# Kettle Creek / Catfish Creek / Long Point Region Water Budget and Water Quantity Stress Assessment

## Peer Review Summary Report

**August 2009**

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# 1. EXECUTIVE SUMMARY

Drinking water source protection is an initiative by the Province of Ontario in which Conservation Authorities (CAs) are working with other partners to help ensure sufficient supplies of safe drinking water for the future. The Technical Experts Committee Report (MOE, 2004) on Watershed-based Source Protection Planning recommended that "the water budgets should be progressively developed for the individual watershed as a method of quantifying water storage volumes, fluxes, pathways, and water takings for the combined surface and groundwater resources." The Report also states that the water budget framework and approach is essential to the source water protection planning process as it provides a logical methodology for evaluating threats and issues related to water quantity. Thus, it is important to perform water budget analysis based on sound scientific principles for the success of the source water protection planning process.

The Water Budget and Water Quantity Risk Assessment, as described in the Assessment Report: Guidance Module 7, will produce reporting that describes groundwater and surface water flow networks and their interaction as well as identifying sub-watersheds and local area communities that may not be able to meet current or future water supply demands from existing or planned water supply sources. It is expected that all the activities that require water, both the needs of people and the environment, will be taken into account. The water budget estimates that come out of the Drinking Water Source Protection (DWSP) project are expected to be the authoritative water budget which will be used as a basis for decision making on the range of water management programs including the Low Water Response and Permit-to-Take-Water (PTTW) programs.

Since much of the work for the Kettle/Catfish/Long Point Water Budget was completed prior to the DWSP initiative, the current work falls into the preliminary stages of Tier 2 as defined in the Guidance Module 7. The first draft of the Kettle/Catfish/Long Point (Tier 2) Water Budget Report was submitted to the Lake Erie Source Protection Region for review by AquaResource Inc. in December 2007. The draft Water Quantity Stress Assessment was submitted for review in March 2009.

In order to develop technically defensible estimates of water budget components, the Province requires that the water budget analysis is peer-reviewed. Provincial direction is provided in an interim guidance document, entitled *Peer Review Water Budget Interim Direction*, *Version 2.0 (DRAFT)* (dated August 9, 2005). A Kettle/Catfish/Long Point Peer Review Team was struck in March 2007 and a Terms of Reference was drafted to outline the roles, responsibilities and deliverables of the team in accordance with the provincial guidance.

This document summarizes the peer review of the water budget and water quantity stress assessment for the Kettle Creek, Catfish Creek and Long Point Region watersheds. This document is intended to summarize the process followed by the Peer Review Team in preparing recommendations to assist in the completion of the Tier 2 Water Budget and the identification specific subwatersheds for further Tier 3 Risk Assessments.

# 2. PEER REVIEW PROCESS

The *Peer Review Water Budget Interim Direction*, *Version 2.0 (DRAFT)* (dated August 9, 2005) describes Peer Review as the process whereby regional source water protection water budget teams engage experts from outside their project team in the development of the water budget on a continuous improvement basis. Peer review, therefore, constitutes outreach to and participation by the broad scientific and engineering communities. Peer review is a continuous

process for enhancing water budget products so that the decision or position taken, based on the water budget products, is technically sound and defensible.

Peer Review is aimed at an in-depth assessment of the assumptions, calculations, extrapolations, alternate interpretations, methodology, and conclusions pertaining to the water budgets and any supporting documentation. At the end of the Peer Review, it is expected that documented review will be created to help ensure that activities are technically adequate, competently performed, and properly documented, and satisfy technical guidance. Peer reviewer comments will be included in the document along with the responses from the water budget technical team and any revisions which may result from those comments. The objectives of the Water Budget Peer Review committee are:

- To ensure that water budgets are scientifically defensible;
- To ensure consistency with the expectations of the water budget technical guidance;
- To validate the water budget deliverables.

Peer review will occur periodically throughout the development of all the phases (Tiers 1, 2 & 3) ensuring that the final water budget is technically sound.

The Kettle Creek, Catfish Creek and Long Point Region Conservation Authorities have been involved in the development of a water budget study for several years, relying upon previous work including hydrologic model studies, municipal groundwater studies, Ontario Geologic Survey geological investigations, and water use inventory reports. The study has used, and improved upon, the existing GAWSER hydrologic models and FEFLOW groundwater models.

The study has also built upon current work by the three CAs to compile, digitize, and analyze additional information available from the MOE Permits to Take Water, and directly from water users, about actual water use. Because of the sensitivity of the water budget and stress assessment to water use estimates, a range of assumptions and methods is being used.

The project is being carried out in accordance with the Ontario Ministry of the Environment (MOE) Guidance Module 7 for preparing Water Budget and Water Quantity Risk Assessments. The study fulfills the requirements for the Tier 2 Water Budget and Water Quantity Stress Assessment. On the basis of the detailed conceptual understanding of the watershed generated by its previous work, the three CAs proceeded directly to the Tier 2 reporting stage. The GRCA, as project manager, selected AquaResource Inc. (ARI) to complete the Water Budget and Water Quanty Stress Assessment reports which were submitted for staff and peer review.

## *2.1. Terms of Reference*

In October 2006, Lake Erie Source Protection Region staff developed a Terms of Reference (TofR) to guide the peer review process. The TofR, found in Appendix A, was developed in accordance with the provincial guidance document, entitled *Peer Review Water Budget Interim Direction*, *Version 2.0 (DRAFT)* (dated August 9, 2005).

The TofR outlines the following details of the peer review:

- Roles and responsibilities of the team members,
- Team composition,
- Conflict of interest,
- Statement of the work required,
- Schedule of peer review milestones, and
- Level of effort required by the peer reviewers.

## 2.2. Peer Review Committee

The Peer Review Committee consists of:

- The Peer Review Leader,
- The Water Budget Project Team,
- External Technical Experts, and
- Provincial and Conservation Ontario Observers.

The composition of the committee formed in March 2007 is outlined in Table 1.

**Table 1 – Kettle Creek / Catfish Creek / Long Point Region Water Budget Peer Review Committee and Technical Resources**

| Peer Review Role | Peer Review Committee |
|---|---|
| Peer Review Leader | James Etienne, GRCA |
| Peer Reviewers | Dr. Dave Rudolph, University of Waterloo |
| | Dr. Hugh Whiteley, University of Guelph |
| | Dr. Rob Schincariol, University of Western Ontario |
| | Chris Neville, S.S. Papadopulos and Associates |
| | John Warbick, Ministry of Agriculture & Rural Affairs (intermittent) |
| | Deborah Goudreau, Oxford County |
| | Bob Fields, Norfolk County |
| | **Technical Resources** |
| SPP Director | Lorrie Minshall, Lake Erie SP Region |
| Consultant Team | Paul Martin, Dave VanVliet, Sam Bellamy, AquaResource Inc. |
| Agency Representatives | Mike Garraway, Scott Bates, Ministry of Natural Resources |
| | Clara Tucker, Ministry of the Environment |
| | Jennifer Havelock, Scott Lister, Conservation Ontario |
| SP Region Staff Support | Gregg Zwiers, Sonja Strynatka, Stephanie Shifflett, Amanda Wong, GRCA |
| | Bill Baskerville, Heather Surette, Craig Jacques, LPRCA |
| | Peter Dragunas, CCCA |
| | Jennifer Dow, KCCA |

## 2.3. Completing the Peer Review

The peer review is considered to be complete when peer review comments are incorporated into the water budget products, or reasons are stated why such comments are not to be incorporated. This document includes copies of all the peer review meeting minutes and the consolidated comment matrices used by the consultant to complete the final report drafts for Peer Reviewer acceptance. Each matrix includes an "action" column which describes the response to Peer Review comments. A complete file of the documentation collected throughout the peer review process is available for review at the GRCA's Administrative Offices at 400 Clyde Road in Cambridge.

# 3. WATER BUDGET PEER REVIEW

The preparation of the Water Budget and Water Quantity Stress Assessment by ARI was broken into two phases. Phase 1 involved the collection of background information for the preparation of a Draft Interim Report in November 2007 for peer review. Although the report was initially signed-off by the Peer Review Committee in March 2008 as the Interim Water Budget Report, the report was revised and posted in March 2009 using new information and a revised modeling approach applied in Phase 2.

## *3.1 Committee Meetings*

The meeting minutes for the Water Budget Peer Review may be found in Appendix B-1.

The Peer Review committee, which was assembled in March 2007, was invited to comment on the TofR for the project. Upon selection of ARI for the preparation of the Water Budget report, a kick off meeting was held on May 31, 2007. At this meeting the team considered the uncertainty of the geological conceptual model based on the paucity of deep bedrock data within the study area. It was agreed that the consultant could develop a calibrated model within an acceptable level of confidence for the peer reviewers using the available data and appropriate assumptions.

The Peer Review committee reconvened in September 2007 to review the initial findings of the consultant and to advise the consultant on their modeling approach. New information gathered from the Ontario Geological Survey (OGS) generated some concerns about the conceptual model, forcing ARI to rethink some of their initial assumptions. In addition, the consultant identified the significant amount of calibration required to balance potential irrigation demand with observed summer baseflows. As a result of these significant uncertainties, ARI requested an additional month to conduct groundwater sensitivity runs in the FEFLOW model and to fine tune the irrigation assumptions in the GAWSER model.

The draft Water Budget report was circulated for Peer Review in November 2007 and the committee met to receive a presentation of the report on November 22, 2007. The Peer Reviewers were asked to submit their initial comments and questions for discussion at a subsequent meeting on December 17, 2007. In order to provide an orderly tracking of the comments for discussion and follow-up by ARI, a comment matrix was prepared and circulated to the team prior to the December 17th meeting. The written comments in the matrix were discussed at this meeting, and responses (leading to actions) were added to the matrix which directed ARI's revisions to the draft report (Appendix B-2).

## *3.2 Peer Review Recommendations*

In January of 2008, ARI took the consolidated comments from the matrix and developed a strategy for revising the Integrated Water Budget Report. One of the main points raised by the Peer Reviewers throughout Phase 1 was the need clarify the certainty in the modeling. The December 17th meeting also identified the need to draw a close to the existing conditions scenario and prepare for the future and drought conditions scenarios. While a stress assessment for the existing conditions was completed by ARI in Phase 1, it was agreed that this assessment would not be published until the future and drought scenarios had been assessed in Phase 2. The revised Integrated Water Budget Report that was delivered to the GRCA in March 2008 and circulated to the Peer Reviewers for another round of document review during which the team compared the revisions to their comments in the matrix. The comments received indicated that it would be appropriate for the consultant to proceed with the next phase of work on the Water Quantity Stress Assessment.

# 4. WATER QUANTITY STRESS ASSESSMENT PEER REVIEW

Phase 2 of the Water Budget and Water Quantity Stress Assessment by ARI involved the completion of the future and drought scenarios and the identification of significant groundwater recharge areas (SGRAs) in accordance with the new Source Protection Technical Rules (MOE, 2008). The report was revised and ultimately posted in August 2009 based upon final Peer Reviewer input and sign-off.

## *4.1 Committee Meetings*

The meeting minutes for the Water Quantity Stress Assessment Peer Review may be found in Appendix C-1.

The Peer Review committee reconvened in March 2009 to review the draft Water Quantity Stress Assessment report. The committee met to receive a presentation of the report on March 19, 2009. By this time, ARI had revisited the FEFLOW and GAWSER models developed in Phase 1 to address a number of the uncertainties raised by the Peer Review Committee. New water use data and revised models were used to bring the Integrated Water Budget report up to date for posting in April 2009.

The Peer Reviewers were asked to submit their initial comments and questions for discussion at a subsequent teleconference on April 7, 2009. As was the case in Phase 1, a comment matrix was prepared and circulated to the team prior to the teleconference. The written comments in the matrix were discussed at this teleconference, and responses (leading to actions) were added to the matrix which directed ARI's revisions to the draft report (Appendix C-2).

## *4.2 Peer Review Recommendations*

The consolidated matrix and subsequent Peer Reviewer comments were used to revise the draft report. In addition, the consultant solicited specific comments from the Peer Reviewers on the preferred approach to SGRA delineation as required by the Technical Rules (MOE, 2008) The final document was subsequently circulated to the Peer Reviewers for another round of document review during which the team compared the revisions to their comments in the matrix. The Peer Reviewer sign-off correspondence received indicates that the Tier 2 Integrated Water Budget and Water Quantity Stress Assessment reports are scientifically defensible and satisfy the provincial guidelines for water budget documents. For the most part, the Peer Reviewers were satisfied that their comments had been received and addressed in a professional manner by ARI. As a result, the documents provide clear direction for further municipal Tier 3 Water Quantity Risk Assessments

In August 2009, the Peer Review of the Long Point Region, Catfish Creek and Kettle Creek Tier 2 Integrated Water Budget and Water Quantity Stress Assessment was considered substantially complete and all reports were posted on the Lake Erie Source Protection website.

# 5. FUTURE WORK

The Peer Review Committee have recognized that the Tier 2 work completed serves as a "screening tool" for further municipal water quantity risk assessment work. The peer review has been completed within the context of the provincial water budget framework, assessing the completeness and technical accuracy of the documentation. The Peer Reviewers have identified the need for the Source Protection Committee to decide upon the need for additional Tier 3 work and how the technical results (ie. SGRAs) will be applied to the development of source protection policies in the Lake Erie Source Protection Region.

