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HALIFAX REGIONAL MUNICIPALITY

P.O. Box 1749
Halifax, Nova Scotia
B3J 3A5 Canada

Chebucto Community Council
November 1, 2010

TO: Chair and Members of Chebucto Community Council

SUBMITTED BY: [signature]
Phillip Townsend, Director, Infrastructure and Asset Management

DATE: October 6, 2010

SUBJECT: **Water Quality Monitoring at Harbour Beaches**

INFORMATION REPORT

ORIGIN

Chebucto Community Council meeting of September 13, 2010, item 12.1.

BACKGROUND

At the Chebucto Community Council meeting on September 13, 2010, Councillor Mosher requested a staff report to address water quality testing practices to reduce unnecessary beach closure periods at both Black Rock and Dingle Beaches.

DISCUSSION

Water quality in Halifax Harbour has been of concern to Council for many years, most especially since 2008 when a decision was taken to open public beaches along its shoreline. The re-opening of the Halifax wastewater treatment facility in June 2010, which led to harbour water quality safe for swimming, revitalized public interest in the use of Black Rock and Dingle Beaches.

HRM staff assumed responsibilities for testing water quality at its beaches in 2009, after the Nova Scotia Department of Environment (NSE) ceased provision of that service. NSE used fecal coliform to determine the potential for human health concerns in both freshwater and saltwater environments, and HRM applied the same standard in 2009.

In spring 2010, HRM adopted fecal Enterococci as the bacterial indicator of risk to human health in salt water, and Escherichia coli (E. coli) as the indicator for fresh water. This adoption was made in consideration of Health Canada's Guidelines for Canadian Recreational Water Quality, Third Edition (document for public comment, released fall 2009), and in consultation with officials from Nova Scotia Health Promotion & Protection and Nova Scotia Environment. Staff confirmed that the private laboratory conducting water quality analyses on HRM's behalf had the capacity to test these bacteria, and the 2010 swimming season began on June 30 with the use of these new bacterial indicators in place. Black Rock beach & Dingle Beach opened on July 2.

Several significant rain events occurred throughout the summer, triggering overflows and temporary closures of both harbour beaches, as is standard procedure, as a precautionary measure. These closures are affected every time there is a heavy rainfall that results in overflows of screened wastewater into the harbour. These overflows occur when rainfall increases the flow in the combined waste water collection system to more than four times the average dry weather flow, the design capacity of the three Harbour Solutions Project waste water treatment facilities. Water testing is performed after the closures to determine if the water is safe for swimming

The earliest heavy rainfall events, Sunday July 11 and Wednesday July 14, triggered precautionary beach closures. Water samples were collected one day after these events and submitted for testing. Sample results for fecal enterococci were slow to come back from the lab due to the testing methodology in place. This methodology, MA700 – EN 1.0, is performed at a laboratory in Montreal, and begins with a 48 hour incubation period. If no organisms are detected after this period ("non-detect" or "ND"), then a final report is issued at that time. If organisms are detected after 48 hours, then an additional four days (96 hours) of incubation are required for further incubation and final results. The delay between sample collection and reporting of fecal enterococci results for beach management was clearly unsatisfactory, and triggered immediate amendments to the monitoring protocol.

Improvements in water testing measures made to date:
Effective Monday July 19, a revised sampling protocol was put in place, whereby paired water ~~samples were collected at the harbour beaches: both Fecal Enterococci and E. coli. Results from~~ E. coli sampling, available within 24-36 hours of lab submission, were used to determine whether the water was safe for swimming. Fecal enterococci results were not used as the basis

for closing or re-opening beaches but kept for future comparative analysis. This revised protocol was kept in place through the remainder of the summer.

Sample collection protocols were also improved. Beach staff coordinated their collection and submission schedules to complement laboratory operational schedules, thereby minimizing the holding time at the lab before water testing could proceed.

Procedural changes were also made with the laboratory, such that E. coli results were shared with HRM Aquatic Services staff immediately upon their availability, before the results from enterococci analyses were completed.

Planned improvements to water testing measures:
Several additional improvements are planned to enhance the value of the current testing protocol; these will take effect in 2011, 2012, and beyond.

Effective 2011, HRM Aquatic Services staff will arrange for weekend water sampling in the event of wastewater facility treatment plant overflows as notified by Halifax Water staff, due to heavy rainfall which lead to the overflows. "Rush" 24-hour turnaround times will be required for analysis and reporting by the laboratory.

HRM staff will continue to collect and test both E. coli and fecal enterococci at harbour beaches throughout the 2011 season. Comparative analysis of the results of these bacterial indicators for water quality in the harbour over the 2010 and 2011 seasons, will enable HRM to determine whether E. coli. is suitable to serve as the sole water quality indicator for salt water in the future.

Future contracts for water quality analyses, effective summer 2012, will require the use of the best locally available technology to enable shorter analysis times, and therefore earlier water quality reporting and shorter beach closure periods, when water quality is suitable for swimming.

Finally, HRM intends to evaluate bacteria levels following overflow & closure events in the harbour, to help determine if mandatory closures are required. If the evaluation reveals that mandatory closures are not required, then a revised protocol may enable earlier beach re-openings.

Other considerations:
The primary concern with respect to overflows and re-opening of beaches is the protection of public health. Making a judgment as to when it is safe to re-open beaches is difficult as there are many factors that come into play, such as volume of overflow, dilution, wind currents, tides, temperature/bacterial die-off, and possibly others of which staff are not aware. Given the public health concerns, HRM and Halifax Water feel that it is best to be conservative and to not re-open beaches until we are certain that it is safe. This approach was developed in consultation with staff, with Nova Scotia Environment and the Medical Officer of Health, and they agree that a conservative approach is appropriate.

HRM will continue to engage in consultation with the MOH and Nova Scotia Health Promotion & Protection to identify and discuss new research or evidence to guide decision-making around beach closures/openings.

HRM staff will continue to examine water sample collection, submission, analysis and reporting protocols with our laboratory partners to minimize unnecessary or avoidable delays in holding or processing times.

Awaiting water quality test results is the primary cause for delays in reopening any beaches for public swimming, salt and freshwater beaches alike. Bacteria testing require standard incubation periods, regardless of the bacterial indicator. Fecal coliform and E. coli analyses take 24 hours to produce a result, regardless of where the test is done. Fecal enterococcus testing takes longer, in part due to a requirement to re-test any positive indications, as part of the standard method protocol. All certified local laboratories, including Maxxam Analytics, AGAT, and the Victoria General ('VG') hospital labs, can provide results for E. coli or fecal coliforms in 24 hours, if a rapid turnaround is required, although for a higher cost.

Although Halifax Water does have in-house capability to test for both E. coli and fecal coliform, it too is constrained by the 24-hour minimum. The HWRC does do not provide any testing services outside of their own sampling requirements, and its facilities are not available for the beach testing program. All of HWRC's bacteria tests done for reporting to NS Environment are conducted by outside labs.

BUDGET IMPLICATIONS

The current testing protocol incurs less than $10,000 in costs for analytical services. Faster turnaround times and weekend analyses, if necessary, will incur higher fees, but these will likely be infrequent. At most, this will increase analytical expenses from 3 - 6%. The eventual selection of a single bacterial indicator will reduce analytical costs, as may potential changes to the current mandatory closure policy. These costs are included in the operating budget for D935.

FINANCIAL MANAGEMENT POLICIES/BUSINESS PLAN

This report complies with the Municipality's Multi-Year Financial Strategy, the approved Operating, Project and Reserve budgets, policies and procedures regarding withdrawals from the utilization of Project and Operating reserves, as well as any relevant legislation.

COMMUNITY ENGAGEMENT

N/A

ATTACHMENTS

1. Beach program protocol 2010 (draft)
2. Overflow protocol 2010
3. Guidelines for Canadian Recreational Water Quality, Third Edition (draft for consultation; Health Canada, 2009 - selected pages)

A copy of this report can be obtained online at http://www.halifax.ca/commcoun/cc.html then choose the appropriate Community Council and meeting date, or by contacting the Office of the Municipal Clerk at 490-4210, or Fax 490-4208.

Report Prepared by: Cameron Deacoff, Environmental Performance Officer , Sustainable Environment Management Office, 490-1926

Report Approved by: Richard MacLellan, Manager, Sustainable Environment Management Office, 490-6056

HRM Water Quality Monitoring Procedures & Protocols
Beaches Recreation Program
Summer 2010

This document describes the role of water quality in the operation of HRM's Aquatic Services – Beaches Program.

Beach Management:
The HRM Supervised Outdoor Swim (Beaches) program is offered as a public service during the summer months of every year, from late June through the last Friday before Labour Day. This service, offered at 28 locations throughout HRM (see Appendix A) is highly valued by our residents, and is one of the signature recreational services available during summer months. Public services offered in natural environments can only be offered when an adequate measure of public safety can be assured. Both freshwater and marine aquatic environments pose potential threats to human health, due to the possibility of contact with various chemicals or biological materials, and physical hazards.

The primary hazard posed by water quality is the potential for contact with microorganisms associated with fecal contamination. The best way to manage this risk is through the effective operation of a water quality monitoring program, including the use of risk awareness measures, appropriate guidelines and standards for collection, handling, analysis and reporting.

Beach Operation:
Beaches are to be open to the public except in the following circumstances:

- Test results for a given beach are above the 'automatic close' limit (i.e., based on measured bacterial counts)
- Beach personnel suspect water quality concerns (precautionary – all sites)
- Notification of sewage treatment plant overflows (i.e., precautionary – for Halifax Harbour sites only)

Beach staff responses to either close-worthy test results or overflow notifications are described later in this protocol.

The opening and closure of beaches to the public is driven by water quality test results. HRM personnel are responsible for the collection, handling, delivery and documentation of the samples to the analytical laboratory, and the lab is responsible for confirming documentation and analytical procedures, conducting analytical procedures, and reporting analytical results to HRM staff. HRM and lab staff responsibilities are described separately below.

Water Quality - HRM Front End: Sample Collection, Handling, Delivery & Documentation

Sample collection is the process of obtaining an uncontaminated sample of water from within a supervised beach area. Samples are best collected by submerging the open bottle below the water surface approximately 5-10 cm, with the open end upright and oriented towards the current (if present). The most important consideration in sample collection is to avoid contaminating the sample. Human skin naturally harbours several varieties of microorganisms, including bacteria, even when freshly washed. If your hand touches the inside of the bottle or the inside of the lid, these bacteria could be transferred to the water sample, and may cause false test results, which could result in unnecessary beach closures, further testing requirements and unnecessary expense.

All beaches should be sampled once a week and only one sample should be collected at each location during each sampling event – with two exceptions. The two beaches located on the shore of Halifax Harbour (Dingle Beach and Black Rock Beach) should have both E. coli and Fecal enterococci samples collected during each sample event. This collection protocol is required to support an ongoing study of the relationship between these two bacteria and their respective use as indicators of risk exposure in salt water environments.

Beach Supervisors receive hands-on training on proper sample collection procedures from permanent HRM personnel at the start of each beach season. Only Beach Supervisors should actually collect water samples from supervised beaches. In extenuating circumstances, they may delegate collection to other staff, provided that delegates are told proper collection procedures and care is taken to ensure they are followed.

Handling procedures for water samples are intended to ensure safe, secure, and controlled collection of samples from the time they are collected until delivered to the lab. They include proper bottle labelling and storage – including refrigeration. Bottles must be labelled with the following information:

- Date and Time of sample collection
- Sample ID: Beach Name (preferably) or Lake/Inlet/Pool Name
- Sample Type: (FW for Fresh Water or Pool Water; SW for Salt Water)
- Analysis (Bacteria to be Analyzed): E. Coli for FW, Fecal enterococci for SW

The lab prefers water samples to be 10°C or cooler, so freshly collected samples should be immediately placed into a cooler upon return to the vehicle. If electronic coolers are unavailable or non-functional, Beach Supervisors should immediately make arrangements, such as the use of standard 'picnic' coolers and crushed ice to cool the samples during transport.

