Lake Vernon Water Quality Characterization and Threats Evaluation

Prepared for
Lake Vernon Environmental Association
and the
Lake Vernon Association

Submitted by
Gartner Lee Limited

August, 2008

Gartner Lee

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Reference: **GLL 80166**

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August 27, 2008

Mr. Peter McBirnie
Lake Vernon Environmental Association
611 Skyhills Road
Huntsville, Ontario P1H 2N5

Dear Mr. McBirnie:

Re: GLL 80166 – Water Quality Strategy for Lake Vernon – Water Quality Characterization and Threats Inventory

We are pleased to submit this report "Lake Vernon Water Quality Characterization and Threats Evaluation", which represents Element 1 of the Lake Vernon Water Quality Strategy.

We look forward to presenting our findings at the Annual General Meeting of the Vernon Association this Saturday at Camp Tawingo and to our continued work with the Association in completing the next phases of the project.

If you or the Association have any questions or concerns about this report, or require clarification regarding the next steps in the study, please contact Tammy Karst-Riddoch at (705) 646-0908 ext. 5512.

Yours very truly,
GARTNER LEE LIMITED

Tammy Karst-Riddoch, PhD
Aquatic Scientist

TKR:jd

11b Taylor Road, The Granary, Bracebridge, Ontario, P1L 1S6 tel 705.646.0908 fax 705.646.0692
www.gartnerlee.com

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1. Introduction

In 2003, a detailed "Lake Vernon Plan" (French Planning Services, 2003) was completed for the Lake Vernon Association in order to identify, protect and conserve the significant natural, physical and social features of Lake Vernon that are important to users of the lake. The lake plan identified 7 primary issues of concern that were relevant to the health and character of the lake including:

1. Protection of Water Quality
2. Appropriate Economic and Property Development
3. Maintenance of Natural Habitats
4. Maintenance of Cultural Historic Features
5. Protection of Landscape and Aesthetics
6. Improvement of Social Life, and
7. Maintenance of Natural Shorelines.

From the above, protection of water quality was identified as the primary issue for Lake Vernon in the lake plan. Development and general urbanization of shoreline areas within the watershed were the key concerns for water quality due to their potential to impact on increased nutrients and turbidity, and several land use planning and stewardship actions were recommended to address these issues.

In recognition that 'Protection of Water Quality' is the primary issue of concern for Lake Vernon and given the recommendations contained in the Lake Vernon Plan, the Lake Vernon Environmental Association retained Gartner Lee Limited in April 2008 to develop a **Water Quality Strategy** that aims to protect and enhance water quality of the lake through community involvement. This strategy includes a review of current data to characterize existing water quality conditions in the lake to identify potential concerns or threats to water quality that are then used to provide recommendations for effective community-based water quality monitoring, education and stewardship activities. As such, the development of the **Water Quality Strategy** consists of three elements:

Element 1 – Water Quality Characterization and Threats Identification, which summarizes all available data on water quality in Lake Vernon, identifying potential threats, issues and concerns and imparting expert opinion.

Element 2 – Issues Evaluation and Threats Assessment, which seeks input from local residents at the General Annual Meeting of the Lake Vernon Association on August 30th, 2008 to include their opinions and perceptions of the most significant threats or concerns.

Element 3 – Water Quality Management Plan, which uses information from Elements 1 and 2 to develop a plan of citizen-based water quality monitoring, stewardship initiatives (e.g., septic system upgrades) or recommendations for political action (e.g., to address large scale threats like climate change and acid rain) to protect and enhance water quality in Lake Vernon.

The following report represents Element 1 of the **Lake Vernon Water Quality Strategy**. This includes an assessment of current water quality conditions in Lake Vernon based on a review of available data obtained from several sources including:

- District Municipality of Muskoka
  - Lake System Health Program
- Ministry of the Environment
  - Dorset Environmental Science Centre
  - Sport Fish Contaminants Monitoring Unit
- Simcoe Muskoka District Health Unit
- Federal Contaminated Sites Inventory (FCSI)

2. Water Quality Characterization

2.1 General Water Chemistry

General water chemistry data are available for Lake Vernon from the MOE's Dorset Environmental Science Centre (1982-1995) and from the District Municipality of Muskoka (2004, 2006) as part of their regular monitoring under the Lake System Health Program. General water chemistry parameters measured in these programs are summarized in Table 1 along with available Provincial Water Quality Objectives (PWQO; MOE, 1994) for the protection of aquatic life and recreation for comparison. More detailed description of total phosphorus concentrations are provided in Section 2.2 as they relate to lake productivity.

Table 1. General water chemistry for Lake Vernon. Highlighted values exceed available Provincial Water Quality Objectives (PWQO).

Parameter	Units	n	Mean	Maximum	Minimum	PWQO
Alkalinity	mg/L	27	3.0	4.4	1.9	
Aluminum	µg/L	3	102.0	114.0	95.2	10%[2]
Ammonium	µg/L	27	19	40	2	
Anions	µg/L	3	0.2	0.3	0.2	
Barium	µg/L	3	15.5	16.5	14.5	
Beryllium	µg/L	2	0.0	0.0	0.0	11
Cadmium	µg/L	3	0.2	0.3	0.0	0.1
Calcium	µg/L	6	2.6	2.9	2.4	
Cations	µg/L	3	0.3	0.3	0.3	
Chloride	µg/L	21	1.9	3.6	1.2	
Chlorophyll *a*	µg/L	21	1.7	3.1	0.5	
Chromium	µg/L	1	0.1	0.3	0.0	1
Cobalt	µg/L	0	0.0	0.0	0.0	0.9
Colour	TCU	20	46.8	65.2	33.0	
Conductivity	µS/cm	26	33.4	40.8	21.0	
Copper	µg/L	3	0.4	0.5	0.2	5
Dissolved Organic Carbon	mg/L	26	5.5	7.3	5.0	
Iron	µg/L	24	281.7	431.0	32.0	300
Lead	µg/L	2	0.5	1.1	0.0	5
Magnesium	mg/L	6	0.7	0.8	0.6	
Manganese	µg/L	3	62.5	68.3	55.4	
Molybdenum	µg/L	2	0.0	0.2	0.0	40
Nickel	µg/L	2	0.4	1.4	0.0	25
Nitrate	µg/L	27	229	1040	70	
pH		26	6.2	6.8	5.7	6.5-8.5
Potassium	mg/L	6	0.5	0.6	0.4	
Silicon	mg/L	6	2.0	2.1	1.9	
Sodium	µg/L	6	2.0	2.7	1.6	
Strontium	µg/L	3	21.4	22.5	20.5	
Sulphate	µg/L	23	6.0	7.3	3.4	
Titanium	µg/L	3	1.4	1.5	1.2	
Total Kjeldahl Nitrogen	µg/L	25	279	360	0	
Total Phosphorus (1997-2006)[1]	µg/L		10.5			20
Total Phosphorus (1991-2001)[1]	µg/L		11.4			20
Vanadium	µg/L	2	0.6	1.6	0.0	6
Zinc	µg/L	3	6.8	8.0	5.9	30

[1]*mean concentrations from the North Bay (north of Big Island), the main basin and Hunter's Bay*

[2]*the aluminum objective is dependent on the pH of the water and the form of aluminum present. It states that at pH 5.5-6.5, the acid soluble inorganic portion should not be allowed to increase by >10% form natural values.*

Overall, the general water chemistry of Lake Vernon reflects conditions typical of many Precambrian Shield lakes. Due to thin soils and granitic bedrock in the watershed, the lake has relatively low conductivity, concentrations of cations and alkalinity, and therefore, a low acid-neutralizing capacity making it sensitive to acidification. pH values below 7.0 mean that the lake is acidic and the mean value of 6.2 is below the PWQO of 6.5-8.5. This is partly the result of acid deposition ("acid rain") the transport and deposition of acids added to the atmosphere by human activities from long-range sources because there are no known significant local or point sources of acidic substances to Lake Vernon. Due to large wetland areas in the watershed that can supply substantial amounts of weak organic acids (e.g., humic acids) to the lake, however, Lake Vernon is also likely naturally acidic.

Supply of organic matter from the wetlands as dissolved organic carbon (DOC) gives the lake water a 'tea-stained' appearance that contributes to the relatively high colour value of the lake water and lower water clarity. Water clarity for Lake Vernon is measured as Secchi depth by the District, and ranges from 2.6 m in Hunter's Bay to 3.1 m in the Main basin (10-year average) (see Figure 1). Additional Secchi depth data have been collected by Mr. Doug Jaggar, an area resident, for the past 10 years. Mr. Jaggar's data reflect similar values with mean Secchi depth of 2.6 m at 5 locations in the lake (see Figure 2). Additional details regarding water clarity and Secchi depth as they relate to lake productivity are provided in Section 2.2, below.

Two metals, iron and cadmium have exceeded the PWQOs. Iron exceeded the PWQO of 300 μg/L on 12 of 24 sampling occasions between 1985 and 2006. Cadmium has only been measured in 2006 and exceeded the PWQO of 0.1 μg/L in the main basin (0.318 μg/L) and north basin (0.286 μg/L), but not Hunter's Bay (0.027 μg/L).

