APPENDIX – S (SEVERN)

GENIVAR CONSULTANTS LP (FORMERLY JAGGER HIMS) TECHNICAL MEMORANDUMS

Severn Groundwater:

- Technical Memorandum N2 - Drinking Water Issues Evaluation

DILLON CONSULTING LIMITED: WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

- Dillon Consulting Limited WHPA Peer Review Report Memo
- Wellhead Time of Travel Capture Zone Peer Review Evaluation Results
    - Table 1: Bass Lake Woodlands
    - Table 2: Coldwater

GENIVAR

TECHNICAL MEMORANDUM N2

Date: July 23, 2010

To: Don Goodyear, P.Geo – South Georgian Bay
Lake Simcoe Protection Region

From: Sarah Dignard / Colleen Barfoot / Lloyd Lemon, P.Geo

Project No.: 071948.09

Subject: Drinking Water Issues Evaluation – Severn Groundwater
Township of Severn

OBJECTIVE:

To document the Drinking Water Issues Evaluation for the groundwater supply for the Township of Severn in the South Georgian Bay Lake Simcoe Source Protection Region.

OVERVIEW:

Work has been completed to meet the requirements of Technical Rules 114 through 117 of the Technical Rules: Assessment Report, *Clean Water Act, 2006* as provided by the Ontario Ministry of the Environment on December 12, 2008 and as amended in November 2009. The Drinking Water Issues Evaluation portion focuses on identifying recurring water quality impacts or situations with a possibility of impacting drinking water sources in the short-term. This work results in a preliminary list of identified issues.

The approach for the Drinking Water Issues Evaluation is described in more detail in "Technical Memorandum A5 - Drinking Water Issues Evaluation Methods". The steps included:

Step 1: Assemble Available Data

Step 2: Review Data and Identify Drinking Water Issues

Step 3: Evaluate Drinking Water Issues

Step 4: Identify Contributing Area for Drinking Water Issues

Step 5: Prepare List of Drinking Water Issues

Municipal Wells and Aquifers

The Township of Severn municipal groundwater supply is provided by three systems: the Bass Lake Woodlands Well Supply operates three groundwater wells, the Coldwater Well Supply operates three groundwater wells and the Severn Estates Well Supply operates one well.

Bass Lake Woodland Well Supply

Water for Bass Lake Woodlands Well Supply comes from the three groundwater wells located on Ridley Boulevard, east of Glen Oak Lane. The Bass Lake Woodlands wells are drilled into a confined artesian aquifer found locally in the elevation range of approximately 210 and 225 meters above sea level (masl), described as fine to coarse sand. This aquifer is regionally extensive and overlies a bedrock aquifer. The wells are protected by approximately 15 m of confining till materials. Limestone bedrock is found at a depth of approximately 43 m in the vicinity of the municipal wells, where it is in contact with the deepest aquifer. It is believed that the sand and gravel and bedrock aquifers are hydraulically connected and the municipal wells draw water from both aquifer units.

Groundwater is chlorinated using sodium hypochlorite and then stored in a 136 m^3 underground contact chamber and reservoir. This two cell tank gives sufficient time for the chlorine to adequately disinfect the groundwater before it is distributed to the residents. Treated water is pumped from the reservoir through four pressure tanks prior to discharge to the distribution system. The distribution system is comprised of PVC and copper piping. It services the approximately 300 residents of the Community of Bass Lake Woodlands. The permitted capacity of the wells is of 189 L/min, 455 L/min and 515 L/min from Wells 1, 2 and 3 respectively. Wells 1 and 2 are the production wells while Well 3 is a standby well.

Coldwater Well Supply

The Coldwater Well Supply was built in 1994 to replace the spring water supply west of the village. Water now comes from three drilled groundwater wells. Two wells are located on the pump house property and the third is across the street from the pumping station and reservoir on Sheridan Drive. The area in which the Coldwater wells are located is underlain by a confined sand and gravel aquifer. The aquifer directly overlies Precambrian (granite) bedrock, into which the municipal wells are extended. This aquifer is bounded on either side by rising bedrock and/or till overlying bedrock. These wells are most likely drawing water from a combination of the overburden and bedrock aquifer systems.