The same type of bottle is used for both E. coli and fecal enterococci samples. This bottle contains a preservative, Sodium Thiosulphate ($Na_2S_2O_3$) in crystalline (solid powder) form, to ensure that the water sample is suitable for laboratory analysis for up to 24 hours after sample collection. HRM personnel will not come into contact with this material under normal handling procedures. If the material does get onto someone's skin, thorough washing with soap and water is recommended. The Material Safety Data Sheet (MSDS) for Sodium Thiosulphate is given as Appendix B.

Documentation of water samples is critical, because incomplete or false paperwork can lead to confusing, misleading, or useless sample results. In some circumstances, however unlikely, these could result in the bathing public being exposed to unsafe waters under HRM supervision – a condition to be avoided at all costs.

The primary documentation to be made for water samples is on the Chain of Custody (COC) form supplied by the lab, customized for the HRM Beaches program – see Appendix C. This form requires the following information:

- Field Sample Identification (I.e., Beach / Lake name)
- Matrix (i.e., Fresh Water or Salt Water)
- Date & Time of sample collection
- # and Type of Bottles (per beach / lake) – usually one*
- (Identification of Analysis Required) - check either E. coli or enterococci

- Name of (HRM staff delivering samples), plus date and time of delivery

* For both Dingle Beach and Black Rock Beach, there will be two samples collected. Mark the number of bottles as '2', and check both E.coli and enterococci

Water samples are only valid for bacteriological analysis within 24 hours of sample collection, so HRM staff should attempt to deliver all samples to the lab on the same day they are collected. If this is not possible, samples should be stored in a refrigerated environment (either coolers or a dedicated refrigerator) and delivered to the lab as soon as possible the following morning, BEFORE 24 hours has elapsed from the earliest sample collection point the previous day. Samples delivered more than 24 hours after collection are not reliable indicators of water quality and should be repeated.

Water Quality – Laboratory Back End: Documentation Confirmation, Analysis & Reporting
HRM contracts with only accredited and certified laboratories for the testing of water samples through the Beaches program. These labs apply thorough quality control and assurance programs at all stages of their work, which begins with sample reception. Reception staff are responsible for confirming that the number and type of bottles received match those reported on the COC form, and for following up on any inconsistencies, errors, or uncertainties with the client. Normally this would be the HRM Beach Supervisor who is delivering and signing for the samples, but it may also or instead be the primary client contact (i.e., Cameron Deacoff).

Upon satisfactory receipt and confirmation of all samples, the lab conducts the appropriate analysis as requested on the COC. Some labs can conduct analyses for all bacteria on-site, and others sub-contract affiliated (and accredited/certified) labs to analyze bacteria where on-site facilities do not exist.

As indicated in the previous section, samples remain viable for analysis only when delivered to the laboratory within 24 hours of sample collection. It is therefore critical to accurately observe and record the collection time, and to deliver samples less than 24 hours later. The table below identifies the key drop times and corresponding reporting periods for both parameters on a weekly basis.

Figure 1. Laboratory cut-off points for sample reception and reporting of results*.

Drop-Off Date	**Parameter**	**Preferred Drop Time**	**Latest Acceptable Drop Time**	**Results Availability Time & Day**
Monday – Thursday	E. coli	4pm (same day)	8am (day after sample collected)	Next day by Noon
Monday – Thursday	Fecal enterococci	3pm (same day)	Noon	3 Days – Noon (if count = 0); 8 days – Noon (if count >0)**
Friday	E. coli	3pm (same day)	3pm (same day)	Monday – Noon
Friday	Fecal enterococci		Noon	3 Days – Noon (if count = 0); 8 days – Noon (if count >0)**

* The lab guarantees to report all results by Noon but aims to report them sooner (by 11am) if possible.

** Maxxam Laboratories subcontracts its Fecal enterococci analysis to an affiliated lab in Quebec.

As of mid-July 2010, lab results from Maxxam Laboratories are sent to the following personnel via email:

- Cameron Deacoff
- Chad Wadden
- John Henry
- Marlo McKay
- Matthew Showell
- Meagan Young
- Natalie Doucette

Water Quality Results

HRM uses the best available scientific guidance, in consultation with Nova Scotia Health Promotion and Protection and Nova Scotia Environment, to determine the bacteria levels at which swimming and other primary contact recreation is safe. This guidance comes from Health Canada, which publishes Guidelines for Canadian Recreational Water Quality. The latest edition of these guidelines was published, in draft format for consultation, in late 2009.

E. coli is recommended as the best indicator of fecal contamination in fresh water, and as a suitable indicator in marine waters. Fecal enterococci is recommended as the best indicator of fecal contamination in salt water, and as a suitable indicator in fresh waters.
Since 1) HRM has historically used fecal coliforms in all aquatic environments (fresh and salty), 2) the concentration values recommended for E. coli are identical to those previously used for fecal coliforms, and 3) analytical results for Fecal enterococci are not available within a satisfactory time period to effect satisfactory beach management, HRM has opted to use E. coli as the sole indicator of water quality for the purposes of beach management in 2010.

During 2010 and 2011, HRM will test for both E. coli and enterococci at beaches adjacent to Halifax Harbour (i.e., Dingle Beach and Black Rock Beach). This testing will be done to determine if there is a positive relationship between E. coli and enterococci, and to determine the adequacy of E. coli to demonstrate the presence of fecal contamination in salt water.

Two thresholds are used to determine our response to bacteria levels. Results at or above the first threshold, but less than the second, require immediate retesting. Results at or above the second threshold require immediate beach closure and subsequent retesting.

Bacteria	**Immediate Retest**	**Immediate Beach Closure**
E. Coli	200 - 399	$\geq$ 400
Enterococci	35 – 69	$\geq$ 70

HRM Response to Water Quality Results

Lab results are received by seven HRM personnel, Coordinators or Supervisors with the Beach program.

Where E. coli results exceed 200 units, Beach Supervisors should arrange to retest the affected beach as soon as possible.

Where E. coli results meet or exceed 400 units, the following steps should be taken:

Step #	Action	Person(s)
1	Notify Coordinator of Aquatic Services	Beach Administrator, Coordinator or Supervisor (A.C.S.)
2	Notify staff on affected beach location	Beach Staff
3	Place appropriate signage at site	Lifeguard(s) on site
4	Notify Manager of Public Affairs (Shaune MacKinlay) or alternate: 490.6531 Office 233.6838 Cell	Beach Staff
5	Prepare & Send Public Service Announcement (to Shaune MacKinlay & Dustin O'Leary)	Beach Staff
6	Remain on station for at least 7 days for Public Relations	Lifeguard(s) on site
7	Direct all media questions to the Coordinator of Aquatic Services or designate. Staff to maintain "no comment" unless otherwise directed.	All staff

In the event of overflows at Halifax Water Pumping Stations or other potential overflow points, Halifax Water has developed a response procedure for Dingle Beach and Black Rock Beach. See Appendix D for this Procedure.

Beach Retesting in Case of Closure

When water sample results are the cause of a beach closure, the beach is automatically re-sampled the next day (or the next possible day) to confirm the results. If results continue to exceed the threshold (≥400), then the beach will remain closed for a minimum of 72 hours before re-sampled. Beaches should remain closed until a single sample result is below 200.

When wastewater (sewage) system overflows are the cause of beach closures, water samples (both E. coli and fecal enterococci) should be collected one day after the overflow. If E. coli levels are ≥ 200, the beaches should remain closed and the water re-tested. Beaches should remain closed until a single result is below 200.

During retesting conditions, Beach Supervisors should consider documenting the following conditions to assist in interpreting water results as necessary:

- Was it raining at the time of collection or at any time during the previous 24 hour period?
- How clear or turbid was the water
- Were ducks or other waterfowl present? How many?
- Did you see any other possible signs of water contamination, or possible causes?

HRM Beach Program Contacts:

Coordinator – Aquatic Services	John Henry HRM Recreation – Aquatics 479.4690 / 222.3854 henryj@halifax.ca
Coordinator - Beaches	Chad Wadden HRM Recreation - Aquatics 225-2222 waddenc@halifax.ca
Aquatic Specialist	Rhonda Dea HRM Recreation – Aquatics 479-4479 / 476-1761 dear@halifax.ca
Water Quality Program Coordinator:	Cameron Deacoff Environmental Performance Officer Sustainable Environment Management Office 490.1926 / 476.0363 deacofc@halifax.ca
Beach Administrator	Kristian Swan HRM Recreation – Aquatics 490-5458 ext. 0 swank@halifax.ca
Beach Supervisor	Matthew Showell HRM Recreation – Aquatics 483-7065 showem@halifax.ca
Beach Supervisor	Natalie Doucette HRM Recreation – Aquatics 233-3458 doucetn@halifax.ca
Beach Supervisor	Meagan Young HRM Recreation – Aquatics 221-6050 youngm@halifax.ca

List of Appendices:

No Acid

Anachemia

255 Norman.
Lachine (Montreal), Que
H8R 1A3

Material Safety Data Sheet

EMERGENCY NUMBERS:

(USA) CHEMTREC : 1(800) 424-9300 (24hrs)
(CAN) CANUTEC : 1(613) 996-6666 (24hrs)
(USA) Anachemia : 1(518) 297-4444
(CAN) Anachemia : 1(514) 489-5711

WHMIS	Protective Clothing	TDG Road/Rail
WHMIS CLASS: D-2B		Not controlled under TDG (Canada). PIN: Not applicable. PG: Not applicable.
(T)		

Section I. Product Identification and Uses

Product name	SODIUM THIOSULFATE, ANHYDROUS
Chemical formula	Na2S2O3
Synonyms	Sodium hyposulfite, Sodium thiosulfate, AC-8547, 85786
Supplier	Anachemia Canada. 255 Norman. Lachine (Montreal), Que H8R 1A3
Material uses	For laboratory use only.

CI#	Not available.
CAS#	7772-98-7
Code	AC-8547
Formula weight	158.11
Supersedes	

Section II. Ingredients

Name	CAS #	%	TLV
1) SODIUM THIOSULFATE	7772-98-7	100	Not established by ACGIH: ACGIH (Sulfur dioxide) TWA 2 ppm (5.2 mg(SO2)/m3); STEL 5 ppm (13 mg(SO2)/m3)

Toxicity values of the hazardous ingredients	SODIUM THIOSULFATE: INTRAPERITONEAL (LD50): Acute: 5200 mg/kg (Mouse).

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Section III. Physical Data

Physical state and appearance / Odor	Clear to white granules or crystals. Odorless.
pH (1% soln/water)	8.6
Odor threshold	Not available.
Percent volatile	0% at 21°C
Freezing point	Transition at 48°C
Boiling point	Decomposes at >100°C.
Specific gravity	1.66-1.73 (Water = 1)
Vapor density	Not applicable.
Vapor pressure	Not applicable.
Water/oil dist. coeff.	Not available.
Evaporation rate	Not applicable.
Solubility	33% (in H2O)

Section IV. Fire and Explosion Data

Flash point	Not available.
Flammable limits	Not available.
Auto-ignition temperature	Not available.
Fire degradation products	Oxides of sulfur and sodium. Hydrogen sulfide. Sodium sulfide.
Fire extinguishing procedures	Use DRY chemical, carbon dioxide, foam or water spray. Wear adequate personal protection to prevent contact with material or its combustion products. Self contained breathing apparatus with a full facepiece operated in a pressure demand or other positive pressure mode. Disperse vapors with water spray if they have not ignited. Cool containing vessels with flooding quantities of water until well after fire is out.
Fire and Explosion Hazards	The sensitivity to impact is not applicable. The sensitivity to static discharge is not applicable. Heating above 100°C yields a flammable residue sodium sulfide. Contact with oxidizers may cause fire and/or explosion. Emits toxic fumes under fire conditions.

