APPENDIX – BWG (BRADFORD-WEST GWILLIMBURY)

GENIVAR CONSULTANTS LP (FORMERLY JAGGER HIMS) TECHNICAL MEMORANDUMS

Bradford/Bondhead Distribution and Supply Wells:

- Technical Memorandum D1 - 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: Bradford/Bondhead – 8th Line
    - Table 2: Bradford/Bondhead – Soda Pop, Simcoe and Bingham Wells
    - Table 3: Bradford/Bondhead – Doane

GENIVAR

TECHNICAL MEMORANDUM D1

Date:	July 16, 2010
To:	Don Goodyear, P.Geo. – South Georgian Bay Lake Simcoe Protection Region
From:	Sarah Dignard/Lloyd Lemon, P.Geo.
Project No.:	950699.09
Subject:	Drinking Water Issues Evaluation – Town of Bradford-West Gwillimbury

OBJECTIVE:

To document the Drinking Water Issues Evaluation for the groundwater supply for the Town of Bradford-West Gwillimbury 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 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 A4 - 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 Town of Bradford-West Gwillimbury Water Supply consists of several municipal wells that obtain groundwater from artesian aquifers. The municipal wells include the Doane Well, Church Well 1, Church Well 2, 8th Line Well, Soda Pop Well, Bingham Street Well, Simcoe Well. The permitted capacity based on the operation of the seven production wells, is 9,185 L/min or 13,226 cubic metres per day. The Bradford Water Supply also supplies the community of Bond Head.

Each pump house facility includes a chlorine disinfection system including all related equipment for monitoring in-process parameters. Chlorinated water storage contact chambers and /or piping are employed at each pump house to ensure a minimum 15-minute chlorine contact time with the water, prior to pumping into the distribution system.

To meet the expected future water supply demand, the Town negotiated to become connected into the Innisfil/Bradford Transmission Watermain. The John Fennel Reservoir and re-chlorination facility became operational during April 2006. The treated water supplied from this facility contributed approximately 10% of the Town's overall water supply in 2006.

Church Wells

The Church Wells are screened between 90 and 95 m deep in a granular overburden formation that is interpreted to be within the *Bradford Aquifer*, which is a lower aquifer that consists of sand and gravel deposits that infilled valleys in the pre-glacial bedrock surface. The Church Street well site is physically located within the Township of King, within The Regional Municipality of York, to the east of the Community of Bradford. The Church Wellfield began operation in 1968 and currently provides the majority of the water supply for the Town of Bradford (65% in 2006). Church Well No. 2 was constructed in 1975 and is operated as the leas well (50% of total groundwater production).

Simcoe Well

The Simcoe Well was constructed in 1930 and is the oldest of the municipal supply wells. The Simcoe Well is located in roughly the centre of the Community of Bradford. The well is approximately 34 m deep and is considered to obtain water from the Intermediate, or *West Gwillimbury Aquifer.* This well is now used to address peak supply demands between May and August. Water from the Simcoe Well is delivered to a common treatment system shared with the nearby Bingham and Soda Pop Wells before being delivered to the distribution system. A replacement well for the Simcoe Well has been constructed, but is not yet in service. The Simcoe Well is intended to be retained as an observation well for monitoring groundwater elevations within the *West Gwillimbury Aquifer*.

Bingham Well

The Bingham Well was constructed in 1948 and is located near the Simcoe Well. The Bingham Well is approximately 29 m deep and is also screened within the Intermediate, or *West Gwillimbury Aquifer*. The Bingham Well is now used to address peak supply demands between May and August. Water from the Bingham Well is delivered to a common treatment system shared with the nearby Simcoe and Soda Pop Wells before being delivered to the distribution system.

Soda Pop Well

The Soda Pop Well was constructed in 1967 and is located near the Simcoe Well. The Soda Pop well is approximately 82 m deep and is screened to intersect the deeper Bradford Aquifer. The water quality from the Soda Pop Well is characterized by the presence of dissolved gases. The Soda Pop Well is now only used to address peak supply demands between May and August. Water from the Soda Pop Well is delivered to a common treatment system shared with the nearby Simcoe and Bingham Wells before being delivered to the distribution system.

8th Line Well

The 8th Line Well is located at the northern edge of the Community of Bradford. The 8th Line Well was constructed in 1990 and is the newest of the wells that currently service the community. The 8th Line well is approximately 113 m deep and is screened within the deep *Bradford Aquifer.*

Doane Well

The Doane Well is located to the southwest of the Community of Bradford along the northern perimeter of the Holland River Valley/Holland Marsh area. The Doane Well was constructed in 1962 and is approximately 26 m deep. The Doane Well is screened in the *West Gwillimbury Aquifer* (Jagger Hims Limited, 2008).