## *5.1. Tier 3 Water Quantity Risk Assessments*

The Stress Assessment report identifies the Lehman Reservoir in Delhi as a municipal surface water supply that meets the requirements to proceed with a Tier 3 Water Quantity Risk Assessment. The report also identifies municipal groundwater sources in Oxford County (Tillsonburg) and Norfolk County (Delhi, Simcoe and Waterford) that also meet the requirements for additional Tier 3 work. ARI are currently developing Terms of Reference for Tier 3 work in Norfolk County and will be soliciting further input from the Peer Review Committee on a revised modeling approach based on their previously reported comments and concerns. The July 14, 2009 Peer Review comments from Chris Neville suggest that the Tier 3 assessment for Tillsonburg be deferred pending a clear indication of future water demand as growth occurs.

## *5.2. Continuous Improvements*

The July 14, 2009 Peer Review comments from Chris Neville (Appendix C-3) refer to some gaps and reservations that should addressed in any future water budget work. It is recommended that this correspondence be referenced with respect to continuous improvement of the data sets the modeling approach and the water quantity assessments.

# Appendix A

# Lake Erie Source Protection Region Peer Review Terms of Reference

# Lake Erie Source Protection Region

# Water Budget and Water Quantity Stress Assessment Peer Review

# TERMS OF REFERENCE

**October 2006**

**(Revised August 2008)**

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# 6. OVERVIEW

Source water protection is an initiative by the Province of Ontario in which Conservation Authorities (CAs) are working with other partners to help ensure sufficient supplies of safe drinking water for the future. The Technical Experts Committee Report (MOE, 2004) on Watershed-based Source Protection Planning recommended that "the water budgets should be progressively developed for the individual watershed as a method of quantifying water storage volumes, fluxes, pathways, and water takings for the combined surface and groundwater resources." The Report also states that the water budget framework and approach is essential to the source water protection planning process as it provides a logical methodology for evaluating threats and issues related to water quantity. Thus, it is important to perform water budget analysis based on sound scientific principles for the success of the source water protection planning process.

The Water Budget and Water Quantity Risk Assessment, as described in the Assessment Report: Guidance Module 7, will produce reporting that describes groundwater and surface water flow networks and their interaction as well as identifying sub-watersheds and local area communities that may not be able to meet current or future water supply demands from existing or planned water supply sources. It is expected that all the activities that require water, both the needs of people and environment, will be taken into account. The water budget estimates that come out of the Source Water Protection (SWP) project are expected to be the authoritative water budget which will be used as a basis for decision making on the range of water management programs including the Low Water Response and Permit-to-Take-Water (PTTW) programs.

The framework for the water budget process is presented in Figure 1. Please note, however, that, because much of the work for the Grand River, Long Point Region, Catfish Creek, and Kettle Creek was completed prior to the SWP initiative, the current work falls into the preliminary stages of Tier 2 as defined in the Guidance Module 7. The process schematic for the Tier 2 Water Budget and Stress Assessment is attached as Figure 2.

In order to develop technically defensible estimates of water budget components, the Province requires that the water budget analysis is peer-reviewed. Provincial direction is provided an interim guidance document, entitled *Peer Review Water Budget Interim Direction*, *Version 2.0 (DRAFT)* (dated August 9, 2005).

This document is a Terms of Reference for peer review of the water budget and water quantity stress assessment in the Lake Erie Source Protection Region, comprised of the Grand River, Long Point Region, Catfish Creek, and Kettle Creek Conservation Authorities. This Terms of Reference is intended to guide the peer review process and the work of this Peer Review Committee.

# 7. PEER REVIEW

The *Peer Review Water Budget Interim Direction*, *Version 2.0 (DRAFT)* (dated August 9, 2005) describes Peer Review as the process whereby regional source water protection water budget teams engage experts from outside their project team in the development of the water budget on a continuous improvement basis. Peer review, therefore, constitutes outreach to and participation by the broad scientific and engineering communities.

Peer review is a continuous process for enhancing water budget products so that the decision or position taken, based on the water budget products, is technically sound and defensible.

Peer Review is aimed at an in-depth assessment of the assumptions, calculations, extrapolations, alternate interpretations, methodology, and conclusions pertaining to the water budgets and any supporting documentation. At the end of the Peer Review, it is expected that documented review will be created to help ensure that activities are technically adequate, competently performed, and properly documented, and satisfy technical guidance. Peer reviewer comments will be included in the document along with the responses from the water budget technical team and any revisions which may result from those comments.

The objectives of the Water Budget Peer Review committee are:

- To ensure that water budgets are scientifically defensible;
- To ensure consistency with the expectations of the water budget technical guidance;
- To validate the water budget deliverables.

Peer review will occur periodically throughout the development of all the phases (Tiers 1, 2 & 3) ensuring that the final water budget is technically sound.

# 8. ROLES AND RESPONSIBILITIES

The Peer Review Committee will consist of:

- The Peer Review Leader,
- The Water Budget Project Team,
- External Technical Experts, and
- Provincial and Conservation Ontario Observers.

## *8.1. Peer Review Leader*

The Peer Review Leader will organize, manage, document, and respond to the peer review of the water budgets. James Etienne, Sr. Water Resources Engineer, Grand River Conservation Authority, will act as the Peer Review Leader and facilitate the meetings for the peer review team.

In particular, the Peer Review leader will:

- Manage the peer review process by following the Terms of Reference,
- Foster an organized and balanced discussion amongst the peer review committee;
- Fill vacancies on the committee;
- Ensure that peer reviewers understand their responsibilities,
- Deal with questions regarding the review process or specific documentation.
- Prepare agendas and background information for the team members;

- Maintain minutes of meetings and provide regular reporting on the activities of the Peer Reviewers,
- Ensure coordination of comments and feedback from the Peer Reviewers regarding the water budgets, and
- Establish and maintain the required peer review record.

## *8.2. Project Team*

The project team is comprised of the lead scientists/engineers preparing the water budget models and reports, including respective CA staff and consultants.

Specific responsibilities of the Technical Leads are to:

- Compile and prepare the required water budget documents, reports, results of analysis, maps and associated technical material for the Peer Review Committee
- Work with the Peer Review Leader on the preparation of required material for the Peer Review meetings such as, agendas, background information, presentations, etc.
- Incorporate the peer review report and the Peer Review Committee's suggestions and modifications into the water budget reports.

## *8.3. Technical Experts (Peer Reviewers)*

The peer reviewers are qualified external team members who are independent of those who performed the work, but who are collectively equivalent (or superior) in technical expertise to those who are performing the work. The peer reviewers should have technical expertise in ground and/or surface water processes, and a good understanding of water budget concepts and approaches

Peer reviewers can be academics, private practitioners, municipal/provincial government staff, adjoining conservation authority staff and others.

The role of the peer reviewers is to:

- Be active and objective participants in the peer review process;
- Read provincial guidance documents and water budget deliverables;
- Perform the review and submit written comments by the agreed deadline, clearly differentiating between 1) comments to be dealt with for the satisfaction of the immediate product, 2) advice with respect to next steps, and 3) comments intended to contribute to the continuous improvement process;
- Protect confidential information and maintain the confidentiality of the product;
- Work positively towards the completion of a satisfactory product (even while understanding the short-comings in the science, analytical tools, data, and understanding).

## *8.4. Provincial and Conservation Ontario Representatives*

Provincial and Conservation Ontario representatives will:

- Ensure that Provincial standards are being followed in the water budget process adopted in this region.

# 9. MATERIAL TO BE PROVIDED TO THE COMMITTEE

The Peer Review Leaders and the Project Team will provide the following documentation to each peer reviewer:

- A current copy of the water budget products to be peer reviewed, associated background material, and the terms of reference,
- Information concerning the process for the peer review, including the due date of reviewer comments, the format of those responses, and a point of contact for questions,
- A bibliography and/or any particularly relevant scientific articles from the literature to aid in decision-making.

# 10. PEER REVIEW TEAM

The attached Table 1 lists the proposed committee members, their affiliations and expertise. Additional expertise may be required depending on the subject area. The core peer review team will be asked to help identify other experts to fill these gaps in expertise if and when the need arises.

# 11. CONFLICT OF INTEREST

Conflict of interest is a situation in which, because of other activities or relationships with other persons, an individual is unable or potentially unable to render impartial assistance or advice. Generally, a conflict of interest arises when the person is affected by his/her private interests, when he/she or his/her associates would derive benefit from incorporation of their point of view in a water budget activity/product, or when their professional standing and status or the significance of their principal area of work might be affected by the outcome of the peer review. Individuals contacted for peer review are expected to report any conflicts of interest that may affect their ability to participate in peer review in an unbiased manner.

# 12. STATEMENT OF WORK

The water budgets will address both surface and ground water resources. The conceptual models will include a description of all surface water and groundwater features and processes that may affect the quantity, movement, and accessibility of water. The final water budget will be developed with numerical models in Tiers 1, 2, and 3. It must be able to predict and reflect the water quantities and fluxes within hydrologic cycle reservoirs in order to make allocation decisions and to conserve the resource. The peer reviewers will consider the following aspects of the water budget as a tool to assess existing conditions, future development and water use decisions:

**Appropriateness of Method**

- Does the water budget meet the expectations of the provincial interim direction and the needs of the Source Protection Region?

**Scale and Data Sources**

- Is the scale of the water budget appropriate for the objectives outlined in the current phase of the project?
- Does the water budget make use of all relevant data sources and data at an appropriate scale both spatially and temporally?
- Does the water budget incorporate water budget outputs from adjacent Regions?

**Description of Hydrologic Features and Processes**

- Are all components of the water cycle considered in the water budget?
- Does the water budget consider physical hydrologic features on the surface and in the subsurface (i.e., dams, eskers, faults)?
- Are the surface water framework and the hydrostratigraphic framework sufficiently described (i.e. stream connectivity, aquifer distribution)?
- Does the water budget describe the hydraulic properties (including a range of values) of the physical features (i.e. soil characteristics, basin characteristics, hydraulic conductivity, porosity, storage parameters)?
- Does the water budget consider all the natural processes that may affect the quantification of water volumes and water movement (i.e. runoff, evapotranspiration, infiltration)?
- Are the surface and subsurface processes sufficiently explained and ranges of values provided?

**Water Usage**

- Are all anthropogenic and natural uses of water within the watersheds described and quantified?

**Questions, Limitations and Recommendations**

- Is the range of uncertainty for all values provided?
- Are the underlying assumptions reasonable and fully explained?
- Are the limitations of the water budget clearly outlined?
- Is the level of detail provided in the water budget sufficient to provide enough information for stress assessment?
- Are data gaps and/or information gaps summarized?
- Do the calculations seem reasonable?
- Do the maps meet the technical requirements?
- Do the maps fulfill their purpose?
- Are the numerical models sufficiently complex to assist with resolution of water quality threats or issues?
- If necessary, what additional work or changes should be undertaken?
- Why should the work be undertaken?

# 13. COMPLETING THE PEER REVIEW

The peer review will be considered to be complete when peer review comments are incorporated into the water budget products, or reasons are stated why such comments are not to be incorporated.

# 14. ANTICIPATED SCHEDULE

A tentative schedule and topics are proposed as shown in the following table:

| | |
|---|---|
| Week of October 23, 2006: | Distribution of documents to the water budget Peer Review Committee:<br>• Provincial guidance on water budget and water quantity risk assessment<br>• Peer review committee Terms of Reference<br>• Draft Grand River Water Budget and Preliminary Stress Assessment report<br>• Support material referenced in the draft Report |
| November 24, 2006 | **Grand River Meeting #1:**<br>Overview of the Water Budget and Water Quantity Risk Assessment Framework<br>Confirm Peer Review Committee Terms of Reference<br>Presentation of Grand River Water Budget report, followed by questions and discussion |
| December 13, 2006 | **Grand River Meeting #2:**<br>Discuss / set out action for the consolidated comments and advice.<br>Discuss scope / Terms of Reference for next step Grand River investigations. |
| March 9, 2007 | **Long Point Region/Catfish/Kettle Meeting #1:**<br>Agree to proposed Consultant Terms of Reference |
| April 2007 | Distribution of Grand River Peer Review Report for review / endorsement |
| May 31, 2007 | **Long Point Region/Catfish/Kettle Meeting #2:**<br>Receive information on Conceptual Water Budget<br>Review work plan for Fall 2007 deliverables |
| September 17, 2007 | **Long Point Region/Catfish/Kettle Meeting #3:**<br>Solicit advice on the modelling approach to present in the draft report and discuss the timing for the delivery of the draft report to the Peer Reviewers |
| November 22, 2007 | **Long Point Region/Catfish/Kettle Meeting #4:**<br>Solicit advice on the modelling approach to present in the draft report and discuss the timing for the delivery of the draft report to the Peer Reviewers |
| December 17, 2007 | **Long Point Region/Catfish/Kettle Meeting #5:**<br>Solicit advice on the modelling approach to present in the draft report and discuss the timing for the delivery of the draft report to the Peer Reviewers |
| March 26, 2008 | **Grand River Meeting #3:**<br>Description and Discussion of Grand River Tier 3 Pilot work plans |
| October 2008 | 1 meeting, 6 week process as described above for each of the Interim Grand River Tier 3 Water Quantity Risk Assessment investigations |
| December 2008 | 2 meeting, 8 week process for Grand River Tier 2 Water Budget and Stress Assessment (for drought and future scenarios) |
| December 2008 | 2 meeting, 8 week process as described above for Long Point Region/Catfish/Kettle Tier 2 Water Budget and Stress Assessment (for drought and future scenarios), toward confirming scope for Tier 3 Risk Assessments |
| Spring/Summer 2009 | 1 meeting, 6 week process as described above for each of the Final Grand River Tier 3 Water Quantity Risk Assessment investigations |

Additional meetings or conference calls may be organized to discuss issues pertaining to a specific topic.

# 15. LOGISTICS

## *10.1 Peer Review Team Meetings*

All members will be notified in advance of the peer review meetings and provided with the appropriate logistical information. Meeting locations may vary however the majority of the meetings will be held at a place convenient to most of the members.