Section V. Toxicological Properties

Routes of entry	Inhalation and ingestion. Eye contact. Skin contact.
Effects of Acute Exposure	May be harmful by ingestion, inhalation, or skin absorption. Irritant.
Eye	May irritate or burn eyes and cause temporary conjunctivitis.
Skin	May cause skin irritation. Aqueous solutions or dust may cause irritation from repeated or prolonged contact.
Inhalation	Dust or mist may cause severe irritation to the respiratory tract. Exposure may cause coughing, chest pains, and difficulty in breathing. If heated to the point where sulfur dioxide gas is driven off, then this gas is highly irritating to the respiratory tract.
Ingestion	May cause gastrointestinal irritation. May cause nausea, vomiting, purging, cyanosis. Doses of 8 g/kg (oral, rat) were non-toxic.

HRM Supervised Beaches 2010

Community	Beach Name	Associated Lake/Watercourse	Aquatic Environment	Parameter Tested	PID	Civic Address	Community (GSA)
Halifax	Black Rock Beach	Halifax Harbour	Marine Water	E. Coli & Fecal Enterococci		Point Pleasant Park, 5718 Point Pleasant Dr.	Halifax
	Campbell Point Beach	Hatchet Lake	Fresh Water	E. Coli	40286403	187 Lakewood Dr.	Brookside
	Chocolate Beach	Chocolate Lake	Fresh Water	E. Coli	00258269	2 Melwood Ave.	Halifax
	Cunard Beach	Cunard Pond	Fresh Water	E. Coli	00310276	121 Williams Lake Rd.	Halifax
	Dingle Beach	Northwest Arm, Halifax Harbour	Marine Water	E. Coli & Fecal Enterococci		Dingle Rd.	Fleming Park, Halifax
	Kearney Beach	Kearney Lake	Fresh Water	E. Coli	40095218	Unaddressed - Hamshaw Dr.	Halifax
	Kidston Beach	Kidston Lake	Fresh Water	E. Coli	00307462	94 Fieldstone St.	Halifax
	Long Pond Beach	Long Pond	Fresh Water	E. Coli	40000408	869 Herring Cove Rd	Herring Cove
Oakfield	Oakfield Provincial Park	Shubenacadie Grand Lake	Fresh Water	E. Coli	00574145	366 Grand Lake	Oakfield
Waverley	Silverside Beach	Lake William	Fresh Water	E. Coli	40115479	1971 Waverley Rd.	Waverley
Dartmouth	Albro Beach	Albro Lake	Fresh Water	E. Coli	40581241	199 Albro Lake Rd.	Dartmouth
	Birch Cove Beach	Lake Banook	Fresh Water	E. Coli	00094953	46 Oakdale Cres.	Dartmouth
	Penhorn Beach	Penhorn Lake	Fresh Water	E. Coli	00229500	70 Penhorn Dr.	Dartmouth
	Shubie Beach	Lake Charles	Fresh Water	E. Coli	00258285	30 John Brenton Dr.	Dartmouth
Bedford/Sackville	Kinsman Beach	First Lake	Fresh Water	E. Coli	00359968	31 First Lake Dr.	Sackville
	Sandy Beach	Sandy Lake	Fresh Water	E. Coli	00417360	115 Smiths Rd.	Bedford
	Saunders Beach	Paper Mill Lake	Fresh Water	E. Coli	40186660	119 Millrun Cres. (Scott Saunders Memorial Park)	Bedford
	Springfield Beach	Springfield Lake	Fresh Water	E. Coli	40183261	Lakeview Ave.	Sackville
	Kinap Beach	Porters Lake	Brackish Water	E. Coli	40469884	181 Greenough Dr.	West Porters Lake
Eastern Shore	Lake Echo Beach	Lake Echo	Fresh Water	E. Coli	40164337	3170 Highway 7	Lake Echo
	Mallay Falls	East River Sheet Harbour	Fresh Water	E. Coli	n/a	Lochaber Mines Rd., off Highway 374	Sheet Harbour
	Government Wharf	Musquodoboit Harbour	Marine Water	E. Coli	40289720	169 West Petpeswick Rd.	West Petpeswick
	Pleasant Drive Beach	Petpeswick Lake	Fresh Water	E. Coli	40497984	Pleasant Dr.	Gaetz Brook
	Webber's Beach	Lake Charlotte	Fresh Water	E. Coli	00558098	738 Upper Lakeville Rd.	West Petpeswick

Section V. Toxicological Properties

Effects of Chronic Overexposure	Carcinogenic effects: Not available. Mutagenic effects: Not available. Teratogenic effects: Not available. Toxicity of the product to the reproductive system: Not available. To the best of our knowledge, the chemical, physical, and toxicity of this substance has not been fully investigated.

Section VI. First Aid Measures

Eye contact	Immediately flush eyes with copious quantities of water for at least 15 minutes holding lids apart to ensure flushing of the entire surface. Seek immediate medical attention.
Skin contact	Immediately flush skin with plenty of water and soap for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash contaminated clothing before reusing.
Inhalation	Remove patient to fresh air. Administer approved oxygen supply if breathing is difficult. Administer artificial respiration or CPR if breathing has ceased. Seek immediate medical attention.
Ingestion	If conscious, wash out mouth with water. Have conscious person drink several glasses of water to dilute. Seek immediate medical attention. Never give anything by mouth to an unconscious or convulsing person.

Section VII. Reactivity Data

Stability	Stable. Conditions to avoid: High temperatures, sparks, open flames and all other sources of ignition, contamination.
Hazardous decomp. products	Not available.
Incompatibility	Oxidizing agents (e.g., nitrates, sodium nitrite, halogens) cause vigorous exothermic reactions. Acids release sulfur dioxide gas. Water-reactive materials such as sodium, cause strong exothermic reaction. Mercury salts, lead, silver, iodides, iodine, mercury.
Reaction Products	Sulfur dioxide gas which is toxic, corrosive, and an oxidizer, is driven off above 100°C leaving, a sodium sulfide residue which is flammable, a strong irritant to skin and tissue and is also incompatible with acids. Hazardous polymerization will not occur.

Section VIII. Preventive Measures

Protective Clothing in case of spill and leak	Wear respirator, chemical safety goggles, rubber boots and heavy rubber gloves.
Spill and leak	Evacuate the area. Sweep up and place in container for disposal. Avoid raising dust. Ventilate area and wash spill site after material pick up is complete. DO NOT empty into drains. DO NOT touch damaged container or spilled material. Avoid run off.
Waste disposal	According to all applicable regulations.
Storage and Handling	Store in a cool place away from heated areas, sparks, and flame. Store in a well ventilated area. Store away from incompatible materials. Do not add any other material to the container. Do not wash down the drain. Do not breathe dust. Keep away from direct sunlight or strong incandescent light. Keep container tightly closed and dry. Manipulate in a well ventilated area or under an adequate fume hood. Avoid raising dust. Handle and open container with care. Minimize dust generation and exposure - use dust mask or appropriate protection. This product must be manipulated by qualified personnel. Do not get in eyes, on skin, or on clothing. Wash well after use. In accordance with good storage and handling practices. Do not allow smoking and food consumption while handling.

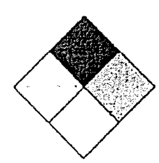
Section IX. Protective Measures

Protective clothing	Splash goggles. Impervious gloves, apron, coveralls, and/or other resistant protective clothing. Sufficient to protect skin. If use conditions generate dusts, wear a NIOSH-approved respirator appropriate for those emission levels. Appropriate respirators may be a full facepiece or a half mask air-purifying cartridge respirator with particulate filters, a self-contained breathing apparatus in the pressure demand mode, or a supplied-air respirator. Do not wear contact lenses. Make eye bath and emergency shower available. Ensure that eyewash station and safety shower is proximal to the work-station location.
Engineering controls	Local mechanical exhaust ventilation capable of minimizing dust emissions at the point of use. Do not use in unventilated spaces.

Section X. Other Information

Special Precautions or comments

Irritant! Do not breathe dust. Avoid all contact with the product. Avoid prolonged or repeated exposure. Manipulate in a well ventilated area or under an adequate fume hood. Keep away from heat, sparks and flame. Handle and open container with care. Container should be opened only by a technically qualified person.
RTECS NO: XN6472000.



NFPA

Prepared by MSDS Department/Département de F.S.. | **Validated 28-Jul-1999**

Telephone# (514) 489-5711

While the company believes the data set forth herein are accurate as of the date hereof, the company makes no warranty with respect thereto and expressly disclaims all liability for reliance thereon. Such data are offered solely for your consideration, investigation and verification.

4-4

Maxxam Analytics 200 Bluewater Road, Suite 105, Bedford, Nova Scotia B4B 1G9 Tel: 902-420-0203 Fax: 902-420-8612 Toll Free: 1-800-565-7227
www.maxxamanalytics.com E-mail: Clientservicesbedford@maxxamanalytics.com

MAXXAM Chain of Custody Record

COC#: Page of

This column for lab use only:
Client Code
Maxxam Job#

Cooler Id	Seal Present	Seal Intact	Temp 1	Temp 2	Temp 3	Average Temp

Integrity YES NO
Integrity/Checklist by:
Labelled by:
Location/Bin#

INVOICE INFORMATION:

Company Name: Halifax Regional Municipality
Contact Name: Cameron Deacoff
Address: P.O Box 1749 40 Alderney Dr.
Halifax NS Postal Code B3J 3A5
Email: deacofc@halifax.ca
Ph 490-1926 Fax: 490-5862

REPORT INFORMATION (if differs from invoice):

Company Name: Halifax Regional Municipality
Contact Name: Cameron Deacoff
Address: P.O Box 1749 40 Alderney Dr.
Halifax NS Postal Code B3J 3A5
Email: deacofc@halifax.ca
Ph: 490-1926 Fax: 490-5862

PO#
Project # / Phase#
Site Location
Quote
Site #
Sampled by

TURNAROUND TIME
Standard ☐
10 day ☐
24 Hour Rush
3 Day TAT - Enteroc.
Pre-schedule rush work
Charge for # Jars used but not submitted

Guideline Requirements/ Detection Limits/ Special Instructions

Send results by email only

CC results to Marlo McKay and John Henry at:
mckaym@halifax.ca
henryj@halifax.ca

* Specify Matrix; Surface/Salt/Ground/Tapwater/Sewage/Effluent/ Potable/NonPotable/Tissue/Soil/Sludge/Metal/Seawater

	Field Sample Identification	Matrix *	Date/Time Sampled	# & type of bottles	Ecoli	Enterococci
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

RELINQUISHED BY: (Signature/Print)	Date	Time	RECEIVED BY: (Signature/Print)	Date	Time

White : Maxxam Yellow : Mail ATL FCD 00149 / Revision 9

August 1, 2010

PROCEDURE FOR RESPONDING TO SEWAGE OVERFLOWS - Where Dingle or Black Rock Beaches may be affected.

Pumping Stations of Concern:

Dingle Tower PS
Balmoral PS
Armdale PS
Pier A PS

Other Overflow points:

Armdale Roundabout
Jubilee Road
Coburg Road
Fairfield Holding Tank

PROCEDURE:

1. Overflow event occurs, as detected by Halifax Water (HW) Wastewater Collection Services

2. HW Wastewater Collection Services to begin notification.

If an HHSP pumping station overflow occurs, Tim Burbine or designate will make the contact.

