Saugeen Conservation
Water Quality Status Report 2010

Produced March 2011
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Introduction

Good water quality in rivers and streams sustains the algae, plants, bugs and fish that are the foundation for a healthy aquatic ecosystem. The water quality program at Saugeen Conservation (SC) monitors and reports on the health of the watershed. There is a need to understand the long-term trends and recognize changes in the quality of surface and groundwater.

The program began in 2002 with 14 surface water sites. It has expanded to include groundwater monitoring wells, an additional 15 surface water sites, and a benthic invertebrate monitoring program.

The water quality program is divided into three separate programs:

- Surface Water Monitoring under the Provincial Water Quality Monitoring Network,
- Groundwater Monitoring under the Provincial Groundwater Monitoring Network,
- Biological Monitoring under the Ontario Benthos Biomonitoring Network.

This report is a summary of the programs undertaken in 2010 and includes data from 1964 to 2010. An additional document entitled Water Quality Data Summary Report is available with the surface water data and groundwater levels presented in chart form. The raw data are available on request.

Surface Water Quality Program

Surface water monitoring sites fall within the Saugeen, Pine, and Penetangore River watersheds (Figure 1). Surface water chemistry has been monitored at sites in the watershed as far back as the 1960s. There was a gap in sampling from the mid 1990s to 2002 at which time Saugeen Conservation was once again able to procure funding to participate in the program.

In 2010 surface water chemistry was monitored at twenty-nine sites; 14 sites as part of the Provincial Water Quality Monitoring Network (PWQMN) and an additional 15 SC sites. Sites located along the Lake Huron shore were included in a Ministry of the Environment lakeshore study in 2010 and were sampled every two weeks.

The PWQMN is a partnership between Saugeen Conservation and the Ministry of the Environment (MOE). SC is responsible for the collection of samples, while the MOE analyzes the samples. The 15 SC sites were added to provide better coverage of the watersheds and include the downstream end of some watersheds that were not previously being sampled. SC is responsible for the cost of the collection and for the analysis at a private laboratory.
Samples are collected eight times per year, during the ice-free period. The sampling is done at approximately 30 day intervals. An attempt is made to represent the range of streamflow conditions including snowmelt, runoff from rain events of varying magnitude and baseflow conditions during different seasons. While on-site, temperature, conductivity, pH, and dissolved oxygen are measured using a hand-held YSI meter. Observations are made of stream conditions, weather, and any upstream activities (e.g. construction or cattle in the stream).

PWQMN samples are shipped to the MOE laboratories in Etobicoke, while the SVCA samples are shipped to SGS laboratories in Lakefield, where they are analyzed for the presence of chemicals. Analysis for general chemistry and nutrients are completed at all PWQMN sites (11 parameters). Metals are analyzed at three strategically selected PWQMN sites (33 parameters). At the SC sites analysis for general chemistry and nutrients are completed (12 parameters). Metals analysis at SC sites was dropped in 2010 after 5 years of collection and no issues with elevated metals concentrations were found.

Bacteria levels are also monitored in the watershed as an indicator of the presence of pathogenic bacteria in the rivers. Bathers and others coming in contact with contaminated water containing pathogenic bacteria can develop ear, nose and throat infections. Bacteria samples were collected at all sites on a monthly basis and sent to a private laboratory to be analyzed for *Escherichia coli* (*E. coli*). *E. coli* is used as a monitoring tool as it is a strong indication of recent sewage or animal waste contamination. Sewage may contain many types of disease-causing organisms and *E. coli* is just one of them.

One additional sampling site is monitored for a Nutrient Management Monitoring Program in conjunction with the MOE. The purpose of the program is to examine long term trends in water quality in relation to changing agricultural practices. Eight streams in priority agricultural watersheds across southwestern Ontario were chosen for the study with one of them in our watershed. This project will be useful in providing feedback on the effectiveness of the Nutrient Management Act and whether it is successful in reducing nutrient loading and improving water quality. The SC site is on Muskrat Creek in the Teeswater River watershed. No reports have been produced to date by the Ministry of the Environment but reviewing the data, nitrate concentrations are consistently above the Provincial Water Quality Objectives. The 2010 samples for phosphorus also exceeded the guideline 36% of the time.