## *10.2 Remuneration*

External Technical Experts will be compensated based on agreed-upon per diem rates plus travel costs.

It is expected that peer reviewers from the Province or other Conservation Authorities participating on behalf of their organization, will not be reimbursed for peer review, other than for travel costs.

Purchase orders will be issued to External Technical Experts for each peer review segment. As per the Anticipated Schedule, peer review segments will be planned as '2 meeting, 8 week' segments or '1 meeting, 6 week' segments with level of effort estimated as follows:

| | **Assumed hours of effort** | |
|---|---|---|
| | **2 meeting, 8 week segment** | **1 meeting, 6 week segment** |
| Review | 16 | 8 |
| Q&A meeting | 4 | 0 |
| Comment/advice prep | 8 | 4 |
| Meeting to put action to the consolidated comment/advice | 4 | 4 |
| Review peer review report | 4 | 4 |
| Review follow-up Report or RFP | 4 | 4 |
| **Total assumed hours of effort for peer review segments** | **40** | **24** |

If additional meetings or conference calls are scheduled, additional compensation for the External Technical Experts will be paid accordingly.

**Figure 1 - Water Budget and Risk Assessment Framework**

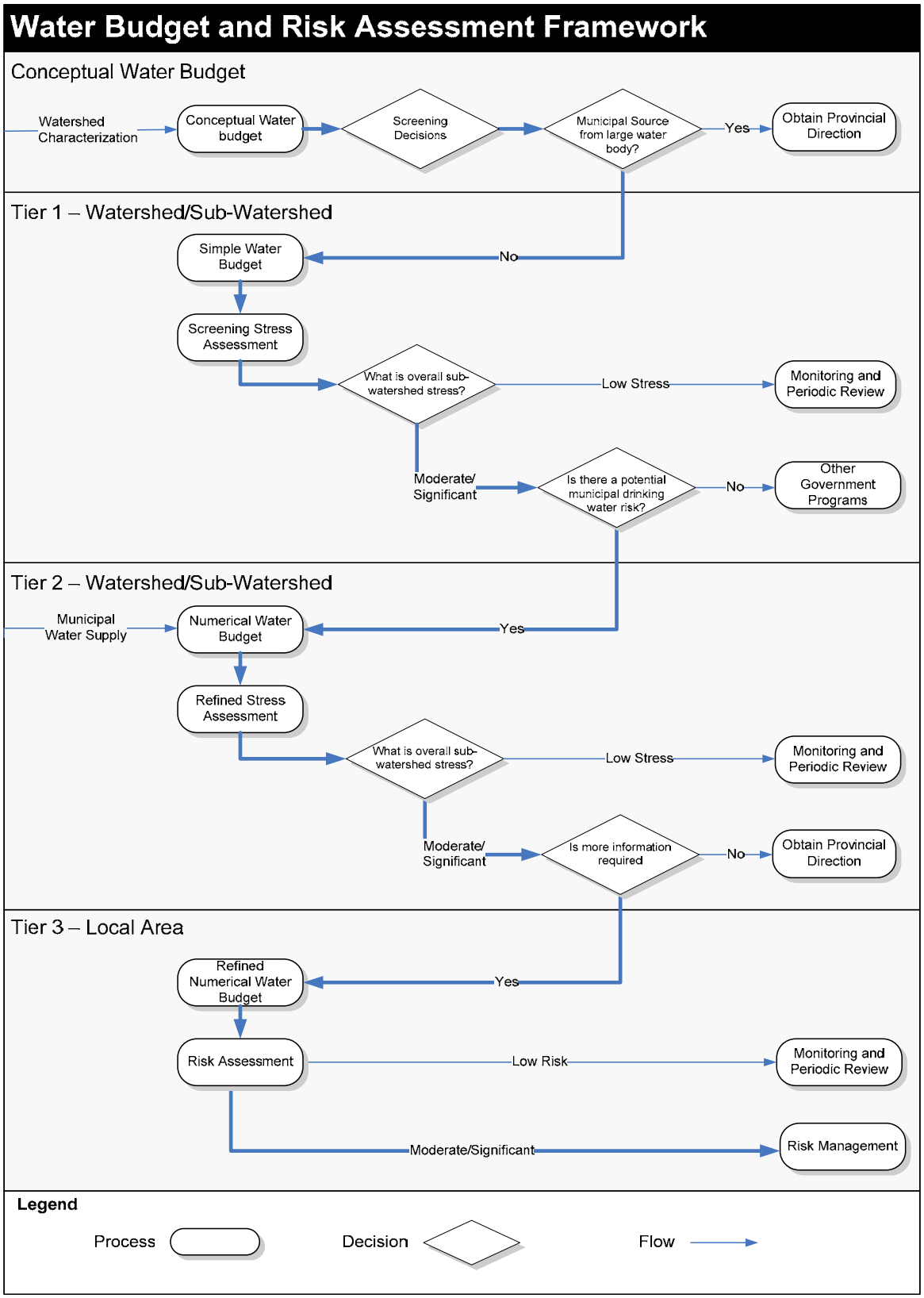

**Figure 2 - Tier 2 Water Budget and Stress Assessment Process**

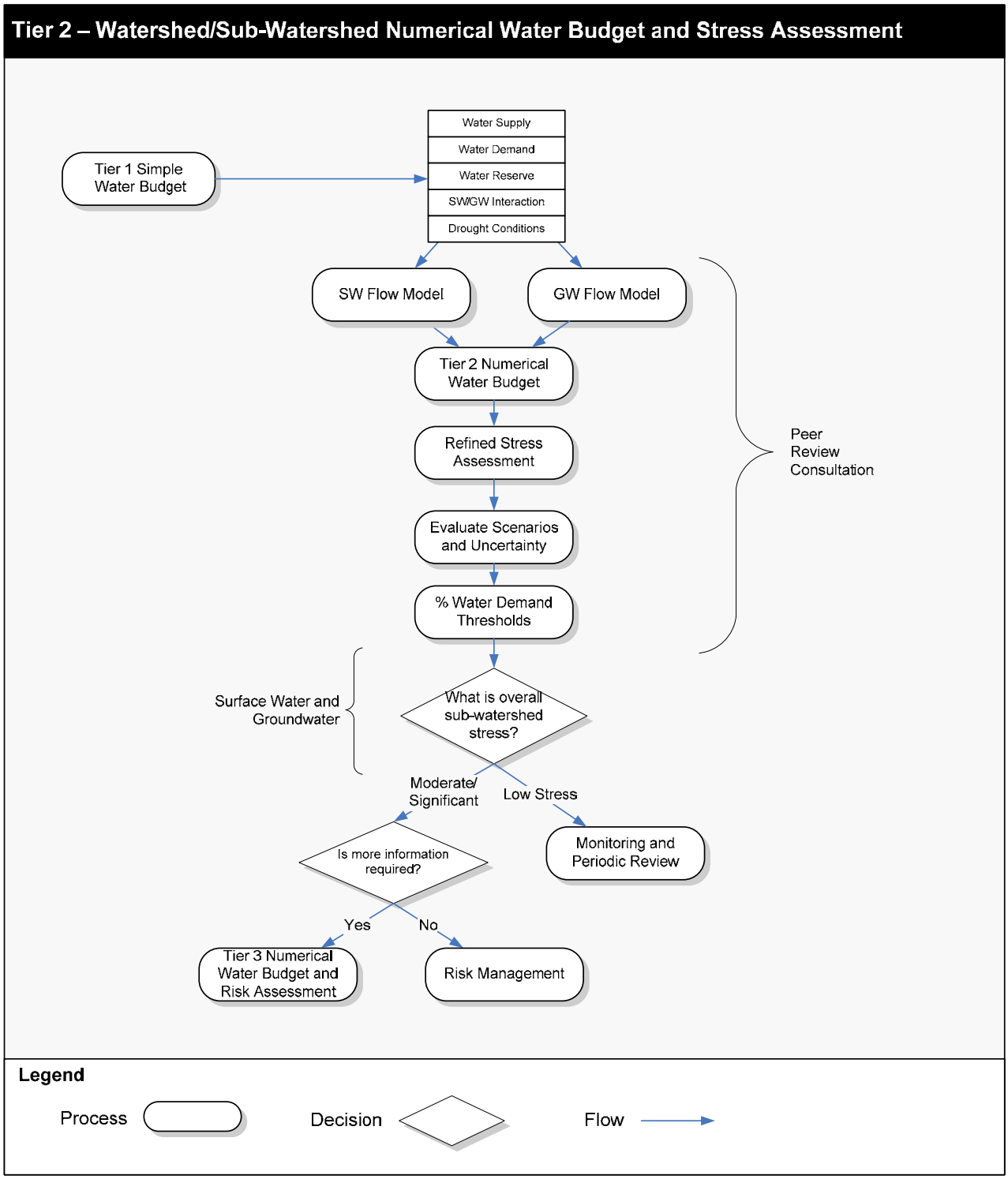

**Figure 3 - Study Area.**

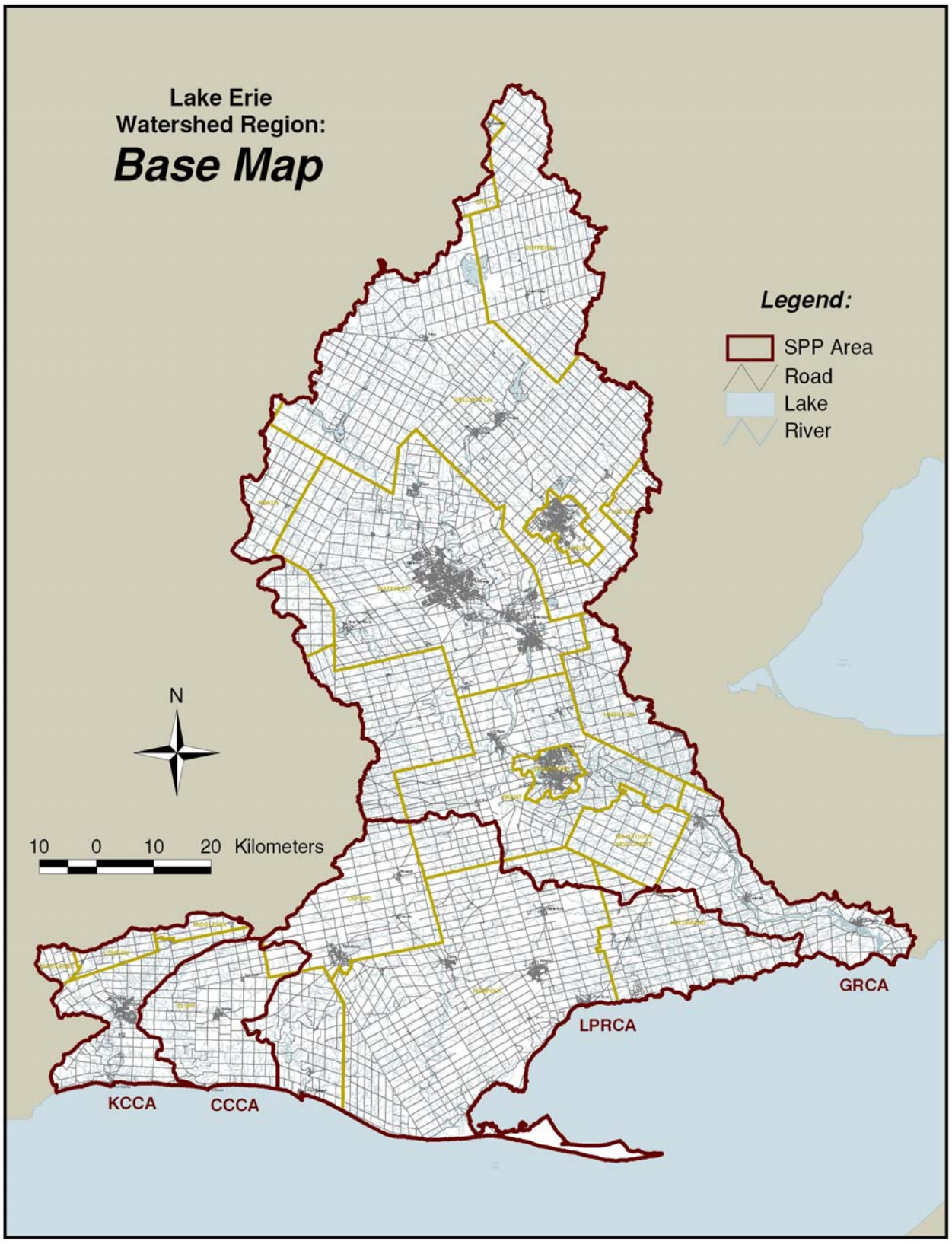

**Table 2 - Peer Review Committee for Lake Erie Source Protection Region**

| Peer Review Role | Grand River (Tier 2 & Tier 3) | Long Point Region, Catfish Creek, Kettle Creek |
|---|---|---|
| Peer Review Leader | James Etienne, P.Eng., Grand River Conservation Authority | James Etienne, P.Eng., Grand River Conservation Authority |
| Peer Reviewer | Dr. Dave Rudolph, University of Waterloo | Dr. Dave Rudolph, University of Waterloo |
| Peer Reviewer | Dr. Hugh Whiteley, University of Guelph | Dr. Hugh Whiteley, University of Guelph |
| Peer Reviewer | Chris Neville, S.S. Papadopulos and Associates (Tier 2) | Chris Neville, S.S. Papadopulos and Associates |
| Peer Reviewer | Dave Belanger, P.Eng, City of Guelph (Tier 2) | Dr. Robert A. Schincariol, University of Western Ontario |
| Peer Reviewer | Eric Hodgins, P.Geo., Regional Municipality of Waterloo (Tier 2) | John Warbick, Ministry of Agriculture and Rural Affairs (March 2007-March 2008) |
| Peer Reviewer | Tony Lotimer, M.Sc., P.Geo., ARL Groundwater Resources Ltd. (Tier 3) | |
| MNR Representative | Mike Garraway, Ministry of Natural Resources | Mike Garraway, Ministry of Natural Resources |
| MNR Representative | Scott Bates, Ministry of Natural Resources | Scott Bates, Ministry of Natural Resources |
| CO Representative | Jennifer Havelock, Conservation Ontario (Tier 2) | Jennifer Havelock, Conservation Ontario |