For all other HW infrastructure, the HW on-duty supervisor will make the contact.

HW Operations to notify the following if the overflow event (or the malfunction) lasts for 1 hour or greater:

a. **HRM Recreation** – to begin shut down of affected beach(es).

Weekdays, call **Chad Wadden, Aquatics Supervisor**
Cell: 225-2222

Weekends, call the **Beach Line**
490-5458

Recreation Supervisors check first thing in the morning and in the afternoon.

b. **Halifax Water's Environmental Services Department**
When an overflow event occurs, or if there is any occurrence of malfunctions or shut-downs which result in discharges, HW Operations will notify Halifax Water's Environmental Services Department.

Tony Blouin, Compliance Coordinator
Work: 490-1814
Cell: 237-0706

Or Alternates: Environmental Services P2 Group (see Contacts).

Water sampling: In the event of a significant overflow, Halifax Regional Municipality, through Cameron Deacoff, will sample at the relevant beach or beaches as per the attached sampling protocol.

3. **HRM Parks staff will initiate the process of shutting down the beaches.**

As per the procedure followed when weekly NSE water sampling reveals high bacterial levels at any of the other HRM supervised beaches: The beach staff clear the water of all swimmers. The parks supervisor will put the information out to the media, update the HRM website, post signage at the beach and keep staff at the beach for at least a week to prevent swimmers from entering the water. This will continue until testing has confirmed that bacterial levels have fallen to within acceptable limits, as advised by HW Environmental Services.
For Black Rock and Dingle beaches the PSA should list a representative from HRM Beaches and James Campbell, or designate from HW as contacts on the PSA.

4. **HW Environmental Services will advise NSE and Dept. of Health Promotion and Protection** that the beach/beaches has/have been shut down and provide any available information on sampling.

Gerald Smith - Beach Sampling
Inspector
NSE Bedford
424-7053

Don Feldman,
District Manager
NSE Bedford
424-2573

Dr. Gaynor Watson-Creed,
Medical Officer of Health
Capital Health, IWK Health Centre - Central Region
7 Mellor Avenue, Unit 5
Dartmouth, N.S.
B3B 0E6
Phone: (902) 481-5883 (Fax) 481-5803

Other Contact Info:

HW Supervisors:

Name	Work Phone	Cell	e-mail
Lewis Stewart	490-4943	476-6445	stewarl@halifax.ca
Dave Verge	490-4943	476-7833	verged@halifaxwater.ca
Peter Sullivan	490-4959	476-6823	sullivp@halifax.ca
Wayne Martin	490-4960	476-7725	martinwa@halifax.ca
Martin Parsons	490-4943	476-5724	parsonm@halifax.ca
Cliff Doubleday	490-6729	476-2858	doublec@halifax.ca
Tim Burbine	490-6116	476-7222	burbint@halifax.ca

Superintendants:

Name	Work Phone	Cell	e-mail
Danny Patey	490-1799	476-5902	pateyda@halifax.ca

Sheldon Parsons	490-6139	476-6327	parsonsh@halifax.ca.
Dennis Leblanc	490-4107	476-4731	lebland@halifax.ca

HW P2 Group:

Name	Work Phone	Cell	e-mail
Heather Crowell	490-6950		crowelh@halifaxwater.ca
Kim Fawcett	490-5215		fawcetk@halifaxwater.ca
John Sibbald	490-5527	476-6042	sibbalj@halifaxwater.ca

HW Communications:

James Campbell	490-4604	476-5885	campbej@halifaxwatwer.ca

August 1, 2010

<u>Environmental Services (ES) Sampling Procedure</u>
<u>in Event of a CSO/Malfunction/Shutdown Event</u>

Black Rock (Point Pleasant Park) and Dingle (Fleming Park) Beaches

In the event of an overflow/discharge notification from TUGS, HRM Recreation will close the corresponding beach(es) at the earliest opportunity when the lifeguarding staff is next on duty.

When an overflow/discharge notification is received by ES from TUGS, the role of ES is to conduct daily sampling at the closed beach(es) for fecal enterococci. Field sampling is through grab samples taken at approximately ½ meter depth by wading to a water depth of approximately 1 meter at the beach, taking 1 sample bottle per beach. Sampling will commence on the day following a notification (if the notification is issued overnight), or on the day of a notification if the notification is issued during working hours. Daily sampling will continue until levels of enterococci return (if elevated) below the swimming guideline level (35/100ml).

Samples are to be delivered to the Victoria General Laboratory in Halifax, which provides 1-2 day turnaround for fecal enterococci results.

When the level returns below the guideline for 2 consecutive daily samples, Environmental Services will notify HRM Recreation that levels are safe and the beach(es) may re-open.

ES will also notify NSE and NS Health Promotion and Protection, as outlined in the Protocol, that beaches are re-opening.

October 6, 2010

PROCEDURE FOR RESPONDING TO SEWAGE OVERFLOWS - Where Dingle or Black Rock Beaches may be affected.

Pumping Stations of Concern:

Dingle Tower PS
Balmoral PS
Armdale PS
Pier A PS

Other Overflow points:

Armdale Roundabout
Jubilee Road
Coburg Road
Fairfield Holding Tank

PROCEDURE:

1. Overflow event occurs, as detected by Halifax Water (HW) Wastewater & Stormwater Collection Services

2. Halifax Water Wastewater & Stormwater Collection Services to begin notification.

If an HHSP pumping station overflow occurs, Tim Burbine, or designate, will make the contact.

For all other Halifax Water infrastructure, the HW on-duty supervisor will make the contact.

Wastewater Collections Services Operations to notify the following if the overflow event (or the malfunction) lasts for 1 hour or greater:

a. **HRM Aquatic Services** – to begin shut down of affected beach(es).

Weekdays, call **Chad Wadden, Aquatics Supervisor**
Cell: 225-2222 (best contact number)
Work: 4904515

Or

Kristian Swan, Beach Administrator
Work: 490-5458

Weekends, call the **Beach Line**
490-5458

Aquatic Services Beach Supervisors check first thing in the morning and in the afternoon.

b. **Halifax Water's Environmental Services Department**
When an overflow event occurs, or if there is any occurrence of malfunctions or shut-downs which result in discharges, Wastewater Collections Services Operations will notify Halifax Water's Environmental Services Department and Halifax Water Communications & Public Relations Coordinator.

Tony Blouin, Compliance Coordinator
Work: 490-1814
~~Cell: 237-0706~~

Or Alternates: Environmental Services P2 Group (see Contacts).

James Campbell, Communications & Public Relations Coordinator.
Work: 490-4604
Cell: 476-5885
Email: campbej@halifaxwater

3. **HRM Aquatic Services staff will initiate the process of shutting down the beaches.**

As per the procedure followed when weekly HRM water sampling reveals high bacteria levels at any of the other HRM supervised beaches: The beach staff clears the water of all swimmers. HRM Communications staff will put the information out to the media and update the HRM website and beach line. HRM beach staff post signage at the beach and keep staff at the beach for at least a week to prevent swimmers from entering the water. This will continue until testing has confirmed that bacteria levels have fallen to within acceptable limits. For Black Rock and Dingle beaches the PSA should list a representative from HRM Aquatic Services and James Campbell, or designate from HW, as contacts on the PSA.

Water sampling: In the event of a significant overflow, Halifax Regional Municipality (HRM), Aquatic Services, through Cameron Deacoff (water monitoring coordinator), will sample at the relevant beach or beaches as per the attached sampling protocol.

4. **Halifax Water - Environmental Services will advise NSE and Dept. of Health Promotion and Protection** that the beach/beaches has/have been shut down and provide any available information on sampling.

Steve Westhaver,
District Manager
NSE Bedford
424-8183

Dr. Gaynor Watson-Creed,
Medical Officer of Health
Capital Health, IWK Health Centre - Central Region
7 Mellor Avenue, Unit 5
Dartmouth, N.S.
B3B 0E6
Phone: (902) 481-5883 (Fax) 481-5803

Other Contact Info:

Halifax Water Supervisors:

Name	Work Phone	Cell	e-mail
Lewis Stewart	490-6116	476-6445	stewarl@halifaxwater.ca
Dave Verge	490-4943	476-7833	verged@halifaxwater.ca
Martin Parsons	490-4943	476-5724	parsonm@halifaxwater.ca
Cliff Doubleday	490-6729	476-2858	doublec@halifaxwater.ca
Tim Burbine	490-2360	476-7222	burbint@halifaxwater.ca
Tony Makin	490-4960	476-7132	makint@halifaxwater.ca
Albert MacMaster	490-4959	476-6823	macmasa@halifaxwater.ca

Superintendants:

Name	Work Phone	Cell	e-mail
Danny Patey Sheldon Parsons Dennis Leblanc	490-2004 490-1781 490-4107	476-5902 476-6327 476-4731	pateyda@halifaxwater.ca parsonsh@halifaxwater.ca lebland@halifaxwater.ca

Halifax Water P2 Group:

Name	Work Phone	Cell	e-mail
John Sibbald	490-5527	476-6042	sibbalj@halifaxwater.ca
Heather Crowell	490-6943	222-6689	crowelh@halifaxwater.ca
Kim Fawcett	490-5215	476-0556	fawcetk@halifaxwater.ca

Halifax Water Communications:

James Campbell	490-4604	476-5885	campbej@halifaxwatwer.ca

Sampling Procedure in Event of a CSO/Malfunction/Shutdown Event

Black Rock (Point Pleasant Park) and Dingle (Fleming Park) Beaches

In the event of an overflow/discharge notification from Halifax Water Wastewater & Stormwater Collection Services, HRM Aquatic Services will close the corresponding beach(es) at the earliest opportunity when the lifeguarding staff is next on duty.

When an overflow/discharge notification is received by HRM Aquatic Services from Halifax Water Wastewater & Stormwater Collection Services, HRM Aquatic Services will collect water samples at the closed beach(es). Samples are to be tested for both 1) E. coli and 2) fecal enterococci. Field sampling is through grab samples taken at approximately ½ meter depth by wading to a water depth of approximately 1 meter at the beach, taking 1 sample bottle per analyte per beach. Sampling will commence on the day following a notification (if the notification is issued overnight), or on the day of a notification if the notification is issued during working hours. Daily sampling will continue until E. coli counts return (if elevated) below the swimming guideline level (200/100ml).

Samples are to be delivered to the Maxxam Analytical Laboratory in (Dartmouth or Bedford), which provides 24-36 hour turnaround for E. coli results.

When the level returns below the guideline for a single sample, HRM Aquatic Services will notify Halifax Water, NSE and NS Health Promotion and Protection that the beaches are re-opening, and will re-open the beaches. HRM Aquatic Services will also update beach line, website and issue PSA.

Guidelines for Canadian Recreational Water Quality

Third Edition

Document for Public Comment

Prepared by the Federal-Provincial-Territorial Working Group on Recreational Water Quality of the Federal-Provincial-Territorial Committee on Health and the Environment

Consultation Period Ends
January 8, 2010

September 2009

September 2009

Guidelines for Canadian Recreational Water Quality, Third Edition

Purpose of Consultation

The Federal-Provincial-Territorial Working Group on Recreational Water Quality was established by the Federal-Provincial-Territorial Committee on Health and the Environment to review and evaluate current scientific information on recreational water quality. This has resulted in the development of an updated version of the *Guidelines for Canadian Recreational Water Quality*, which incorporates current science and outlines a recommended risk management approach.

In preparing this document, the Working Group re-evaluated the criteria for existing indicators of recreational water quality and conducted reviews of the literature published on the topic of recreational water quality and human health and safety, including research papers, reports of epidemiological investigations, published texts, disease surveillance reports and guideline documentation developed by other government and multinational organizations worldwide.