Chemical levels in samples are compared to the Provincial Water Quality Objectives (PWQO), which are Ministry of the Environment objectives. Their goal is “To ensure that the surface waters of the province are of a quality which is satisfactory for aquatic life and recreation”. (Ministry of the Environment and Energy, 1994) These are minimum acceptable levels of water quality. Where there are no Provincial Water Quality Objectives, the Canadian Council of Ministers of the Environment (CCME) has put in place the Canadian Water Quality Guidelines (CWQG). These guidelines are for the protection of aquatic life.

There are selected indicator parameters that are most useful in assessing the health of a watershed. These parameters are the nutrients of total phosphorus and nitrate, chloride, suspended solids and bacteria. Charts of these parameters for each site are compiled in *Water Quality Data Summary Report*. Where there was a significant amount of data, box-and-whisker plots were used. When there were limited data, scatter plots were used. There are examples of each type of chart in this report.
Figure 1. Surface water quality monitoring sites.
Phosphorus is required for the growth of aquatic plants and algae, however, excessive amounts can lead to algal blooms and a lack of oxygen in the river. Conditions such as these can cause fish kills. Possible sources of phosphorus are soaps, cleaning products, and urban and agricultural pesticides and fertilizers. The phosphorus levels are below the provincial objective at the majority of the sites around the watershed, however, following major storm events or spring runoff there are higher levels occurring at many of the sites. Phosphorus binds to suspended solids which are flushed into the streams during run-off events. Within any one watershed, phosphorus concentrations generally increase from upstream to downstream sites.

Sites with data limited to the last ten years have their results shown in scatter plots. Figure 2 shows phosphorus concentrations in the Beatty Saugeen River upstream of Hanover. Trendlines in charts are shown as a red line. At sites with limited data the trendlines should be regarded with caution as there are not enough data to accurately determine trends. Charts of phosphorus concentrations for the remaining watersheds are available in the Water Quality Data Summary Report.

![Figure 2](image_url)

**Figure 2.** Scatter plot of phosphorus concentrations in the Beatty Saugeen River, upstream of Hanover.

Figure 3 depicts phosphorus concentrations at each site in the watershed for the years 2002 to 2009. Each subwatershed is depicted by a different colour of box. The Provincial Water Quality Objective (PWQO) for the protection of aquatic life for total phosphorus is 30 µg/L. This chart is an example of a box-and-whisker plot. The top of the box represents the 75th percentile (3rd quartile) which means that 75% of the data points fall below this value. The bottom of the box represents the 25th percentile (1st quartile) which means that 25% of the data points fall below this value. The lines (whiskers) coming out of the boxes represent the highest and lowest values in the set of data points. Where there is a line rather than a box the majority of the samples were at or below the lab detection limit with the whisker representing a single sample with an elevated concentration.
Figure 3. Box-and-whisker plot of phosphorus concentrations by subwatershed.
As evidenced by the whiskers in the plot (Figure 3) the Lake Fringe subwatersheds, the Saugeen River upstream of Hanover, and the North Saugeen River at Lockerby had the highest individual concentrations of phosphorus. The sites with consistently high concentrations were Clark Creek, the Pine River and Mill Creek. These watersheds drain basins with high agricultural land use. In the Main Saugeen River phosphorus tends to increase from upstream to downstream with the exception of the site at County Road 28, upstream of Hanover. The same trend is evident in the North Saugeen River with the site at Lockerby having three samples with concentrations exceeding 100 µg/L.

Phosphorus is showing a decreasing trend at many sites (Figure 4). This chart depicts trends for sites where there are enough historical data. This downward trend is occurring across the province. Of the sites plotted in the chart below the only watershed showing an increase in phosphorus is the Pine River but the concentrations are considerably lower than they were historically.

Nitrates can be toxic to aquatic organisms. Nitrate levels over 30 mg/L can inhibit growth, impair the immune system and cause stress in some aquatic species. These levels of nitrate can also lead to algae blooms which may cause other changes to ecosystem function, favouring some groups of organisms over others. Possible sources of nitrate include sewage treatment plant effluent, septic systems, industrial wastewaters, landfills, livestock waste, urban and agricultural pesticides and herbicides, and atmospheric deposition.
Figure 5 depicts nitrate concentrations in the Pine River. These data were pooled into 5 year blocks (with the exception of the last 4 years) and graphed to show trends in the data (red trendline). The appearance of a possible downward trend for 2007-2010 should be regarded with caution as there is not the recommended 5 years of data to accurately determine trends. The Canadian Water Quality Guideline (CWQG) for the protection of aquatic life is 3 mg/L.