**Table 2 – Technical Resources for the Peer Review Committee**

| Technical Team Role | Grand River (Tier 2 & Tier 3) | Long Point Region, Catfish Creek, Kettle Creek |
|---|---|---|
| SPP Lead | Lorrie Minshall, P.Eng.,<br>Lake Erie SP Region | Lorrie Minshall, P.Eng.,<br>Lake Erie SP Region |
| Consultant | Paul Martin, AquaResource Inc. | Paul Martin, AquaResource Inc. |
| Consultant | Dave VanVliet, AquaResource Inc. | Dave VanVliet, AquaResource Inc. |
| Consultant | Sam Bellamy, AquaResource Inc. | Sam Bellamy, AquaResource Inc. |
| Support Staff | Gregg Zwiers, P.Geo., GRCA | Gregg Zwiers, P.Geo., GRCA |
| Support Staff | Sonja Strynatka, GRCA | Sonja Strynatka, GRCA |
| Support Staff | Stephanie Shifflett, GRCA | Stephanie Shifflett, GRCA |
| Support Staff | Amanda Wong, GRCA | Amanda Wong, GRCA |
| Support Staff | | Bill Baskerville, LPRCA |
| Support Staff | | Saleem Sial, LPRCA |
| Support Staff | | Peter Dragunas, CCCA |
| Support Staff | | Jennifer Dow, KCCA |
| Municipal Rep | | Deborah Goudreau, Oxford County |
| Municipal Rep | | Bob Fields, Norfolk County |

# Appendix B-1

## Phase 1 Peer Review Meeting Minutes

- **March 9, 2007**
- **May 31, 2007**
- **September 17, 2007**
- **November 22, 2007**
- **December 17, 2007**

**Long Point Region, Catfish Creek and Kettle Creek**

**Water Budget Peer Review Meeting Minutes**

**March 9th, 2007**

**Present:** *Peer Review Leader*

James Etienne – GRCA

*Peer Reviewers*

Hugh Whiteley – University of Guelph

Dave Rudolph – University of Waterloo

Rob Schincariol – University of Western Ontario

*Peer Review Representatives*

Scott Bates – Ministry of Natural Resources (by telephone)

Jennifer Havelock, Matthew Miller – Conservation Ontario

*Project Support Team*

Lorrie Minshall, Sonja Strynatka, Stephanie Shifflett, Amanda Wong – GRCA

Bill Baskerville - LPRCA

**Regrets:** Mike Garraway – Ministry of Natural Resources

Chris Neville – S.S. Papadopulos & Associates

Gregg Zwiers - GRCA

## Introduction

J. Etienne welcomed the Peer Review Team for their initial meeting and explained the purpose of this session was to provide a status report on the consultant selection process for the Water Budget and finalize their comments on the Terms of Reference. James advised that he would be preparing purchase orders for the peer reviewers. James circulated copies of the background reports on CD. Additional copies of the CDs will be sent to Chris and Scott by courier.

## Status of Consultant Selection

Invitations to submit expressions of interest were sent to 6 consultants known for their background work in GAWSER and FEFLOW modelling. Invitations for expression of interest were also advertised in the Kitchener Record on the GRCA webpage. Draft Terms of Reference were requested by a total of 9 consultants. 5 consulting teams submitted expressions of interest and the project support team invited 3 teams to submit proposals (Aqua Resources Inc., EarthFX (with Harold Schroeter) and Waterloo Hydrogeologic Inc. (with CH2M Hill and Philip Engineering). Proposals are due in to the GRCA by March 19th. An all candidates meeting will be held on March 12th to provide final input on the Terms of Reference and clarify any questions about the project and selection process. The project support team will

review the proposals and make a recommendation to the GRCA board on March 30th to sign a contract with the preferred consultant.

J. Etienne advised that concerns have been raised by consultants about the timelines for the project. Lorrie has recommended that the Long Point/Catfish/Kettle study follow the lead of the Grand study and provide the results of the existing conditions assessment to the Peer Review Team by October 1st, 2007, and follow up with the future and drought scenarios after the Peer Review Team give their approval to the existing conditions modelling and assessment. The Peer Review Team agreed to this approach, which will be presented to the consultants on March 12th.

L. Minshall informed the team that Heather Malcomson from the MOE had received a request from Norfolk County to conduct a parallel water budget to address local concerns about the timing of this study and the possibility that results may not be available for several years to address Norfolk Federation of Agriculture (NFA) concerns about the water use permit "moratorium". Norfolk County are anxious to do whatever it takes to speed up the water budget process. L. Minshall explained that there is misunderstanding about the timing of this study, and that results will be available this fall. H. Whiteley suggested that Norfolk might consider working with the NFA to generate a better understanding of agricultural water use. L. Minshall will pursue with Norfolk County and the MOE the possibility of conducting an assessment of agricultural water use and irrigation on the Norfolk Sand Plain from the NFA's perspective.

**Review Consolidated Peer Reviewer Comments**

J. Etienne circulated copies of Scott Bates' comments on the Terms of Reference and solicited feedback from the other Peer Reviewers. The comments centered on the following areas:

- Wording changes for clarification,
- Grammatical changes,
- Mapping additions,
- Timing of project completion deadlines,
- Provision of data for the Peer Review Team,
- Uncertainty and reliability of data, and
- Consultant selection scoring

The Peer Review Team agreed that due to the tight timelines for the project, they should be involved in the consultant's first project update meeting (scheduled for May 31, 2007) to hear if the consultants have identified any data gaps that may preclude them from submitting a first draft of the water budget for review by October 1, 2007. The Peer Review Team also agreed that it made sense for them to approve the results of the existing conditions scenario before the consultant proceeded to the drought or future conditions scenario.

**Action Items**

As a result of the meeting, the following action items were generated:

- J. Etienne will prepare P.O.s for the work of the Peer Review Team, including the March 9th meeting.
- J. Etienne will send copies of the Background Document CD to Scott Bates and Chris Neville.

- L. Minshall will pursue with Norfolk County and the MOE the possibility of conducting an assessment of agricultural water use and irrigation on the Norfolk Sand Plain to address NFA concerns about a water use permit “moratorium”.
- J. Etienne will amend the Terms of Reference for the Long Point Region, Catfish Creek and Kettle Creek Water Budget for circulation to the three consultants invited to submit proposals for the project and to the Peer Review Team.
- J. Etienne will prepare minutes and action items from the March 9th meeting.

**Next Meeting**

The Peer Review Team will reconvene in late May or early June 2007 to review the selected consultant’s progress on the water budget and to discuss any barriers to meeting the September 28, 2007 deadline for a first draft.

**Long Point Region, Catfish Creek and Kettle Creek**

**Water Budget Peer Review Meeting Minutes**

**May 31st, 2007**

**Present:** *Peer Review Leader*

James Etienne – GRCA

*Peer Reviewers*

Hugh Whiteley – University of Guelph

Dave Rudolph – University of Waterloo

John Warbick - OMAFRA

*Peer Review Representatives*

Scott Bates – Ministry of Natural Resources

Jennifer Havelock – Conservation Ontario

*Project Team*

Paul Martin, Sam Bellamy, Rob Brown – AquaResource Inc.

Bill Blackport – Blackport and Associates

*Project Support Team*

Lorrie Minshall, Sonja Strynatka, Stephanie Shifflett, Amanda Wong,

Gregg Zwiers, Jeff Pitcher - GRCA

Bill Baskerville - LPRCA

Jennifer Dow – KCCA

Peter Dragunas - CCCA

**Regrets:** Rob Schincariol – University of Western Ontario

Chris Neville – S.S. Papadopulos & Associates

## Introductions

All attendees were introduced and James Etienne sent regrets from Rob Schincariol and Chris Neville. Written comments from Rob S. and Chris N. will be shared with the rest of the team (see attached). James advised that the objective of the meeting was to review the progress of Long Point Region, Catfish Creek & Kettle Creek Water Budget Project. The Peer Review Team will be receiving a presentation on the Conceptual Water Budget and reviewing AquaResource Inc's work plan for the proposed October 2007 delivery of the draft water budget report. The Project team will receive the Peer Review's comments and questions in order to ensure that the expectations for the draft report are clearly understood.

## Presentations by the Project Team

Paul Martin gave an overview of the Tier 2 process with a focus on characterization, assessment and modelling needs.

Bill Blackport provided a characterization of the regional groundwater system. Sam Bellamy discussed the surface water system and gave an overview on water use. Amanda Wong provided an update on the GRCA's refined water use database. Dave Rudolph inquired about consumptive demand and the need to consider the lake water cycling (ie. Elgin Area water supply pipeline) impact on baseflow. Lorrie Minshall commented that most maps can be left to focus on the individual CA's but some, such as the regional geologic setting, should be presented as a whole and that GRCA could patch a few maps together.

Sam B. gave an explanation of the surface water modelling in GAWSER, including the existing model description and the work plan toward Tier 2 stress assessment. The project team discussed the complexity of presenting the impact of irrigation in GAWSER. Lorrie M. commented that the project team would need to assess the sensitivity of the system to different scenarios. Because of the significant irrigation demands in the Norfolk Sand Plain, the model is not as stable as it was in the Grand watershed. Paul M. provided an explanation of the groundwater modelling in FEFLOW, including the existing model description, structure, properties, boundaries and calibration updates. He also explained AquaResource's plans to improve the model.

**Peer Review Team Questions and Comments**

Following the presentations, Lorrie M. asked the Peer Reviewers if they had enough confidence in the proposed water budget work plan and if not what they needed to develop that confidence level.

Dave R. asked AquaResource how they would quickly optimize the existing models and data (ie. conductivity, transmissivity). Paul M. advised that he needs to use revised conductivity figures for a sensitivity analysis to prepare for model calibration. Dave R. asked which water producing member should be included below Long Point Region (the Guelph-Amabel formation is very deep). The Peer Review team will consider this issue and provide feedback to AquaResource Inc. on the depth of bedrock units to use to avoid bias to the model. Dave R. also asked if there is a need to refine the recharge model, and what is the biggest hurdle to on time delivery. Paul M. explained that he needs to get enough facts associated with the watershed characterization to reduce the amount of calibration time. He said his team will proceed, during the month of June, to assess the uncertainty of the geologic characterization. If there is a significant deviation from the proposed work plan, he will report his difficulties back to the Peer Review team to discuss revisions to the work plan.

Hugh Whiteley inquired about a Kettle Creek flow anomaly with respect to flow out, and suggested that Lake Erie intake flows be represented separately. Hugh W. noted that 90% consumptive use for agriculture is quite high and that studies have concluded 75% is more appropriate. Hugh W. asked AquaResource Inc. to clarify the impact upon streamflow of groundwater versus surface water takings in the model. He also asked the project team to check their consumptive use assumptions and to confirm how baseflow models will be included in the groundwater model.

John Warbick recommended that the project team talk to historic gas well drillers (not just read well logs) to confirm some of the details of deep bedrock formations and water tables. John W. commented that some Devonian groundwater wells were causing surface water interference. He also asked the project team to consider how old the sink holes around Port Dover are and to refer to irrigation and rainfall data in soil moisture studies from McGill University.

James asked the rest of the Project Support Team if they had any other comments for the Project Team. Bill Baskerville reminded the Project Team to consider the impact of rural

domestic water takings from sand wells in the Norfolk Sand Plain and cisterns in the Haldimand Clay Plain.

Paul M. concluded that the Project Team will continue their data collection and calibration of the model in keeping with their proposed work plan. If there are difficulties in achieving a satisfactory level of certainty in the modelling, the Peer Review Team will be advised. Lorrie M. reiterated that it was paramount for the Project Team to generate a quality water budget with an acceptable level of confidence in the modelling as opposed to rushing to meet a deadline with an inferior product. The group concurred that quality of product was most important.

**Action Items**

As a result of the meeting, the following action items were generated:

- J. Etienne will prepare minutes and action items from the May 31st meeting.
- J. Etienne will attach the written comments from Rob S. and Chris N. to the minutes.
- AquaResource Inc will coordinate with J. Pitcher the preparation of consolidated watershed mapping for subjects of regional interest (ie. geologic setting).
- The Peer Review team will recommend to AquaResource Inc. the depth of bedrock units to use to avoid bias to the groundwater model.
- The Project Team will proceed, during the month of June, to assess the uncertainty of the geologic characterization. If there is a significant deviation from the proposed work plan, they will report these difficulties back to the Peer Review team to discuss revisions to the work plan.
- The Project Team will review the comments of the Peer Review team and make the necessary adjustments to their work plan and/or Water Budget report.

**Next Meeting**

The Peer Review Team will contacted in late August or early September 2007 to review the Project Team's progress on the calibration of the water budget models and to discuss any barriers to meeting the October 2007 deadline for a first draft.

