

# Beach Quality in Ontario

## Summary of Recent MOE Projects

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***Presentation to:***  
**Great Lakes Beaches and Coasts Workshop**  
**April 15, 2010**

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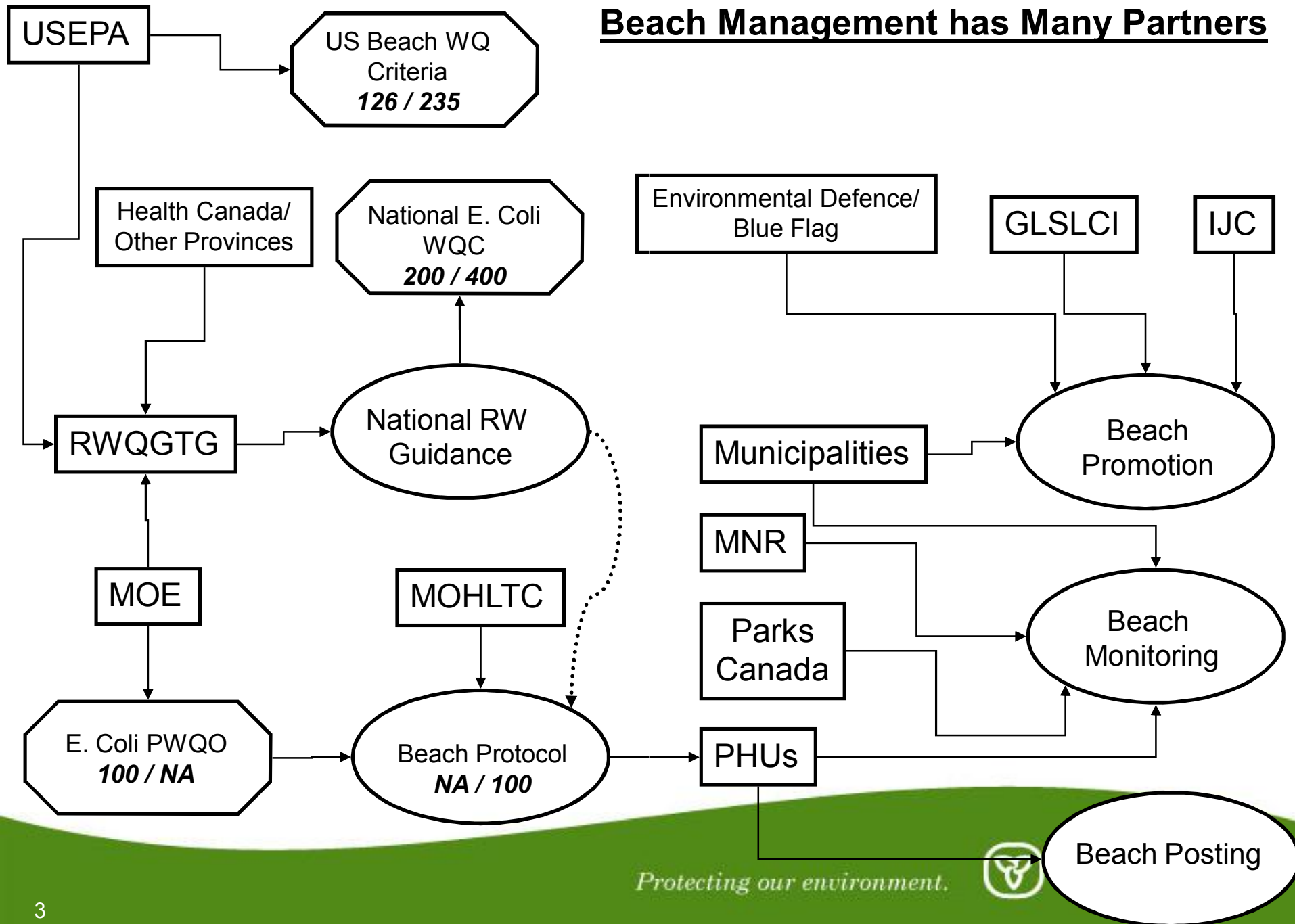
*Protecting our environment.*