Figure 5. Box-and-whisker plot of nitrate concentrations in the Pine River.

Charts of nitrate concentrations for the remaining watersheds are available in the Water Quality Data Summary Report. With the addition of more recent data to the charts it is interesting to note that many sites now appear to be displaying a decreasing trend in nitrogen. The reason for this decrease is as yet unknown but a reasonable assumption would be the positive effect of SC management programs along with the implementation of Best Management Practices on farms and rural properties. Again, at sites with limited data the trendlines should be regarded with caution as there are not enough data to accurately determine trends but the trendlines at least give an indication of what is taking place. The Pine River trendline is a good representation as there are substantial data for that site.

Figure 6 is another box-and-whisker plot of the subwatersheds depicting concentrations of nitrates. Each subwatershed is indicated by a different colour of box. As in the phosphorus plot with all of the subwatersheds the highest concentrations of nitrate are occurring in the Lake Fringe watersheds and in the Teeswater River, and Muskrat Creek watersheds.
Figure 6. Box-and-whisker plot of nitrate concentrations by subwatershed.
Figure 7 shows a decreasing trend in nitrate concentrations for the Main Saugeen River at Durham. The Main Saugeen River at Walkerton, the Teeswater River at Chepstow, the Penetangore River, and the Pine River are showing increasing trends in nitrates. The Pine River concentrations are now above the Canadian Water Quality Guideline of 3 mg/L. The 2007 to 2010 data should be regarded with caution as there are only four years of pooled data, where five years is optimum. There are gaps in the data when sampling was discontinued during certain years.

![Nitrate Concentrations Graph](image)

Figure 7. Summary of historical nitrate concentrations in six rivers.

* indicates the pooled data are only from 4 years – not the recommended 5 years

**Chloride**

While chloride can be naturally occurring, the presence of elevated chloride may indicate contamination from road salt, industrial discharges, or landfill leachate. Potassium chloride is used in the production of fertilizers. Chloride ions tend to remain in solution once dissolved. Ontario does not presently have a water quality guideline for chloride. British Columbia has set a water quality guideline of 150 mg/L (30-day average exposure) as a maximum concentration designed to protect sensitive species of aquatic plants and invertebrates.

In 2001, heightened concerns over contamination of surface waters by road salts and its effects on freshwater organisms led to inclusion of “road salts” on the second Priority Substances List under the Canadian
Environmental Protection Act (CEPA). Also in 2001, a detailed report by Environment Canada concluded that road de-icing chemicals containing inorganic chloride salts have serious adverse impacts on the aquatic environment and are therefore toxic (Environment Canada, 2001). In 2004, the government instituted a voluntary code of practices to encourage municipalities and others to use the de-icer more sparingly, while maintaining highway safety. Optimistically this will begin to show an effect in the coming years.

At all of the sites with an extensive data set chloride levels are showing an increase although they remain well below the Environment Canada level for toxicity to sensitive aquatic species of 210 mg/L. This trend is evident province-wide. The chloride concentrations in the South Saugeen River at Cedarville illustrate this increasing trend (Figure 8).

![CHLORIDE - South Saugeen River, Cedarville](image)

Figure 8. Box-and-whisker plot of chloride concentrations in the South Saugeen River, Cedarville.

**Suspended Solids**

Total suspended solids are a measure of the total particulate matter that is suspended in water. When unnaturally high levels of suspended solids occur in surface waters there is a reduction in the amount of sunlight available for aquatic plants and animals. As well, fish gills can become clogged, spawning areas can get covered and feeding habits can be disrupted. Suspended solids can contain significant quantities of trace organic and inorganic contaminants such as pesticides, phosphorous and heavy metals which may further degrade water quality and possibly impact human health.