The groundwater is chlorinated and treated to sequester the naturally-occurring iron and manganese. Beginning in 2008, the water is treated with Granular Activated Carbon filtration to remove concentrations of trichloroethylene that have been detected in the Coldwater wells. The water is stored in a 1612 m^3 two cell, concrete, underground reservoir (chlorine contact chamber) below the pump house. This tank gives sufficient time for the chlorine to adequately disinfect the groundwater before it is distributed to the residents. The treated water is pumped from the reservoir through five pressure tanks prior to being discharged to the distribution system. This system services the approximately 1,400 residents of the village of Coldwater. The permitted capacity of the wells is of 936 L/min each with a maximum amount of taking of 982 m^3/ha from Well 2 and Well 3. The maximum amount of taking per day for Well 1 is 2,141 m^3. Well 1 is used as the lead well while Well 2 and Well 3 are listed as a standby source.

Severn Estates Well Supply

Water for the Severn Estates Well Supply is pumped from a 69 meter deep drilled well located within the Severn Estates pump house at 4532 Trent Trail. The Severn Estates well is located in a granite bedrock aquifer, which is under unconfined to marginally confined conditions.

The water is chlorinated using sodium hypochlorite for disinfection and for iron precipitation. It is then filtered using a two train ceramic filter system for iron removal. Filtered water is stored in a 13.6 m^3 underground concrete reservoir. It is transported to the distribution system by two high lift pumps and pressure is maintained by three hydropneumatic pressure tanks. The Severn Estates Well Supply was constructed in the 1970s. It serves the 23 homes located on Trent Trail. The permitted capacity from the well is of 68 L/min and a maximum daily taking of 98 m^3.

***Step 1:* Assemble Available Data**

The data sources that were reviewed to identify potential issues included:

- Permits to Take Water and Applications;
- Certificates of Approval;
- North Simcoe Groundwater Study WHPA for the Township of Severn by Dixon Hydrogeology Limited and Golder Associates Limited (2004);
- Annual Water Supply Water Quality Monitoring Reports (2003-2007);
- Municipal Raw and Treated Groundwater Quality Data (2003-2008); and
- Operator Interview.

Ms. Stephanie Schell, Utilities Sub-Foreman of the Township of Severn Drinking Water Quality Management System, was interviewed to obtain operator insight into potential issues identified in the published data as well as identifying potential issues that may not have been identified in published data to date.

***Step 2:* Review Data and Identify Drinking Water Issues**

A set of tables have been prepared to document a series of potential issues from the raw and treated water at the Township of Severn as identified from various data sources. The tables are as follows:

Table Number	Township of Severn Well Supply	Water Type	Water Source
N2-1A	Bass Lake Woodlands	Raw	Well #1
N2-1B			Well #2
N2-1C			Well #3
N2-1D		Treated*	
N2-2A	Coldwater	Raw	Well #1
N2-2B			Well #2
N2-2C			Well #3
N2-2D		Treated*	
N2-3A	Severn Estates	Raw	Well #1
N2-3B		Treated*	

* The treated water data collected may reflect the use of any or all wells in that particular water system.

The tables are designed to document:

1) The source reports or data that result in the identification of a parameter as a potential Drinking Water Issue;
2) Results of comparison of observed parameter concentrations to relevant benchmarks and situations where:
    a. Parameter concentrations exceed the primary benchmark established by the Ontario Drinking Water Quality Standard (ODWQS);
    b. Parameter concentrations exceed a locally established benchmark value (typically a background concentration);

c. Parameter concentrations exceed the established method detection limit (MDL) [typically applied for organic chemical parameters];

3) Professional judgment on the reliability of the data based on the number of measurements and the relative consistency of the observed occurrence;

4) The nature of observed trends in parameter concentrations;

5) Input from local System Operators and other Stakeholders as to the significance of the parameter as a Drinking Water Issue;

6) Whether treatment is in place for the observed parameters and its effectiveness; and

7) The nature of the source of the parameter listed as a potential issue.

Trends were determined through graphing municipal water supply system water quality data. Most of the parameters listed on the preliminary list of drinking water threats for each well have been assessed graphically for trends. The available data has been provided between 2003 and 2008.

Step 3: **Evaluate Drinking Water Issues**

The N2 series of tables have been developed to identify Drinking Water Issues in accordance with the "Decision Process for Identification and Evaluation of Drinking Water Issues" as presented in Figure A5-1 of "Technical Memorandum A5 - Drinking Water Issues Evaluation Methods".

The positive or negative responses entered in the N2 series of tables correspond to the steps in the decision process. Professional judgment was built into the decision process in the evaluation of data reliability to identify anomalous conditions and in the consideration of operational insights. Trend analysis was used to identify parameters that are projected to exceed the ODWQS within approximately 50 years. The N2 series of tables also allow for the identification of the source of the potential Drinking Water Issue, whether treatment is in place, and its effectiveness.