# Topics

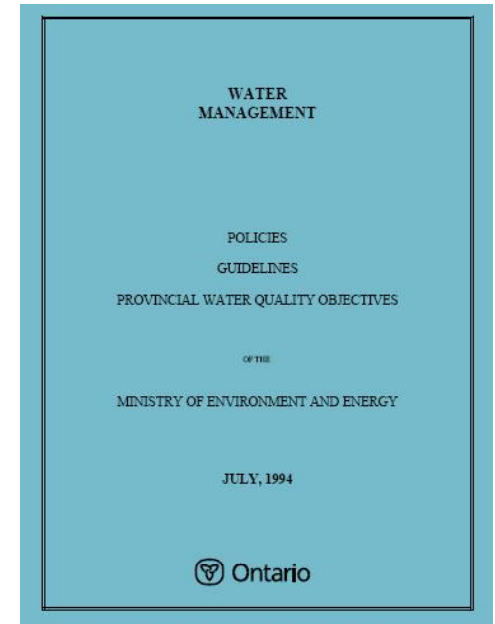
- Role of Ministry of Environment on Beach Quality
- Provincial Water Quality Objective for E. coli
- Status of Canadian Recreational Water Quality Guidelines (revised)
- IJC Beach Working Group
- Survey of Beach Quality in Ontario
- Beach Forecasting Project
- Next Steps

# Beach Management has Many Partners



# Provincial Water Quality Objectives

*“To ensure that the surface waters of the Province are of a quality which is satisfactory for aquatic life and recreation”.*



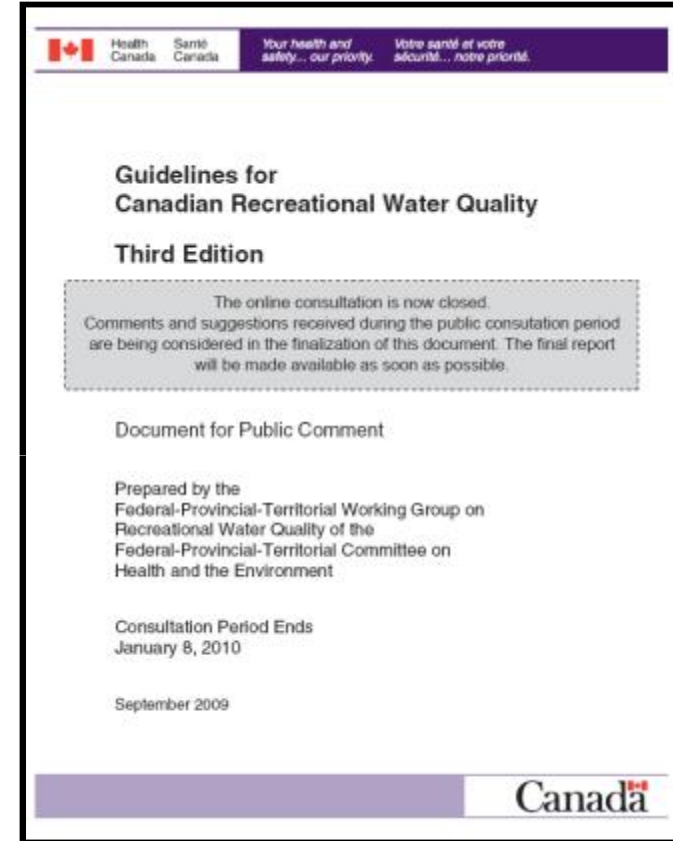
- Are numerical and narrative ambient surface water quality criteria
- Represent desirable surface water concentrations to protect all aquatic life and recreational water uses, including taste and odour of water and fish flesh.
- Are strictly science-based, and do not consider implementation issues (i.e. technological and economic feasibility)
- PWQOs are not regulatory instruments (i.e. not true Standards)

# Recreational PWQOs

- *“the use of water for swimming, bathing, and other recreational activities requiring immersion of the user should not cause disease in the human user ... or irritation or to loss of enjoyment of the water”*
- 1984 MOE SCD for Standard Development – Microorganisms in Recreational Water
  - PWQO for FC – 100 E. coli per 100 mL (based on geometric mean of at least 5 samples)
  - About 7 swimmers per 1000 (about 0.7%) are at risk of contracting GI symptoms
  - *“to ensure that the Provincial Standards reflect the most recent scientific advances in public health protection, regular review is strongly recommended”*
- 1992 RWQG (provincial) Committee report
  - Use a MAC of 100 E. coli per 100 mL (even though National numbers are 200/400)