**Long Point Region, Catfish Creek and Kettle Creek**

**Water Budget Peer Review Meeting Minutes**

**September 17th, 2007**

**Present:** *Peer Review Leader*

James Etienne – GRCA

*Peer Reviewers*

Dave Rudolph – University of Waterloo

Rob Schincariol – University of Western Ontario

Chris Neville – S.S. Papadopulos & Associates

*Peer Review Representatives*

Scott Bates – Ministry of Natural Resources

*Project Team*

Paul Martin, Sam Bellamy – AquaResource Inc.

*Project Support Team*

Lorrie Minshall, Sonja Strynatka, Stephanie Shifflett, Amanda Wong,

Gregg Zwiers - GRCA

Bill Baskerville - LPRCA

Peter Dragunas, Tony Difazio – CCCA

Jennifer Dow – KCCA

**Regrets:** Hugh Whiteley – University of Guelph

John Warbick – OMAFRA

Jennifer Havelock – Conservation Ontario

## Introductions

All attendees were introduced and James Etienne sent regrets from Hugh Whiteley, John Warbick and Jennifer Havelock. Dave Rudolph, Rob Schincariol and Scott Bates joined the meeting by conference call. The goal of the meeting was to review the progress of AquaResource Inc. (ARI) over the summer, ask the Peer Reviewers for advice on the modelling approach to present in the draft report and discuss the timing for the delivery of the draft report to the Peer Reviewers.

## Presentations by the Project Team

The Peer Review Team were circulated a Water Budget Modelling Update technical memo and Powerpoint presentation by ARI on September 17th. Paul Martin apologized for the delay in

delivering these materials to the Peer Review Team and advised all that he would walk them through the update during the Powerpoint presentation.

Sam Bellamy provided an overview of the GAWSER surface water modelling revisions. He explained the approach to calibrating the representation of irrigation events in the GAWSER model. Initial irrigation demand assumptions resulted in a total consumption of baseflow. Water demand was subsequently factored into the model to maintain summer baseflows. It was concluded for this calibration that irrigators were not using the maximum permitted amounts during summer dry conditions. Rob Schincariol asked for clarification of upstream flows in the model results. Sam explained that the model's initial assumption did not account for inflows from upstream catchments, but now it does. There was general discussion by the group about ways to get a better understanding of the irrigatible area associated with farm irrigation permits (ie a 100 acre farm may only have 75 acres of productive and/or irrigatible land). ARI will try to do calculations to verify irrigatible land area being assumed in the GAWSER model.

Paul Martin provided an overview of the FEFLOW groundwater modelling revisions. The group discussed the approach to removing the deep bedrock layers from the model (Guelph-Eramosa, Salina and some of the Dundee members). The layers are being removed because they are not seen as contributors to the watershed groundwater balance and could skew the subwatershed stress assessments it they are included. ARI were asked to conduct a sensitivity analysis to support this conclusion. Chris Neville will look for deep well data logs in the Nanticoke Creek area that may be useful to ARI.

The group also discussed ARI's concerns arising from their changing understanding of the geologic conceptual model. Additional field testing carried out by the Ontario Geological Survey (OGS) during the summer of 2007 have forced ARI to rethink some of their initial assumptions. ARI asked the Peer Review Team to comment on the assumptions and confidence that could be placed on the revised conceptual model. Chris Neville suggested that the exact layer recognition is not as important as establishing a good estimate for hydraulic conductivity to be used in the groundwater model.

Paul Martin presented some of the initial results that compared the simulated water table results to observed measurements. The comparisons indicated that the model predicted better in the north of the watershed and that refinements were needed along the Lake Erie side of the watersheds. Both higher and lower water table results are being recorded with significant variability. The Peer Review Team directed ARI to revisit the model to improve these spatial residuals.

**Summary and Next Steps**

After reviewing the update from ARI, it was agreed that new information obtained from OGS since June 2007 has placed some uncertainty on the original conceptual model and that additional work is required to refine the groundwater model. ARI are recommending a need to expand the uncertainty analysis to evaluate water budget under multiple conceptualizations including, existing layers, uniform layers throughout the overburden and approximate layers to follow the current conceptual model(s).

The implications to the project schedule were discussed. Paul Martin agreed that an additional month would be required to complete the suggested model refinements. Lorrie Minshall asked the Peer Reviewers if they could manage a quick turn around of the draft report if it were delivered in late October instead of late September. The reviewers agreed that this would not be much of a problem due to already busy schedules in October. It was agreed that ARI would aim for a late October delivery of the draft report.

## Action Items

As a result of the meeting, the following action items were generated:

- J. Etienne will prepare minutes and action items from the September 17th meeting.
- AquaResource Inc. will try to do calculations to verify irrigatible land area being assumed in the GAWSER model.
- AquaResource Inc.will conduct a sensitivity analysis to test their recommendation to eliminate the deep bedrock layers from the geologic model
- Chris Neville will look for deep well data logs in the Nanticoke Creek area that may be useful for the deep bedrock assessment.
- AquaResource Inc will revisit the model to try and achieve better spatial residual results.
- AquaResource Inc will aim for a late October delivery of the draft report to the Peer Review Team.

## Next Meeting

The Peer Review Team will be contacted upon completion of the draft report to arrange a meeting in November 2007 to receive a presentation on the Tier 2 Water Budget and to discuss the draft Water Quantity Stress Assessment. The meeting will also help establish the timelines for the finalization of Peer Review and the completion of the final report. The meeting and conference call adjourned at 2:10pm.

**Long Point Region, Catfish Creek and Kettle Creek**

**Water Budget Peer Review Meeting Minutes**

**November 22nd, 2007**

**Present:** *Peer Review Leader*

James Etienne – GRCA

*Peer Reviewers*

Dave Rudolph – University of Waterloo

Hugh Whiteley – University of Guelph

John Warbick – OMAFRA

Chris Neville – S.S. Papadopulos & Associates

*Project Team*

Paul Martin, Sam Bellamy – AquaResource Inc.

*Project Support Team*

Lorrie Minshall, Sonja Strynatka, Stephanie Shifflett, Amanda Wong,

Gregg Zwiers, Jeff Pitcher – GRCA

*Others*

Dirk Gevaert – AMEC

John Spoelstra – Environment Canada

**Regrets:** Rob Schincariol – University of Western Ontario

Bill Baskerville - LPRCA

Peter Dragunas, Tony Difazio – CCCA

Jennifer Dow – KCCA

Scott Bates – Ministry of Natural Resources

Jennifer Havelock – Conservation Ontario

## Introductions

All attendees were introduced. James E. identified that a number of representatives could not attend due to the inclement weather. The goal of the meeting was to receive a presentation by AquaResource Inc. on the results presented in the first draft of the Phase 1 Water Budget Report and to allow the Peer Reviewers to seek initial clarification to assist with commenting on the draft document.

## Presentations by the Project Team

Sam Bellamy provided an overview of the water demand and GAWSER surface water modelling findings. He explained the approach to calibrating the representation of irrigation events in the

GAWSER model which generated a fair bit of discussion amongst the Peer Review group. It was agreed that the logistics of irrigation make full utilization of the permits impossible and the model has been adjusted to reflect much lower actual demands, however there was concern that high volume irrigation permits could be fully utilized by other high volume uses in the future (ie. canning plants).

Paul Martin provided an overview of the FEFLOW groundwater modelling and stress assessment. The initial statistical results of the calibration were discussed with respect to the variations between simulated water table results to observed measurements. Hugh W. asked about the significance of external boundary flows. The question concerned a subtlety in the reporting of the water budgets for each subwatershed. Only some of the subwatersheds had non-zero values (positive or negative) for the term "External Boundary" [Slide #26]. These watersheds are located along the perimeter of the groundwater flow model. Paul explained the boundary conditions. Subwatersheds that do not extend to the limits of the groundwater model will not have a reported net External Boundary flow.

With respect to the stress assessment, Chris N. noted that there appears to be some controversy with respect to reserve quantity – in particular that it is an arbitrary amount. Chris explained that arguments about this term can be avoided by indicating that the reserve is included only to provide a margin of safety in the Tier 1 stress assessment, and is not included in the Tier 2 or 3 assessments. It would be very surprising to see a case in which the reserve would 'tip the balance' and drive a Tier 1 designation from "Not significantly stressed" to "Potentially stressed". Hugh W. would like the commentary to identify the potential stress to smaller streams in subwatersheds that have low potential stress scores. Chris N. asked if any of the low stress potential subwatersheds were benefiting from a reliance on external flows. Paul noted that the level of certainty was being considered to determine if any low potential subwatersheds should be elevated to moderate potential. Dirk G. talked about the potential for the Norfolk Water Study to add some certainty to the water demand estimates as a result of their proposed 200 farm use surveys.

At the end of his presentation, Paul identified several questions about future demand and drought scenarios for consideration by the Peer Reviewers and the CA representatives. Specifically, the reviewers were asked to consider the need to define "key hydrologic functions" in significant recharge areas. John W. & Dirk G. discussed the prospect of switching surface water users to off line groundwater-fed ponds to take advantage of surplus flows during the spring runoff.

Due to the potential for uncertainty regarding future water demand (ie. if underutilized permits are maximized) Dirk G. suggested identifying demand limits for subwatersheds. Lorrie M. suggested that a preliminary drought assessment using sensitivity criteria would be a quick way to identify trends of concern. This could be used to make a list of subwatersheds where future agricultural water demands may put limitations on agricultural land uses. Municipal land uses are not expected to put a lot of extra demand on the system.

Finally, there was discussion about the type of year to use for modelling drought scenarios. In reference to the estimated number of irrigation events shown in Figure 3.2, it was suggested that an "appropriate drought" year would be significantly dry enough to warrant a higher than average number of irrigation events to achieve reasonable crop yields, but not so dry as to cause a "catastrophic" crop failure.

**Summary and Next Steps**

James E. advised the Peer Review Team that the presentation is available on the AquaResource ftp site at ftp://Lpt_CF_KC.aquaresource.ca:Courtland@www.aquaresource.ca and

that he would be circulating minutes to bring everyone up to speed. All members are asked to submit any follow-up questions or requests for clarification on the draft document to James E. for circulation to the Peer Review Team and the Consulting Team. Written comments on the draft report should be submitted to James E. by December 12th. James E. will consolidate the comments into a matrix for distribution to the Peer Review Team on December 14th and discussion at the next meeting on December 17th.

**Action Items**

As a result of the meeting, the following action items were generated:

- James E. will prepare minutes and action items from the November 22nd meeting.
- AquaResource Inc. will take into consideration the comments raised in the Peer Review meeting for integration into the final report.
- Peer Reviewers and CA representatives were asked to consider the need to define "key hydrologic functions" in significant recharge areas.
- All members are asked to submit any follow-up questions or requests for clarification on the draft document to James E. for circulation to the Peer Review Team and the Consulting Team.
- Written comments on the draft report should be submitted to James E. by December 12th.
- James E. will consolidate the comments into a matrix for distribution to the Peer Review Team on December 14th and discussion at the next meeting on December 17th

**Next Meeting**

The Peer Review Team will reconvene on Monday, December 17th at 11:30am at the GRCA to discuss their comments on the document. This meeting will follow the completion of the Source Protection Project Team meeting. Lunch will be provided at the beginning of the meeting.

**Long Point Region, Catfish Creek and Kettle Creek**

**Water Budget Peer Review Meeting Minutes**

**December 17th, 2007**

**Present:** *Peer Review Leader*

James Etienne – GRCA

*Peer Reviewers*

Dave Rudolph – University of Waterloo

Hugh Whiteley – University of Guelph

Rob Schincariol – University of Western Ontario

*Project Team*

Paul Martin, Sam Bellamy – AquaResource Inc.

*Project Support Team*

Lorrie Minshall, Sonja Strynatka, Stephanie Shifflett, Amanda Wong - GRCA

Bill Baskerville - LPRCA

Scott Bates – Ministry of Natural Resources

**Regrets:** John Warbick – OMAFRA

Chris Neville – S.S. Papadopulos & Associates

Peter Dragunas – CCCA

Jennifer Dow – KCCA

Jennifer Havelock – Conservation Ontario

## Introduction

All attendees were welcomed. James E. identified that a number of representatives could not attend due to the inclement weather or other commitments. The goal of the meeting was to accept and review peer review comments and confirm that the draft report is satisfactory (with appropriate edits) to present to the MOE and to move on to Phase 2. James E. asked if there were any comments on the November 22nd minutes. Chris N. provided comments that will be noted in revised minutes. Paul M. provided the peer review team with a recap of the stress calculation methodology and explained how it related to issues of uncertainty with the modelling.

## Review Consolidated Peer Reviewer Comments

James E. provided a matrix of comments received from Rob S., Dave R. & Hugh W. Chris N. and John W. were unable to attend the meeting and will submit comments directly to James E. for inclusion in the comments matrix. James E. asked the peer reviewers to submit a formal list of their comment for inclusion in documentation of the Peer Review process. The comments received from Rob, Dave & Hugh were reviewed and discussed under the following themes:

Errors and Omissions, Data Input, GAWSER & FEFLOW Modelling, Certainty and Other Items. It was agreed that the editorial comments in the text and mapping would be addressed directly by AquaResource Inc. in their revision of the document. It was also agreed that a number of the comments could be addressed with simple clarifications in the text of the document. In order to save time, James E. asked the Peer Reviewers if they would elaborate on just those comments that required further discussion with the group. James E. tracked the discussion and action items for inclusion in the response on the comments matrix.

AquaResource Inc. has identified drought under existing conditions as a significant issue for these watersheds. Sam Bellamy provided an overview of the existing drought conditions for the various subwatersheds. The Peer Review team were asked to consider appropriate triggers for moderate and significant drought potential based upon reoccurrence thresholds and frequency of occurrences that could be used to develop thematic maps. As a result of this discussion, AquaResource Inc. will prepare a technical memo to the peer review team outlining the approach used to calculate an existing drought scenario.