For each of the water works systems, most of the parameters identified in the N4 tables are not considered to be Drinking Water Issues. Parameters common to most systems in the Township of Severn that were removed from consideration include:

- Coliforms and E.Coli are typically absent but can be observed on rare occasions in low numbers. The presence of coliforms and E.Coli in the raw water is not persistent or indicative of deterioration of raw water quality. Disinfection is in place and is effective.
- Concentrations of iron, manganese, and turbidity have occasionally exceeded aesthetic or operational objectives. These parameters are considered to be naturally-occurring and are not likely to result in the deterioration of the water quality for use as a drinking water source. Treatment of these parameters is provided at Coldwater Well Supply.
- Lead concentrations at Severn Estates Well Supply have exceeded ODWQS objectives under circumstances that are considered to be anomalous. Concentrations have consistently been less than ODWQS objectives during other sampling events and are not increasing. This parameter is therefore not considered to result in the deterioration of the water quality for use as a source of drinking water.
- Concentrations of sodium are consistently less than the ODWQS value of 200 mg/L in some of the raw and treated water from the Township of Severn wells. The sodium concentration data displays no discerning trend. Sodium is therefore not considered to be a Drinking Water Issue at these locations but should be closely monitored. Concentrations have exceeded the guideline of 20 mg/L. Sodium is a concern at 20 mg/L as the Medical Officer of Health is to advise individuals on low-sodium diets. Observed concentrations of sodium are variable and the source has not been confirmed, but is typically related to winter de-icing or septic system effluents from water

softeners. Reduction of sodium use in the contributing watershed would be beneficial to the drinking water quality.

- Organic parameters, such as trihalomethanes, are present in trace concentrations in raw or treated water at Severn Estates Well Supply as byproducts of disinfection by chlorination. Concentrations are typically well below ODWQS values and do not display increasing trends.

Trichloroethylene (TCE) has been detected in low concentrations at all three Coldwater wells and is considered to be a Drinking Water Issue. The measured concentrations of TCE have exceeded the ODWQS value of 0.005 mg/L. The Maximum Acceptable Concentration (MAC) for TCE as per the Ontario Drinking Water Quality Standard was reduced from 0.05 mg/l (50 µg/L) to 0.005 mg/L (5 µg/L) in June 2006. Observed concentrations of TCE have been variable and there is no clear apparent trend. Monitoring to date has not identified the presence of other degradation products from PCE or TCE, specifically vinyl chloride, in the groundwater.

Studies were undertaken to identify potential sources of TCE and to evaluate options available to the Township for maintaining the quantity and quality of the water supply system. The studies to date were not successful in identifying specific source areas of the TCE, nor were they successful in fully delineating the extent of impacts from TCE in groundwater. The work completed concluded that the TCE resulted from a historical land use and not from a current land use activity.

TCE presents substantial challenges for work to understand the distribution and extent in the subsurface and for remediation from the raw groundwater sources. TCE can be removed from groundwater but the greatest likelihood of success occurs when the source area of TCE is completely removed. Success in these initiatives is also typically **very** expensive. Technologies for removing TCE from water are known to be highly effective and are an industry-accepted option around the world for allowing continued use of a water source that has been impacted by TCE.

Following review of options, the Township of Severn decided to proceed and provide treatment to remove TCE from the groundwater. This system was supported by the Ontario Ministry of the Environment through issuance of a Certificate of Approval to operate a treatment system. A Granular Activated Carbon (GAC) filtration system was installed and began operating in 2008. The treatment system has been effectively reducing the concentrations of TCE in the groundwater supply since 2008. Results of raw water quality testing on TCE since the treatment system has been established do not identify an increasing concentration trend. It is therefore anticipated that the existing treatment system is robust and capable of continuing to provide effective treatment of the TCE in groundwater for the near future.

***Step 4:* Identifying Contributing Area for Drinking Water Issues**

In consideration of the best available information, the 25 year Time-of-Travel Area, WHPA-D for the Coldwater wells is proposed for use as the Issues Contributing Area. The Issues Contributing Area will be used in the assessment of threats to drinking water. In the case of DNAPL threats to drinking water, it is not necessary that the land use activity (existing or historical) must be within the delineated capture area for the wells. Liquid phase DNAPL parameters are known to spread as driven by gravity. As a minimum, the liquid phase contaminants must have spread from the source area into the capture area for the wells in order to be present at the wells. Use of WHPA-D as the Issues Contributing Area in this case is reasonable as the chemical parameters are already known to have been present in water at the well.