Suspended solids remain fairly low with the highest levels occurring after storms or run-off events. In many cases the levels are below the laboratory detection limits. There is no water quality guideline to compare these values. Charts of suspended solids concentrations for the watersheds are available in the Water Quality Data Summary Report.
Many areas of the watershed are experiencing high levels of bacteria. The highest levels appear to occur during the spring and early summer at most sites or after periods of high flow associated with rainfall events. *E. coli* originate from the wastes of any warm blooded animal, including humans, livestock, wildlife, pets, and waterfowl. *E. coli* from livestock manure storage systems or land application of manure may reach surface waters from direct runoff or via groundwater flow. Human wastes can enter watercourses from faulty septic systems, discharge from treated sewage plants or combined or cross-connected storm sewers. *E. coli* can affect the suitability of water for irrigation, recreation, and drinking water.

Figure 9 illustrates *Escherichia coli* (*E. coli*) concentrations in the Main Saugeen River, downstream of Burgoyne. The Provincial Water Quality Objective for *E. coli* is 100 CFU/100mL (CFU = colony forming units) for recreational waters (Ontario Ministry of the Environment, 1994). The objective was exceeded in 22% of the samples taken from 2003 to 2010 at Burgoyne Figure 10. Graphs are shown using a log scale on the y-axis for *E. coli* concentrations because of the range of values. Charts of *E. coli* concentrations for the remaining watersheds are available in the Water Quality Data Summary Report.

Figure 9. Scatter plot of *E. coli* concentrations in the Main Saugeen River, downstream of Burgoyne.
Figure 10 depicts the percent of the \textit{E. coli} samples greater than the Provincial Water Quality Guidelines for each subwatershed. The subwatersheds with the highest occurrence of exceedences were Muskrat Creek, followed by Clark Creek, and the Pine River. These are watersheds with high agricultural land use and this follows the trends that were seen for phosphorus and nitrates.

<table>
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<th>Site</th>
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Figure 10. Summary of the percent of the bacteria samples with concentrations higher than 100 CFU/100mL at each site. (CFU = colony forming units) (100 CFU/100mL is the PWQO for \textit{E. coli} for recreational waters)
Saugeen Conservation signed an agreement with the Ministry of the Environment (MOE) in June of 2000 to participate in a province-wide groundwater monitoring network. The Provincial Groundwater Monitoring Network (PGMN) is a partnership between the Ministry of the Environment and conservation authorities. There are now over 470 ambient groundwater monitoring wells in the program. The intent of the monitoring program is to report on ambient groundwater levels and groundwater quality. Information collected by the Network is providing necessary baseline data about groundwater and information about ambient groundwater conditions.

The wells located throughout the watershed target both overburden (material below topsoil and above bedrock) and bedrock aquifers. The wells are located at seventeen locations around the watershed (see Error! Reference source not found.). Where possible, the wells monitor multiple aquifers with two or three 2 inch piezometers installed inside the outer steel casing. In total, there are twenty-three aquifers being monitored of which thirteen are overburden and ten are bedrock aquifers.

The wells incorporated into the Network are equipped with automated water level monitoring equipment (levelogger). The levelogger automatically measures water levels and records this value every hour, along with the corresponding time and temperature.

Each well is equipped with an automated cellular data transmitter or telemetry unit which allows the MOE to do an automated upload of the well data every two weeks.

Sixteen of the wells have been equipped with dedicated pumps. The remaining wells have to be sampled with portable equipment.

Precipitation is also monitored at three of the SC PGMN sites to allow for a better understanding of correlations between precipitation and groundwater levels, and in shallow aquifers, between precipitation and groundwater chemistry. Provincial 85 rain gauges have been incorporated into the network.

Water quality samples were collected from each of the wells by the SVCA staff in the fall of 2010. All of the wells were analyzed for:

- major ions and nutrients including pH, alkalinity, conductivity, and turbidity
- metals

and five of the wells were sampled for

- volatile organic compounds
- herbicides
- pesticides

Some of the water quality data are now incorporated into the Provincial Groundwater Monitoring Information System (PGMIS) which is available online to specified users. Data can be viewed online or downloaded. As well, the data are now available to CA staff on the Ministry of the Environment GIS Portal. The plan is for the GIS Portal to eventually be available to the general public.