Step 1: **Assemble Available Data**

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

- Bradford Water Supply Annual Reports (Jagger Hims Limited, 2000-2002);
- Memoranda regarding water sampling results (Jagger Hims Limited, 2001);
- Water complaint summary tables (2002);
- Bradford Annual Permit to Take Water Report (Jagger Hims Limited, 2003);
- Bradford Annual Compliance Reports (Jagger Hims Limited, 2003-2008);
- Bradford-West Gwillimbury Annual Drinking-Water Systems Report (2004-2008);
- Bingham Well Biofouling Investigation Results (Jagger Hims Limited, 2004);
- Schedule A Class Environmental Assessment for Construction, Development and Testing of the Simcoe Replacement Well (Jagger Hims Limited, 2005);
- News Releases by the Town of Bradford-West Gwillimbury (2005);
- Bradford Raw Water Data (2006);
- Community of Bradford Vulnerability Assessment (Jagger Hims Limited, 2008); and
- Operator Interview.

Mr. Jim Evans, Operations Standards Technician for the Town of Bradford-West Gwillimbury Public Works, 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 Town of Bradford-West Gwillimbury as identified from the various data sources. The tables are as follows:

Table Number	Water Type	Water Source
D1-1	Raw and Treated	Doane Well
D1-2	Raw and Treated	Church Well 1
D1-3	Raw and Treated	Church Well 2
D1-4	Raw and Treated	8th Line Well
D1-5A	Raw	Soda Pop Well
D1-5B	Raw	Bingham Street Well
D1-5C	Raw	Simcoe Street Well
D1-5D	Raw	Simcoe Replacement Well
D1-5E	Treated	Soda Pop, Bingham and Simcoe Wells

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 selected parameters of the municipal water supply system water quality data. 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 2000 and 2008.

Step 3: **Evaluate Drinking Water Issues**

The D1 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 A4-1 of "Technical Memorandum A4 - Drinking Water Issues Evaluation Methods".

The positive or negative responses entered in the D1 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 D1 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, all of the parameters identified in the D1 tables are not considered to be Drinking Water Issues. Parameters common to most wells in the Town of Bradford-West Gwillimbury that were removed from consideration include:

- The occasional presence of coliform bacteria in raw or treated water is not considered to represent a specific Drinking Water Issue as these parameters have only been rarely observed under circumstances that are not observed in repeat testing. Disinfection is in place and is effective.
- N-nitrosodimethylamine (NDMA) was also present in trace concentrations in treated water at 8th Line well. Concentrations are typically well below ODWQS values, are not persistent, and do not display increasing trends. There are plans to potentially relocate the 8th Line Well. This parameter is not considered to be a Drinking Water Issue within the raw water.
- Other organic parameters are present in trace concentrations in the treated water that are well below ODWQS values, such as prometryne and toxaphene. These parameters were not tested in the raw water. These parameters originate from unknown sources but are also not considered

to represent Drinking Water Issues as they are not consistently measured above the detection limit in other samples.

- Colour, dissolved organic carbon, hardness, iron, pH, manganese, organic nitrogen, total dissolved solids, sulphate and turbidity are parameters that exceed ODWQS values for aesthetic or operational guidelines. Most of these parameters are considered likely to be naturally-occurring. Iron sequestering has been shown to effectively reduce concentrations of iron, as well as minimize colour. Turbidity and pH exceedances are occasionally observed but are not a consistent and persistent occurrence. They are not currently considered to result in the deterioration of the water quality in use as a source of drinking water.

- Concentrations of total dissolved solids at the Doane Well are projected to exceed ODWQS aesthetic objective within the next 50 years, as is displayed in Figure D1-1. This parameter is considered likely to be naturally-occurring and is related to the iron concentrations. Although the concentrations are increasing, they are not observed consistently. Additional data is required to confirm the observed trend. Total dissolved solids are not currently considered to result in the deterioration of the water quality in use of the Doane Well as a source of drinking water.

- Concentrations of methane are occasionally measured above aesthetic ODWQS guidelines at the 8th Line Well and Soda Pop Well. Methane is considered to be naturally-occurring and the concentrations are variable. The methane is currently not contributing to the deterioration of the drinking water quality, but long-term plans are in place to shut down the wells if the concentrations increase. This parameter is currently not considered to be a Drinking Water Issue.

- Chloride has persistently been detected at most wells in concentrations that are less than the ODWQS value but above the detection limit. At the Soda Pop Well, concentrations have been projected to exceed the chloride ODWQS objective of 250 mg/L within the next 50 years, as is displayed in Figure D1-2. The data results are variable but the automated line fitting program identified a potential trend. It is likely that this parameter is naturally-occurring in the bedrock according to the water quality results from the vulnerability assessment produced by Jagger Hims Ltd in March 2008. Based on the evaluation process, this parameter is not considered to be a Drinking Water Issue at these wells.