Iron in surface waters can originate from the weathering of rocks and minerals, acid mine water drainage, landfill leachates, sewage effluents and iron-related industries. In Lake Vernon, elevated iron concentrations are likely due to natural sources. Iron is held in solution by Dissolved Organic Carbon (DOC), the same material that colours the water of Lake Vernon. Wetlands are a natural source of DOC and lakes with coloured waters also show high iron and aluminum levels, in the absence of any direct human influence. While iron can have toxic effects at very high levels, there is no evidence to indicate that concentrations of iron commonly present in food or drinking water pose any hazard to human health (Health Canada, 2006). The PWQO of 300 μg/L (= 0.3 mg/L) represents the solubility limit of iron in fresh waters. The concentrations observed on Lake Vernon are typical and within the range of natural water quality.

Cadmium is a natural element in the earth's crust and is contained in soils and rock including coal and mineral fertilizers. Cadmium can enter the environment from various human sources including smelting and refining of other metals such as zinc, lead and copper, coal combustion, and acid mine waste, and is contained in batteries, pigments, metal coatings and plastics. The low levels of cadmium present in fresh waters means that analysis is highly subject to contamination during the sampling process. We note that cadmium has only been tested in 2006, and may not reflect accurate concentrations (Health Canada, 2006). We recommend that cadmium be sampled again,

and that field and laboratory blanks be submitted to the lab at the same time to assess whether or not sample contamination has influenced the results.

Recommendation: **We recommend that cadmium be sampled again, and that field and laboratory blanks be submitted to the lab at the same time to assess whether or not sample contamination has influenced the results.**

The Lake Vernon Plan (French Planning Services, 2003) recommended that the Association continue to support the District Municipality of Muskoka's Water Quality Program by conducting water quality monitoring for those years that the District does not do it. We suggest, however, that additional monitoring of general water chemistry is not required for Lake Vernon because there are no significant changes in any of the parameters over the past ~25 years for which data are available, and sampling under the present District Municipality of Muskoka's Water Quality Monitoring Program is conducted approximately every 2 years, providing good baseline data that are necessary to characterize overall water quality conditions in Lake Vernon and to identify many potential water quality issues.

Recommendation: We suggest that any citizen-based monitoring program for Lake Vernon not duplicate efforts of the District by monitoring general water chemistry parameters.

2.2 Nutrients and Productivity

In most softwater lakes on the Precambrian Shield, algal growth is controlled by the concentration of phosphorus in water, which is the limiting nutrient in many of these lakes including Lake Vernon. The Ministry of the Environment's interim Provincial Water Quality Objective (PWQO) for total phosphorus states that average concentrations for the ice-free period should not exceed 20 μg/L to avoid nuisance growth of algae in lakes (MOE, 1994).

The mean total phosphorus concentration (1997-2006) in Lake Vernon is 10.5 μg/L, which is below the PWQO and indicative of low to moderate productivity. This average includes data from all available sources including the District's Lake System Health Program (see Section 3.1) and the MOE's Lake Partner Program (see Section 3.2). We note that there have been submissions to the MOE's Lake Partners for Lake Vernon from three sites in the lake (North Bay, main basin and Hunter's Bay) in 1995, 1996, 2002 and 2004.

The Lake Vernon Plan (French Planning Services, 2003) identified phosphorus enrichment from development as a primary issue of concern for water quality and recommended that up-to-date information on current development, occupancy rates and capacities be reviewed and included in the Water Quality Model that was being updated for the District at the time of the Lake Plan's production. The revised Recreational Water Quality Model was completed in 2005 by Gartner Lee Limited to inform the policy and planning with respect to shoreline development and phosphorus concentrations, as described in Section 4. The Recreational Water Quality Management report (GLL 2005) is available online (www.muskokawaterweb.ca) and contains detailed information used

in the development of the water quality model including shoreline development numbers for Lake Vernon.

Briefly, the Recreational Water Quality Model was used to:

1. Determine 'natural' phosphorus loads and concentrations to more than 500 lakes and rivers in Muskoka (including Lake Vernon);
2. Assess the sensitivity of area lakes to increased phosphorus loads;
3. Establish the amount of shoreline development (capacity) that could be sustained without degrading water quality; and
4. Provide recommendations for policy and planning.

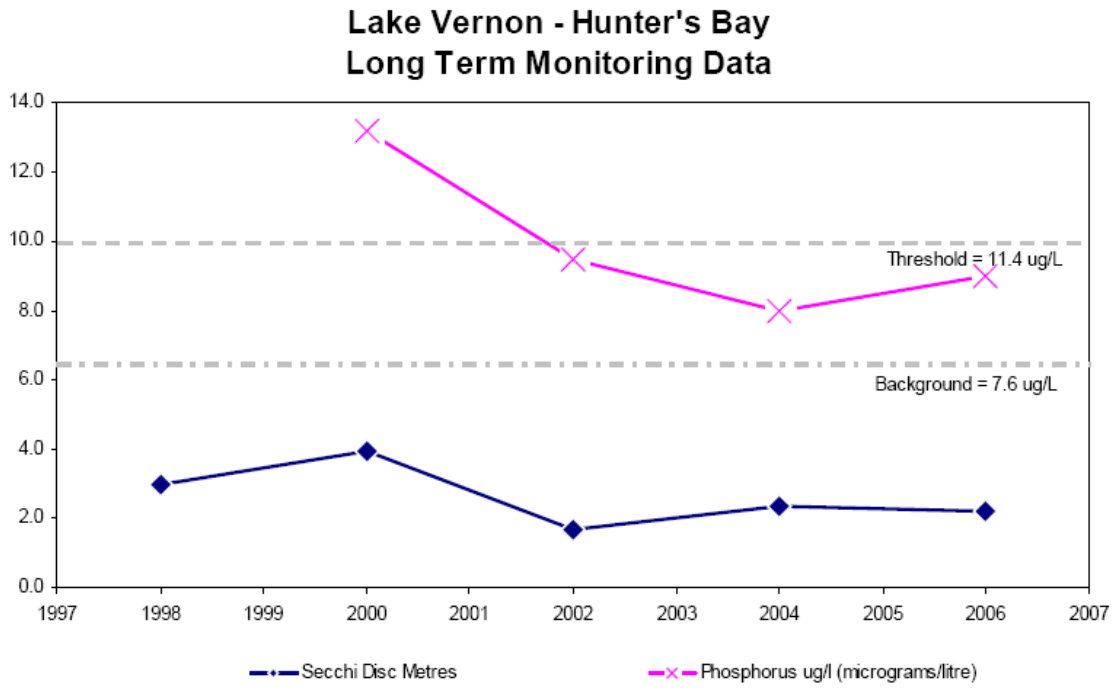
Results of the model indicated that natural phosphorus concentrations (in the absence of human sources) in Lake Vernon were estimated to be 7.6, 7.4 and 12.4 μg/L in Hunter's Bay, the main basin and North Bay (north of Big Island), respectively. Due to human sources of phosphorus from development in the watershed (including shoreline development), the recent phosphorus concentration (2001-2006) is approximately 2 μg/L higher in Hunter's Bay and the Main basin. Interestingly, recent measured phosphorus (2001-2006) in North Bay is 0.2 μg/L lower than the modeled background concentration. This may reflect the relative insensitivity of this basin to human sources of phosphorus, or variance in analytical results but it is more likely part of a regional scale decline in lake water phosphorus concentrations observed in Ontario. The cause of this decline is not fully understood and is being investigated by the scientific community, but may be due to a combination of acid rain and climate change (Paterson, DESC, Pers. Comm.).

Figure 1 illustrates trends in measured phosphorus concentrations in relation to natural (background), concentrations and the individual threshold value for Hunter's Bay, North Bay and the main basin of Lake Vernon. The threshold values are calculated as a 50% increase over modelled background values in the absence of human influence and are 11.4, 18.6 and 11.1 μg/L for Hunters Bay, North Bay and the Main basin respectively. The "Background + 50%" concentration is recommended as a "trigger" for determining whether or not phosphorus concentration from human activities may threaten recreational water quality Environment Canada, 2004; Gartner Lee Limited, 2005) and as a revised PWQO for total phosphorus by the Ontario Ministry of the Environment. Implications of threshold values are further discussed in Section 3.1.

Figure 1 also includes Secchi depth measurements since 1998. Secchi depth data collected by Mr. Doug Jaggar are provided in Figure 2. Secchi depth is a measure of water clarity and can be used as an indicator of changes in water quality related to algal productivity. For example, long-term trends of decreasing Secchi depth can indicate an increase in algal production. Available Secchi depth data do not indicate any long-term trends that would suggest changes in algal productivity in Lake Vernon. There are, however, some annual differences that likely reflect variability in weather conditions from year to year. Secchi depth can be influenced by a large number of factors that act to affect water clarity such as turbidity (e.g., from river or stream inputs), dissolved organic carbon and iron. Weather patterns, particulary precipitation, can strongly influence turbidity and the concentrations of dissolved organic carbon and iron. There are only minor differences in water

clarity between different locations in Lake Vernon, but overall, annual patterns are similar between them.