# Status of National Guidelines For RWQG

- Consultation Draft posted on Health Canada website for comment until Jan. 8 2010.
- Re-affirmed existing National E. coli guidelines of 200 and 400 E. coli/100 ml (geomean of > 5 samples) for “primary” contact
- Addition of new “secondary” contact guidelines of 1000 E. coli /100 ml
- Addition of guidelines for Cyanobacteria (100,000 cells/mL total microcystin) and Cyanobacterial toxins (20 ug/L total microcystins)
- Final release expected ?????

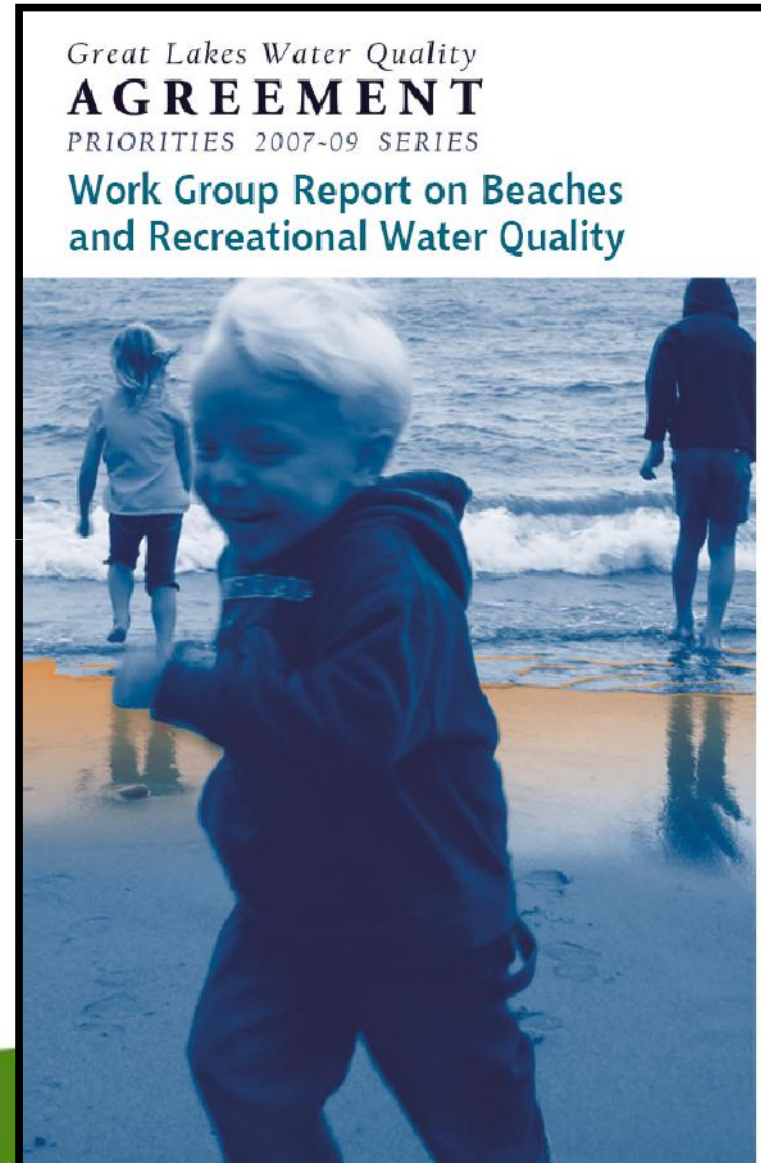


# IJC Beaches Working Group (2007 to 2009)

*“No public bathing beaches closed as a result of human activities or conversely, all beaches are open and available for public swimming.”*