**Action Items**

As a result of the meeting, the following action items were generated:

- James E. will revise and recirculate the minutes from the November 22nd meeting.
- James E. will prepare minutes and action items from the December 17th meeting.
- Peer Reviewers are asked to submit a formal list of their comment for inclusion in documentation of the Peer Review process.
- AquaResource Inc. will prepare a technical memo to the peer review team outlining the approach used to calculate an existing drought scenario.
- Written peer review comments on the draft report should be submitted to James E. by January 11th.
- James E. will consolidate the final comments and responses into the comment matrix to be forwarded to AquaResource Inc. by January 15th.
- AquaResource Inc. will prepare a “peer reviewed” draft document by January 31st for circulation to the MOE.

**Next Meeting**

The Peer Review Team will reconvene in 2008 to discuss Phase II of the Water Budget and the assessment of Significant Recharge Areas.

# Appendix B-2

# Phase 1 Peer Reviewer's Comments Matrix

## KETTLE/CATFISH/LONG POINT WATER BUDGET PEER REVIEW COMMENTS (March 2008)

DR – Dave Rudolph RS – Rob Schincariol CN – Chris Neville HW – Hugh Whiteley

| REVIEWER | REVIEWER COMMENTS | ACTION |
|---|---|---|
| CN | p. 3 - The spatial scale of the analysis is raised early in the report (Page 3) and in our opinion is crucial for placing the assessments in an appropriate context (an appropriate "level of exactness" if you will). We are not clear on the relations between the terms used in the report to describe the scale. The analyses are qualified as "regional scale". What are the operational definitions for *regional scale* and *local scale*? Are the watersheds regional or local? What about the subwatersheds? The results of the analyses are reported at the level of subwatersheds; should this be interpreted as "regional scale", or something smaller than that? | Added Section on "Scale of Assessment" in Introduction |
| CN | p. 3 - it is indicated that because the numerical models are regional tools, they cannot be used to describe the local hydrologic conditions, or to infer that the identified subwatershed is experiencing hydrologic or ecologic stress due to water pumping. We understand that at the Tier 2 level that the assessment is not conducted at the level of an individual well or wellfield, but isn't the whole point of the evaluation precisely to make a preliminary identification of those areas that may be stressed? | Revised text to be more clear about stress assessment limitations |
| CN | p. 3 - The report indicates that the analyses should assess the trends. We concur, but did not see any indication that temporal trends were reviewed. In our opinion this is particularly important with respect to the evaluating the reliability of the final stress assessment. Relatively large surface and/or groundwater withdrawals are noted for some subwatersheds, in which the final stress assessment was "Low". Are any data available to support or refute these assessments? Are streamflow data available that show streamflows never declining significantly in response to withdrawals? Are any histories of groundwater levels available that show water levels are either stable, or recover completely following periods of relatively heavy withdrawals? | Groundwater data too limited for trend analysis. Trends in surface water data were investigated, with no decline apparent. Issues with the start date of available data (during the 60's drought), increasing sewage treatment plant discharges, and accuracy of historic streamflow estimates are likely confusing the issue. Added text. |
| RS | p. 3 second paragraph – you say the FEFLOW and GAWSER models "…cannot be used to describe the local hydrologic conditions, or to infer that the identified subwatershed is experiencing hydrologic or ecological stress due to water pumping." Your disclaimer needs to be re-written as this is exactly what you did in this report – use the models to determine stress due to water pumping and you did it on a subwatershed scale. Your disclaimer is also in contrast to your statement on p. 8 (2.2 5$^{th}$ paragraph) where you state how the subwatersheds have to be delineated. | Revised Text |
| CN | P. 3: We do not want to focus on typographical errors; however, on Page 3 there is a statement that requires comment. The sentence reads, "The groundwater and surface models were *not* coupled via recharge rates." Should this read instead, "The groundwater and surface models were coupled via recharge rates"? | This sentence was focused on the FEFLOW model prior to this study, where the groundwater models and surface water models were not coupled. Added text to clarify |
| CN | P. 5: How was the WHI model "significantly refined"? Were new or additional data available, or were | Add revisions done to model as part of |

| REVIEWER | REVIEWER COMMENTS | ACTION |
|---|---|---|
| | interpretations revised, or was the spatial discretization/model layer structure revised for this study? | this study |
| CN | P. 5: What are the differences between a catchment and a subcatchment, and a watershed and subwatershed? | Added section with definitions for scales |
| CN | P. 5: It is indicated in the report that "evapotranspiration can also be evaluated by subtracting runoff and recharge from precipitation." This seems backwards to us. Isn't evapotranspiration calculated ahead of runoff and then recharge represents the difference? | Clarified difference between GAWSER estimates of ET and alternative "checks" of ET via streamflow analysis |
| CN | P. 6: It is indicated in the report that the distribution of groundwater discharge is often measured at stream gauges. Unless we are considering an extraction well, groundwater discharge is never measured, only inferred. | Added caveat about baseflow and gw discharge (not necessarily the same thing) |
| RS | p. 6 - Was the baseflow component determined from GAWSER ever compared to the baseflow determined from FEFLOW? This comparison forms one part of an uncertainty analysis. | The baseflow estimates from the two models were not compared, but are effectively the same. Both the GAWSER and FEFLOW estimates of baseflow are generated by the same thing, GAWSER predicted recharge values. There may be some slight differences in spatial distribution of discharge, however the overall volumes would be the same |
| CN | P. 7: The report refers to 14 watersheds in the Long Point Conservation Authority. Referring to Table 2.1, we count 5 watersheds and 14 subwatersheds. | Common terminology wrt subwatersheds/watersheds |
| CN | P. 8: It is indicated in the report that in some areas of mixed geology, subwatersheds were split. Should the text indicate instead that some watersheds were split into additional subwatersheds to accommodate geologic contrasts? | Revised text |
| CN | P. 12, 13: It is indicated in the report that St. Thomas Moraine varies in width *of* up to 5 km between London and Tillsonburg. Does this mean that the moraine is up to 5 km wide, or should the text indicate that the width varies *by* up to 5 km? | Yes, revise text |
| CN | P. 14: What data were used to develop the bedrock surfaces plotted in Maps 2.6a-2.6c? | Added text |
| CN | P. 23: It is indicated in the report that water can discharge to local surface water features or travel great distances from its source of recharge. Is this observation consistent with the way groundwater infiltration and storage is treated in the GAWSER model? Is GAWSER capable of routing recharge from the subwatershed in which it infiltrates to a distant subwatershed? | Yes it does, but text describing such is not appropriate here. Text added to GAWSER section |
| CN | P. 23 and P. 27: Are there any "golden spikes" in the study area (i.e., locations where a boring has been logged by a professional geologist)? | No golden spikes were gathered as part of this study, or as part of WHI 2003 |
| CN | P. 27 and 28: It is suggested in the report that the regional hydrostratigraphic model used for the westward expansion of the Norfolk County groundwater model may not be appropriate. Why? What is in the WHI (2007) model? It is also suggested that the Gamsby & Mannerow conceptual model of the Norfolk Sand | Added text |

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| | Plain area may also need to be refined. Why? | |
| CN | P. 28, P.s 69-70: Was the database of MOE water well records parsed before it was used for this study?<br>• How many records were there in the original database?<br>• How many records indicated unreliable well coordinates?<br>• How many records did not include geological descriptions?<br>• How many records did not include any water level measurement?<br>• How many records indicated an unreliable water level elevation? | Added to Section 6 |
| RS | p. 28 – Why is there no Long Point overburden potentiometric surface map as in Catfish and Kettle? | Due to a lack of well data, the Norfolk GW study did not produce water table maps of the individual overburden aquifers. Noted in text |
| CN | P. 29: What is the source for the cited range of the hydraulic conductivity of the sandy silt and clay? | Added source (WHI, 2003) |
| RS | p. 33 – How are the zero recharge areas determined vs. 1 to 25 mm/yr areas? Why is Long Point all set at 0 recharge? | Areas with 0 recharge are impervious. Long Point having 0 recharge was a mapping error - there was no recharge estimates made for Long Point. No hydrologic modelling was done for Long Point.<br>Note - this section has been taken out of the watershed characterization chapter. The discussion and referenced mapping was using older recharge mapping. New recharge maps were made as part of this study, and are included in Section 5 |
| CN | P. 33: The description of recharge in the Catfish Creek CA does not appear to be consistent with Map 2.13b. Our interpretation of the map is that there are pockets of low recharge (for example at the confluence of Catfish Creek and its tributaries) surrounded by areas of moderate to high recharge. | The section was describing work done to quantify recharge from previous work. Since this work has been updated, this section is removed (deferred to section 4) |
| CN | P. 34: The description of recharge in the Kettle Creek CA does not appear to be consistent with Map 2.13c. Our interpretation of the map is that the recharge is about 50 to 100 mm/yr, with low recharge around St. Thomas. | Same as above |
| CN | P. 35: A vertical gradient is evident in Figure 2.4. If the differences in water levels between Maps 2.10a and 2.12a are calculated, do they indicate a similar magnitude of head difference at the location of W012 and W014 (using bedrock as a surrogate for deep overburden)? | Graph is mislabeled. Is a downward gradient.<br>The gradient indicated by comparison of the two graphs is beyond the resolution of the water table maps (in terms of both spatial resolution, and aquifer unit |

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| | | resolution) |
| CN | P. 36: Will the fact that all 5 PGMN wells in the Catfish Creek watershed are located in the eastern portion of the watershed represent a data gap over the long term? | Likely…..add to “data gap” |
| CN | P. 36: How many well completions are there at the location W353-1? If there is more than one well, the data from the other wells should also be plotted in Figure 2.5. | Other loggers at this monitoring site were for very short periods (15 days). Added to text |
| CN | P. 37: When reviewing hydrographs such as those plotted in Figures 2.4, 2.5, and 2.6 we are never sure whether the transducer data are reliable. We recommend that the plots of the continuous records be supplemented with the manual measurements taken whenever a transducer is downloaded. | Dip tape observations were not supplied |
| CN | P. 37: There appears to be a consistent difference of about 4 m between the water levels in W372-1 and W410-1. If the differences in water levels between Maps 2.10a and 2.12a are calculated, do they indicate a similar magnitude of head difference at this location? | Gradient indicated by comparing two graphs beyond the resolution of the water table maps (in terms of both spatial resolution, and aquifer unit resolution) |
| CN | P.38: Are there any dedicated observation wells associated with the municipal water supply wells? | Data from municipal observation wells were not collected as part of this study |
| RS | p. 38 to 46 Climate Sections – problems with stations used. | Updated all climate related tables and graphs in report. |
| RS | p. 45 – Table 2.8. Why for Catfish Creek do you pull in London A and not St. Thomas or Port Stanley. These two stations have much higher average precip. than London A. London A is not even on map 2.15b. I realize London A is a high quality station but you should justify why you have excluded St. Thomas & Port Stanley. | Updated all climate related tables and graphs in report. |
| RS | p. 45 – There is no table for Kettle Creek precipitation (equivalent to Table 2.8). | Added table to report. |
| RS | p. 46 – Table 2.9 and 2.7 are exactly the same yet one is for Kettle and the other Catfish. Culloden Easey and London A are not even on the map for Kettle Creek. Furthermore Figure 2.8 and 2.9 are exactly the same – can overlay them – yet one is for Catfish and the other Kettle. | Updated all climate related tables and graphs in report. |
| CN | P. 47: We support the recommendation that some of the abandoned weather stations be restored and that maps of precipitation and temperature be standardized. These data are crucial for water budget studies, and we suggest that this recommendation be reproduced in the final section of the report. | Add to recommendations |
| RS | p. 48 – 4$^{th}$ paragraph – potential evapotranspiration is NOT “… also known as lake evaporation.” Potential evapotranspiration can be calculated from lake evaporation by applying certain formulae or correction factors but they are not the same. | Revised text |
| CN | p. 48 - After having reviewed the entire report, one sentence that appears relatively early in the text stands out, “Evaporation is a critical parameter in understanding the Water Budget across an area, as it is usually the largest component.” We concur with this statement; however, we could not find further suggestions in the report regarding the reliability of the evapotranspiration estimates, or the implications of uncertainties in these estimates on the results of the water budget calculations or stress assessments. In subsequent sections of the | Added discussion about uncertainty associated with the ET estimates |