Figure 1. Phosphorus and Secchi Depth Trends in Lake Vernon (source: DMM, 2006)



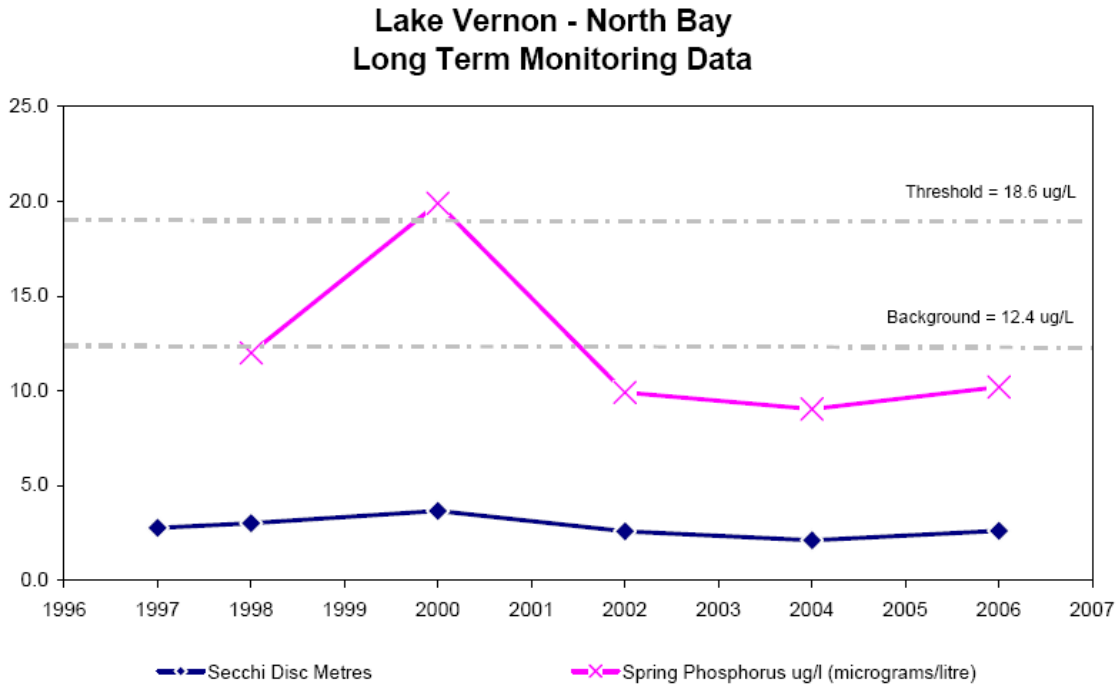


Figure 1 (continued). Phosphorus and Secchi Depth Trends in Lake Vernon (source: DMM, 2006)

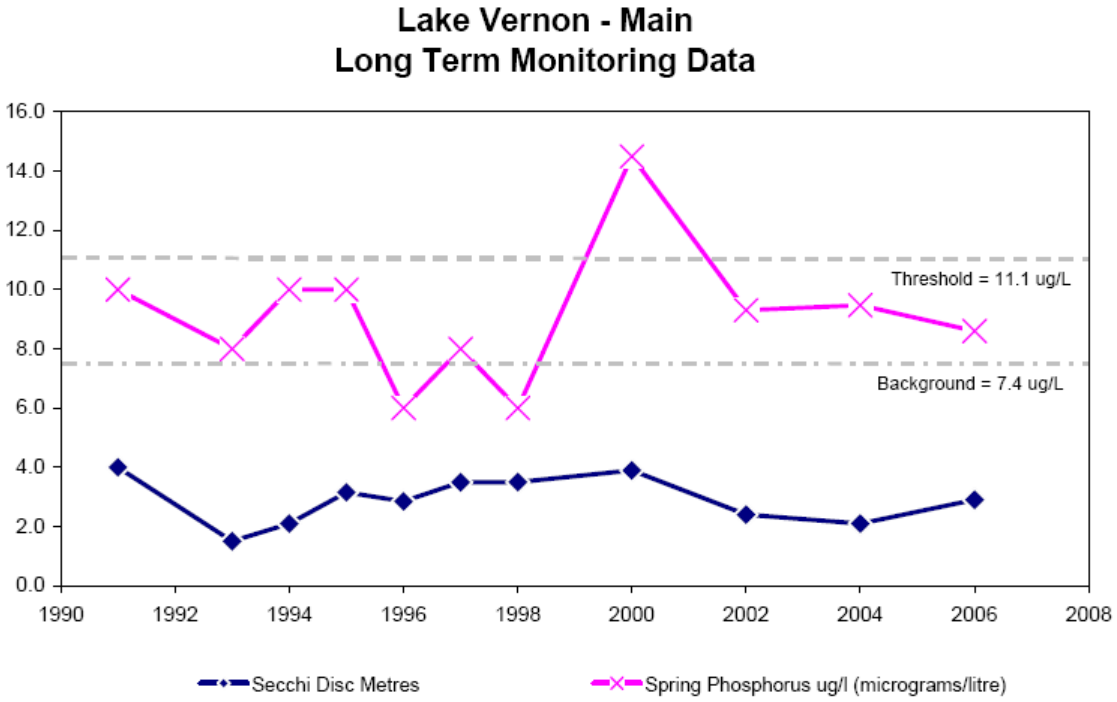
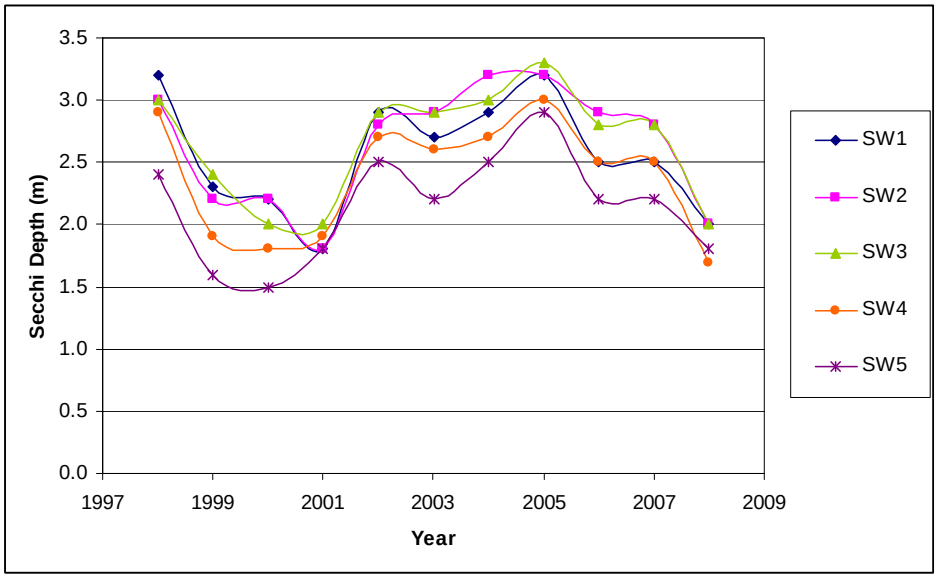


Figure 2. Secchi Depth in Lake Vernon (source: Doug Jaggar)



SW1 - West side of Big Island, SW2 - Between Gallauger Island and Camp Wabanaki, SW3 - Mouth of Big East River, SW4 - Peacock Bay, SW5 - Mouth of Hoodstown Rapids

2.3 Contaminants in Sport Fish

The Lake Vernon Plan (French Planning Services, 2003) stated that there was no known monitoring for chemical pollutants in Lake Vernon. Since that time, however, the District Municipality of Muskoka has sampled for trace metals (Table 1). The Ontario the Ministry of the Environment (MOE) monitors contaminant levels in sport fish as biological indicators of contaminants in the environment. Levels of persistent toxic contaminants and associated consumption advisories set by the MOE were reviewed for sport fish from Lake Vernon. In the *Guide to Eating Ontario Sport Fish* (OMOE, 2007), consumption advisories have been recommended for lake trout, smallmouth, largemouth and rock bass and northern pike due to mercury contamination (Table 2). The consumption advisories in Table 2 are specific to the length of the fish because longer, older fish have greater concentrations of mercury in their tissues due to bioaccumulation over time. Consumption restriction advisories for mercury begin at 0.26 ppm for the sensitive population (i.e., children and women of child-bearing age) and 0.61 ppm for the general population.

Mercury levels in lake trout and smallmouth bass from Lake Vernon have declined considerably since 1977 (see Figure 3). This is a commonly observed trend in Ontario resulting from the reduced use of mercury by industry since the late 1960s and early 1970s. Atmospheric deposition of mercury from man-made (i.e., coal burning) and natural sources still exists, however, and mercury remains the contaminant of concern restricting consumption of sport fish in most inland Ontario lakes, including Lake Vernon.

Other contaminants including PCBs, mirex/photomirex and pesticides have also been analyzed in lake trout, largemouth bass and smallmouth bass from Lake Vernon in recent years (2003 and 2004). PCBs, DDT and its metabolite pp-DDE were detected in lake trout and smallmouth bass, but in very low concentrations that are below the consumption guidelines. The pesticides chlordane, cis-nonachlor and trans-nonachlor were detected in lake trout, but only at trace levels.

Given that Lake Vernon sport fish were recently analyzed for contaminants (2003 and 2004) and that no significant new concerns were identified, the OMOE would not likely consider analyzing additional samples from the lake in the near future (Emily Awad, Sport Fish Unit, OMOE, pers. comm.). It would be useful, however, to have the MOE repeat the sampling at ten-year intervals. In practice, the MNR generally sample the fish and MOE complete the analyses and publish the data.

Further to examining the sport fish contaminants data, we consulted the Federal Contaminated Sites Inventory (FCSI), a database that reports information on known federal contaminated sites, to determine whether any such sites exist in the Lake Vernon watershed that may pose a risk to water quality. There are no reported federal contaminated sites in the Lake Vernon Watershed.

Recommendation: We recommend that members of the Lake Vernon Association and users of Lake Vernon be advised of the existing consumption guidelines for sport fish from Lake Vernon.