- Recommendations

- Further research to determine sources of contamination, especially NPS, and human vs non human contributions to the risk to human health
- Research to develop novel indicators of human fecal contamination that are rapid and reliable
- Investigate predictive value of now/fore casting models vs persistence models
- Develop binational, standardized surveillance and monitoring protocols
- Adopt binational standardized criteria for posting
- Develop a binational, centralized method to report and evaluate waterborne illnesses in the GL



# IJC Beaches Working Group (2009 to 2011)

- Work builds on findings and recommendations from previous working group
- Contracted white papers on a series of topics;
  - Avian Impacts on Recreational Water Quality in the Great Lakes Basin (Kleinheinz)
  - Livestock and Recreational Water Quality (McDermott)
  - Cladophora as a Source and Sink of Fecal Indicator Bacteria and Pathogens in the Great Lakes (Ishii and Sadowsky)
  - Surface water pathogen and indicator organism association with risk potential for human health [looks at HH risks from different sources of e. coli] (Slawson)
  - A Review of Best Management Practices Benefiting Great Lakes Recreational Waters (Kinzelman)
- White papers will be condensed into recommendations to the IJC board

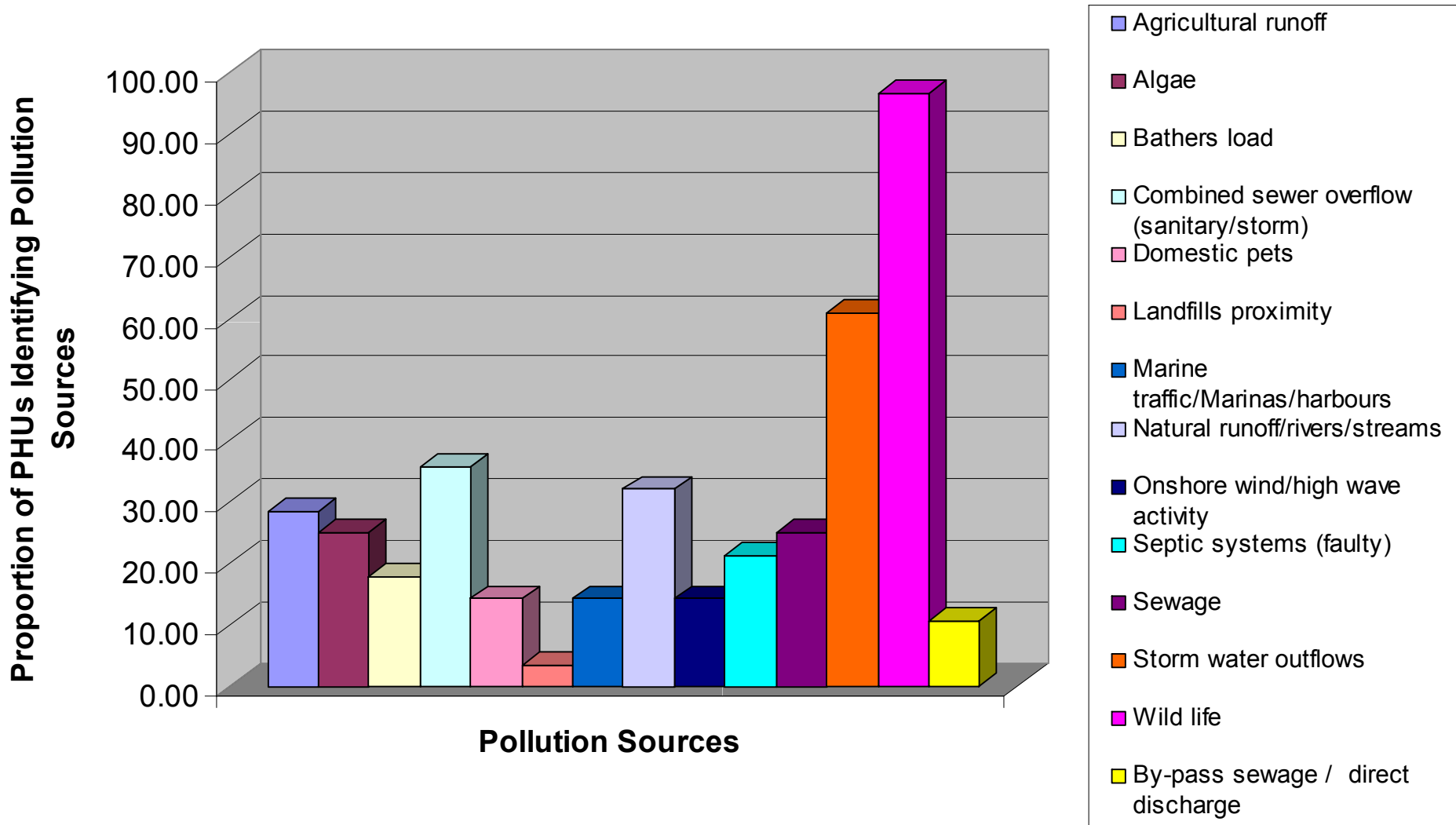


# State of Ontario Beaches: 2007 & 2008

- Beach monitoring data collected from PHUs in late 2008
- Goal:
  - Gain a province-wide perspective on beach quality in ON (i.e. beyond SOLEC)
  - Evaluation of implications of revising the E. coli PWQO
- 32 of 35 PHUs provided monitoring data, 28 answered the survey
- 19 PHUs provided GIS co-ordinates for their beaches
  - Attempted to locate remaining beaches through Google Earth, etc.
- Challenges with “normalizing” data
  - Some PHUs provided raw data, others provided GeoMean data
  - Beach Seasons
  - Monitoring frequency (daily, weekly, monthly or other)
  - Variability in determining whether beach should be posted (number of exceedences, standard, etc.)
- Arbitrary Decisions were taken
  - Single Beach Season (June 4/2 to September 3/1)
  - Single approach to determining posting (see paper)
- Our assessment may be different than PHU reportings