- Concentrations of sodium are consistently less than the ODWQS value of 200 mg/L in the raw and treated water from wells in the Town of Bradford-West Gwillimbury. Sodium concentrations display an increasing trend in the Church Well 1, Church Well 2 and Soda Pop Well. These are all relatively deep wells that draw water from the Bradford Aquifer. Sodium concentrations are not expected to exceed the ODWQS objective of 200 mg/L within the next 50 years at the Church Wells, but may exceed this value at the Soda Pop Well. Figure D1-2 displays the increasing trend of sodium concentrations at the Soda Pop Well and the projected increase. It is likely that the sodium is naturally-occurring in the bedrock formation that underlies the Bradford Aquifer. Sodium is not considered to be a Drinking Water Issue for the Town of Bradford.

  Sodium concentrations at many of the wells 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 sources have not been confirmed. In addition to the natural occurrence in the bedrock aquifer, sodium concentrations may also result from use of winter de-icing agents or septic system effluents from water softeners. Reduction of sodium use in the contributing watershed would be beneficial to the drinking water quality.

- Trichloroethylene (TCE) has occasionally been identified in the treated water for the combined system of the Simcoe/Bingham/Soda Pop wells. The measured concentrations have consistently been less than the ODWQS value of 0.05 mg/L and have normally been less than 0.015 mg/L. Most of the detections occurred during sampling events between February 2002 and August

2003. TCE was not observed in a test of the water from the treated water from the combined Simcoe/Bingham/Soda Pop wells in September 2009.

Samples of the raw water from each of the Simcoe/Bingham/Soda Pop wells were collected in October 2009 and tested for dissolved TCE concentrations. TCE was not detected in the raw water for the Bingham or Soda Pop wells and a trace concentration of 0.0007mg/L was observed in the raw water for the Simcoe Well. The reported detection limit by the laboratory is 0.0001 mg/L.

Dissolved TCE is not considered to be a Drinking Water Issue at this time as the measured concentrations have consistently been less than the ODWQS and the TCE is only detected in one of the three combined wells. The TCE concentrations are observed to be lower in later samples. The Simcoe/Bingham/Soda Pop wells are only used to assist in meeting peak demands. The proportion of the total annual water supply for the town that now comes from these wells is less than 5%. Work is ongoing to review the long-term plans for these wells. The potential sources of the dissolved TCE are not known but based on review of current surrounding landuse it is apparent that historical activities have most likely been responsible for the observed TCE. Continued monitoring, particularly of the raw water intake for the Simcoe well during times when the well is required, will be useful in helping to confirm that the TCE concentrations are not increasing and do not exceed the ODWQS value.

- Organic parameters, such as trihalomethanes (THM), are present in trace concentrations in treated water as byproducts of disinfection by chlorination. Concentrations are typically well below ODWQS values. THM concentrations are observed to show an increasing trend in water from the 8th Line Well. XCG Consultants were hired by the Town to do a study in order to adapt the treatment process in order to decrease the THM concentrations. THM concentrations in the other well supplies did not show increasing trends. Since some of the water supply for the town has been switched to the Innisfil surface water supply, a decrease in concentrations has been noticed. Operators are also working to minimize retention times for the treated groundwater in the distribution system to minimize the effects of THMs. These disinfection byproduct parameters are not considered to be Drinking Water Issues within the raw water.

Available monitoring well water quality data for the area was also reviewed (OW1, OW2, OW3, OW4-I, OW4-II, OW6-I, OW6-I(S), OW6-2 and OW6-3). The data was found to be mostly consistent with the data available for the municipal supply wells.

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

No parameters were identified as Drinking Water Issues at the Town of Bradford-West Gwillimbury wells.

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

No parameters were identified as Drinking Water Issues at the Town of Bradford-West Gwillimbury wells.

FIGURES

FIGURE D1-1 TREND GRAPH FOR TDS, DOANE WELL, BRADFORD WATER SUPPLY
FIGURE D1-2 TREND GRAPH FOR CHLORIDE AND SODIUM, SODA POP WELL, BRADFORD WATER SUPPLY

LAL/SJD:nah

Table D1-1 **Evaluation of Drinking Water Issues**

Municipality: Town of Bradford West Gwillimbury
Community: Bradford
Drinking Water Source: Doane Well and Treated Water
Issues Review Date: May 4, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000-2008
Interview (person/title/date): August

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	Y	N	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Chloride				Y						Y		Y	Y				N	Y	Y	Y			N	N	NO			Y		
Colour				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO	Y				
Hardness				Y				Y				Y	Y				N	Y	Y	Y			N	N	NO	Y				
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				
Total Dissolved Solids				Y						Y		Y	Y				N	Y	Y	Y			Y	N	NO	Y				
Toxaphene					Y					Y		Y				Y	Y	N	Y			Y	N	N	NO			Y		
Trihalomethanes					Y					Y		Y	Y				N	Y	Y			Y	N	N	NO		Y			
Turbidity				Y				Y				Y			Y		Y	N	Y			Y	N	N	NO			Y		
Sulphate				Y						Y		Y	Y				N	Y	Y	Y			N	N	NO		Y			