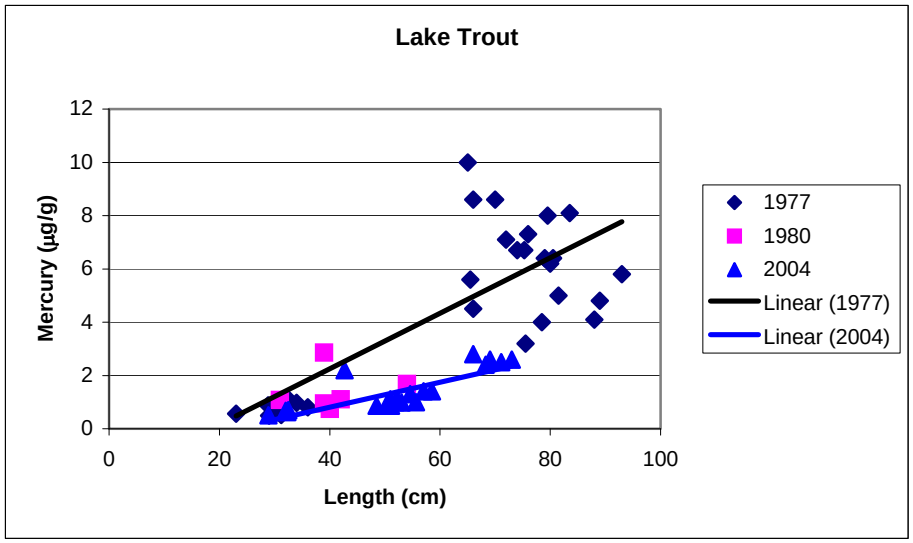
Recommendation: We recommend that the Sportfish Sampling program be repeated at ten year intervals to track changes in contaminants in sport fish.

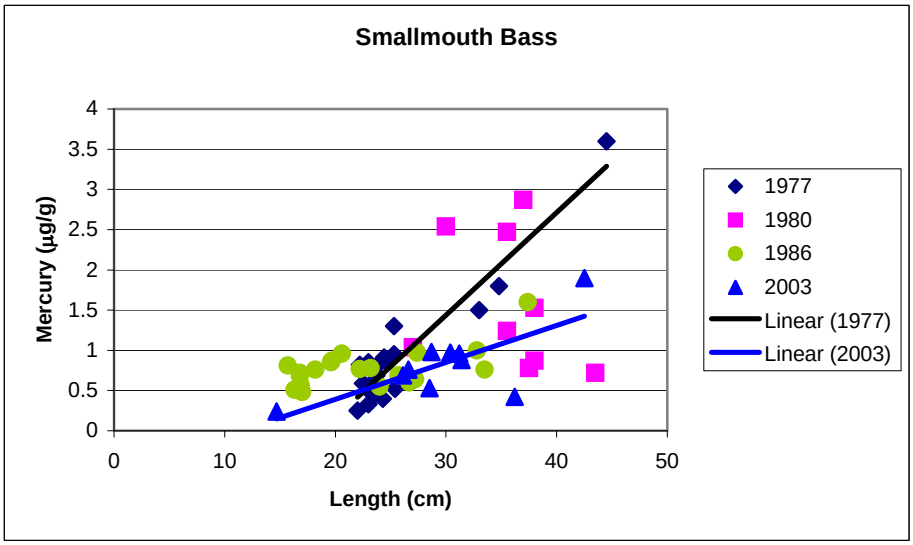
Table 2. Consumption Advisories for Sport Fish from Lake Vernon (from MOE, 2007).

Fish Species	Sample Year	Consumption Advisory (meals per month)
Lake Trout	2004	8 (15–20) / 4 (20–25) / 2 (50–60) / 0 (60–75>) 4 (20–25) / 0 (25–75>)
Northern Pike	1991	4 (50–75>) / 2 (75>) 0 (50–75>)
Largemouth Bass	2003	8 (15–20) / 4 (30–35) / 2 (35–40) 8 (15–20) / 4 (20–30) / 0 (30–40)
Smallmouth Bass	2003	8 (15–20) / 4 (20–25) / 2 (25–30) 4 (15–20) / 0 (20–30)
Rock Bass	2003	4 (15–20) 0 (15–20)
Pumpkinseed	2003	8 (15–20) 8 (15–20) / 4 (20–25)
Length (cm):		15 20 25 30 35 40 45 50 55 60 65 70 75>

Note: Shaded Advisories are for the sensitive population (children and women of child-bearing age).

Figure 3. Changes in Mercury Concentrations in Lake Vernon Sport Fish





2.4 Bacteria

Escherichia coli (*E. coli*) is commonly found in the intestines of warm-blooded animals, including humans, and is considered to be the most reliable and suitable indicator of fecal contamination in fresh water systems. There are many different types of *E. coli*; most are harmless to people, but there are some that can cause enteric symptoms such as diarrhoea, cramps, nausea, and vomiting.

The Simcoe Muskoka District Health Unit has monitored bacteria levels at Avery and Hutcheson Beaches. In the summers of 2005-2007, bacteria levels were maintained below the Provincial

Water Quality Objectives (geometric mean *E. coli* level of 100 colony forming units/100 mL as determined from a minimum of 5 samples). Monitoring results from the SMDH are provided in Appendix A for reference. Based on these results, bacteria levels are within the guideline values for recreational use. We note, however, that all **untreated surface water is considered unsafe for drinking**.

GLL is not aware of any other bacteriological data for Lake Vernon, but local residents may have had samples tested privately by the Health Unit.

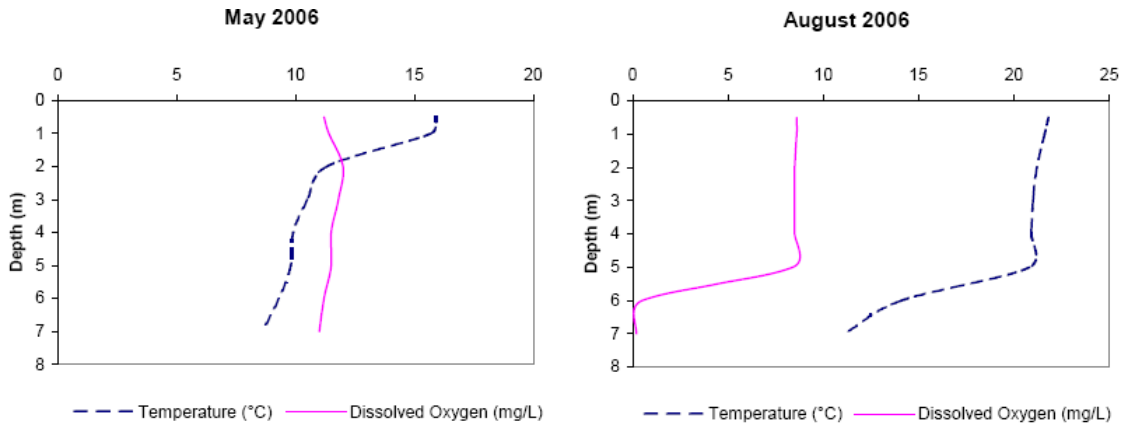
2.5 Dissolved Oxygen

Dissolved oxygen profiles were most recently measured in Hunter's Bay, the main basin and North Bay by the District in the spring and late summer of 2006 (Figure 3). The profiles indicate that in spring, the waters in Lake Vernon are well oxygenated to the bottom, but decline in bottom waters over the summer months. This decline in dissolved oxygen is typical in temperate lakes that thermally stratify. In early spring, after ice off, the water column is nearly uniform in temperature and is easily mixed by wind. This allows the entire water column to be oxygenated from oxygen in the atmosphere. As summer progresses, the surface waters warm resulting in a layer of warm less dense water at the surface (epilimnion), with a cooler, denser layer below (hypolimnion). The decay of organic matter in the bottom waters consumes oxygen, and the density difference between the two layers prevents mixing of the bottom waters with the surface. As a result, oxygen levels decline in bottom waters, as this dense layer of water cannot be mixed to the surface and be replenished with oxygen from the atmosphere. Bottom waters do not get reoxygenated until the surface waters cool sufficiently in the fall, breaking down the density barrier and allowing the water column to mix (fall turnover).