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| | report we frequently asked ourselves, "How wrong might the estimates of evapotranspiration be, and what difference does it make?" | |
| CN | P. 49: With the exception of one, why are all of the Long Point dams shown on Map 2.18 for recreation? | Added text stating that the majority of Long Point dams are for recreational purposes. |
| CN | P. 51: In the report there is reference to "historic" flow data available for selected creeks. Does historic refer to gauges that are no longer active, or gauges that are active and that have a long record? | Historic refers to no longer active – clarify in text |
| CN | P. 53: We are simple-minded hydrogeologists and always have to think about the statistics of streamflows. In our opinion, the explanations of the 50% (median), 10$^{th}$-percentile, and 90$^{th}$-percentile are best understood in the context of an example cumulative probability plot of streamflow. Would it be possible to include just one such figure in the report, for example, the streamflows observed during the month of July at the Big Otter Creek gauge near Calton? | Added example plot of ranked duration with 10th, median and 90th percentile flows |
| CN | p. 53 to 65 - Independent estimation of large-scale recharge rates. It strikes us that the baseflow estimates can be used to infer recharge rates that can provide a rough check on the numerical modelling. With precipitation of about 1000 mm/yr and evapotranspiration of about 575 mm/yr, the average annual recharge rate should be about 425 mm/yr.<br>• Referring to Figure 2.10, for the gauge at Big Otter Creek, the average baseflow is about 9 m$^3$/s. For an area of 712 km$^2$, this is corresponds to a recharge rate of 400 mm/yr.<br>• Referring to Figure 2.15, for the gauge on Catfish Creek near Sparta, the average baseflow is about 1.4 m$^3$/s. For an area of 290 km$^2$, this is corresponds to a recharge rate of 150 mm/yr.<br>• Referring to Figure 2.17, for the gauge on Kettle Creek at St. Thomas, the average baseflow is about 1.35 m$^3$/s. For an area of 330 km$^2$, this is corresponds to a recharge rate of 130 mm/yr.<br>We looked for, but did not find any attempt to check recharge rates against baseflow. Is it worthwhile to do so? | By checking estimated GW discharge to baseflow, we are comparing GAWSER recharge rates against baseflow. Added text to relevant section (Section 6) stating this<br><br>Chris' analysis is using streamflow data, not baseflow – therefore recharge estimates quoted in comment are much higher than expected. |
| CN | P. 55: The word "narrow" is used to describe the monthly flow distributions in Figures21.11 and 2.12. Does this refer to small variations in the median and 90$^{th}$-percentile flows? | Expand on terminology |
| CN | P. 61: It is indicated in the report that in the Silver Creek area groundwater recharge is often higher than runoff. Is this inferred from the results of the GAWSER analyses, or an independent observation? | Text revised to focus on descriptive statements, rather than quantitative statements |
| RS | p. 62 – there is no flow distribution for Upper Kettle? | Added graph for Kettle Above St. Thomas |
| CN | P. 69: It is indicated in the report that "all of the wells in the database were used to characterize private groundwater wells in the Long Point Region watersheds." Could this represent a significant overestimation of private use? Is private use a small fraction of other users, and therefore any overestimation is not significant? | Analysis presented in Chapter 2 was only done to characterize private use, not quantify demand. Stats Can (population) data was used to quantify demand in Chapter 3. Additionally private rural use is very small (~5L/s), and associated |

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| | | uncertainty would not have a significant impact on results. |
| CN | P. 69: It is not the low porosity of clays that limit the transmission of water. Clays typically have relatively high porosity, but low hydraulic conductivity. | Revised text |
| RS | p. 70 – Permits to take water Kettle Creek – I was under the impression from my conversations with KCCA and Elgin water treatment facility engineers that the pipeline has been extended throughout the Kettle Creek area. Thus a large number of private wells were no longer in use. A plot of the current pipeline throughout the area would be very beneficial as it will tell you very likely what wells are still active. | Mapping of pipeline infrastructure was not available. |
| CN | P. 72: It is indicated in the report that of the 2,650 PTTWs contained within the LPRCA, 50 permits were considered to be active non-agricultural or municipal water takers. Does this mean that 2,600 were inactive or expired, or that 2,600 permits were agricultural or industrial? If it is the latter, how many of the permits might be active? | Clarify text, 2650 are the active permits, of the 2650, only 50 are for purposes other than agricultural |
| CN | P.s 77-78 and 93-94: In our opinion the discussion of the interpretation of the information in the PTTWs is excellent. In our opinion it is important that the study team eventually transmit a revised PTTW database to the Ministry of Natural Resources. It is also hard to exaggerate the importance of the information plotted in Figures 3.3, 3.4, and 3.5. | No action required |
| CN | P.s 78-87: In our opinion the discussion of consumptive water use is excellent. We recommend that it be required reading for those working on water budget studies elsewhere in Ontario. | No action required |
| RS | p. 80 – by explicitly adding the sewage flows in the GAWSER models but yet not explicitly accounting for any other return flows does this create a discontinuity (i.e. potential double counting in some areas)? | Potentially, however STP flows would be the most dominant return flow. Return flows for other water use operations would likely be well within streamgauge uncertainty. We are also limited to waste water discharges that have information readily available. |
| RS | p. 82 – last paragraph - What is your basis for increasing the soil water content by 25 mm for an irrigation event (if you have a reference for this cite it or justify)? Why do you set the period of time constraint at 1 week across all soil types? The time constraint would likely vary for different soil types – sandy soils will require higher frequency watering to keep the moisture content below the 'specified threshold'. Is this 7 day period related to the comment on the top of p. 83 regarding a 4 day watering period? P. 84 - Would not the number of pumping days be related to soils type for which you have data? | Revised discussion on how irrigation demand is estimated. |
| DR | p. 82 - The consumptive factors listed in Table 3-3 are extremely critical to the stress assessment, particularly in the case of the irrigation water. The way these factors were selected or the references that were used to derive them should be explained in the text, even if it is a "personal communication" as is explained on P. 84 for the irrigation use specifically. Include the source for these factors. There is a high degree of uncertainty in these factors (eg. Isidoro et. al, 2003: 0.65-0.85) and this should be stated. | Provided reference for Kinkead. Added text on uncertainty of consumptive factors |
| DR | p. 82 - the process for triggering an irrigation event is related to a previous "irrigation study" based on a | Clarified text regarding how the excel- |

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| | previous version of the GAWSER modeling of the area. It is not clear from the text exactly how this previous irrigation needs analysis was used for the current modeling work and it would be useful to have an expanded section on this. For instance, as part of the current work, the GAWSER simulations have been modified significantly so that the soil moisture information used in the previous irrigation study may not be the most appropriate values. The reliance on the previous work and the level of confidence the consulting team has on this information should be explained. | based irrigation demand model, assisted in quantifying irrigation demand. |
| DR | p.82 and 83 - the irrigation process as stated indicates that each irrigation event results in an increase of 25 mm of water in the soil column. This infers then that based on the area irrigated an exact amount of water extracted (accounting for the consumption factor) can be estimated directly. The extracted volume however, is based on a certain time period for a given well based on an extraction rate equal to 60% of the permitted rate. These approaches do not seem to be consistent and it is unclear how they are used conjunctively in the overall water balance. | The 25 mm depth was only used in the irrigation demand model, which was only used to indicate when an irrigation event would be required. This triggered when irrigation PTTWs are active. The text surrounding this has been clarified |
| DR | Finally, it has been recognized that cropping practices throughout the entire region have been changing significantly over the last decade and continue to do so currently. The text should include some discussion on the significance of changing cropping practices on the current and future water demands, as there are significant differences in water demands between different crops and their associated growing seasons. | In the uncertainty section, it has been identified that agriculture is currently in a state of flux, and that future water demands may be far greater than current ones. |
| RS | p. 84 – 3.3.3.2 – The 135 well records that were checked = approx. 5% of the records for the region. Was the check done on well records across Kettle, Catfish, Longpoint or done for wells in the Grand River area? Stated another way was this an unbiased audit of records? | All permits which had reported rates available were used. This was an unbiased audit. Revised text |
| RS | p. 85 – 3.3.4 – 2$^{nd}$ paragraph – Don't just give us the statement that an 'improved understanding' emerged from this study tell us what this improved understanding is. | Revised text |
| RS | p. 86 – While I can understand you cannot, from the census, determine the source of water for agricultural users why would you set it at 50% groundwater 50% surface water. Could you not use a ratio of permitted surface water to permitted groundwater sources in the area? | Assuming the proportion of SW/GW that is used for animal watering is the same as the SW/GW breakdown for irrigation is just as arbitrary as assuming a 50-50 split.<br>Additionally, this water use is insignificant (<10L/s), and would not effect the stress assessment |
| RS | p. 89 – 3.5.2 – You refer to 'pumped volume' here with values as rates ($m^3/s$). Fig. 3.3, 3.4, 3.5 consumed volume are all rates not volumes. | Revised text |
| CN | P. 89: What are the relations between the Estimated, Reported, and Total rates on Table 3.8? | Added note to table describing the relationship between fields |
| CN | P.s 90-92: Referring to Tables 3.9 and 3.10, should the total demands be the same regardless of whether one is summing over the hydrologic source units, or the subwatersheds? For Table 3.9, the total demand (Groundwater+Surface water) is 2.40 $m^3/s$; for Table 3.10, the total demand is 1.91 $m^3/s$. | Clarified difference between source consumptive and subwatershed consumptive |

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| RS | p. 90-91 – I am not sure what the difference between table 3.9 and 3.10 is? Explain the difference between 'By Hydrologic Source Unit' and 'Subwatershed Scale' consumptive demand. | Repeated the difference between source and subwatershed consumptive demand. |
| RS | p. 96 – 3rd paragraph – provide more details on what the 'area/time versus time method' is or cite a reference. | Referenced Harold Schroeter's training document. |
| CN | P. 96: What is the basis for the delineation of the Zones of Uniform Meteorology? The ZUMs appear to be the catchments shown in Maps 4.4 through 4.6. | Expand on how ZUMS are delineated |
| CN | P. 97: We are puzzled by the "Impervious" designation on Table 4.1. Are we correct in understanding that if rock is the uppermost geologic unit, then it is assumed to be impervious? Our appreciation is that the weathered top-of-rock zone may be the most permeable unit in some areas. | Due to regional nature of hydrologic model, exposed bedrock assumed to be impervious. Compared to surficial soils (even clay based), this is likely correct |
| RS | p. 98 – last paragraph – "The fast responding reservoir is intended to represent shallow groundwater flow systems that respond quickly to rainfall events …" This part of the sentence is fine. The follow "… typically seen in less permeable materials (interflow or tile drainage)." is not really correct. We can definitely have fast responding shallow groundwater flow systems in high permeability materials. The 'fast response' is determined by the soil permeability, underlying geology, topography adjacent to stream (flat topography results in quicker response). NOTE – in Section 4.5.2 under Calibration Results you discuss how there is insufficient water being provided to the fast reservoir for the Norfolk Sand Plain. If you don't consider a fast groundwater response in permeable material this makes sense. Points to an error in your conceptual model of fast response in the model. Furthermore on bottom of p. 106 / top of 107 you state that it is a "…timing challenge, rather than an issue with the fundamental hydrology." I think it is likely an issue with the fundamental hydrology. | Added to the discussion about how fast and slow responding systems can be found in both tight and loose surficial materials.<br><br>Expanded discussion on how a HRU only providing water to one of the groundwater reservoirs (slow or fast) is a modelling limitation, not something that can be adjusted |
| CN | P. 99: It is indicated in the report that soils mapping has been done to a "very high level" in Norfolk County. Who has been responsible for the mapping, and where is it documented? | Add reference to soils mapping (OMAF) |
| DR | p. 100 - One hydrologic characteristic typical of this part of southern Ontario, is a significant mid-winter melt period (often in mid January). How does GAWSER deal with the potential for a major infiltration event in during the winter months relative to the seasonal variation that is incorporated into the model as described on P. 100? | Deviation from the "normal" season, is not considered in the seasonal adjustments of infiltration parameters. Infiltration parameters are not adjusted in realtime to account for a mid-winter melt, but only based on the average month. Text added. |
| CN | P. 101: It is indicated in the text that hummocky topography has been used in the past as a surrogate for closed drainage areas, but "this correlation may not hold true in all places." Does this mean that "hummocky topography" is not necessarily synonymous with "closed drainage areas"? | Clarify text that not all areas ID'd as hummocky topography are closed drainage areas. |
| RS | p. 102 – 4.4.1 – This reads that the model was calibrated for Long Point (reduction factor of 0.1) and then this was applied to Catfish and Kettle. Did all three regions GAWSER models undergo calibration and verification? | Removed reference to previous Schroeter's water use work. |

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| RS | p. 103 – 3rd paragraph – What is your reasoning for removing the 4 days of pumping over an 8 day period for surface water and 30 days for shallow groundwater? | Added discussion on timing factors |
| DR | p. 103 - The approach to account for the extraction of groundwater within the GAWSER simulations of stream flow (P. 103) significantly improve the representativeness of the overall simulations but the reader gets a bit confused with all of the modifying factors that were ultimately used to develop the best calibrated simulations of the GAWSER model. It is not clear how the Schroeter 0.1 reduction factor ultimately gets worked into the calculation and why, for example . The issue of time delay between groundwater extraction events for irrigation and the actual impact on the stream flow is addressed on P. 103, but the logic of how these time delays were selected is not documented. For instance, the actual time delay and the volume of water that will be reduced from the stream base flow depends on how far away from the stream channel the wells are and how much the groundwater flow system is modified during pumping (drawing water from outside the subwatershed boundary for example). | Clarified text, to focus only on current water use work, not previous Schroeter work.<br><br>Added discussion on the time delays used to represent flow removed from surface water system. (for both groundwater and surface water) |
| DR | As the GAWSER model calibration depends directly on the baseflow at the limited measurement points available within the simulation domain, the limitations of this approach to incorporating groundwater takings into the GAWSER model should be considered in a bit more detail. Although the complex combination of reduction factors provides a reasonable match to the stream flows, the evaluation of the level of stress in any given part of the water shed depends on the low flow conditions in the stream which in turn depends on timing of the groundwater feeding to the water course, something that is not well handled by the GAWSER model and depends on how this time delay issue is handled. This being said, the consultants have really tried to address this issue and some additional discussion of the potential limitations or ramifications of the approach could be included as it is an important hydrologic interaction that is not well coupled between the two models. | Added discussion on uncertainty associated with the generalized lag times in the uncertainty portion of section 5.0 |
| RS | p. 104 – bottom – how does map 4.8 illustrate pervious soil deposits that overlie tighter quaternary deposits (it shows simulated recharge)? | Wrong map label, revised |
| CN | P. 104: Referring to the results plotted in Figure 4.1, it appears that the revised analysis succeeds in reducing flows to observed levels – some but apparently not all of the time. Are the timings of the predicted water takings correct? | Representation of water takings in GAWSER has been done from a purely physical basis. True timing of irrigation events would be heavily influenced by “human” factors, which we can not replicate. Added text to expand on this. The issue with elevated late spring/early summer simulated flows is also shown in this graph. This is related to too much water being directed to the “slow” groundwater reservoir, and is not related to the timings of the irrigation events. |
| CN | P. 104: It is important to note that while the reduction of the water takings from 0.45 to 0.30 is an absolute reduction of 0.15 it represents a further 33% reduction. | Revised text |
| CN | P. 105: In our opinion, the addition of the category “permeable soil overlying tighter quaternary deposits” is very important. The map of the distribution of this category [the second Map 4.7 in our draft, not Map 4.8] | No action required |