***Step 5:* Prepare List of Drinking Water Issues**

One Drinking Water Issue was identified for the Severn Groundwater Supply: trichloroethylene (TCE).

LAL/SJD:lnc

Table N2-1A **Evaluation of Drinking Water Issues**

Municipality: Township of Severn
Community: Bass Lake Woodlands
Drinking Water Source: Well #1
Issues Review Date: May 15, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2003-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																		
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y					Y				Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y

Table N2-1B **Evaluation of Drinking Water Issues**

Municipality: Township of Severn
Community: Bass Lake Woodlands
Drinking Water Source: Well #2
Issues Review Date: May 15, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2003-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																		
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y					Y				Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y

Table N2-1C **Evaluation of Drinking Water Issues**

Municipality: Township of Severn
Community: Bass Lake Woodlands
Drinking Water Source: Well #3
Issues Review Date: May 15, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2003-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																		
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y					Y				Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y

Table N2-1D **Evaluation of Drinking Water Issues**

Municipality: Township of Severn
Community: Bass Lake Woodlands
Drinking Water Source: Treated Water
Issues Review Date: May 15, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2003-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence						Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years							
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable								Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y						Y			Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y
E. Coli			Y						Y			Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Sodium			Y							Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		
Turbidity			Y						Y			Y			Y		N	Y	Y			Y	N	N	NO		Y			

Table N2-2A **Evaluation of Drinking Water Issues**

Municipality: Township of Severn
Community: Coldwater
Drinking Water Source: Well #1
Issues Review Date: May 15, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2003-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y					Y				Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Trichloroethylene (TCE)				Y				Y				Y		Y			N	Y	Y			Y	N	Y	YES			Y	Y	Y

Table N2-2B **Evaluation of Drinking Water Issues**

Municipality: Township of Severn
Community: Coldwater
Drinking Water Source: Well #2
Issues Review Date: May 15, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2003-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y					Y				Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Trichloroethylene (TCE)				Y				Y				Y		Y			N	Y	Y			Y	N	Y	YES			Y	Y	Y

Table N2-2C **Evaluation of Drinking Water Issues**

Municipality: Township of Severn
Community: Coldwater
Drinking Water Source: Well #3
Issues Review Date: May 15, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2003-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Chemicals																														
Trichloroethylene (TCE)			Y	Y				Y				Y		Y			N	Y	Y			Y	N	Y	YES			Y	Y	Y

Table N2-2D **Evaluation of Drinking Water Issues**

Municipality: Township of Severn
Community: Coldwater
Drinking Water Source: Treated Water
Issues Review Date: May 15, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2003-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Chemicals																														
Iron					Y				Y			Y			Y		Y	N	Y			Y	N	N	NO	Y			Y	Y
Manganese					Y				Y			Y			Y		Y	N	Y			Y	N	N	NO	Y			Y	Y
Sodium			Y							Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		
Trichloroethylene (TCE)			Y						Y			Y		Y			N	Y	Y			Y	N	Y	YES			Y	Y	Y
Turbidity			Y						Y			Y			Y		N	Y	Y			Y	N	N	NO	Y				

Table N2-3A **Evaluation of Drinking Water Issues**

Municipality: Township of Severn
Community: Severn Estates Subdivision
Drinking Water Source: Well #1
Issues Review Date: May 15, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2003-2008
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y					Y				Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y
E.Coli			Y					Y				Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Iron				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO	Y				
Manganese				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO	Y				
Trihalomethane				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO			Y		

Table N2-3B **Evaluation of Drinking Water Issues**

Municipality: Township of Severn
Community: Severn Estates Subdivision
Drinking Water Source: Treated Water
Issues Review Date: May 15, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2003-2008
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y						Y			Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Iron					Y				Y			Y			Y		N	Y	Y			Y	N	N	NO	Y				
Lead			Y						Y			Y				Y	Y	N	Y			Y	N	N	NO	Y				
Manganese					Y				Y			Y			Y		N	Y	Y			Y	N	N	NO	Y				
Sodium			Y							Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		
Trihalomethane			Y						Y			Y			Y		N	Y	Y			Y	N	N	NO		Y			
Turbidity			Y						Y			Y			Y		N	Y	Y			Y	N	N	NO	Y				

July 29, 2010

DILLON CONSULTING

130
Dufferin Avenue
London, Ontario
Canada
N6A 5R2
Mail: Box 426
London, Ontario
Canada
N6A 4W7
Telephone
(519) 438-6192
Fax
(519) 672-8209