# What beach contamination sources did you identify in your beaches?

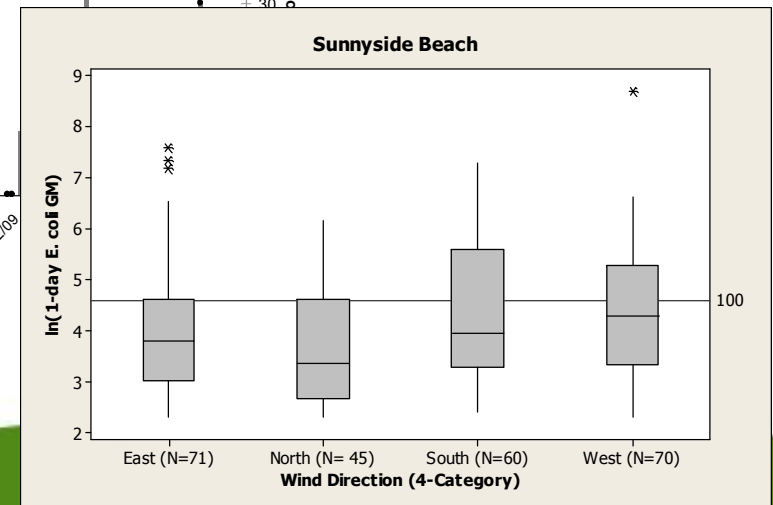
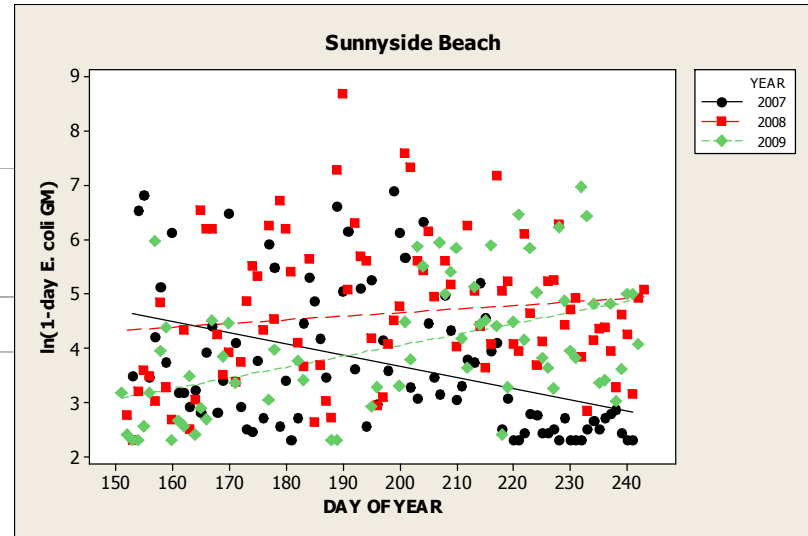
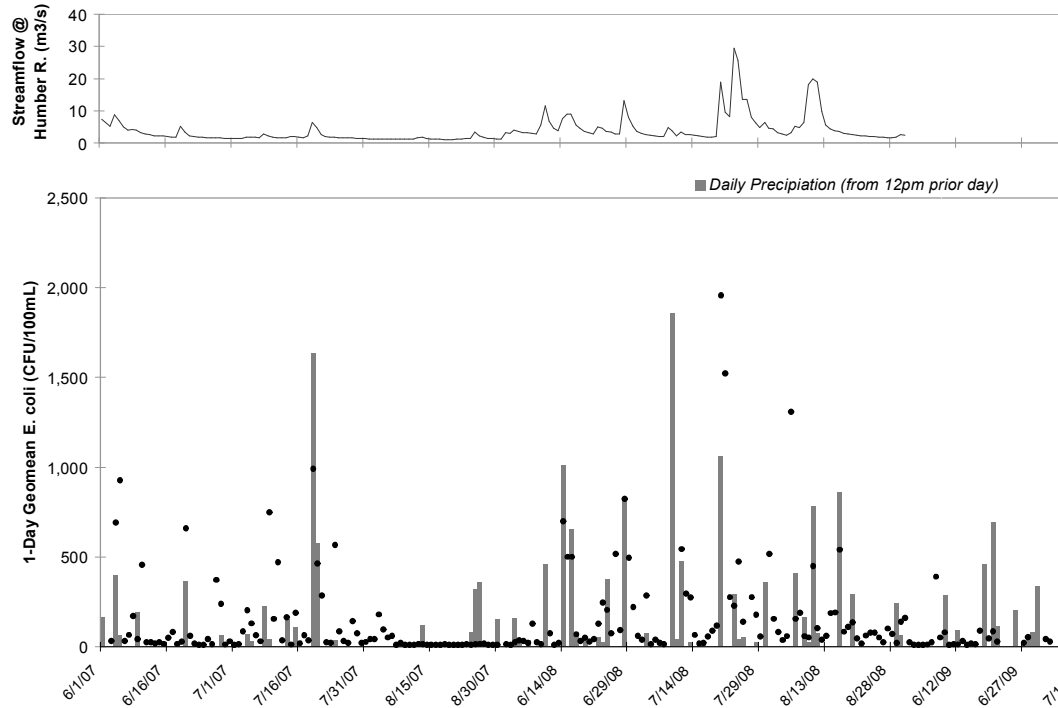
## Pollution Sources Identified by Public Health Unit



# Analyzing Relationships

## Sunnyside Beach

1-Day Geomean *E. coli* Beach Seasons 2007-2009



# Conclusions of Data Review

- There were multiple hydrologic and meteorological parameters that affect Beach Water Quality
- Prior rainfall and streamflow are important variables for many beaches
- No single set of parameters for all beaches
- Turbidity was not measured consistently but may be the best predictor of E. coli.
  - Suggests that PHUs consider including these measurements in their programs