Table D1-2 **Evaluation of Drinking Water Issues**

Municipality: Town of Bradford West Gwillimbury
Community: Bradford
Drinking Water Source: Church Well 1 and Treated Water
Issues Review Date: May 4, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000-2008
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				Y	N	Y	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Hardness				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
Methane				Y	Y			Y	Y			Y				Y	Y	N	Y			Y	N	N	NO			Y		
pH				Y				Y				Y			Y		Y	N	Y			Y	N	N	NO			Y		
Sodium				Y	Y					Y		Y	Y				N	Y	Y	Y			N	N	NO		Y			
Trihalomethane				Y	Y					Y		Y		Y			N	Y	Y			Y	N	N	NO		Y			

Table D1-3 **Evaluation of Drinking Water Issues**

Municipality: Town of Bradford West Gwillimbury
Community: Bradford
Drinking Water Source: Church Well 2
Issues Review Date: May 4, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000-2008
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																														
Chloride				Y						Y		Y	Y				N	Y	Y	Y			N	N	NO			Y		
Hardness				Y				Y				Y		Y			N	Y	Y			Y	N	N	NO	Y				
pH				Y				Y				Y		Y			Y	N	Y			Y	N	N	NO			Y		
Prometryne					Y					Y		Y				Y	Y	N	Y			Y	N	N	NO			Y		
Sodium				Y	Y					Y		Y	Y				N	Y	Y	Y			N	N	NO			Y		
Trihalomethane					Y					Y		Y				Y	Y	N	Y			Y	N	N	NO	Y				

Table D1-4 **Evaluation of Drinking Water Issues**

Municipality: Town of Bradford West Gwillimbury
Community: Bradford
Drinking Water Source: 8th Line Well and Treated Water
Issues Review Date: May 4, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000-2008
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																														
Colour				Y	Y			Y	Y			Y		Y			N	Y	Y			Y	N	N	NO	Y				
Dissolved Organic Carbon				Y	Y			Y	Y			Y			Y		N	Y	Y			Y	N	N	NO			Y		
Hardness				Y	Y			Y	Y			Y	Y				N	Y	Y			Y	N	N	NO	Y				
Methane				Y	Y			Y	Y			Y			Y		N	Y	Y			Y	N	N	NO			Y		
NDMA					Y					Y		Y				Y	Y	N	Y			Y	N	N	NO		Y			
Organic Nitrogen				Y	Y			Y	Y			Y		Y			N	Y	Y			Y	N	N	NO	Y				
pH					Y				Y			Y	Y				Y	N	Y			Y	N	N	NO			Y		
Sodium				Y	Y					Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		
Trihalomethane					Y					Y		Y		Y			N	Y	Y	Y			Y	N	NO		Y			

Table D1-5A **Evaluation of Drinking Water Issues**

Municipality: Town of Bradford West Gwillimbury
Community: Bradford
Drinking Water Source: Soda Pop Well
Issues Review Date: May 4, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000-2008
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																														
Colour				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO	Y				
Chloride				Y						Y		Y	Y				N	Y	Y	Y			Y	N	NO			Y		
Hardness				Y				Y				Y	Y				N	Y	Y		Y		N	N	NO	Y				
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				
Methane				Y				Y				Y				Y	Y	N	Y			Y	N	N	NO			Y		
Sodium				Y						Y		Y	Y				N	Y	Y	Y				Y	N	NO			Y		
Total Dissolved Solids				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO	Y				

Table D1-5B **Evaluation of Drinking Water Issues**

Municipality: Town of Bradford West Gwillimbury
Community: Bradford
Drinking Water Source: Bingham Street Well
Issues Review Date: May 4, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000-2008
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																														
Hardness				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		

Table D1-5C **Evaluation of Drinking Water Issues**

Municipality: Town of Bradford West Gwillimbury
Community: Bradford
Drinking Water Source: Simcoe Street Well
Issues Review Date: May 4, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000-2008
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
Chemicals																														
Colour				Y				Y				Y		Y			N	Y	Y			Y	N	N	NO	Y				
Hardness				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
Iron				Y				Y				Y		Y			N	Y	Y			Y	N	N	NO	Y			Y	
Manganese				Y				Y				Y		Y			N	Y	Y			Y	N	N	NO	Y			Y	
Sodium				Y						Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		

Table D1-5D **Evaluation of Drinking Water Issues**

Municipality: Town of Bradford West Gwillimbury
Community: Bradford
Drinking Water Source: Simcoe Replacement Well
Issues Review Date: May 4, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000-2008
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	
	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	Confirm Presence: Persistent (Always, <90%)	Confirm Presence: Majority of Tests (40-90%)	Confirm Presence: Occasionally (5 - 40%)	Confirm Presence: 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																														
Colour				Y				Y				Y		Y			N	Y	Y			Y	N	N	NO	Y				
Dissolved Solids				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO	Y				
Hardness				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
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				
Sodium				Y						Y		Y	Y				N	Y	Y			Y	N	N	NO	Y				