Lake Simcoe Region Conservation Authority
120 Bayview Parkway
Newmarket, Ontario
L3Y 4X1

Attention: Mr. Don Goodyear, Source Protection Manager

WHPA Peer Review Report

Dear Mr. Goodyear:

Dillon Consulting Limited (Dillon) was retained by the Lake Simcoe Region Conservation Authority (LSRCA) to conducted Peer Reviews of well head protection area (WHPA) mapping for 86 municipal groundwater systems. These systems are located in the South Georgian Bay Lake Simcoe Source Protection Region. External management of the project was conducted by Mr. Dave Ketcheson, P.Eng of Azimuth Environmental Consulting Inc. The results of the peer review are issued in the form of digital spreadsheet files that are attached to this letter. The project scope and peer review methodology is summarized in the letter herein.

PROJECT SCOPE

LSRCA retained Dillon to conduct a 'high level' peer review of the WHPAs that were largely delineated as part of previous WHPA or regional groundwater studies, at a time prior to the finalization of the Director Rules. In general, WHPA delineation was based on an assortment of different model types, including fixed radius, 2-D analytical solutions and numerical 3-D flow modeling. In general, more sophisticated models were applied to those systems where more data was available. The focus of the peer review was on whether the methodologies were consistent with those outlined in the Directors Rules, rather than a more traditional technical modeling critique. Evaluations also identified critical issues or deficiencies that would have implications on subsequent steps in the source protection process, so that these may be addressed as part of the Assessment Report. The review also identify long-term opportunities for improvement in subsequent rounds of the process, recognizing the various levels of effort applied in WHPA delineation across the region (i.e., analytical vs. numerical methods), and the availability of data in the various WHPA settings.

Peer reviewers were Rob Kell, M.A.Sc., P.Eng, P.Geo.; Jeff Hachey, M.Sc. and Darin Burr, M.Sc. P.Geo, all hydrogeologists with Dillon.

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Evaluation of the WHPAs was performed in a systematic fashion following a "score card" approach. The score card contained both objective and subjective criteria that were evaluated for each system. This template approach enabled reviewers to maintain a level of consistency during the reviews, and was suited to the "high level" nature of the evaluation. The criteria that were evaluated is listed below:

Objective Criteria	**Subjective Criteria**
Was modeled pumping rate appropriate?	Complexity of geological Setting
Were approved models and methods used?	Appropriateness of Flow Model
	Reasonableness of input parameters
	Adequate incorporation of natural flow field
	Model Calibration
	Incorporation of Uncertainty

For each criterion, a score between 1 and 10 was awarded. In general, a score <5 for any of the criteria would be given if a critical concern was identified that would either significantly affect the reliability of the WHPAs, or is a contravention of the elements of the Directors Rules. An exception for this rule would be the evaluation of the uncertainty criterion. Failure to adequately incorporate uncertainty into the model results was not deemed a requirement of the Director Rules and therefore would not necessarily cause the system to "fail". Details on conditions that would cause an unacceptable evaluation at the criteria level are presented in the score card sheets.

All systems were given a "pass", "fail" or "conditional pass" result, depending upon the analysis results. A "pass" ranking was given for those systems were the methodology was generally consistent with the Director Rules, and no critical deficiencies were noted. A "conditional pass" was granted, where the potential for considerable uncertainty in the results existed, but either little data was available to improve the accuracy of the results, or it was the reviewer's opinion that the uncertainty on the results would not significantly alter the enumeration of land parcels that may contain significant threats.

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Following criteria scoring, the individual scores were weighted, and summed to produce an overall system score (between 1 and 10) for the WHPA delineation. Higher the score, the more favorable are the results of the evaluation. Please note that this scoring is a relative ranking between the systems, and is not to be interpreted as any type of marking. For example, a score of 6 does not mean a 60% mark, but rather is a system whose delineated WHPAs are deemed more conservatively robust (in lieu of available data) than a system that receives a score of 5. Theoretically, a system evaluated via fixed radius that is very conservative could receive a higher system score than a detailed numerical model result that is not conservative, as the risk of under-representing the area where significant threats may be lower.

RESULTS

The results of the evaluation are presented on digital Excel™ spreadsheets for each system, and are grouped by township or separated municipality name. Rationale for the individual criteria evaluations, along with the criterion scores, overall system scores and recommendations for future improvement are presented on the individual sheets.

