APPENDIX – MN (MONO)

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: Cardinal Woods

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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: CARDINAL WOODS - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**CARDINAL WOODS SUBDIVISION WELL SUPPLY**
Reviewed Report:	**Town of Mono, Groundwater Study, R.J. Burnside, 2001 and Threats Assessment Town of Mono R.J. Burnside, March 2007**
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:	**6.3**
Pass:	**Yes**
Critique Ref:	**Copy of Sent to Client _ Peer Review Score Card Results - 16072010**

System Characteristics

Hydrogeological Complexity	Bedrock aquifer underlying overburden.
Spatial variability in Aquifer Vulnerability	Medium
Known water Quality Issues	None - No human health 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?	10	The Cardinal Woods well field consists of three wells (MW1, MW3, and MW4) installed in limestone of the Amabel Formation. The wells are approximately 60 m deep and the overburden thickness in the area of the wells is 25 m. The model used the permitted rates of 1571 m^3/day for MW3 and a combined 818 m3/day for MW1 and MW4 (these wells cannot be pumped concurrently). The use of PTTW rates is a conservative approach to define capture zones.	None	The model could be re-run at rates based on better estimates of water supply needs.
2. Were rule-approved models and methods used?	Pass	3D Numerical flow model is an approved modelling approach	None	Perform continuous updating and verification/validation of the model data.
Subjective Criteria				
3a. Is geological setting complex?	6	Moderate complexity. The overburden geology consists of lacustrine fluvial and ice-deposited drift. The fluvial deposits range from outwash plains and irregularly stratified kame hummocks. Overburden thickness is greatest within bedrock valleys. There are three main bedrock groups: the Amabel Formation, Clinton/Cataract Groups and the Queenston Formation. The Amabel Formation limestone is the major bedrock aquifer.	None	If planned expansion occurs, further pumping tests and aquifer assessment is required. At that time, the appropriateness of the model to new data should be assessed.
3b. Is Geological Model / Understanding Adequate for assessment method selected?	7	Yes the geologic model requires a 3-D numerical modelling approach given the confined nature of the aquifer which has a significant spatial changes in thickness and overlying aquitard thickness. As well topography and surface drainage are important and a 3-D model incorporates these features as well. Inclusion of cross-section in the documentation (2007) would be beneficial.	None	Improve geological model by additional borehole construction in the future. Better documentation of the geology (e.g., cross-sections) is beneficial.
4. Is Flow Model Complexity Appropriate?	6	Yes - A multi-layered model was used with seven main hydrostratigraphic units represented in the model.	None	

5. Are model input parameters (recharge, porosity, K) reasonable?	7	A variable recharge rates from a surface water model (GAWSER) were input into the model. The report does present a figure illustrating Layer 1 which shows the distribution of hydraulic conductivity values for this layer only. Hydraulic conductivity values were reported for each layer that was assumed to be homogeneous. Layer 1, overburden aquifer/aquitard (three zones, $4x10^{-4}$ m/s, $5x10^{-5}$ m/s and $6x10^{-8}$ m/s) ; Layer 2, contact bedrock aquifer ($8x10^{-5}$ m/s); Layer 3, Guelph-Amabel aquifer ($4x10^{-6}$ m/s); Layer 4, Cabot Head shale aquitard ($6x10^{-8}$ m/s); and Layer 5, the Whirlpool aquifer ($4x10^{-6}$ m/s).	Yes	
6. Was natural flow field adequately incorporated into model? (Numerical Model)	6	Boundary conditions were the Grand River and Credit River watershed boundary and the Niagara Escarpment boundary. The Grand River boundary (west) was designated as no-flow for Layers1-3 and constant head for Layer 4-5. Three recharge zones were used: a high recharge zone of 250 mm/year, a medium recharge zone of 125 mm/year and a low recharge zone of 25 mm/year.	Yes	
7. Was natural flow field adequately incorporated into model? (Analytical Model)				
8. Was the Model Calibrated?	7	The overall Orangeville and area model was calibrated to over 1000 wells and had a NRMS of 6.8% A comparison was made between the simulated base flow and the actual base flow in the Grand River (121%) and the Credit River (79%).	None	An examination of residual values (modelled versus actual water levels) plotted spatially would be beneficial at the local scale.
9. Was Uncertainty considered in the analysis?	5	A sensitivity assessment is documented which identified input parameters (e.g., hydraulic conductivities for certain hydrostratigraphic units) that more highly influence WHPA size. However, an uncertainty assessment was not completed and the WHPA areas are based solely on "best estimate" calibrated input parameters.	Yes	Capture zones are based on "best case" (calibrated) values. Further incorporation of sensitivity and uncertainty would be beneficial.
10. What is the Uncertainty?	High	Designation not provided in report, but Dillon recommends that it be assessed as high.	None	