Table D1-5E **Evaluation of Drinking Water Issues**

Municipality: Town of Bradford West Gwillimbury
Community: Bradford
Drinking Water Source: Treated Water (from Soda Pop, Bingham and Simcoe)
Issues Review Date: May 4, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000-2008
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
Chemicals																														
Colour					Y				Y			Y		Y			N	Y	Y			Y	N	N	NO	Y				
Hardness					Y				Y			Y	Y				N	Y	Y			Y	N	N	NO	Y				
Iron					Y				Y			Y		Y			N	Y	Y			Y	N	N	NO	Y				
pH					Y				Y			Y				Y	Y	N	Y			Y	N	N	NO		Y			
Sodium					Y					Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		
Trichloroethylene					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	Y	N	Y			Y	N	N	NO			Y		

Figure D1-1. Trend Graph for Total Dissolved Solids - Doane Well - Bradford Water Supply

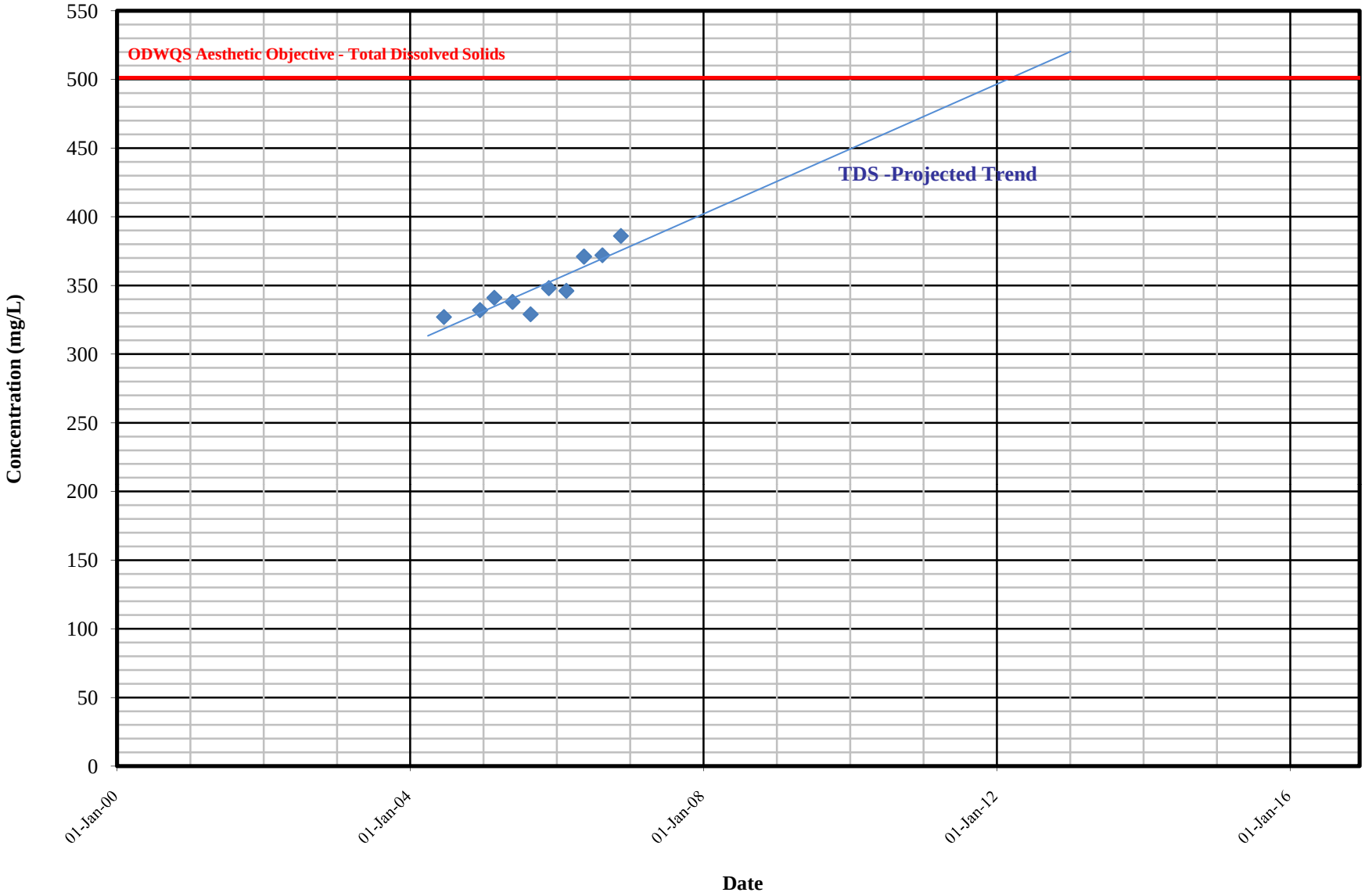
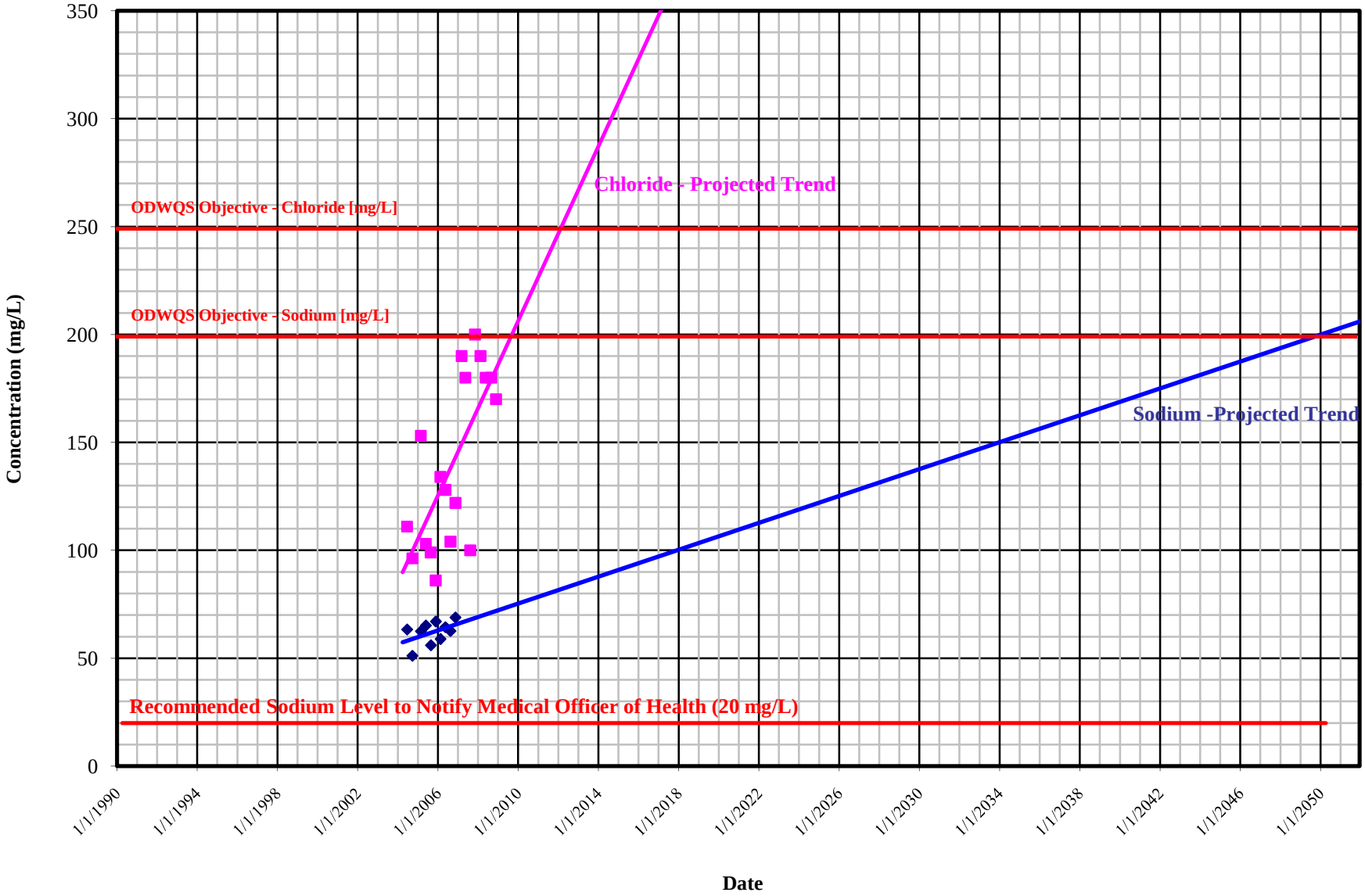