The Federal-Provincial-Territorial Committee on Health and the Environment has requested that this proposed document be made available to the public for a consultation period of 90 days. The purpose of this consultation is to solicit comments on the document, including its scope and the completeness of the scientific information contained therein. Comments are appreciated, with accompanying justification, if required. Comments can be sent to the Working Group Secretariat via e-mail at water_eau@hc-sc.gc.ca. If this is not feasible, comments may be sent by mail to the Recreational Water Quality Secretariat, Water, Air and Climate Change Bureau, 3rd Floor, 269 Laurier Avenue, A.L. 4903A, Ottawa, Ontario K1A 0K9. All comments must be received before January 8, 2010.

It should be noted that the Guidelines document will be revised following evaluation of comments received. This document should be considered a draft for comment only.

Table of Contents

Executive Summary

The primary goal of the *Guidelines for Canadian Recreational Water Quality* is the protection of public health and safety. This document provides guidance on the factors that can interfere with the safety of recreational waters from a human health perspective. It is aimed primarily at responsible authorities and decision-makers.

Recreational water quality generally falls under provincial and territorial jurisdiction, whereas the responsibility for the safe management of recreational waters ultimately rests with the beach operators or service providers who oversee the day-to-day operations of recreational water areas. Recreational waters can be considered as any natural fresh, marine or estuarine bodies of water that are used for recreation. These include lakes and rivers, as well as human-made constructions that are filled with untreated natural waters. The principal health risk associated with exposure to recreational water hazards is infection as a result of contact with pathogenic microorganisms. Other risks include injury or illness due to the physical or chemical properties of the water.

The *Guidelines for Canadian Recreational Water Quality* consider the human health risks associated with recreational activities—primary contact activities, such as swimming, windsurfing and waterskiing, as well as secondary contact activities, such as canoeing or fishing—in natural waters through intentional or incidental immersion. They establish guideline values for specific parameters used to monitor recreational water quality, including the bacteriological indicators of faecal contamination, cyanobacteria and their toxins, and physical and aesthetic parameters. This document also outlines a risk management approach to safe recreational water quality and describes the current scientific knowledge regarding the hazards that can be encountered in the natural recreational water environment. It discusses pathogenic microorganisms of concern, water sampling and analysis, as well as emerging issues, such as faecal contamination of beach sand and faecal pollution source tracking.

Management of recreational waters

The protection and safe management of recreational waters require the cooperation of all stakeholders. The best approach is based on a preventive risk management strategy that focuses on the identification and control of hazards and their associated risks prior to the point of contact. As with drinking water, the multi-barrier approach provides this preventive strategy through an integrated system of procedures, actions and tools that collectively reduce the risk of human exposure to recreational water hazards. The effectiveness of these procedures, actions and tools is then verified or confirmed by monitoring results and the application of guideline values. The success of this approach rests primarily with the establishment of multiple barriers to protect watersheds.

Potential hazards or risk scenarios that can impact the recreational water area need to be identified through an Environmental Health and Safety Survey. The results of this survey are then used to identify the appropriate procedures or actions that should be put in place as barriers. These may include physical actions, such as beach cleanup and grooming, or processes or tools to improve the effectiveness of the recreational water management program, such as monitoring, guidelines and standards, and education and communication strategies.

Guideline values and technical information

Guideline values for a variety of water quality parameters are one important component of the overall risk management approach to safe recreational water quality. They should be used together with the appropriate technical documentation provided for these parameters. Table 1 outlines the guideline values for the recommended water quality parameters. Considerations are also provided for parameters and hazards for which guideline values cannot be established.

Table 1. Guidelines for Canadian Recreational Water Quality: Summary Table

Parameter	Considerations	Guideline Value
Indicators of Fecal Contamination		
Escherichia coli (Primary-Contact Recreation)	Geometric mean concentration (minimum 5 samples) Single sample maximum concentration	≤ 200 *E. coli* /100 mL ≤ 400 *E. coli* /100 mL
Enterococci (Primary-Contact Recreation)	Geometric mean concentration (minimum 5 samples) Single sample maximum concentration	≤ 35 Enterococci /100 mL ≤ 70 Enterococci /100 mL
Escherichia coli (Secondary-Contact Recreation)	Geometric mean concentration not to exceed a value of 5 times the existing guideline value for primary-contact recreation	≤ 1000 *E. coli* / 100 mL
Enterococci (Secondary-Contact Recreation)	Geometric mean concentration not to exceed a value of 5 times the existing guideline value for primary-contact recreation	≤ 175 Enterococci / 100 mL
Pathogenic Microorganisms (bacteria, viruses, protozoa)	Testing only needed when there is epidemiological or other evidence to suggest that this is necessary	No numerical guideline value
Cyanobacteria Cyanobacterial toxins	Total Cyanobacteria Total Microcystins	≤ 100,000 cells/mL ≤ 20 μg/L
Other Biological Hazards (e.g. avian and rodent schistosomes; aquatic vascular plants and algae)	Recreational activities should not be pursued in waters where the presence of these organisms poses a risk to the health and safety of the users	No numerical guideline value
pH	For most recreational waters for waters of low buffering capacity	6.5 to 8.5 5.0 to 9.0
Temperature	Should not cause an appreciable increase or decrease in the deep body temperature of bathers	No numerical guideline value
Turbidity	To satisfy most recreational uses	50 NTU
Clarity	Clarity should be sufficient for users to estimate depth and to see subsurface hazards	Secchi Disc visible at a depth of 1.2 m
Colour	Colour should not be so intense as to impede visibility in areas used for swimming	No numerical guideline value
Oil and Grease	Should not be present in concentrations that can be detected as a visible film, sheen, discolouration or odour; or that can form deposits on shorelines or bottom sediments that are detectable by sight or odour	No numerical guideline value
Litter	Areas should be free from floating debris as well as materials that will settle to form objectionable deposits	No numerical guideline value
Chemical Hazards	Risks associated with specific chemical hazards will be dependent on the particular circumstances of the area and should be assessed on a case-by-case basis.	No numerical guideline value

Indicators of faecal contamination—Primary contact recreation
E. coli is the most appropriate indicator of faecal contamination in fresh recreational waters, and enterococci is the most appropriate indicator of faecal contamination in marine recreational waters. Guideline values for *E. coli* and enterococci have been developed based on the analysis of epidemiological evidence relating concentrations of these organisms to the incidence of swimming-associated gastrointestinal illness observed among bathers. The values represent risk management decisions based on the assessment of possible health risks for the recreational water user and the recognition of the significant benefits that recreational water activities provide in terms of health and enjoyment. Primary contact is defined as recreational activity in which the whole body or the face and trunk are frequently immersed or the face is frequently wetted by spray, and where it is likely that some water will be swallowed. Inadvertent immersion, through being swept into the water by a wave or slipping, would also result in whole body contact.

Indicators of faecal contamination—Secondary contact recreation
There is insufficient epidemiological information to enable the development of health-based guideline values for human exposure to faecal pathogenic microorganisms in recreational waters through secondary contact activities. It is recognized that there may be some waters where a secondary contact use designation with separate guideline values is acceptable and that lower degrees of water exposure can be expected during most secondary contact recreational activities. A guideline value based on risk management decisions and best available knowledge is established at 5 times the guideline value for the geometric mean indicator concentration for primary contact recreation, which represents a reasonable approach for the protection of users during secondary contact recreational activities. Secondary contact is defined as recreational activity in which only the limbs are regularly wetted and in which greater contact (including swallowing water) is unusual. Activities proposed as meeting secondary contact use criteria should be evaluated on an individual basis in order to fully assess the potential health risks to users.

Other potential indicator organisms
The organisms most widely discussed as potential recreational water indicators include *Bacteroides* spp., *Clostridium perfringens*, F^+ RNA coliphages and bacteriophages infecting *Bacteroides fragilis*. At present, none of these organisms meets a sufficient number of the requirements necessary to be successful as a routine indicator of recreational water quality. These organisms appear to be better suited as possible pathogen indicators or as faecal source indicators. Advances in detection and enumeration methods may improve the understanding of these organisms and the roles they may play in future recreational water monitoring programs.

Pathogenic microorganisms (bacteria, viruses, protozoa)
The challenges associated with the detection of pathogenic microorganisms in recreational waters are currently too great to recommend this practice as part of a regular monitoring program. Surveillance is necessary only during special circumstances, such as during waterborne disease outbreak investigations. Faecal indicators such as *E. coli* and enterococci are the best available indicators for the possible presence of enteric pathogenic microorganisms. However, the absence of the recommended faecal indicators should not be interpreted to mean that all pathogenic microorganisms are also absent.

Cyanobacteria and their toxins
Serious bather illnesses have been reported following exposure to toxic cyanobacterial blooms in recreational waters. Guideline values for cyanobacteria and their toxins have been established to protect against both the risk of exposure to microcystins as well as any harmful effects that may be possible as a result of exposure to high densities of cyanobacterial material. Contact with waters that exceed the guideline values or in which a bloom has developed should be completely avoided, and recreational activities should be resumed only once the responsible authorities have established that a health hazard no longer exists.

Other biological hazards
Recreational water activities should not be pursued in areas where other biological hazards are present in significant quantities such that they pose a risk to the health and safety of recreational water users. Examples include the presence of organisms responsible for swimmer's itch and dense growths of aquatic plants.

Physical, aesthetic and chemical characteristics
Physical, aesthetic and chemical characteristics of water can have an impact on recreational water users. Recreational waters should be of good aesthetic quality and should be free from substances that impair its aesthetic appreciation. Aesthetic components can impact the health and safety of recreational water users where visibility has become significantly impaired.

Guideline values for specific chemical parameters in recreational waters cannot be specified. In general, potential risks from exposure to chemical parameters will be much smaller than microbiological risks. It is important for beach operators or service providers to have a mechanism in place to ensure that risks from potential chemical hazards are identified and adequate action is taken.

Faecal contamination of beach sand
Beach sand can present an important non-point source of faecal contamination to recreational waters. Sand may provide a favourable environment for microorganisms of faecal origin, permitting them to survive for longer periods than in the adjacent waters. Physical factors such as wave action, storm surges, tidal activity and high bather load can result in the transference of faecal microorganisms from foreshore and nearshore sand and sediments to bathing waters.

Further research is needed to determine the relationships between faecal indicator bacteria and the possible presence of faecal pathogens in beach sand, as well as the potential implications for human health. Barriers that collectively reduce risk of exposure for beach users could include public education campaigns, improved beach sanitation practices, appropriate sand grooming practices and actions designed to discourage the activities of animals (birds and other wildlife) within the beach area.

Faecal pollution source tracking

Faecal pollution source tracking is an emerging field concerned with understanding the specific sources of faecal contamination impacting an area. Numerous chemical and microbiological source tracking tools have been described. A good understanding and formulation of the nature of the faecal contamination problem are required before any faecal source tracking study can be considered.

Part II: Guideline Technical Documentation

4.0 Recommended indicators of faecal contamination

Recreational waters may be contaminated with faecal material from such sources as discharged sewage, stormwater runoff from agricultural or urban areas, wild or domesticated animals, and even through faecal shedding by bathers themselves. Many epidemiological studies have identified gastrointestinal and upper respiratory illnesses in bathers as a result of such contamination. Historically, the bacteria in the coliform group and its subgroups (total coliforms, thermotolerant [faecal] coliforms, *E. coli*) and the enterococci—the more faecal-specific portion of the faecal streptococci group—have been used to monitor recreational waters for the presence of faecal contamination. As such, they have also been used to indicate the possible presence of pathogenic microorganisms responsible for these illnesses. Routine testing of recreational waters for pathogenic organisms is impractical and is not recommended for the following reasons:

- Testing for every possible waterborne disease-causing microorganism would be prohibitive in terms of both the financial resources necessary and the time required to perform the analyses. These organisms are difficult to isolate and quantify, and testing requires proper laboratory containment facilities, specialized equipment and highly trained and experienced microbiologists. Detection methods for some pathogens do not exist at all.
- Pathogens are usually present at low levels and are irregularly distributed in recreational waters, even during disease outbreaks.
- The absence of one pathogen does not necessarily ensure that other enteric pathogens are also absent.