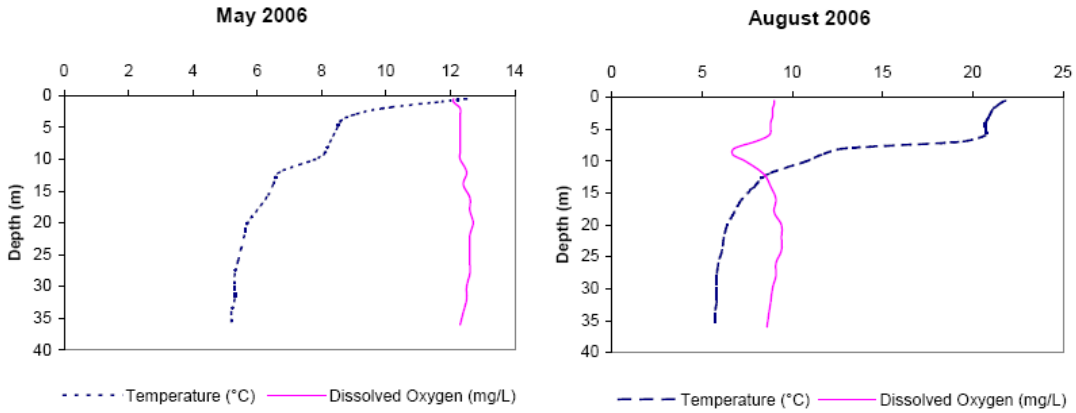
Lake Vernon is considered as a Lake Trout Lake by the Ontario Ministry of Natural Resources (OMN). Recently, the MNR has proposed a new guideline to protect Ontario's lake trout habitat that is based on Mean Volume Weighted Hypolimnetic Dissolved Oxygen concentrations (MVWHDO). Essentially the mass of oxygen is calculated for each 1 meter interval (of the hypolimnion) and the total mass is then divided by the volume of water in the hypolimnion. The reason for volume weighting is to minimize the impact that small volumes of oxygen poor water near the bottom of the lake might have when considering oxygen habitat suitability. To protect lake trout habitat the MVWHDO should remain above 7.0 ppm. Although this is at present proposed as a regulatory guideline or criterion, many jurisdictions currently set development guidelines based on this number. Based on the dissolved oxygen profiles in Figure 4, oxygen levels in the North Bay decline to about 5 mg/L in the hypolimnion and are therefore below the proposed guideline of 7 mg/L to protect lake trout habitat. The main basin of Lake Vernon, however, has relatively high oxygen levels in the hypolimnion and this area of the lake would provide suitable habitat for lake trout. The bottom waters of Hunter's Bay decline to very low levels that would indicate anoxia (lack of oxygen). It should be noted that this basin is relatively shallow, and would not likely constitute prime lake trout habitat.

Figure 4. Dissolved Oxygen and Temperature Profiles for Lake Vernon (Source: DMM, 2006)

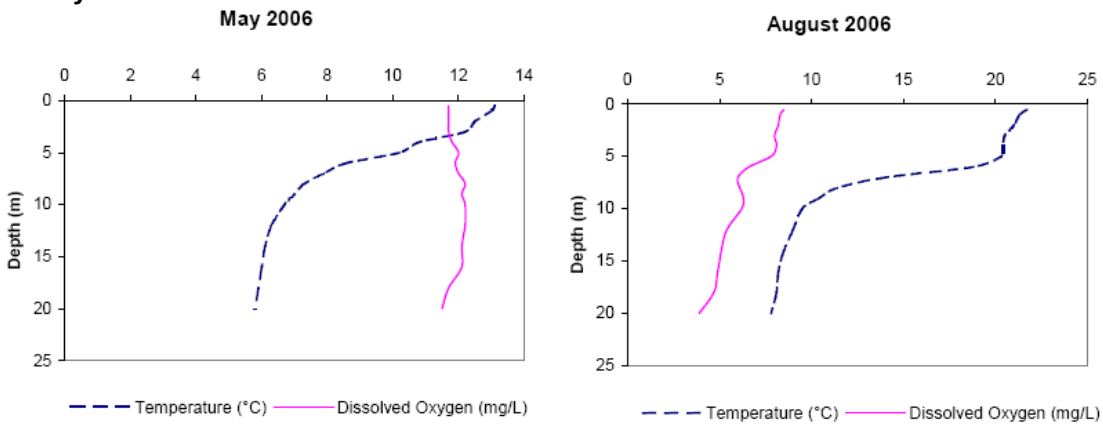
Hunter's Bay



Main Basin



North Bay



3. Protecting Lake Vernon's Water Quality – Existing Programs

There are numerous existing programs and initiatives to protect water quality and the overall health of Muskoka area lakes, including Lake Vernon. We strongly recommend that the Lake Vernon Association take full advantage of these existing initiatives and suggest that these form the foundation for Lake Vernon's Water Quality Strategy. Below, we outline some of these key programs and initiatives for consideration.

3.1 District Municipality of Muskoka – Muskoka Water Strategy

The District Municipality of Muskoka carries out an innovative and effective recreational water quality program which is, to our knowledge, the most advanced program in the country. The District has maintained a water quality program since 1980 in recognition of the important economic link of tourism and water quality. Muskoka was the first municipality in Canada to include protection of recreational water quality in its Official Plan. The District is also able to rely on the resources and expertise of MOE's Dorset Environmental Science Centre, which is one of the leading freshwater research centres in North America. Dorset scientists developed many of the models and techniques used in Muskoka and their scientists have assisted the District since at least the mid 1980s.

In January 2003, the District Municipality of Muskoka's developed its **Muskoka Water Strategy,** which integrates several initiatives to protect Muskoka's water resources, including:

1. The Lake System Health Program,
2. Communication and community involvement, including the Muskoka Water Web site,
3. Initiatives of The Muskoka Watershed Council, such as the Muskoka Watersheds Report Card and Best Practices program, and
4. Broader water initiatives, such as source water protection, storm water management and watershed inventories.

3.1.1 Lake System Health Program

The Lake System Health Program (LSHP) is part of the District of Muskoka's Official Plan, as Amendment No. 32 (OPA 32) consolidated in November 2007, and is a component of the Districts "Muskoka Water Strategy" (approved in 2003). The LSHP evolved from the DMM's Recreational Water Quality Model (GLL, 2005), which recognizes that lakes are different from each other, and that some are more sensitive to development than others (due to their ability to receive and assimilate phosphorus).

The LSHP is based on the fact that phosphorus is the single most significant impact on water quality for most recreational lakes in Ontario. The Muskoka Water Quality Model (GLL, 2005) identifies

lakes according to phosphorus loading **sensitivity** and where they are in relation to each lake's **threshold**. Sensitivity and thresholds are developed using the water quality model and measured phosphorus concentrations, and are defined in the following way:

Sensitivity:

- Lakes of **low sensitivity** respond minimally to the input of phosphorous.
- Lakes of **moderate sensitivity** have some ability to receive phosphorus without a negative impact on water quality.
- Lakes deemed **highly sensitive** to phosphorus loading have the potential for development to input phosphorus to a level that that cannot be sustained

Thresholds:

- A lake is determined to be "**over threshold**" when phosphorus loading to a waterbody exceeds 50% of the undeveloped phosphorus load.

Lake Vernon is identified as **moderately sensitive** to phosphorus inputs and is presently under threshold for all basins (Figure 1). The threshold phosphorus concentrations for Hunter's Bay, the Main basin and the North basin are 11.4, 11.1 and 18.6 μg/L, respectively. Due to its moderate sensitivity designation, shoreline development on Lake Vernon is subject to site plan control or development permitting to protect water quality related to phosphorus.

Recreational water quality monitoring is an important component of the LSHP and is being used to establish a long-term record of water quality parameters to identify trends and potential issues. This field-based program monitors approximately 192 sample locations in Muskoka area lakes on a rotating basis depending upon development pressures and the specific characteristics of the lake. The sampling program measures:

- Secchi depth (a measure of water clarity)
- phosphorus concentrations (monitored in conjuction with the MOE's Lake Partner Program)
- dissolved oxygen and temperature depth profiles, and
- a number of chemical parameters (e.g., pH, conductivity, dissolved organic carbon, alkalinity, nitrates, sulphate, chlorine and metals).

Results for the above parameters were included in the water quality characterization (Section 2) of this report. We note that the District provides data sheets and annual reports that summarize their monitoring results on an annual basis, which can be accessed online from the Muskoka Water Web (www.muskokawaterweb.ca), by emailing watershed@muskokaheritage.org, or by calling (705) 645-7393.

Recommendation: Based on our discussions with the District, a citizen-based program to measure water clarity (as Secchi depth) at regular 2-week intervals over the ice-free season is recommended to support the monitoring initiatives of the LSHP and the Lake Partner Program.

3.1.2 Communication and Community Involvement

The Muskoka Water Web (www.muskokawaterweb.ca) is an excellent source of information regarding all aspects of water quality in Muskoka, including stewardship programs, environmentally-friendly practises, and current District initiatives.

Recommendation: We recommend that members of the Association be advised of Muskoka Water Web and that this tool be incorporated into any education-type initiatives in the Lake Vernon Water Quality Strategy.

3.1.3 Shoreline Land Use Survey

In 2002, a shoreline land use survey was initiated for lakes in Muskoka and surveys have now been completed for 42 lakes. The surveys document all man-made structures, condition of the shoreline and general land-use adjacent to the lake. This information is available to lake associations, Area Municipalities and other interested parties for planning purposes, and the District is willing to support participation by the LVA in this program.

Recommendation: Given the importance of shoreline conditions to general water quality, we recommend that the Lake Vernon Water Quality Strategy consider participation in the Shoreline Land Use Survey.

3.1.4 Biological Monitoring Program

In 2003, under direction from scientists at the MOE's Dorset Environmental Science Centre and Environment Canada's EMAN (Ecological Monitoring and Assessment Network), a Biological Monitoring Program was developed for lake associations interested in becoming more involved in lake monitoring and broader lake planning. Each year, interested lake residents are trained by summer staff to undertake volunteer monitoring programs that are based on standard protocols such as Plantwatch, Frogwatch, Forest Health and Benthic Analysis. The District provides ongoing support to meet the needs of individual lake associations.

Recommendation: We recommend programs under the Biological Monitoring Program be considered in the Lake Vernon Water Quality Strategy.

3.2 MOE's Lake Partner Program

Phosphorus is the nutrient that controls the growth of algae in Ontario Lakes. For this reason, many attempts to assess the development capacity of a lake are based on phosphorus concentrations. At present there are Provincial Water Quality Objectives (PWQOs) that specify concentrations which should not be exceeded in order to avoid nuisance algal growth.