LIMITATIONS

This report was prepared exclusively for the purposes, project and site location(s) outlined in the report. The report is based on information provided to, or obtained by Dillon Consulting Limited ("Dillon") as indicated in the report, and applies solely to site conditions existing at the time of the assessment. Although a reasonable assessment was conducted by Dillon, Dillon's assessment was by no means exhaustive and can not be construed as a certification or acceptance of the reviewed reports. Rather, Dillon's report represents a reasonable review of available information within an agreed work scope, schedule and budget. Further review and updating of the peer review reports will be required as local and site conditions, and the regulatory and planning frameworks, change over time.

This report was prepared by Dillon for the sole benefit of our Client. The material in it reflects Dillon's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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CLOSURE

We appreciate the opportunity to work with LSCRCA on this assignment. If you have any questions about this report, please contact the undersigned.

Yours sincerely,

DILLON CONSULTING LIMITED

Darin Burr, M.Sc., P.Geo.
Project Manager

DTB:amb
Encl.

Table 1: BASS LAKE WOODLANDS - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**Bass Lake Woodlands**
Reviewed Report:	**North Simcoe Groundwater Study, WHPA-Township of Severn, Appendix I, Golder 2005; Capture Zone and Equipotential Surface Review (Golder, 2010).**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**Regional 3-D Modflow**
Score:	**6.9**
Pass:	**Yes**
Critique Ref:	**Sent to Client_Peer Review Score Card Results_051410_1**

System Characteristics

Hydrogeological Complexity	Medium, confined deep aquifer. Confining layer is spatially variable, but consistent
Spatial variability in Aquifer Vulnerability	Medium
Known water Quality Issues	None - No known water quality issues have been reported.

EVALUATION RESULTS

Criterion		Awarded Score	General Comments	Comments / Recommendations: Critical Deficiencies	Comments / Recommendations: Long-term opportunities
Objective Criteria					
1. Were reasonable pumping rates used and documented?		5	The Bass Lake Woodlands area is serviced by three (3) wells, wells #1, #2, and #3. Wells #1 and #2 are the primary production wells, while well #3 is a standby well. 50 day ToT zone was established using the PTTW max. rate (164, 655, and 742 m3/day for wells #1, #2, and #3 respectively), while the remaining ToT zones were established using future pumping rate (155 m3/day for all wells combined). Future pumping rates are based on long term average yields and were calculated using township standards of 360 L/cap/day, which slightly exceeds the 2002 average use rate. A lower score is given because of lack of documentation on future pumping rates.	None	Should pumping regime change, or unplanned expansion of subdivision is proposed, then model should be updated.
2. Were rule-approved models and methods used?		Pass	3-D Analytical Solution is permissible	None	Perform continuous updating and verification/validation of the model data.
Subjective Criteria					
3a. Is geological setting complex?	10	7	Medium complexity. The Bass Lake Woodlands wells are all constructed into a confined overburden aquifer, and are under strong artesian conditions. Based on cross section found in Golder 2005 (Section A-A' and B-B'), wellfield is constructed in an area where the thickness of the confining layer is locally variable, however is present upgradient (i.e. recharge areas). Also, it is believed that the deep overburden aquifer where the wellfield is present is in direct hydraulic contact with the limestone bedrock aquifer present in the area.	None	Further aquifer and confining layer delineation recommended.
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	6	Aquifer type is confined, with varying thickness of overlying confining layer in the area around the production wells, as well as upgradient from wells in recharge areas. Local variations in hydraulic conductivity should be adequately represented with layered conductivity approach, however a more locally scaled model is preferred. Also, it is noted that there is sparse coverage from the MOE WWIS in the area around Bass Lake Woodlands incorporated into the regional MODFLOW model.	None	Improve geological model by additional borehole/well construction gathered on a local scale.