Consequently, authorities monitor for non-pathogenic faecal indicator bacteria that are present in high numbers in both human and animal faeces. Elevated numbers of these indicator bacteria in the aquatic environment are indicative of faecal contamination and therefore suggest the possible presence of enteric pathogens.

The ideal faecal indicator would meet the following requirements (Cabelli et al., 1983; Elliot and Colwell, 1985):

- found within the intestinal tract of humans and warm-blooded animals;
- present in faecally contaminated waters when enteric pathogens are present, but found in greater numbers than pathogens;
- incapable of growth in the aquatic environment, but capable of surviving longer than pathogens;
- applicable to all types of natural recreational waters (fresh, estuarine and marine waters); and
- absent from non-polluted waters and exclusively associated with animal and human faeces.

Other desirable qualities for the indicator include:

- Density of the indicator should be directly correlated with the degree of faecal contamination.
- Density of the indicator should be quantitatively related to swimmer-associated illnesses.
- Detection and enumeration test methods should be rapid, easy to perform, inexpensive, specific and sensitive.

No single microorganism unequivocally meets all of these criteria. *E. coli* and enterococci are currently considered the best indicators of faecal contamination in recreational waters, as they most closely fit the above characteristics.

4.1 Indicator organisms for primary contact recreation

4.1.1 Fresh waters: Escherichia coli (E. coli)

Guideline values

For fresh recreational waters used for primary contact activities, the guideline values are as follows:

Geometric mean concentration (minimum of five samples): ≤ 200 *E. coli*/100 mL Single-sample maximum concentration: ≤ 400 *E. coli*/100 mL

Calculation of the geometric mean concentration should be based on a minimum of five samples, collected at times and sites so as to provide representative information on the water quality likely to be encountered by users. Further action should be initiated if either of these guideline values is exceeded. Minimum action should consist of immediate resampling of the site(s). In addition, a swimming advisory may be issued should the responsible authority identify that the area is not suitable for recreational water use.

The Working Group on Recreational Water Quality further recommends that recreational water areas routinely used for primary contact recreation be monitored at a minimum of once per week, with increased monitoring recommended for those beaches that are highly frequented or are known to experience high user densities. Similarly, under certain scenarios, a reduction in the recommended sampling frequency may be justified. Further guidance on sampling frequency recommendations and the posting of recreational waters can be found in Part I (Management of Recreational Waters).

Enterococci (Section 4.1.2) is also recognized as a suitable indicator of faecal contamination in fresh recreational waters (Cabelli, 1983; Pruss, 1998; Wade et al., 2003, 2006). If it can be shown that enterococci can adequately demonstrate the presence of faecal contamination in fresh waters, then the enterococci maximum limits for marine waters may be adopted. If there is any doubt, samples should be examined for both sets of indicators for extended periods to determine whether a positive relationship exists.

Guideline rationale
The guideline values have been developed based on epidemiological evidence relating *E. coli* concentrations in fresh recreational waters to the incidence of swimming-associated gastrointestinal illness observed among bathers. The existing epidemiological data are not sufficient to permit the estimation of the level of risk for individual exposures. The guideline values for the recommended indicators of faecal contamination for fresh and marine waters are estimated to correspond to a seasonal gastrointestinal illness rate of approximately 1–2% (10–20 illnesses per 1000 bathers). These values represent risk management decisions that have been based on a thorough assessment of the potential risks for the recreational water user. In considering both the potential health risks and the benefits of recreational water use in terms of physical activity and enjoyment, the Working Group concluded that this is a tolerable and reasonable estimate of the risk of illness likely to be experienced by users engaged in a voluntary activity.

The Working Group's evaluation of the epidemiological information published since the Guidelines were last issued concluded that the current body of evidence supports the existing recommendations regarding the use of *E. coli* as the indicator of faecal contamination in fresh recreational waters. There has not been substantial evidence to suggest that revision of the existing guideline values is necessary at this time.

There are limitations associated with the use of indicators in assessing the quality of recreational waters. The Working Group believes that judicious use of these guideline values as part of a multi-barrier approach to recreational water management represents a sound approach to protecting bathers against exposure to faecal pathogens in the recreational water environment.

Description
E. coli most closely fits the requirements of an ideal indicator of faecal contamination for fresh waters. The organisms are found in high numbers in the intestinal tract and faeces of humans and warm-blooded animals. They are considered a more specific indicator of faecal contamination than either total coliforms or thermotolerant (faecal) coliforms and can be rapidly and easily enumerated in recreational waters. *E. coli* are thought not to have non-faecal sources and are typically considered to be incapable of growth in natural temperate fresh waters. In addition, a strong correlation has been demonstrated between the concentration of *E. coli* in fresh waters and the risk of gastrointestinal illness among swimmers (Dufour, 1984; Wade et al., 2003).

For several decades now, recreational water quality experts in Canada have recognized *E. coli* as the indicator of choice for faecal contamination. The use of *E. coli* as an indicator of recreational water quality was hindered until the 1980s, when standardized laboratory methods permitting detection of the organism within 24–48 hours finally became available. Prior to this, the thermotolerant coliform group was used as the primary indicator of faecal contamination in recreational waters. However, subsequent findings that some thermotolerant coliform species had non-faecal or environmental origins and could be isolated in high numbers from waters receiving waste effluents from such sources as pulp and paper and textile manufacturing facilities (Dufour and Cabelli, 1976; Huntley et al., 1976; Rokosh et al., 1977; Vlassoff, 1977) served to question the reliability of using this group as an indicator of faecal contamination in recreational waters. Despite the availability of methods specific for the detection of *E. coli*, testing laboratories were already set up to test for thermotolerant coliforms, and the requirements to perform surveillance of recreational waters for these microorganisms were embedded in long-standing regulatory and legislative documents. As a result, it has taken many years and considerable time to amend the existing guidelines and standards, updating them to reflect the current state of knowledge that *E. coli* is the preferred indicator of faecal pollution for fresh recreational waters.

In the previous edition of the Guidelines (Health and Welfare Canada, 1992), the introduction of *E. coli* as the recommended indicator for freshwater quality represented a new direction for recreational water monitoring, moving away from the previous recommendation regarding the use of thermotolerant coliforms (Health and Welfare Canada, 1983). As a result, a provision was made that allowed thermotolerant coliforms to continue to be used if it could be determined that greater than 90% of the thermotolerant coliforms were, in fact, *E. coli*. This was done to permit an adjustment period for jurisdictions in making the changeover to the new recommendations. Significant time has now passed to allow jurisdictions to make the change from thermotolerant coliforms to the more faecal-specific *E. coli*. As a result, the Working Group on Recreational Water Quality no longer recommends the use of thermotolerant coliforms as an indicator of the quality of recreational waters. The Working Group reaffirms that *E. coli* is the preferred indicator for monitoring fresh recreational waters in Canada.

Occurrence in the aquatic environment
Within human and animal faeces, *E. coli* is present at a concentration of approximately 10^9 cells per gram (Edberg et al., 2000) and comprises about 1% of the total biomass in the large intestine (Leclerc et al., 2001; Health Canada, 2006a). Human faecal flora characterization studies have reported that *E. coli* was detected in 94% and 100% of the subjects tested (Finegold et al., 1983; Leclerc et al., 2001). These values were significantly higher than those reported for other members of the coliform group and were matched or exceeded by only enterococci and certain species of anaerobic bacteria (*Bacteroides*, *Eubacterium*).

E. coli comprises about 97% of the coliform organisms in human faeces, with *Klebsiella* spp. comprising 1.5% and *Enterobacter* and *Citrobacter* spp. together comprising another 1.7%. *E. coli* has been shown to represent between 90% and 100% of all coliforms in faeces from eight species of domestic animals, including chickens (Dufour, 1977).

Once shed from a human/animal host, faecal bacteria are not expected to survive for long periods in the aquatic environment (Winfield and Groisman, 2003). Survival of *E. coli* in the recreational water environment is dependent on many factors, including temperature, exposure to sunlight, available nutrients, water conditions such as pH and salinity, and competition from and predation by other microorganisms.

Numerous authors have reported on the ability of beach sand and sediments to prolong the survival of faecal microorganisms (Whitman and Nevers, 2003; Ishii et al., 2006a; Kon et al., 2007). This environment is thought to provide more favourable conditions of temperature and nutrients than the adjacent waters, as well as to offer protection from certain environmental stressors such as sunlight. Others have reported on the ability of *E. coli* to survive in organic-rich environments not known to be associated with faecal contamination, such as industrial process wastes and wastes from pulp and paper manufacturing (Megraw and Farkas, 1993; Gauthier and

Archibald, 2001). Recently, researchers have reported on the ability of *E. coli* and other faecal bacteria to survive within mats of the green algal species *Cladophora* (Whitman et al., 2003; Olapade et al., 2006).

E. coli is considered to be a good surrogate of the survival of enteric bacterial pathogens in recreational waters. Several authors have reported similar survival rates for *E. coli* and enteric bacterial pathogens (Rhodes and Kator, 1988; Korhonen and Martikainen, 1991; Chandran and Mohamed Hatha, 2005). The indicator is regarded to be more sensitive to environmental stresses than human enteric viruses and protozoa and thus does not survive as long in the environment as these organisms.

In many parts of Canada, freshwater beaches are routinely monitored for levels of *E. coli* as an indication of faecal contamination. Many Canadian recreational waters are of good microbiological quality; however, certain waters are contaminated throughout part, or all, of the bathing season. An examination of beach monitoring data over a 10-year period (1993–2003) at 10 Lake Huron recreational beaches in Ontario demonstrated that levels of *E. coli* can vary widely at a single location from year to year and between beach locations (Ontario Ministry of the Environment, 2005). *E. coli* values can range from 0/100 mL in isolated areas to several thousand per 100 mL in areas directly impacted by faecal contamination (Payment et al., 1982; Sekla et al., 1987; Williamson, 1988; Ontario Ministry of the Environment, 2005).

Association with pathogens

E. coli is considered a good indicator for enteric bacterial pathogens such as *Salmonella*, *Shigella*, *Campylobacter* and *E. coli* O157:H7 (Health Canada, 2006a). Investigations conducted by the Water Environment Research Foundation (Yanko et al., 2004) examined the relationship between *E. coli* concentrations in surface water samples collected from various watersheds in southern California and the probability of detecting *Salmonella* and Shiga toxin-producing *E. coli* (STEC). The results demonstrated that the probability of detecting *Salmonella* using culture-based methods steadily increased up to a concentration of approximately 1000 *E. coli*/100 mL. At this point, a 100% probability of detection was reported. Similar results were reported for the detection of STEC strains using polymerase chain reaction (PCR)-based methods. Although there was clearly an association between *E. coli* concentrations and the probability of detection of *Salmonella* and STEC strains, the authors reported that no single sample could be used to provide absolute assurance of the presence or absence of these pathogens.

E. coli is a less effective indicator of enteric pathogenic viruses and protozoa. Numerous studies have reported on the lack of a correlation between *E. coli* concentrations and the presence of enteric viruses and protozoa in surface waters (Griffin et al., 1999; Denis-Mize et al., 2004; Hörman et al., 2004; Dorner et al., 2007).

