation
  - Loss of validity of samples (estimated at 25%)

- **Chosen solution**
  - Install Tecta on-site in remote communities for all DW samples
  - Capability of expanding use to other water types

- **Outcomes**
  - Faster results – increased public safety within First Nations communities
  - Reduced costs
  - Still maintain 100% integrity of results
  - Self management combined with Health Canada support for networking; automated reporting

“The biggest benefit for us is the shorter timespan for bacteria results. It is also an advantage to be able to receive emails confirming results from the TECTA™ B16, which helps eliminate any human error,” says Jacobs. “In addition to using the machine for testing our distribution network, we hope to eventually use the TECTA™ B16 for all our water samples, including well water and recreational water.”
Enterococcus - New Test

- Enterococcus test
  - Enzyme based
  - Selectivity with ISO Method 7899 (Slanetz & Bartley)
  - Calibration procedure identical to *E. coli*
  - Initial validation shows similar performance
  - External validation partners in US, Australia and Singapore
In Summary...

• Rapid, automated TECTA™ B16 system for *E. coli*, Total Coliform, Fecal Coliform
• Simple and robust for use in remote locations outside a laboratory
• Rapid detection (most positive samples in 2 h to 12 h)
• Approved for drinking water at <1 CFU/100 mL level
• Comparison with other methods shows good agreement for enumeration
• New test for Enterococcus bacteria now available
Acknowledgements

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CRD, I2I programs

Province of Ontario
OCE, MRIS, MOECC

• More information:

See TECTA-PDS at Booth M23 in Exhibition
Questions?

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