4. Is Flow Model Complexity Appropriate?	10	7	Yes - 3D numerical flow model used, however at a more regional scale; moderate complexity of aquifer, model is deemed adequate.	None	Additional monitoring wells positioned upgradient of well field would be beneficial to validate model. Verification of regional model results with results generated on a local scale may also be beneficial, or additional modeling at the local scale could be investigated.
5. Are model input parameters (recharge, porosity, K) reasonable?	5	7	Generally yes - K values are based on pumping test data, and have been assigned spatial variability in model (10:1 ratio between horizontal:vertical conductivity assigned, except in deep aquifer region where 1:1 ratio is maintained). Other hydraulic parameters appear reasonable relative to availability of data. Recharge values (variable between 238 to 275 mm/yr) may be high, however were based on hydrologic analysis of surface water catchments in the area. Recharge was a parameter used in a sensitivity analysis as part of the Orillia WHPA groundwater model. As noted above, the MOE WWIS well coverage in the area seems sparse, and more local information could be beneficial.	None	Additional field work would improve estimates.
6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	7	Yes - natural flow field was based on MOE WWIS database and presented in report (Golder, 2005), but as noted above, well coverage in the area around Bass Lake is sparse. Boundary conditions seem acceptable, however it is noted that Bass Lake is represented as a constant head boundary located near the wellfield. It is noted that the capture zones extend beyond Bass Lake, and based on conductivity distribution, there is little hydraulic connection between Bass Lake and the wellfield. It is noted that drain boundary conditions were assigned to river/stream surface water features. This assumes that all surface water features are gaining (i.e. sinks) in the model. This could be further validated. Potentiometric maps constructed using MOE database and calibrated model flow field are generally consistent. Confirmation that wellfield is not connected to Bass Lake could be beneficial.	None	Run model simulations calibrating to local data, and test validity of drain assumption. Sensitivity analysis could also include adjusting constant head boundary at Bass Lake.
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10				
8. Was the Model Calibrated?	5	6	Model was calibrated regionally (197 wells), and not specific to the aquifer near the well field. It should be noted that large regional scale models often lead to acceptable calibration residuals without optimizing parameters. The only calibration parameter included was hydraulic conductivity. Conductivity, porosity, recharge, and model boundary conditions (constant head boundaries) were the subject of model sensitivity analysis. Calibration produced the following statistics: Abs. Residual mean = 4.2 m, Normalized RMS = 10.15 %. Recharge could have been used in calibration in order to attempt to achieve RMS < 10% (which is usually deemed to be the acceptable threshold). Again, as noted above, there is sparse coverage of calibration wells in the vicinity of the Bass Lake wellfield. Lower score given as a result of lack of local data.	None	Model should be calibrated to the local hydrogeological system rather than the regional system. If "river" boundary condition is used to represent appropriate surface water features, streambed conductivity can be used as an additional calibration parameter.
9. Was Uncertainty considered in the analysis?	5	9	A more rigorous uncertainty analysis was performed, instead of using "shape factors" which increase the length and width of capture zones by 20% as in previous model. Capture zones established during model sensitivity analysis were incorporated into final capture zones to create "composite" capture zones. As mentioned above, conductivity, porosity, recharge, and model boundary conditions (constant head boundaries) were the subject of model sensitivity analysis.	None	Perform uncertainty analysis at the local scale by varying input variables, and consider uncertainty in flow field.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high	None	

Table 2: COLDWATER - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**Coldwater**
Reviewed Report:	**North Simcoe Groundwater Study, WHPA-Township of Severn, Appendix I and Memorandum from Lloyd Lemon, P. Geo (Genivar) to Shelly Cuddy, P.Geo (Lake Simcoe Region Conservation**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**Local 3-D Modflow**
Score:	**5.1**
Pass:	**Yes**

System Characteristics

Hydrogeological Complexity	Medium to high, confined to semi confined bedrock aquifer. Confining layer spatially discontinuous
Spatial variability in Aquifer Vulnerability	Medium to high, partially confined (discontinuous), anthropogenic impacts in aquifer
Known water Quality Issues	High - TCE has exceeded ODWS level (0.005 mg/L) in the past.