E. coli are always present in faecal contamination from human and animal sources. Detection indicates faecal contamination of water and thus the possible presence of faecal pathogenic bacteria, viruses and protozoa. The occurrence of faecal pathogens in recreational waters is strongly dependent on the nature of the contamination sources impacting the bathing area. Their presence and numbers in the environment can be sporadic and highly variable. As well, some enteric pathogens can survive longer than the faecal indicators. The absence of *E. coli* should not be interpreted to mean that enteric pathogenic microorganisms are also absent.

A multi-barrier approach combining routine *E. coli* monitoring alongside actions, procedures and tools to collectively reduce the risk of bather exposure to faecal contamination in the recreational water environment represents the most effective approach to protecting the health of recreational water users.

Related epidemiological studies
The current guideline values for faecal indicator organisms in fresh waters were developed in part based on the results generated by the U.S. EPA's original epidemiological studies in fresh and marine recreational waters (Dufour, 1984, Health and Welfare Canada, 1992).

The studies measured the concentrations of indicator organisms in bathing waters and compared them with the rates of swimming-associated illness reported by bathers experiencing recreational water contact on the same days on which the samples were collected. Statistically significant rates of gastrointestinal illness were observed among swimmers at beaches considered to be more polluted compared with those considered unpolluted. For symptoms unrelated to gastrointestinal illness, no statistically significant differences were observed. Regression coefficients were determined for the levels of each of the indicators and the rates of gastrointestinal illness among swimmers. The best correlations were obtained with *E. coli* ($r = 0.80$) and enterococci ($r = 0.74$). The seasonal risk of gastrointestinal illness per 1000 bathers (y) was estimated to be related to the density of *E. coli*/100 mL (x) by the following relationship:

$$y = 9.40(\log x) - 11.74$$

The Working Group's interpretation of these data was that applying a maximum limit geometric mean *E. coli* concentration of 200 *E. coli*/100 mL, equivalent to the existing thermotolerant coliform guideline value, would equate to a seasonal risk of gastrointestinal illness for recreational water users of approximately 1% (10 illnesses in 1000 bathers) (Health and Welfare Canada, 1992).

In determining the value for the maximum faecal indicator concentration permitted in a single sample, the Working Group reviewed U.S. EPA equations pertaining to the calculation of a single-sample limit (U.S. EPA, 1986). It was resolved that the application of a factor of 2 times the recommended geometric mean value would produce a guideline value consistent with the data regarding the maximum allowable indicator density at designated beach areas. Subsequently, a single-sample maximum concentration of 400 *E. coli*/100 mL was established (Health and Welfare Canada, 1992).

Several freshwater epidemiological studies have been conducted since the *Guidelines for Canadian Recreational Water Quality* were last developed (Lightfoot, 1988; Ferley et al., 1989; Calderon et al., 1991; van Asperen et al., 1998). All have confirmed the existence of a strong relationship between exposure to recreational waters and swimming-associated illness; however, few have been able to demonstrate evidence of a mathematical relationship between faecal indicator counts and illness among swimmers. Van Asperen et al. (1998) reported that the risk of gastroenteritis was significantly higher among triathletes who swam in water with a geometric mean *E. coli* concentration of > 355 colony-forming units (cfu)/100 mL. Ferley et al. (1989) proposed that faecal streptococci were a better indicator of gastrointestinal illness at freshwater beaches in France. Calderon et al. (1991) observed that total staphylococci counts were most closely associated with gastrointestinal illness among swimmers at a recreational pond not affected by point source discharges.

Only a few epidemiological studies have been conducted that have investigated the health effects of recreational activities other than bathing or swimming, such as whitewater canoeing and rafting (Fewtrell et al., 1992; Lee et al., 1997). The data linking water quality and illness through these activities have been less strong. Still, conclusions that have been reported are that gastrointestinal illness similarly constitutes the most frequently reported health outcome during these types of activities; and that factors related to the risk of illness include the quality of the water and the frequencies of immersion and water ingestion.

Several reviews of the epidemiological findings have also been published. In 1998, WHO (Pruss, 1998) published a comprehensive review of the epidemiological research that had been conducted over the period from 1953 to 1996. This was the first extensive review of the existing epidemiological literature. Pruss (1998) concluded that gastrointestinal illness was the most frequent health outcome for which dose–response relationships were reported and that the indicators that best correlated with health outcomes were enterococci for marine waters and *E. coli* and enterococci for fresh waters.

The U.S. EPA published two reviews of the existing epidemiological literature for recreational waters. The first, published in its *Implementation Guidance for Ambient Water Quality Criteria for Bacteria* (U.S. EPA, 2002), was a minireview of the epidemiological studies conducted since the previous guidance had been issued, in 1986. The U.S. EPA concluded that the epidemiological methods used to derive its 1986 Water Quality Criteria remained scientifically valid and that no new scientific principles had been established that would require a revision of the current guidelines. Subsequent to this, the U.S. EPA (Wade et al., 2003) conducted a meta-analysis of the existing epidemiological data available in the literature to determine if its current regulatory standards were sufficiently protective against the risk of gastrointestinal illness in recreational waters. The authors demonstrated that in the freshwater studies, *E. coli* was shown to be the most suitable indicator of recreational water illness. It was further reported that when comparing the summary relative risk values with the U.S. EPA guidelines for fresh water, *E. coli* densities above the guideline values were associated with an increased risk of illness, whereas exposures below the guideline values did not show an association.

Wiedenmann et al. (2006) reported on the results of a randomized controlled prospective cohort study conducted at freshwater bathing sites in Germany. Earlier randomized controlled trials had been conducted in UK coastal waters (Kay et al., 1994; Fleisher et al., 1996); however, this study was the first of its type to be conducted in fresh waters. The study design used by the authors was similar to that originally used in the UK trials. The authors observed evidence of a relationship between the observed rates of illness and measured concentrations of *E. coli*, enterococci, *Clostridium perfringens* and somatic coliphages. No-observed-adverse-effect levels (NOAELs) were reported for several definitions of gastroenteritis, ranging from 78 to 180 *E. coli*/100 mL and from 21 to 24 enterococci/100 mL. The authors proposed possible guidelines by combining all of the data derived from the different definitions of gastrointestinal illness investigated, suggesting values of 100 *E. coli*/100 mL, 25 enterococci/100 mL, 10 somatic coliphages/100 mL and 10 *C. perfringens*/100 mL. The study reported a NOAEL of 180 *E. coli*/100 mL using the UK definition of gastrointestinal illness—considered similar to the highly credible gastrointestinal illness (HCGI) definition originally used in the studies conducted by Cabelli et al. (1983).

The U.S. EPA and Centers for Disease Control and Prevention (CDC) are currently conducting epidemiological studies at freshwater and marine beaches under the National Epidemiologic and Environmental Assessment of Recreational (NEEAR) Water Study. The studies are intended to support the development of new recreational water quality guidelines (U.S. EPA, 2002; Dufour et al., 2003) as well as to investigate new water quality indicators and rapid methods for water quality monitoring. Work is expected to be completed by 2010.

Summary

The Working Group has concluded, based on all of the existing evidence, that *E. coli* remains the most suitable indicator of faecal contamination in fresh recreational waters. In summary:

1. The guideline values have been developed based on the analysis of epidemiological evidence relating *E. coli* concentrations in fresh recreational waters to the incidence of swimming-associated gastrointestinal illness observed among bathers. The values represent risk management decisions based on the assessment of possible health risks for the recreational water user and the recognition of the significant benefits that recreational water activities provide in terms of health and enjoyment.

2. *E. coli* most closely fits the requirements of an ideal indicator of faecal contamination for fresh waters. *E. coli* are always present in faecal contamination from human and animal sources. Detection suggests faecal contamination of water and thus the possible presence of faecal pathogenic bacteria, viruses and protozoa.

3. There are limitations associated with the use of indicators in assessing the quality of recreational waters. The occurrence of faecal pathogens in recreational waters is dependent on many factors and can be variable and sporadic. The absence of *E. coli* should not be interpreted to mean that enteric pathogenic microorganisms are also absent.

4. A multi-barrier approach combining routine *E. coli* monitoring alongside actions, procedures and tools to collectively reduce the risk of bather exposure to faecal contamination in the recreational water environment represents the most effective approach to protecting the health of recreational water users.

4.1.2 Marine waters: Enterococci

Guideline values

For marine recreational waters used for primary contact activities, the guideline values are as follows:

Geometric mean concentration (minimum of five samples): $\leq$ 35 enterococci/100 mL
Single-sample maximum concentration: $\leq$ 70 enterococci/100 mL

Calculation of the geometric mean concentration should be based on a minimum of five samples, collected at times and sites so as to provide representative information on the water quality likely to be encountered by users. Further action should be initiated if either of these guideline values is exceeded. Minimum action should consist of immediate resampling of the site(s). In addition, a swimming advisory may be issued should the responsible authority identify that the area is not suitable for recreational water use.

The Working Group on Recreational Water Quality further recommends that recreational water areas routinely used for primary contact recreation be monitored at a minimum of once per week, with increased monitoring recommended for those beaches that are highly frequented or are known to experience high user densities. Similarly, under certain scenarios, a reduction in the recommended sampling frequency may be justified. Further guidance on sampling frequency recommendations and the posting of recreational waters can be found in Part I (Management of Recreational Waters).

E. coli (Section 4.1.1) is also recognized as a useful predictor of the risk of gastrointestinal illness in marine recreational waters (Wade et al., 2003). If it can be shown that *E. coli* can adequately demonstrate the presence of faecal contamination in marine waters, then the *E. coli* maximum limit for fresh waters may be adopted. If there is any doubt, samples should be examined for both sets of indicators for extended periods to determine whether a positive relationship exists.

Guideline rationale

The guideline values have been developed based on epidemiological evidence relating enterococci concentrations in marine recreational waters to the incidence of swimming-associated gastrointestinal illness observed among bathers. The existing epidemiological data are not sufficient to permit the estimation of the level of risk for individual exposures. The guideline values for the recommended indicators of faecal contamination for fresh and marine waters are estimated to correspond to a seasonal gastrointestinal illness rate of approximately 1–2% (10–20 illnesses per 1000 bathers). These values represent risk management decisions that have been based on a thorough assessment of the potential risks for the recreational water user. In considering both the potential health risks and the benefits of recreational water use in terms of physical activity and enjoyment, the Working Group concluded that this is a tolerable and reasonable estimate of the risk of illness likely to be experienced by users engaged in a voluntary activity.

The Working Group's evaluation of the epidemiological information published since the Guidelines were last issued concluded that the current body of evidence supports the existing recommendations regarding the use of enterococci as the indicator of faecal contamination in marine recreational waters. There has not been substantial evidence to suggest that revision of the existing guideline values is necessary at this time.

There are limitations associated with the use of indicators in assessing the quality of recreational waters. The Working Group believes that judicious use of these guideline values as part of a multi-barrier approach to recreational water management represents a sound approach to protecting bathers against exposure to faecal pathogens in the recreational water environment.

Description
Enterococci are members of the genus *Enterococcus*. The genus was created to house the more faecal-specific species of genus *Streptococcus*, formerly considered as group D streptococci. In practice, the terms enterococci, faecal streptococci, *Enterococcus* and intestinal enterococci have been used interchangeably (Bartram and Rees, 2000). Enterococci are characterized by their ability to fulfil the following criteria: growth at temperatures of 10°C and 45°C, resistance to 60°C for 30 minutes, growth in the presence of 6.5% sodium chloride and at pH 9.6, and the ability to reduce 0.1% methylene blue (Bartram and Rees, 2000; APHA et al., 2005). Species of the genus include *E. faecalis*, *E. faecium*, *E. durans*, *E. hirae*, *E. gallinarum* and *E. avium*.