# Development of Models

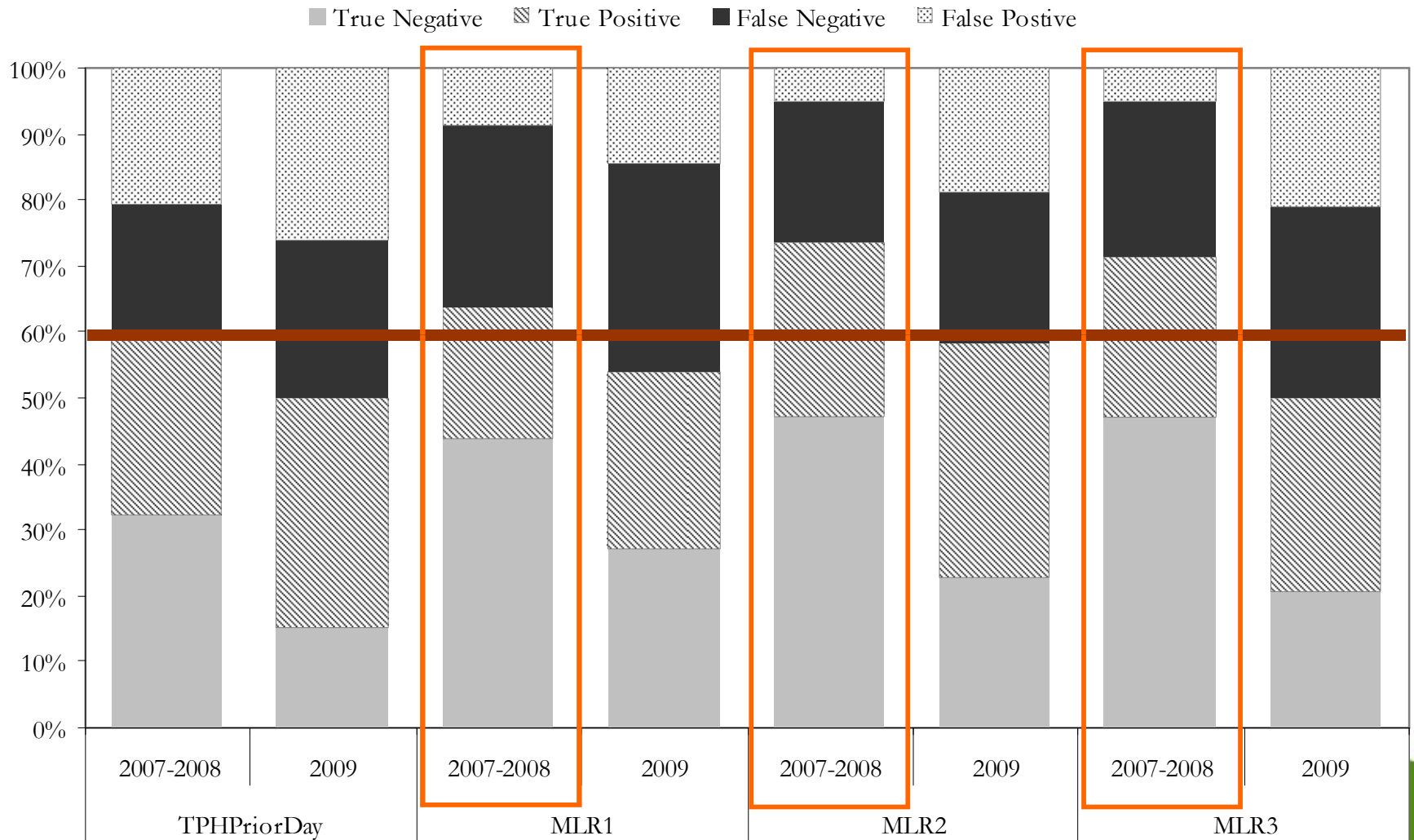
- Multiple Regression Models
  - Predicts an E. coli concentrations (with Prediction Intervals)
  - If Prediction Interval exceeds Standard – high confidence that standard is being exceeded

$$y = \beta_0 + \beta_1 x_1 + \dots + \beta_k x_k + \varepsilon$$

- Logistic Models
  - User sets a target value (i.e. Standard of 100 E. coli /100 ml)
  - Model output is a probability that the Standard will be exceeded
  - If >0.5, standard is likely exceeded

$$p = \frac{\exp(b_0 + b_1 x_1 + \dots + b_k x_k)}{[1 + \exp(b_0 + b_1 x_1 + \dots + b_k x_k)]}$$