EVALUATION RESULTS

Criterion		Awarded Scored	General Comments	Comments / Recommendations: Critical Deficiencies	Comments / Recommendations: Long-term opportunities
Objective Criteria					
1. Were reasonable pumping rates used and documented?		9	Three wells service the Coldwater area, wells #93-4, Swaile Well, and #93-2 (now referred to as Wells #1, #2, and #3 respectively). All wells are completed in the upper horizons of a fractured bedrock aquifer (Golder, 2005). The wells were all modeled as one point sink, as wells fell within the same MODFLOW grid cell. Capture zone delineation for the Coldwater wells was based on a "Forecast Rate" as directed by the Lake Simcoe Conservation Authority (Golder, 2010). The forecast rates for individual wells specified in the model were calculated based on the allowed combined maximum daily extraction (2,138 m3/day) and the ratio of maximum permitted extractions for each individual well (52% for Well #1, 24% for Well #3, and 24% for Well #2). Rates are deemed acceptable as they are the lesser or planned or permitted. Also, a commercial supply consisting of four wells located approximately 750 m north of the Coldwater Municipal wells (Coldwater Fisheries System) was incorporated into the numerical groundwater model.	None	Should pumping regime change, then model should be updated.
2. Were rule-approved models and methods used?		Pass	3-D Analytical Solution is permissible	None	Perform continuous updating and verification/validation of the model data.
Subjective Criteria					
3a. Is geological setting complex?	10	5	High to medium complexity. Multiple aquifers in area, and wellfield for system is completed in partially confined bedrock aquifer. Aquitard is spatially discontinuous. Discontinuous confining layers throughout geological system. Golder (2005) identifies that TCE has been detected in pumping wells. Also, chloride (aesthetic related parameter) and sodium (health related parameter) have been detected in wells, and attributed to recharge from adjacent roadways. This implies that confining layers are not present in major recharge areas, and that major water bearing fractures are continuous across potential sources of contamination.	None	
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	5	Aquifer is completed in partially confined bedrock aquifer, as aquitard is spatially discontinuous. Previous report has identified that leakage from shallower aquifers upgradient is possible. Golder (2005) has identified that TCE has been detected in pumping wells. Source of TCE is unknown, and not confirmed to be within the delineated ToT zones. Also, chloride (aesthetic related parameter) and sodium (health related parameter) have been detected in wells, and attributed to recharge from adjacent roadways. Due to this, increased local scale model accuracy is important.	None	Improve geological model by additional borehole construction
4. Is Flow Model Complexity Appropriate?	10	5	Yes - 3D numerical flow model used, model is deemed adequate. However, given the local variations in overburden thickness, and the potential for vertical conductance of contaminants, a more complete description on the process for assigning hydraulic parameters across the model domain is preferred.	None	Additional monitoring wells positioned upgradient of well field would be beneficial to validate model. Note that if TCE is identified as an issue, additional modelling is recommended.
5. Are model input parameters (recharge, porosity, K) reasonable?	5	5	Generally yes - K values are based on pumping test, however it is unclear if/how hydraulic parameters have been assigned spatial variability in model. Other parameters appear reasonable relative to availability of data. Incorporation of large groundwater takings from Coldwater Fisheries wells is noted, and appropriate An exception is recharge (200 mm/year) which seems high given that a clay unit is assigned as the top unit in the aquifer. Also, a 10:1 ratio of horizontal:vertical hydraulic conductivity in top layer of model may be questionable. Low score given because of recharge.	None	Additional field work would improve estimates. Simulations with lower recharge values should be performed.
6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	5	Yes - it seems that the natural flow field was used to calibrate the model, however there is no discussion (in Appendix I) relating to model calibration. In Appendix I, there is no reference given to the number of calibration wells, abs. residual mean error, or normalized RMS. Omission of this data makes assessing relative fit of the model difficult. Overall, boundary conditions appear acceptable however there is also no discussion of the effects that Coldwater River has on model output. Also, proximity of updated capture zones presented in Golder (2010) to model boundaries should be considered, as the eastern and western no flow boundaries likely influence the shape of the capture zones. Groundwater flux in/out of this boundary would be beneficial to present. Also, it is unclear if model input parameters were adjusted to obtain a "best fit" calibrated model. Low score given as a result of lack of data.	None	Assess if wells are GUDI due to presence of Coldwater River. Results of any future GUDI assessment work done for this wellfield could be incorporated into numerical model to increase accuracy.
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10				

8. Was the Model Calibrated?	5	5	As discussed above, it is unclear (based on Appendix I) that the model was calibrated given the lack of information regarding model calibration. It should be noted, however, that page 19 of Appendix I does state that a potentiometric surface map for the aquifer contained within the report is based on the "calibrated" model surface. The basis for this calibration is not stated. Unclear which (if any) calibration parameters were used. At the least, hydraulic conductivity and recharge could be used as calibration parameters. Neither Genivar Memo (2009) or Golder Technical Memorandum (2010) present any calibration statistics. Low score given as a result of lack of calibration information.	None	Model should be calibrated to the local hydrogeological system, and results of calibration process should be presented.
9. Was Uncertainty considered in the analysis?	5	6	Limited uncertainty analysis, performed by increasing the length and width of capture zones by 20%, which may be arbitrary. Given that TCE and various other anthropogenic constituents of concern (COC) may be present in aquifer, a more complete uncertainty analysis is preferred. This could include incorporation of the output from multiple runs adjusting various input parameters (i.e. recharge, hydraulic conductivity, riverbed conductivity, boundary conditions) to construct "composite" ToT travel zones. Given that the above COC's are/may be present in the aquifer, further uncertainty analysis and evaluation of past and present land use practices within delineated capture zones may be beneficial	None	Perform uncertainty analysis at the local scale by varying input variables, and consider uncertainty in flow field
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high	None	