Steady-state or long-term mean phosphorus concentrations can be estimated using mass balance models such as the District of Muskoka's Recreational Water Quality Model and the Ontario Ministry of the Environment's Lakeshore Capacity Model. These estimates can be used to consider the capacity of the lake to support shoreline development without having to take numerous phosphorus measurements over many years. For many reasons, it is also important to obtain precise, measured data for any lake to establish the long-term mean total phosphorus concentrations. It is useful to have the actual measured data to compare with any modelled values since models can be in error if the inputs are not robust. Measured values in this way can be used to add confidence to the modeled numbers. In addition, long-term measurement records can tell us instantly if the lake has exceeded the PWQO for phosphorus e.g. are the concentrations above 20 μg/L? Finally, it is useful to collect data each year to assess whether or not there are trends in the phosphorus concentrations in the lake that are the result of influences other than human activity in the watershed. Modeled estimates would change only if the amount of human activity in the watershed changed or if there were recent updates to the model assumptions.

Since precise, phosphorus concentrations measured at spring turnover each year can be considered the gold standard for monitoring, the Lake Partner Program uses extremely precise methods to analyze phosphorus in water samples at the Dorset Environmental Science Centre (DESC). The resulting data are approximately 10 times more accurate than the analysis provided by other government or private laboratories. These precise data allow the observation of differences between years and hence the identification of any increases (or decreases) in the lake's phosphorus concentrations.

The LPP is not a minimal program that can be enhanced by further monitoring. It reflects a comprehensive science design that, if followed, will provide all of the trophic status information required to make informed decisions about the potential effects of algal nutrients (phosphorus) in a lake. Participation in the Lake Partner Program will yield defensible long term mean values after 3 or 4 years and track changes in the trophic status of the lake through time.

Recommendation: Citizens have participated in the Lake Partner Program (LPP) in 1995, 1996, 2002, and 2004. There are no reported LPP data for 2006 and results for the 2008 sample year are not yet available. We therefore recommend that the LPP co-ordinator be contacted to 1) determine whether there were participants in the program in 2008 and if not, would the program accept new partners to the program, and 2) if there remain active partners, could the co-ordinator contact the Lake Vernon Environmental Association if the partners are unable to continue their participation. We note that the MOE is not able to release the names of present or past Lake Partners (A. DeSellas, Lake Partner Program).

4. Summary and Next Steps

Water quality monitoring in Lake Vernon has been conducted over the past ~25 years for general water chemistry and various contaminants (from sport fish contaminant monitoring), with a focus on phosphorus and dissolved oxygen concentrations. These data provide an excellent source of information to identify water quality issues, and based on our assessment of the data, Lake Vernon exhibits excellent recreational water quality, with no major causes for concern. We therefore recommend that the Water Quality Strategy for Lake Vernon include citizen-based monitoring and education initiatives that aim to protect and enhance water quality that are founded on established programs under the District's **Muskoka Water Strategy**.

The next step to completing the Water Quality Strategy is to communicate the findings of this report to area residents and executives of the Lake Vernon Environmental Association (LVEA) and the Lake Vernon Association (LVA) at the LVA Annual General Meeting on August 30th, 2008. This meeting will also serve as a forum for residents to express their opinions and concerns regarding water quality and potential programs to be included in the strategy (Element 2). Finally, GLL will consider public feedback and develop the Lake Vernon Water Quality Management Plan (Element 3) to be presented to the LVEA and LVA at their meeting in October, 2008.

Report Prepared By:

Tammy Karst-Riddoch, Ph.D.
Aquatic Scientist

Report Reviewed By:

Neil J. Hutchinson, Ph.D.
Lead Consultant

5. References

French Planning Services, 2003:

Lake Vernon Plan. Report prepared for the Environment Committee, Lake Vernon Association, May 6, 2003. 174 pp.

Gartner Lee Limited (GLL), 2005:

Recreational Water Quality Management in Muskoka. Report prepared for The Department of Planning and Economic Development, District Municipality of Muskoka.

Ontario Ministry of the Environment, 2007:

Guide to Eating Ontario Sport Fish 2007-2008, 24th edition, Queen's Printer for Ontario.

Appendix A

Simcoe Muskoka District Beach Monitoring Results

SIMCOE MUSKOKA DISTRICT HEALTH UNIT

2005 **Core Team Inspector** **Core Team Area** Muskoka

Municipality Town of Huntsville
Beach Hutcheson Beach

Environmental Assessment Date: May 20, 2005
Number of Samples required: 5

Contact Name Judy Vanderveer
Contact Phone 789-6421 x23
Contact Fax 789-8943

yyyymmdd	Jan 01	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10	
CodeDate	Real Date	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	G_Mean
20050615	Jun 15	90	50	80	100	60						73.6
20050621	Jun 21	9	20	30	60	10						20.0
20050627	Jun 27	9	10	9	10	9						9.4
20050705	Jul 05	70	120	130	30	40						66.6
20050712	Jul 12	20	40	20	10	9						17.0
20050720	Jul 20	1	10	1	1	10						2.5
20050726	Jul 26	20	50	1	10	20						11.5
20050802	Aug 02	10	30	10	30	1						9.8
200508098	Aug 09	30	1	10	10	30						9.8
20050816	Aug 16	9	10	9	9	10						9.4
20050823	Aug 23	20	1	1	10	1						2.9
20050829	Aug 29	20	20	20	10	10						15.2
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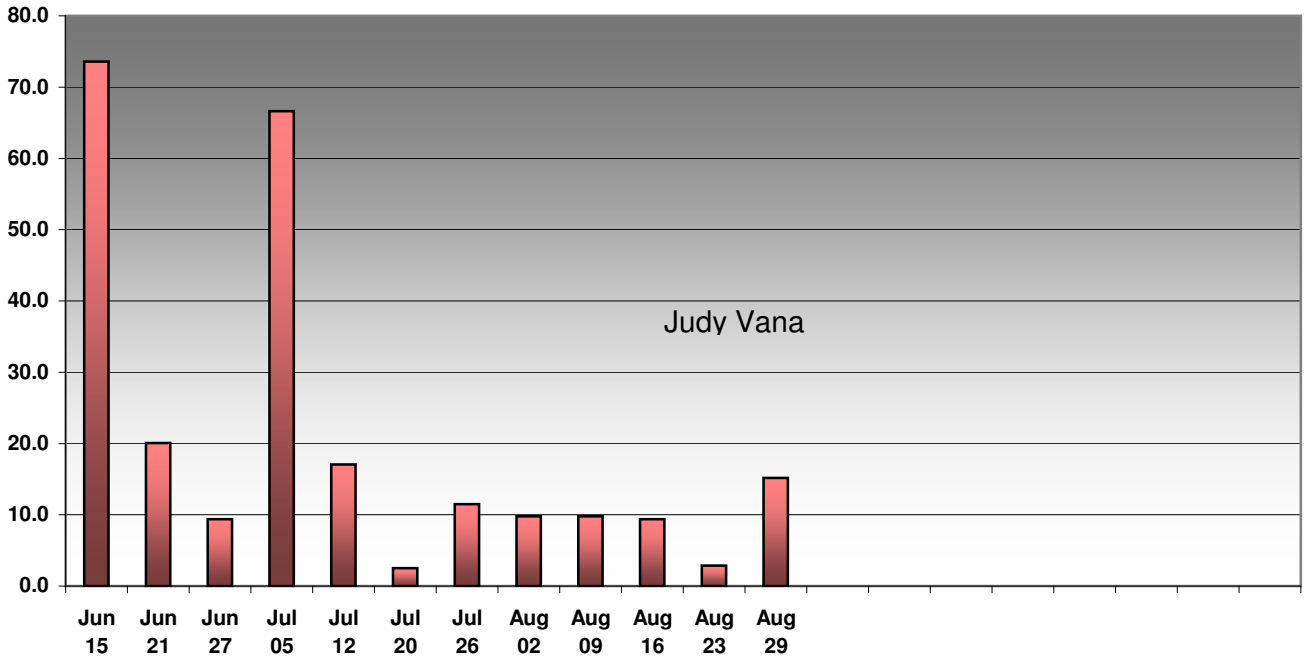
60



SIMCOE MUSKOKA DISTRICT HEALTH UNIT

Sampling Time Enter 1 for am 2 for pm	Water Temperature in Celsius Enter only the Number	Rainfall in last 24 or 48 hrs. Enter 24 or 48 1 rain now 0 no rain	Wind Direction 1 Toward 2 Away 3 Parallel 0 No wind Enter the #	Sunlight 1 Bright 2 Intermed. 3 Dull Enter the #	Bather Density 1 Light 2 Medium 3 Heavy 0 No bathers Enter the #	Waterfowl affecting site 1 Yes 0 No Enter the #	Wave Action 0 None 1 Medium 2 Heavy Enter the #	Water Clarity 1 <100 cm 2 >100 cm Enter the #	Algae Present 1 Yes 0 No Enter the #

AM_PM	TEMP	RAIN	WIND	SUN	BATHERS	BIRDS	WAVES	CLARITY	ALGAE
PM	23.0	24.0	1.0	3.0	1.0	1.0	0.0	2.0	0.0
1.0	19.0	0.0	1.0	2.0	0.0	0.0	2.0	2.0	0.0
1.0	24.0	0.0	0.0	1.0	0.0	1.0	0.0	2.0	0.0
2.0	23.0	1.0	0.0	3.0	0.0	1.0	0.0	2.0	0.0
1.0	26.0	0.0	0.0	1.0	1.0	1.0	0.0	2.0	0.0
1.0	23.0	1.0	0.0	3.0	0.0	0.0	0.0	2.0	0.0
	23.0	0.0	0.0	3.0	0.0	0.0	0.0	2.0	0.0
1.0	24.0	0.0	1.0	1.0	0.0	1.0	1.0	2.0	0.0
	23.0	0.0	0.0	1.0	0.0	1.0	0.0	2.0	1.0
	19.0	24.0	1.0	3.0	0.0	0.0	0.0	2.0	0.0
	22.0	24.0	0.0	2.0	0.0	0.0	0.0	2.0	1.0

NOTES:

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Tel: 721-7520
Toll free: 1-877-721-7520
www.simcoemuskokahealth.org
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2006 Beach Reporting History

Town of Huntsville

About this report:

This report summarizes the sampling results and posting history of each beach that was monitored by the health unit in this municipality.