Figure D1-2. Trend Graph for Chloride and Sodium - Soda Pop Well - Bradford Water Supply



July 29, 2010

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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: BRADFORD/BONDHEAD - 8TH LINE - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**Bondhead Distribution and Supply Wells - 8th Line Wellfield**
Reviewed Report:	**South Simcoe Groundwater Study, WHPA-Township of Bradford West Gwillimbury, Appendix F**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**Local Scale 3D MODFLOW**
Score:	**5.7**
Pass:	**Yes**
Critique Ref:	**Group 1 Peer Review Score Card Results_030210**

System Characteristics

Hydrogeological Complexity	Very High (Bradford Aquifer which is in a buried bedrock valley, overlain by intermediate and shallow aquifers, interaction/interference with other well fields. Long-term aquifer dewatering occurring)
Spatial variability in Aquifer Vulnerability	High
Known water Quality Issues	None

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?		7	Modelled based on 50% of max PTTW rate, which was justified as being close to the 1.9 max day factor. No documentation of future committed serviced populations. Nevertheless, the modeled input pumping rate at individual wells and municipal system are higher than the 2002 Average Pumping rate, but less than the PTTW rate. An exception is for Church street, which was modelled at the max PTTW rate as it is the main well system. This system is not included in this Peer Review. Overall, rates are considered okay as long as pumping regime does not deviate from model inputs.	None	Determine committed population requirements to ensure that it is within permitted rate. Confirm with municipality that modelled rates represent likely conditions. Should pumping regime change, then model should be updated.
2. Were rule-approved models and methods used?		Pass	3D Numerical flow model is an approved modelling approach	None	Perform continuous updating and verification of the model data
Subjective Criteria					
3a. Is geological setting complex?	10	5	Very Complex - Lower Aquifer (Bradford Aquifer) found within buried bedrock valley, multiple aquifers above. Report states that hydrostratigraphic correlation is difficult.	None	Extent of aquifer can be improved by additional borehole drilling
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	5	Variety of data used in assessment including regional information (geology mapping, WWIS) and site investigation data (monitoring wells); however, conceptual model could benefit from increased borehole data. Report states that little data is available of bedrock valley surface north of Bradford. Therefore, we deem that there is considerable uncertainty in aquifer location.	None	Improve delineation of hydrogeology through additional borehole investigations, especially in areas within capture zone/bedrock valley
4. Is Flow Model Complexity Appropriate?	10	7	Yes - 3D flow model used, moderate to high degree of spatial representation; however, hydrogeology is complex	None	

5. Are model input parameters (recharge, porosity, K) reasonable?	5	6	Generally yes - K values are based on pumping tests, and have been assigned spatial variability in model. Recharge values appear realistic. A 6 is given largely because of the complexity of the system and the difficulty in characterizing these parameters in a system of such heterogeneity. It appears that the use of field collected data is limited relative to complexity.	None	Obtain additional field measurements of K, use water budget results for Recharge.
6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	8	Model was calibrated to natural flow field. Explanation of the boundary conditions appears reasonable. Capture zones appear oriented properly in direction of gradients	None	Confirm direction of capture zone with water level data from deep aquifer
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10	N/A			
8. Was the Model Calibrated?	5	6	Yes- Calibrated to MOE Water Well Record data and available monitoring well water level data. The model RMS was 4.5%, which meets requirements (<10%). Comparison of model results to field measured baseflow conditions at Holland River was reasonable. Lower score given because of large complexity of system relative to calibration points and the fact that system is not at equilibrium (aquifer dewatering occurring).	None	Report states that calibration can be improved by the collection of additional detailed water level data from existing monitoring wells and wells in broader area. Collection of data from new wells may also be required considering system complexity. Recommend that evaluation of calibration be performed at the scale of individual well fields.
9. Was Uncertainty considered in the analysis?	5	1	Capture zones were determined based on a single (best) model setup, and uncertainty only considered for WHPA-D. An uncertainty analysis was performed, but it is not clear that the results were incorporated into the WHPA (except for WHPA-D)	None	Incorporate the results of the sensitivity analysis into capture zone development.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high	None	

Table 2: BRADFORD/BONDHEAD - SODA POP, SIMCOE, AND BINGHAM WELLS - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**Bondhead Distribution and Supply Wells - Soda Pop, Simcoe, Bingham**
Reviewed Report:	**South Simcoe Groundwater Study, WHPA-Township of Bradford West Gwillimbury, Appendix F**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**Local Scale 3D MODFLOW**
Score:	**6.1**
Pass:	**Yes**
Critique Ref:	**Group 1 Peer Review Score Card Results_030210**

System Characteristics

Hydrogeological Complexity	Very High (Soda Pop is in Bradford Aquifer which is in a buried bedrock valley, overlain by intermediate (Bingham and Simcoe) and shallow aquifers, potential interaction/interference with other well fields in York Region)
Spatial variability in Aquifer Vulnerability	High
Known water Quality Issues	TCE above MAC in 2007

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?		7	Modelled based on 50% of max PTTW rate, which was justified as being close to the 1.9 max day factor. No documentation of future committed serviced populations. Nevertheless, the modeled input pumping rate at individual wells and municipal system are higher than the 2002 Average Pumping rate, but less than the PTTW rate. Overall, rates are considered okay as long as pumping regime does not deviate from model inputs.	None	Determine committed population requirements to ensure that it is within permitted rate. Confirm with municipality that modelled rates represent likely conditions. Should pumping regime change, then model should be updated.
2. Were rule-approved models and methods used?		Pass	3D Numerical flow model is an approved modelling approach	None	Perform continuous updating and verification of the model data
Subjective Criteria					
3a. Is geological setting complex?	10	5	Very Complex - Lower Aquifer (Bradford Aquifer) for Soda Pop well found within buried bedrock valley, multiple aquifers above. Report states that hydrostratigraphic correlation is difficult. .	None	Extent of aquifer can be improved by additional borehole drilling
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	7	Variety of data used in assessment including regional information (geology mapping, WWIS) and site investigation data (monitoring wells); however, conceptual model could benefit from increased borehole data. Moderate score as a result of complexity of aquifer	None	Improve delineation of hydrogeology through additional borehole investigations, especially in areas within capture zone/bedrock valley
4. Is Flow Model Complexity Appropriate?	10	7	Yes - 3D flow model used, moderate to high degree of spatial representation; however, hydrogeology is complex	None	