Figure 11 is an example of bedrock water level data that are being collected from the monitoring wells. The measurements are in metres below top of casing (mbtoc). As might be expected there are definite seasonal trends occurring each year. With spring melt the groundwater levels rise. During the dry summer months there is a decrease and then with the heavy levels of precipitation in the late fall, levels rise again. In general,
water levels appear to be higher since the fall of 2007 in many of the wells. These types of data are available for all of the wells in the network (Section 19, Water Quality Data Summary Report).

Any charts in the data report with gaps in the data are due to equipment failure and/or lack of available data from the Ministry of the Environment. The MOE, at the time of writing this report, has not made the most recent data (July 2009 to present) available to Saugeen Conservation. As such it is not included in this report.

The water quality data collected to date are insufficient to establish any trends. There were no pesticides, herbicides, or hydrocarbons found in any of the wells. There were numerous exceedences of the Ontario Drinking Water Standards for health-related parameters in the monitoring wells. Through the PGMN Protocol-For-Actions the Ministry of the Environment notifies the Spills Action Centre (SAC), the district, regional and Drinking Water offices of the MOE, the local Health Unit, and Saugeen Conservation of any results that exceed the Standards. Saugeen Conservation then notifies the municipality. Any actions to be taken are at the discretion of the local Health Unit.

Figure 12 identifies the exceedences that have occurred since 2003. The only exceedence that was not confirmed by additional sampling was the arsenic exceedence. The well with the arsenic exceedence is an old Ontario Water Resources well and sat stagnant for many years. It is believed that the elevated arsenic was due to that fact. The arsenic has not shown up again.
## Health-Related Exceedences of the Ontario Drinking Water Standards at the PGMN Monitoring Wells

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Figure 12. Health-Related Exceedences of the Ontario Drinking Water Standards (2003-2010).
Figure 13. Locations of groundwater monitoring wells.
Saugeen Conservation participates in the Ontario Benthos Biomonitoring Network (OBBN) which is a provincially standardized program jointly developed by Environment Canada - Environmental Monitoring and Assessment Network (EMAN), Environment Canada - National Water Research Institute (NWRI), and the Ministry of the Environment.

Biomonitoring is a type of monitoring that examines the benthos or benthic macroinvertebrates (large, bottom dwelling insects, crustaceans, worms, mollusks, and related aquatic animals) that live in watercourses. Benthic macroinvertebrates are good indicators of water quality as they respond to stressors (e.g. pollution) after a relatively short exposure. By collecting benthos in streams, the Authority will be able to assess the general health and water quality of each watercourse and monitor any changes that occur over time.

The reference condition approach is being utilized in this network. A reference site is a site that is “minimally impacted”. It is not necessarily a pristine site but one that would provide a target for improvement for a test site. A test site is an area with a questionable biological condition (i.e. downstream of a discharge).

A number of reference sites are sampled with a wide range of physiographic characteristics. Sites are grouped according to the similarity of their biological communities. Test sites can be compared to reference sites that have the most similar physiographic characteristics. Statistical tests are then applied to determine if the test site falls within the “normal” range of biological conditions established by the reference group of sites. When a test site falls outside of the normal range further testing is required to determine if the observed differences were caused by human activities. These sites should be re-sampled.

In 2006, in consultation with the Ministry of the Environment, SC decided to use a random survey design. Scientists often wish to make watershed-scale generalizations about ecosystem condition but a complete census is impossible due to restricted time and funding. For these assessments, sites selection should be based on random sample surveys to ensure that broader extrapolations of ecosystem condition are statistically reliable and scientifically credible (Hughes 1995, Larsen 1997, Didonato 2003).

The assumptions and decisions made to help set random sites:

- Ease of access requires drive-to sites
- Average coverage of 1 site per 50 km² is sufficient for making watershed-scale generalizations
- 5-year report interval
- SC wishes to assess water quality in streams of all sizes
- Water management requires water quality information for each of 9 sub-watersheds

Using GIS a set of 100 random sites were selected from all of the road crossings in the watershed. The 5th year of sampling has now been completed. Analysis of the data has begun but no results are available as yet.

The MOE GIS Portal will be the site for the test site database. The Portal will compare the test site data to the most similar reference group, and analyze the data for significant differences. This database is not operational as yet.