Included in this report are:
1. A chart of geometric means of Escherichia coli (E. coli) calculated from the individual sample results.
2. A summary of postings and closures issued (if any).
3. An appendix of all individual sample results for each beach.

Report notes:

- All sample results are reported by the lab in *cfu* (colony forming units).
- *Geometric mean* is a type of average that minimizes the effect of very high or very low numbers.
- The Ministry of Health and Long-Term Care (MOHLTC) advises that when a geometric mean of 100 cfu or greater of E. Coli is reported, the Medical Officer of Health may consider issuing an advisory.
- A blank posting history section indicates no posting for this season.

Background:

Beach water quality monitoring usually begins mid June and continues to the end of August.

An ***advisory*** is a warning to swimmers but it is not a beach ***closure***. During an ***advisory***, a beach is posted with warning signs when the water contains levels of bacteria that indicate there may be an increased risk of developing minor skin, eye, ear, nose and throat infections and stomach disorders. If you choose to swim during an ***advisory*** it may be prudent to avoid ducking your head or swallowing the water.

A beach ***closure*** is issued when a catastrophic event occurs or an immediate risk to health is present. Sewage spills or toxic chemical releases are examples. Beach ***closures*** are rare.

During the sampling season, advisories and closures are posted on the health unit's website (www.simcoemuskokahealth.org).

Contact Information:

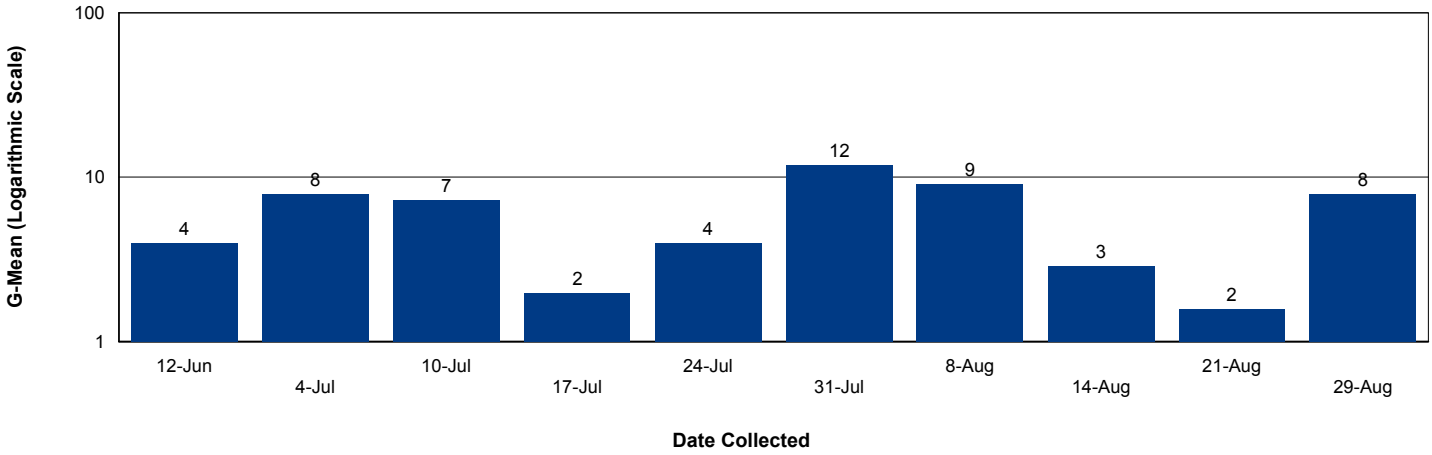
Area Inspector: Craig Dale
Phone: 705-721-7520 Ext. 7222