# Development of Beach-Specific Models



# Data Entry Screen

Explanatory Variables		Value	Notes
Date		8/6/08	
Rainfall	24-hr Rainfall (mm)	11.4	24-hr rainfall is measured rainfall at the University of Toronto for the 24 hour period ending at noon on the day of sample collection.
	48-hr Rainfall (mm)	11.4	48-hr rainfall is measured rainfall at the University of Toronto for the 48 hour period ending at noon on the day of sample collection.
	Previous day 24-hr Rainfall (mm)	0	Previous day 24-hr rainfall is measured rainfall at the University of Toronto for the 24 hour period ending at noon on the day previous of sample collection.
Streamflow	Etobicoke Streamflow (cms)	5.81	Mean Daily Streamflow of Etobicoke Creek at the monitoring station below Queen Elizabeth Highway
	Humber Streamflow (cms)	5.03	Mean Daily Streamflow of Humber River at the monitoring station at Weston
	Rouge Streamflow (cms)	3.06	Mean Daily Streamflow of Rouge River at the monitoring station near Markham
Lake Level (m)		0.918	Lake Ontario (Station 13320)
Average WindSpeed (km/h)		11.2	
Wind Direction	North Wind	0	Mark Only the Primary Wind Direction with "1", the other three are "0"
	East Wind	1	
	West Wind	0	
	South Wind	0	
Day of the Year (1 to 365)		219	Calculated based on Date entered in Cell C2
<b>Beach-Specific Data</b>			
Sunnyside Beach	Prior Day 1-day GM E. coli (#/100mL)	1309	
	Water Temperature (C)	19.7	
Woodbine Beaches	Turbidity (NTU)	8.6	
	Prior Day 1-day GM E. coli (#/100mL)	6.3	
Ward's Island Beach	Prior Day 1-day GM E. coli (#/100mL)	9.4	
Kew Balmy Beach	Prior Day 1-day GM E. coli (#/100mL)	6.1	
	Wave Height Group (1=low; 2=moderate; 3-high)	1	

# Prediction Screen

## Marie Curtis Park East Beach

### Multiple Linear Regression (MLR) Models

Model	$b_0$	$b_1 * \ln(\text{Etobicoke Streamflow (cms)})$	$b_2 * \text{South Wind}$	$b_3 * \text{West Wind}$
MLR#1	4.33	0.646		
MLR#2	4.41	0.702	0.736	-0.94
MLR#3	4.78	0.755		-1.68

### Logistic Regression (LR) Model

Model	$b_0$	$b_1 * \ln(\text{Etobicoke Streamflow (cms)})$	$b_2 * \text{West Wind}$
LR#1	0.662	0.987	-2.967

### Prediction

Data			
Date	$\ln(\text{Etobicoke Streamflow (cms)})$	South Wind	West Wind
06/08/2008	1.760	0	0

$\ln(\text{1-day GM } E. coli \text{ (#/100mL)})$			1-day GM <i>E. coli</i> (#/100mL)		
MLR#1	MLR#2	MLR#3	MLR#1	MLR#2	MLR#3
5.47	5.65	6.11	237	283	450

Exceedance Probability
LR#1
0.92



# Conclusions and Next Steps

- MLR and/or LR models using readily available data provide better overall correct classification and higher R-squared values than existing empirical model
- No single set of variables is applicable for all beaches
- Best candidates for predictive modeling are beaches with:
  - A greater number of exceedances
  - An obvious driver of water quality
- Findings are consistent with performance of models developed for other freshwater beaches
  
- Testing of models at Toronto Beaches over Summer 2010
- Refinement of models
- Discussion document on moving approach to other Ontario beaches
  
- However, Nevers (2009) wrt predictive models in the Great Lakes .....
  - Models for beaches with typically lower E. coli concentrations had poorer predictive performance
  - *“despite the attractiveness of predictive models as an alternative beach monitoring approach, it is likely that indicator bacteria fluctuations at some beaches defy simple prediction approaches”.*

# MOE Beach Program Next Steps

- Incorporate 2009 Beach Quality Data (request through MOHLTC)
- Obtain Geospatial data for beaches, identify Great Lakes beaches
- Finalize Beach Quality in Ontario report
  
- Continue to work with Toronto on forecasting project
  - Facilitate forecasting work in other PHUs
  
- Work with MOHLTC on assessing E. coli standard
- Investigate reduced time / real time indicator technologies
- Wait for USEPA to indicate their direction (2012)
  - New epi studies
  - New technologies
  - New indicators and/or new standards

# Thank You

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