E. faecalis and *E. faecium* occur in significant quantities in both human and animal faeces and, along with *E. durans*, have been reported to be the species most frequently encountered in polluted aquatic environments (Bartram and Rees, 2000). *E. gallinarum* and *E. avium* occur at high concentrations in animal faeces, but are not exclusively associated with animal sources.

Enterococci closely satisfy many characteristics of a suitable indicator of faecal contamination in recreational waters. Many species within the group enterococci are found in high numbers in human and animal faeces. They are not commonly found in unpolluted waters and are generally regarded to be incapable of growth in recreational waters (Ashbolt et al., 2001). Compared with other indicator organisms (e.g., *E. coli*, thermotolerant coliforms), enterococci have demonstrated greater resistance to certain environmental stresses in recreational waters, such as conditions of sunlight and salinity. Enterococci have also demonstrated greater resistance to wastewater treatment practices, including chlorination. A strong correlation has also been demonstrated between the concentration of enterococci in marine waters and the risk of gastrointestinal illness among swimmers (Cabelli, 1983; Kay et al., 1994).

In the past, a ratio of thermotolerant coliforms to faecal streptococci concentrations was used in attempts to indicate the origin of bacterial contamination (Geldreich, 1976; Clausen et al., 1977). A thermotolerant coliform/faecal streptococcus ratio of 4 or higher was said to indicate a human source of contamination, whereas a lower ratio would represent an animal source. However, because of the noted differences in the survival times between these two groups in the environment and the variability of the different methods used for their enumeration, the use of the thermotolerant coliform/faecal streptococcus ratio is now considered inaccurate (Ashbolt et al., 2001; APHA et al., 2005). As a result, the use of this ratio is not recommended. Further information on faecal pollution source tracking can be found in Section 10.0 (Faecal pollution source tracking).

Occurrence in the aquatic environment

Enterococci can be routinely isolated from marine and fresh recreational waters known to be impacted by human and animal faecal pollution sources. These organisms are present in high concentrations in human and animal faeces, with concentrations reported on the order of 10^6–10^7/g (Sinton, 1993; Edberg et al., 2000). Overall, it is thought that enterococci are present at concentrations approximately 1- to 3-fold lower than those of *E. coli* in faeces and municipal wastes (Sinton, 1993; Edberg et al., 2000). Human faecal flora studies reported by Leclerc et al. (2001) demonstrated that *Enterococcus* species could be detected in the faeces of 100% of the subjects tested.

Several publications have reported that prolonged survival of enterococci is possible in marine and freshwater sediments (Davies et al., 1995; Desmarais et al., 2002; Ferguson et al., 2005). These are thought to provide more favourable conditions of temperature and nutrients than the adjacent recreational waters. Others have reported on the ability of enterococci to survive in organic-rich environments not known to be associated with faecal contamination, such as on mats of the green algae species *Cladophora* (Whitman et al., 2003).

In Canada, there have been few published investigations on the distribution of enterococci in the marine environment. Gibson and Smith (1988) conducted a study to investigate the distribution of enterococci at 26 marine beaches in the Vancouver region. The findings of this study demonstrated that 1.6% of the results would have exceeded the enterococci geometric mean concentration guideline value of 35/100 mL. In 1988, Allen (1989) monitored eight marine beaches along the Northumberland Strait in New Brunswick. The overall enterococci levels were low, showing a geometric mean concentration of 3.5/100 mL. The results of the study indicated that enterococci were absent in 60% of the samples.

Association with pathogens

Enterococci are considered a good indicator for enteric bacterial pathogens. In a survey of surface waters collected from various watersheds in southern California, enterococci were shown to demonstrate good predictive ability with PCR detection of STEC (Yanko et al., 2004). It was reported that above an enterococci concentration of 100 most probable number (MPN)/100 mL, the probability of detection of STEC was approximately 60–70%.

Enterococci are somewhat less effective as an indicator of the presence of enteric pathogenic viruses and protozoa. A number of researchers have reported on the lack of a relationship between enterococci concentrations and the presence of human viruses in surface waters (Griffin et al., 1999; Schvoerer et al., 2000, 2001; Jiang et al., 2001, Jiang and Chu, 2004)

~~Enterococci are considered the best available indicator of water quality for marine recreational~~ waters (Pruss, 1998; WHO, 1999; Wade et al., 2003). Detection indicates faecal contamination of water and thus the possible presence of faecal pathogenic bacteria, viruses and protozoa. Human enteric viral and protozoan pathogens of faecal origin can survive for prolonged periods in marine waters. Although the presence of high enterococci counts may indicate the possible presence of viral and protozoan pathogens, the opposite—that the absence of enterococci indicates that these pathogens are also absent—cannot be assured.

A multi-barrier approach combining routine monitoring for enterococci alongside actions, procedures and tools to collectively reduce the risk of bather exposure to faecal contamination in the recreational water environment represents the most effective approach to protecting the health of recreational water users.

Related epidemiological studies

The current marine water guideline values (Health and Welfare Canada, 1992) were developed based on the results generated by the U.S. EPA's original epidemiological studies in fresh and marine recreational waters (Cabelli, 1983).

The studies measured the concentrations of indicator organisms in bathing waters and compared them with the rates of swimming-associated illness reported by bathers experiencing recreational water contact on the same days on which the samples were collected. Statistically significant rates of gastrointestinal illness were observed among swimmers at beaches considered to be more polluted compared with those considered unpolluted. For symptoms unrelated to gastrointestinal illness, no statistically significant differences were observed. Regression coefficients were determined for the levels of the indicators measured and the rates of gastrointestinal illness among swimmers. The best correlation was obtained with enterococci ($r = 0.75$). Further, the seasonal risk of gastrointestinal illness per 1000 bathers (y) was estimated to be related to the density of enterococci/100 mL (x) by the following relationship:

$$y = 0.20 + 12.17(\log x)$$

The Working Group's interpretation of these data was that applying a maximum limit geometric mean enterococci concentration of 35 enterococci/100 mL would equate to a seasonal risk of gastrointestinal illness for recreational water users of approximately 2% (19 illnesses in 1000 bathers) (Health and Welfare Canada, 1992). It was noted that in Canada, owing to geography and climate, a significantly smaller percentage of the population engages in marine recreational water activities as compared with those engaging in freshwater recreation.

In determining the value for the maximum faecal indicator concentration permitted in a single sample, the Working Group reviewed U.S. EPA equations pertaining to the calculation of a single-sample limit (U.S. EPA, 1986). It was resolved that the application of a factor of 2 times the recommended geometric mean concentration would produce a guideline value consistent with the data regarding the maximum allowable indicator density at designated beach areas. Subsequently, a single-sample maximum concentration of 70 enterococci/100 mL was established (Health and Welfare Canada, 1992).

Several marine water epidemiological studies have been conducted since the *Guidelines for Canadian Recreational Water Quality* were last developed (Cheung et al., 1990; Alexander et al., 1992; von Schirnding et al., 1992; Corbett et al., 1993; Harrington et al., 1993; Kay et al., 1994; Kueh et al., 1995; Marino et al., 1995, Fleisher et al., 1996; van Dijk et al., 1996; McBride et al., 1998; Haile et al., 1999; Prieto et al., 2001). All of the studies have confirmed the existence of a relationship between exposure to marine recreational waters of varying quality and symptoms of water-related illness among swimmers. The most significant findings came from the results of the randomized controlled program of epidemiological studies conducted at coastal beaches in the United Kingdom (Kay et al., 1994; Fleisher et al., 1996). These studies were designed to address some of the perceived shortcomings of the traditional beach survey design used in many of the earlier studies. The key features of the randomized controlled design were efforts to ensure a more random distribution of subjects in the bathing and non-bathing groups and tighter monitoring of the water quality experienced by the individual bathers. It was observed that of the faecal indicators monitored, only faecal streptococci levels measured at chest depth showed a significant relationship with the incidence of both gastrointestinal illness and respiratory illness among swimmers. The authors further reported the existence of possible thresholds for an increased risk of gastroenteritis at a concentration of 32 faecal streptococci/100 mL and an increased risk of respiratory illness at a concentration of 60 faecal streptococci/100 mL. In other studies, McBride et al. (1998) reported an increasing risk of respiratory illness with increasing enterococci levels among swimmers at New Zealand beaches. Cheung et al. (1990) observed a moderate correlation (r = 0.63) between enterococci levels and rates of HCGI and skin symptoms combined at coastal beaches in Hong Kong, although a stronger correlation was observed with *E. coli* (r = 0.73).

A few epidemiological studies have been conducted that have investigated the health effects of recreational activities other than bathing or swimming, such as surfing (Gammie and Wyn-Jones, 1997; Dwight et al., 2004). The data linking water quality and illness through these activities have been less strong. Still, conclusions that have been reported are that gastrointestinal illness similarly constitutes the most frequently reported health outcome during these types of activities and that factors related to the risk of illness include the quality of the water and the frequencies of immersion and water ingestion.

Several reviews of the epidemiological findings have also been published. WHO (Pruss, 1998) published a comprehensive review of all of the recreational water epidemiological studies conducted over the period from 1953 to 1996. From the review, it was concluded that gastrointestinal symptoms were the most frequently reported outcome for which water quality dose–response relationships were reported, and that the indicator organisms that best correlated with the health outcomes were enterococci for marine waters and *E. coli* and enterococci for fresh waters. The U.S. EPA has also published two reviews of the existing epidemiological literature for recreational waters. The first, published in its *Implementation Guidance for Ambient Water Quality Criteria for Bacteria* (U.S. EPA, 2002), was a minireview of the epidemiological studies conducted since the previous guidance had been issued, in 1986. The U.S. EPA concluded that the epidemiological methods used to derive its 1986 Water Quality Criteria remained scientifically valid and that no new scientific principles had been established that would require a revision of the current guidelines. More recently, Wade et al. (2003) conducted a meta-analysis of all of the existing epidemiological data to have been published since 1950 linking microbiological indicators of recreational water quality to gastrointestinal illness in bathers. The authors concluded that in the marine water studies, enterococci and, to a lesser extent, *E. coli* were the most reliable predictors of gastrointestinal illness. Moreover, it was observed that the reported risks of gastrointestinal illness at enterococci concentrations below the current U.S. EPA standards were not statistically significant, whereas values above the standards were elevated and statistically significant.

The U.S. EPA and CDC are currently conducting epidemiological studies at freshwater and marine beaches under the NEEAR Water Study. The studies are intended to support the development of new recreational water quality guidelines (U.S. EPA, 2002; Dufour et al., 2003), as well as to investigate new water quality indicators and rapid methods for water quality monitoring. Work is expected to be completed by 2010.

Summary

The Working Group on Recreational Water Quality has concluded that, based on all of the existing evidence, the enterococci group remains the most suitable indicator of faecal contamination in marine recreational waters. In summary:

1. The guideline values have been developed based on the analysis of epidemiological evidence relating enterococci concentrations in marine recreational waters to the incidence of swimming-associated gastrointestinal illness observed among bathers. The values represent risk management decisions based on the assessment of possible health risks for the recreational water user and the recognition of the tremendous benefits that recreational water activities provide in terms of health and enjoyment.

2. Enterococci most closely fit the requirements of an ideal indicator of faecal contamination for marine recreational waters. Detection suggests faecal contamination of water and thus the possible presence of faecal pathogenic bacteria, viruses and protozoa.

3. There are limitations associated with the use of indicators in assessing the quality of recreational waters. The occurrence of faecal pathogens in recreational waters is dependent on many factors and can be variable and sporadic. The absence of enterococci should not be interpreted to mean that enteric pathogenic microorganisms are also absent.

4. A multi-barrier approach combining routine enterococci monitoring alongside actions, procedures and tools to collectively reduce the risk of bather exposure to faecal contamination in the recreational water environment represents the most effective approach to protecting the health of recreational water users.