Program Manager: Jerry Capko
Phone: 705-721-7520 Ext. 7370

AVERY BEACH PARK

Geometric Mean of E. Coli by Date Sample Collected

For AVERY BEACH PARK



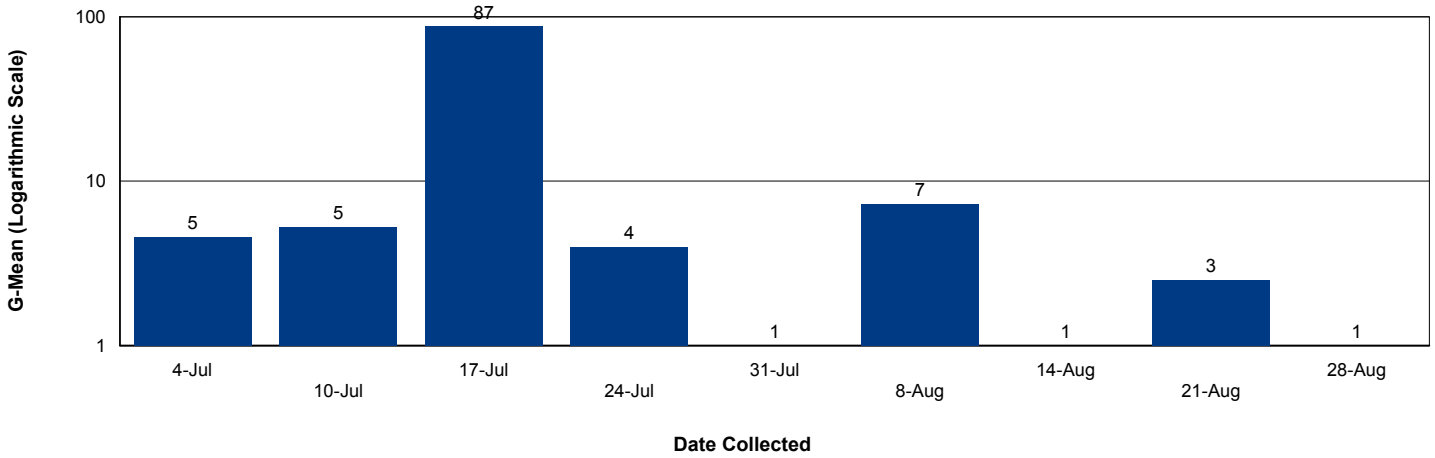
2006 Beach Posting History

Posting	Date Posted	Date Lifted

HUTCHESON BEACH

Geometric Mean of E. Coli by Date Sample Collected

For HUTCHESON BEACH



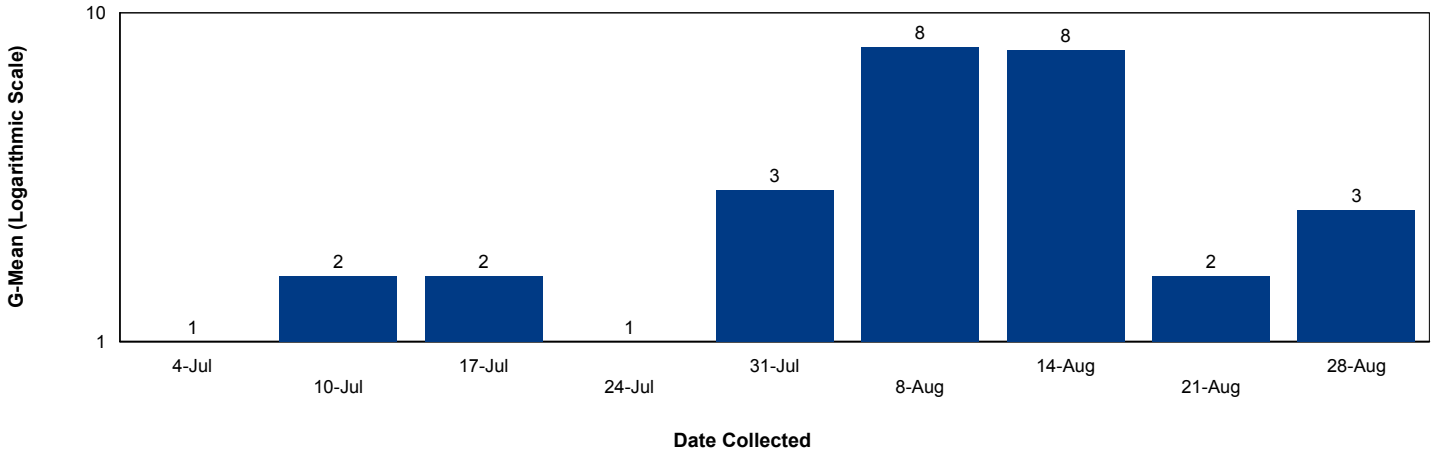
2006 Beach Posting History

Posting	Date Posted	Date Lifted

LONGS LAKE BEACH

Geometric Mean of E. Coli by Date Sample Collected

For LONGS LAKE BEACH



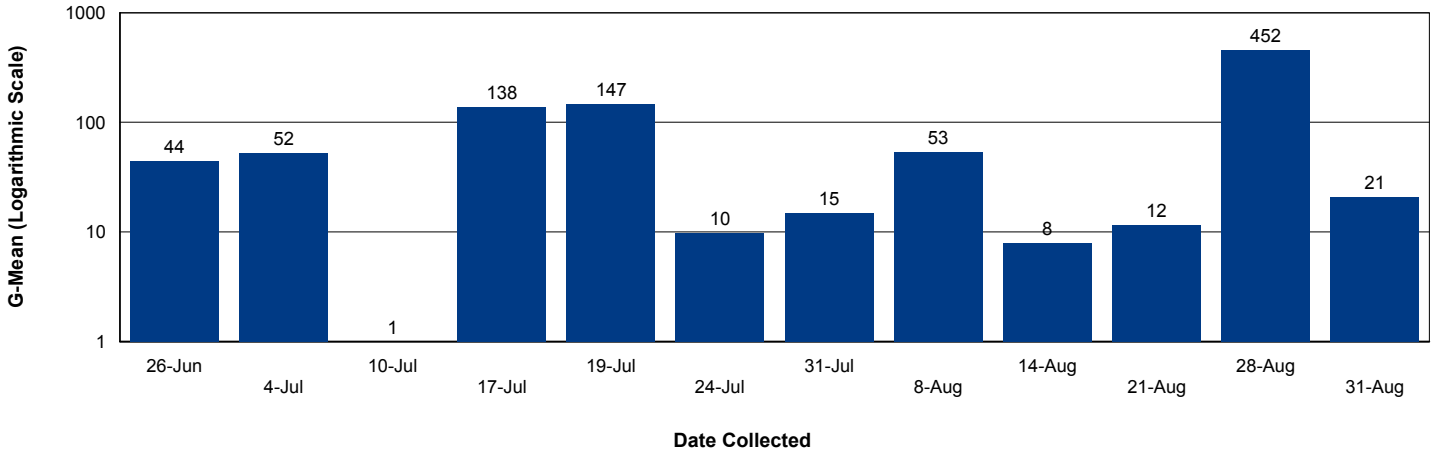
2006 Beach Posting History

Posting	Date Posted	Date Lifted

PORT SYDNEY BEACH

Geometric Mean of E. Coli by Date Sample Collected

For PORT SYDNEY BEACH



2006 Beach Posting History

Posting	Date Posted	Date Lifted
Advisory	18 - Jul	26 - Jul
Advisory	30 - Aug	1 - Sep

Appendix - Individual Sample Results: Town of Huntsville

AVERY BEACH PARK

Date	Individual Sample Results					GMean
12 - Jun	10	10	1	10	1	**3.98**
4 - Jul	1	10	10	30	10	**7.86**
10 - Jul	10	20	10	1	10	**7.25**
17 - Jul	1	1	1	30	1	**1.97**
24 - Jul	10	10	10	1	1	**3.98**
31 - Jul	40	30	10	1	20	**11.91**
8 - Aug	10	30	10	20	1	**9.03**
14 - Aug	1	20	1	10	1	**2.89**
21 - Aug	1	10	1	1	1	**1.58**
29 - Aug	10	1	10	30	10	**7.86**

HUTCHESON BEACH

Date	Individual Sample Results					GMean
4 - Jul	20	10	10	1	1	**4.57**
10 - Jul	20	20	1	1	10	**5.25**
17 - Jul	280	160	80	70	20	**87.12**
24 - Jul	10	1	10	1	10	**3.98**
31 - Jul	1	1	1	1	1	**1.00**
8 - Aug	10	1	10	10	20	**7.25**
14 - Aug	1	1	1	1	1	**1.00**
21 - Aug	1	10	10	1	1	**2.51**
28 - Aug	1	1	1	1	1	**1.00**

LONGS LAKE BEACH

Date	Individual Sample Results					GMean
4 - Jul	1	1	1	1	1	**1.00**
10 - Jul	1	1	1	1	10	**1.58**
17 - Jul	1	10	1	1	1	**1.58**
24 - Jul	1	1	1	1	1	**1.00**
31 - Jul	1	1	10	1	20	**2.89**
8 - Aug	30	1	10	10	10	**7.86**
14 - Aug	1	1	30	30	30	**7.70**
21 - Aug	1	1	10	1	1	**1.58**
28 - Aug	1	1	10	1	10	**2.51**

PORT SYDNEY BEACH

Date	Individual Sample Results					GMean
26 - Jun	120	80	30	20	30	**44.41**
4 - Jul	50	20	110	70	50	**52.13**
10 - Jul	1	1	1	1	1	**1.00**
17 - Jul	160	100	150	140	150	**138.19**
19 - Jul	140	260	150	210	60	**147.07**
24 - Jul	30	1	10	10	30	**9.79**
31 - Jul	10	40	90	1	20	**14.84**
8 - Aug	540	100	20	10	40	**53.35**
14 - Aug	30	10	10	10	1	**7.86**
21 - Aug	1	10	70	10	30	**11.60**
28 - Aug	140	720	570	550	600	**452.45**
31 - Aug	80	590	1	1	80	**20.67**

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2007 Beach Reporting History

Town of Huntsville

About this report:

This report summarizes the sampling results and posting history of each beach that was monitored by the health unit in this municipality.

Included in this report are:

1. All individual sample results for each beach.
2. A summary of postings and closures issued (if any).

Report notes:

- All sample results are reported by the lab in *cfu* (colony forming units).
- *Geometric mean* is a type of average that minimizes the effect of very high or very low numbers.
- The Ministry of Health and Long-Term Care (MOHLTC) advises that when a geometric mean of 100 cfu or greater of E. coli is reported, the Medical Officer of Health may consider issuing an advisory.
- A review of recorded data on beach water conditions is used to help predict improvements or deterioration of water quality.
- The duration of beach posting takes into account any available evidence and historical data that illustrates the behaviour of the beach
- A blank posting history section means no posting for this season.

Background:

Beach water quality monitoring usually begins mid June and continues to the end of August.
An ***advisory*** is a warning to swimmers but it is not a beach ***closure***. During an ***advisory***, a beach is posted with warning signs when the water contains levels of bacteria that indicate there may be an increased risk of developing minor skin, eye, ear, nose and throat infections and stomach disorders. If you choose to swim during an ***advisory*** it may be prudent to avoid ducking your head or swallowing the water.

A beach ***closure*** is issued when a catastrophic event occurs or an immediate risk to health is present. Sewage spills or toxic chemical releases are examples. Beach ***closures*** are rare.
During the sampling season, advisories and closures are posted on the health unit's website (www.simcoemuskokahealth.org).

Area Inspector: Craig Dale
Phone: 705-721-7520 Ext.7222

Program Manager: Jerry Capko
Phone: 705-721-7520 Ext. 7370

AVERY BEACH PARK

Date	# samples	Individual Sample Results					GMean
18-Jun-07	5	20	10	10	10	10	**11.49**
25-Jun-07	5	1	10	10	1	1	**2.51**
3-Jul-07	5	1	1	1	10	1	**1.58**
9-Jul-07	5	60	10	20	20	20	**21.69**
16-Jul-07	5	10	20	20	1	10	**8.33**
23-Jul-07	5	10	1	30	70	10	**11.60**
30-Jul-07	5	10	1	1	1	20	**2.89**
7-Aug-07	5	20	10	1	1	40	**6.03**
13-Aug-07	5	10	50	10	10	20	**15.85**
20-Aug-07	5	20	1	40	20	1	**6.93**
27-Aug-07	5	20	20	10	1	10	**8.33**

Type of Posting	Date Posted	Date Lifted

HUTCHESON BEACH

Date	# samples	Individual Sample Results					GMean
18-Jun-07	5	10	10	1	10	1	**3.98**
25-Jun-07	5	30	60	1	20	1	**8.15**
3-Jul-07	5	1	40	10	1	20	**6.03**
9-Jul-07	5	1	10	1	1	1	**1.58**
16-Jul-07	5	1	1	1	10	10	**2.51**
23-Jul-07	5	1	1	1	10	1	**1.58**
30-Jul-07	5	1	1	1	10	1	**1.58**
7-Aug-07	5	20	10	10	1	10	**7.25**
13-Aug-07	5	1	10	1	1	1	**1.58**
20-Aug-07	5	1	1	1	50	1	**2.19**
27-Aug-07	5	40	30	1	10	20	**11.91**

Type of Posting	Date Posted	Date Lifted

PORT SYDNEY BEACH

Date	# samples	Individual Sample Results					GMean
25-Jun-07	5	1	10	40	1	1	**3.31**
3-Jul-07	5	20	10	10	10	20	**13.20**
9-Jul-07	5	40	1	20	20	10	**10.99**
16-Jul-07	5	140	60	140	110	130	**110.96**
23-Jul-07	5	30	1	1	1	1	**1.97**
30-Jul-07	5	40	40	20	30	10	**24.91**
7-Aug-07	5	20	10	1	20	10	**8.33**
13-Aug-07	5	220	80	50	50	50	**73.87**
20-Aug-07	5	1	1	1	1	20	**1.82**
27-Aug-07	4	20	10	100	130		**40.16**

Type of Posting	Date Posted	Date Lifted