5. Are model input parameters (recharge, porosity, K) reasonable?	5	6	Generally yes - K values are based on pumping tests, and have been assigned spatial variability in model. Recharge values appear realistic. A 6 is given largely because of the complexity of the system and the difficulty in characterizing these parameters in a system of such heterogeneity. It appears that the use of field collected data is limited relative to complexity.	None	Obtain additional field measurements of K, use water budget results for Recharge.
6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	8	Model was calibrated to natural flow field. Explanation of the boundary conditions appears reasonable. Capture zones appear oriented properly in direction of gradients	None	
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10	N/A			
8. Was the Model Calibrated?	5	6	Yes- Calibrated to MOE Water Well Record data and available monitoring well water level data. The model RMS was 4.5%, which meets requirements (<10%). Comparison of model results to field measured baseflow conditions at Holland River was reasonable. Lower score given because of large complexity of system relative to calibration points and the fact that system is not at equilibrium (aquifer dewatering occurring).	None	Report states that calibration can be improved by the collection of additional detailed water level data from existing monitoring wells and wells in broader area. Collection of data from new wells may also be required considering system complexity
9. Was Uncertainty considered in the analysis?	5	1	Capture zones were determined based on a single (best) model setup, and uncertainty only considered for WHPA-D. An uncertainty analysis was performed, but it is not clear that the results were incorporated into the WHPA (except for WHPA-D)	None	Incorporate the results of the sensitivity analysis into capture zone development.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high	None	

Table 3: BRADFORD/BONDHEAD - DOANE - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**Bondhead Distribution and Supply Wells - Doane**
Reviewed Report:	**South Simcoe Groundwater Study, WHPA-Township of Bradford West Gwillimbury, Appendix F**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**Local Scale 3D MODFLOW**
Score:	**7.1**
Pass:	**Yes**
Critique Ref:	**Group 1 Peer Review Score Card Results_030210**

System Characteristics

Hydrogeological Complexity	Medium High (Upper Aquifer), largely unconfined
Spatial variability in Aquifer Vulnerability	High
Known water Quality Issues	None

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?		7	Pumping rate is determined from model, and is limited to the recharge area. The pumping rate of 300 m^3/day is much higher than the 2002 average rate of 168 m3/day, but is only 20% of the PTTW rate. Overall, rate is considered okay as long as pumping regime does not deviate from model inputs.	None	Determine committed population requirements to ensure that it is within permitted rate. Confirm with municipality that modelled rates represent likely conditions. Should pumping regime change, then model should be updated.
2. Were rule-approved models and methods used?		Pass	3D Numerical flow model is an approved modelling approach	None	Perform continuous updating and verification of the model data
Subjective Criteria					
3a. Is geological setting complex?	10	7	Medium complexity. It is largely unconfined or poorly confined. Extent of aquifer is spatially limited, and therefore better defined	None	
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	8	Variety of data used in assessment regional information (geology mapping, WWIS) and site investigation data (monitoring wells); however, conceptual model could benefit from increased borehole data. Geology more simpler than other well fields	None	
4. Is Flow Model Complexity Appropriate?	10	8	Yes - 3D flow model used, moderate to high degree of spatial representation relate to simpler hydrogeology relative to other well fields	None	
5. Are model input parameters (recharge, porosity, K) reasonable?	5	7	Generally yes - K values are based on pumping tests, and have been assigned spatial variability in model. Recharge values appear realistic.	None	Obtain additional field measurements of K, use water budget results for Recharge.

6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	8	Generally yes - Model was calibrated to natural flow field. Explanation of the boundary conditions appears reasonable. Direction of capture zone correlates with natural flow field which mimics topography	None	
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10	N/A			
8. Was the Model Calibrated?	5	8	Yes- Calibrated to MOE Water Well Record data and available monitoring well water level data. The model RMS was 4.5%, which meets requirements (<10%). Comparison of model results to field measured baseflow conditions at Holland River was reasonable. Higher score given relative to other well fields because of less complexity of system.	None	Report states that calibration can be improved by the collection of additional detailed water level data from existing monitoring wells and wells in broader area. Collection of data from new wells may also be required considering system complexity
9. Was Uncertainty considered in the analysis?	5	1	Capture zones were determined based on a single (best) model setup, and uncertainty only considered for WHPA-D. An uncertainty analysis was performed, but it is not clear that the results were incorporated into the WHPA (except for WHPA-D)	None	Incorporate the results of the sensitivity analysis into capture zone development.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high	None	