SVCA staff is continuing to participate in a collaborative research study with the Ministry of the Environment OBBN staff and one other Conservation Authority. The five year study was designed to identify periods throughout the sampling season when rapid changes occur in the benthic community structure. This will confirm or dispute the assigned sampling time periods described in the OBBN protocol. Sampling occurs bi-weekly during the ice-free period at one site on our Sulphur Springs property. The study began in 2005 and has now been extended to look at the long-term effects of climate change. Some preliminary data have been
assessed but it takes longer than five years for patterns to emerge and therefore no results have been reported.

The sites sampled to date for the Random Survey are a work in progress. Many of the sites have had the invertebrates identified and analysis is complete, while others are pending benthos identification. A system called the ‘Hilsenhoff Family Biotic Index’ was used to assess water quality based on the number and type of invertebrates found in a sample. Each invertebrate species is given a score that relates to its pollution-tolerance. The larger the number, the more pollution tolerant the organism is therefore we would expect to see D or F grades at downstream sites and A grades at headwater sites. This is generally the case as illustrated in Error! Reference source not found..

The grading system (Figure 14) used in this report was based on the provincial grading system established for the Watershed Report Cards (Conservation Ontario, 2003).

<table>
<thead>
<tr>
<th>Benthos (Biotic Index)</th>
<th>Grade</th>
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<tr>
<td>&lt; 5.00</td>
<td>A</td>
</tr>
<tr>
<td>5.01 - 5.75</td>
<td>B</td>
</tr>
<tr>
<td>5.76 - 6.50</td>
<td>C</td>
</tr>
<tr>
<td>6.51 - 7.25</td>
<td>D</td>
</tr>
<tr>
<td>&gt; 7.25</td>
<td>F</td>
</tr>
</tbody>
</table>

Figure 14. Benthic invertebrate site grading system.

The graded sites are shown in Figure 15. A number of the lower grades are located in watersheds that drain highly agricultural basins. This highlights the need to continue to improve riparian cover, expand forest cover, implement Best Management Practices, and protect existing wetlands and forests.
Figure 15. Map showing sampling locations with grades for the Biomonitoring Program.
Surface Water

- The most positive news to date is that it appears that phosphorus concentrations are continuing to decline as they have in previous years.
- Nitrate concentrations in a number of the watersheds are beginning to decline. Previously, the nitrate levels were on the rise in most of the watersheds.
- Watersheds with longer records of data still indicate an increasing trend in nitrates although the majority of the samples are below the Canadian Water Quality Guideline with the exception of the downstream end of the Teeswater River, the Pine River, Clark Creek and Muskrat Creek.
- Chloride concentrations are rising as in previous years.
- E. coli concentrations are highly variable and are predictably high when phosphorus and nitrates are elevated.
- E. coli exceed the guideline more frequently in many of the lake fringe watersheds and highly agricultural streams.

With decreasing levels of nutrients in many of the streams, it appears that programs put in place to expand forest and riparian cover, and to promote Best Management Practices are producing positive results. These programs must be maintained and improved upon in some watersheds. Existing wetlands must be protected and fragile farmland should be retired. We must maintain the watersheds with good water quality and improve the watersheds where some of the parameters are an issue.

Groundwater

- There are ongoing exceedences for sodium and fluoride at four wells.
- No pesticides, herbicides or hydrocarbons are present in any of the wells.
- Water levels are exhibiting seasonal trends and some wells are showing an increase over time.

Biomonitoring

- Benthos grades are lower in watersheds that drain highly agricultural basins. This is similar to the surface water results. The higher concentrations of nutrients found in the surface water chemistry at these sites has an impact on the types of benthos found. Degraded stream bank areas associated with cattle access and lack of riparian cover can contribute to the increase in nutrients.
- Lake fringe watersheds would benefit from expanded forest cover and additional wetlands as would other highly agricultural areas.

Water quality reflects both the natural features and the land use. Focus should be placed on the areas with lower grades and exceedences of the guidelines. An attempt should be made to increase stewardship initiatives in these areas. Every positive step in this regard will lead to improved or protected watershed health.
References

Ontario Ministry of the Environment, 1994. Water management: policies, guidelines, provincial water quality objectives of the Ministry of the Environment. This document is available on the OMOE Internet site (http://www.ene.gov.on.ca/envision/gp/3303e.pdf) and is commonly referred to as the ‘Blue Book’.