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| | should inform all future studies in Ontario. We recommend that at some point the water budget analyses conducted in the Grand River watershed be reviewed to evaluate whether this situation arises in any areas, and whether the results of previous analyses should be revised. | |
| CN | P. 105: It is interesting to note that the approach to simulating infiltration through permeable soils overlying tighter quaternary deposits is very different, and in our opinion more appropriate, to the use of a recharge spreading layer that has been previously been adopted in models in the Region of Waterloo. | No action required |
| CN | P. 105: Although the available data are not sufficient to assess the effect of the HRU revision on Black Creek, we presume that the effect on groundwater levels at the smaller scale may have been profound. Was the new approach effective in eliminating areas where groundwater levels in excess of 1000 m were calculated? | Add text describing that the extremely high GW elevations in Black Creek were removed with the inclusion of this new recharge layer. |
| RS | p. 105 – 4.5 – You state 'calibration/verification' and then go on to state Dr. Schroeter 'validated' each of the 3 models. Do you not mean 'verified' the models? Model validation usually refers to a 'postaudit' study (i.e. years after modeling study is complete). | Modified text - "validated" to "verified" |
| CN | P. 106: It is indicated in the report that conditions were simulated between "the entire climate period ranging from 1960 to 1999", but only data between January 1995 and November 2004 were considered for the calibration. Are we correct in understanding that the entire period should read 1960 to 2004? Why were data considered only for a portion of the entire period, and why in particular 1995 to 2004? | Changed model simulation period to 2004. Only looked at 1995-2004 comparisons because we are including PTTW data in the simulations (which is representative of present day pumping) |
| CN | P. 106-107: Are we correct in understanding that the categorization of HRUs as either having "slow" or "fast" groundwater reservoirs is somewhat arbitrary and adjustable. Could the matches be improved by "tweaking" the apportioning? | Supplemental text added to describe the model's limitations with respect to the slow and fast reservoirs. Tweaking will not address the model limitation (water from pervious response units is directed to "slow" reservoir) |
| CN | P. 107: Are we correct in understanding that the data and simulation results plotted in Figures 4.3 through 4.12 represent averages of the year-by-year conditions? | Yes, results are the monthly daily mean, or monthly daily median flow from 1995-2004 period. |
| DR | p. 107 - One of the ways to determine if the actual recharge rates that are estimated from the GAWSER model make physical sense would be to do some local calculations of Potential ET in different areas based on the available MET data. This would be very easy to do and would provide a degree of validity with respect to the final values that are drawn from GAWSER and used to calibrate the FeFlow model. | Checking recharge rates in this manner, still requires soil moisture accounting to arrive at AET. Once AET is estimated, the surplus precipitation (Precip-AET) would have to be partitioned between direct runoff and recharge. The uncertainty associated with this analysis would likely be greater than the uncertainty associated with the hydrologic modelling, which is what the suggested exercise is meant to check |

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| DR | p. 112 - In examining the impact of modifying the HRU's as illustrated in Fig. 4.2, it appears as though the mean monthly flows are not very sensitive to the changes in the regional HRU distribution . On the other hand, the spatial distribution of groundwater recharge, is likely highly sensitive to these changes, a very active topic of discussion in the literature these days. The results displayed in Figs. 4.3 to 4.12 illustrate the fit between the measured and simulated nature of the stream flow but based on how insensitive the model appears to be to regional changes in the HRU's (as one parameter), how much confidence does the team have that these results are reasonable or could many different distributions of groundwater recharge have produced as acceptable a result based on the flow rate match. In other words, how unique is the final calibration? In the end, the key is to be on the conservative side. The report could include a brief discussion of how important the uniqueness of the final parameter set is relative to assessing water quantity risk. I believe that the sensitivity work presented at the last peer review meeting goes a long way to illustrate this point and I anticipate that it will be covered in the revised version of the report that includes an explanation of the sensitivity results. | Revised text to emphasize that the small difference shown for Big Otter Creek is due to the small proportion of affected HRUs. Added graph for Black Creek, to illustrate difference the HRU revision had in streamflow |
| RS | p. 107 – 112 (Figures 4.3 to 4.12) – In all these plots you consistently see the GAWSER model under-predict flows in spring and over-predict flows in early summer. Could this not be adjusted – some fundamental hydrological process is not being represented correctly. | Similar to comment 20. Cannot be adjusted, is a limitation of the model. Added discussion in response to Comment 17 on this |
| HW | p. 112 to 119 - As noted in discussion in December I would like to see a table added to this section which gives for the watersheds covered in Fig 4.3 through 4.12 the following as averages for the period of record: Measured mean monthly-total streamflow in mm; modeled mean monthly-total streamflow in mm and difference. This comparison of monthly streamflow in mm is a good basis for assessing the ability of the model to conform to the subwatershed water balance as it varies by season. | Added calibration plots of gauges for mean-monthly streamflow in mm |
| CN | P. 113: Our understanding is that soil water content is defined as volume of water per unit volume of porous medium. What is the soil water content expressed in terms of depth of water? | Definition issue - soil water is the depth of water held in the modeled soil layer within GAWSER, per unit area. Added to text |
| CN | P. 116: We concur that local streamflow estimates may be subject to higher levels of uncertainty; however, in our opinion it is important to indicate that in a fundamental sense this does not reflect inadequate refinement of the models, but the lack of streamflow data at this scale. | Revise text to indicate that calibration is limited to available streamflow data |
| CN | P. 116: There appears to be an important typo in the sentence, "This simplification accounts for larger-scale differences in land cover, but may exactly reflect local conditions." We think the sentence should read, "This simplification accounts for larger-scale differences in land cover, but may *not* exactly reflect local conditions." | Revise text to include the "not" |
| CN | P. 117: The state of the science of the representation of snow processes is mentioned briefly. How advanced is the state of the science, and how current is GAWSER with respect to the state of the science? | Revised text |
| CN | P. 118: It is indicated that as a rule-of-thumb, manual streamflow measurements may be in error by ±10 to ±15%. Have any assessments been reported in the literature to support this? | Reference added |

| REVIEWER | REVIEWER COMMENTS | ACTION |
|---|---|---|
| CN | P. 118: Do the limitations with respect to the representation of changes in hydrologic parameters reflect limitations of the models, or in the data available to parameterize them? | Revised text to emphasis this is not really a limitation of the model used, but rather a limitation of the state of science, and the modeller's ability to properly characterize the process |
| RS | p 118 – first paragraph – don't refer to ± 10 to 15% as a 'rule of thumb'. There are likely many references on this – one I have used is Winter (1981) who sets it at 5-15% (Winter, T.C. 1981. Uncertainties in estimating the water balance of lakes. Water Resources Bulletin 17: 82-115. | Added a reference. |
| CN | p. 121 - In our opinion it is reasonable to represent the bedrock with two layers. Based on our experience with similar rocks in the Niagara region, a 5 m thick weathered zone is appropriate. With respect to the 50 m thick lower layer, it is important to point out that this layer likely contains discrete flow zones that may have a relatively large cumulative transmissivity (Johnston, 1964; Yager, 1996). We have tried to locate hydraulic testing results from bedrock boreholes in the study area. Mark Jensen of Ontario Power Generation provided us with a report on the Nanticoke Generating Station site ( This report contained the results of hydraulic conductivity profiling using packer testing; however, only one borehole extended below the weathered top-of-rock zone. The profile is plotted in the next figure. In our opinion, in general the transmissivity below 50 m is likely to be insignificant; however there may be locations where it may be significant. | Added references and plot to text |
| CN | P. 121: Are we correct in understanding that in FEFLOW jargon, "boundary conditions" is a general term that refers to all sources and sinks and not just to those along the perimeter of the model? | Yes, text revised |
| CN | P. 122: Are we correct in understanding that no site-specific constraints were imposed on the generation of the overburden hydraulic conductivity distributions? Are no estimates of hydraulic conductivity available from wellfield testing? What information was used to check whether the hydraulic conductivity distribution is realistic, as is indicated in the text? | This is a data gap for our study – we have not gathered observations of measured hydraulic conductivity. We are simply estimating K based on borehole lithology and adjustments required by calibration. Text clarified. |
| CN | P. 122: It is indicated in the report that "bedrock values [of hydraulic conductivity] were applied based on generalized bedrock responses". What does that mean? | Revised text |
| CN | P. 122: We are puzzled by the discussion of the assignment of the hydraulic conductivity for the surficial model layer (layer 1). It is indicated in the report that the values determined for the soil infiltration parameter were multiplied by 100. What values does this refer to? Is this some value other than the vertical hydraulic conductivity? Later in the same paragraph it is indicated "using the same distribution in both models provides another level of continuity between the surface and groundwater models". What distribution is being referred to, hydraulic conductivity or recharge? | Factor is likely required due to unsaturated zone properties in FEFLOW. Additional text supplied |
| RS | p. 122 – The 'factor of 100' seems pretty black-box. Can you come up with a better technical reasoning behind the factor of 100. | Text Added |
| CN | p. 123-151 - Interpretation of the water budgets. In our opinion, although the components of the surface water | Added columns for subwatershed |

| REVIEWER | REVIEWER COMMENTS | ACTION |
|---|---|---|
| | budget are calculated appropriately, the water budget itself is not set up correctly. | surface water inflows and outflows |
| | The apportioning of precipitation is written as: | |
| | $P = ET + RO + I$ | |
| | where *P* is precipitation, *ET* is evapotranspiration, *RO* denotes runoff, and *I* is recharge (infiltration to the water table). The surface water budget is expressed as: | |
| | $SW_{in} + RO + GW_{from\ streams} = SW_{out} + SW_{consumptive\ takings}$ | |
| | where $SW_{in}$ and $SW_{out}$ are the cumulative inflows and outflows from surface entering and exiting a watershed or subwatershed, respectively, and $GW_{from\ streams}$ is the groundwater discharge to the surface water system. | |
| | The values assembled on Table 6.5 and 6.6 support checking of the apportioning of precipitation, but not the surface water budget. | |
| | In contrast to the surface water, the groundwater budget is set up correctly and can be checked with the information provided in the report: | |
| | $I + GW_{trans-boundary} = GW_{to\ streams} + GW_{to\ Lake\ Erie} + GW_{consumptive\ takings}$ | |
| RS | p. 123 – section 5.2.3 – You should provide a map with the actual model boundary conditions. Boundary conditions are very important to understanding how the model functions. The discussion of 'specified boundary conditions around the perimeter of the model were minimized to reduce the potential for re-circulating boundary effects' is not clear. Section 5.2.3.2 – again you should map the Strahler Class 3 streams and show where the specified head nodes are. In the Upper Kettle area the previous discussion provided strong evidence that the streams (in particular Dodd) are not connected to the groundwater system. Is Dodd modeled as a specified head boundary? Section 5.2.3.3 again show us the boundary conditions. | Added a separate map of lateral boundary conditions.<br><br>Added a separate map of watercourses. |
| CN | P. 123: It should be noted that the water level trends around the perimeter of the model are interpreted from interpolated surfaces of water levels reported in the MOE water well records. | Revise text |
| CN | P. 125: It is indicated in the report that the level of calibration is "considered appropriate". Who has suggested using NRMS as an error criterion and who considers 5.3% as appropriate? What is the source for the suggestion that a mismatch of ±5 m is "generally accepted to be inherent in the use of water well data"? If this is indeed an appropriate acceptance criterion, isn't an RMS error of 7.3 m relatively high? Are the residuals normally distributed? | Added additional text |
| CN | P. 125: How do the calculated water levels at the locations of PGMN wells compare with average water levels inferred from hydrographs (Figures 2.4, 2.5, and 2.6, for example)? Furthermore, the results shown in Map 5.4 suggest that water level residuals in excess of 15 m are relatively plentiful, and geographically concentrated. | text added |
| CN | P. 126: It seems that the report of Bellamy et al. (2003) would be an important resource for local practice. Is this document readily available? | No action required |
| CN | P. 126: What are "naturalized" streamflows? | Revise text to explain that STP discharges were considered when |

| REVIEWER | REVIEWER COMMENTS | ACTION |
|---|---|---|
| | | producing calibration targets |
| CN | P. 126: The scatterplots suggests that an envelope on the model residuals is at least ±5 m, and perhaps as large as ±20 m. | text added |
| RS | p. 126 – What pass of BFLOW did you use ? | Used 3rd pass, revised text |
| CN | P. 127: Why might adjustments to model layers and hydraulic conductivity improve the local calibration to baseflow? Isn't the distribution and magnitude of recharge the key to matching baseflows? | text added |
| CN | P. 128: We concur with the value of particle tracking calculations. Were any calculations made as part of study? | revised text |
| CN | P. 128: How is recharge over areas of strong hydraulic gradients handled in the FEFLOW model? Is the recharge rejected? | text added |
| RS | p. 128 – Map 5.7 – To what extent do the green areas where strong upward gradients exist correlate with the specific head stream boundary conditions? If they correlate then these upward gradients could simply be an artifact of the imposed boundary conditions. | The areas of upward gradient correlate very well with the stream boundary conditions. It is likely that this is caused by more than just imposed boundary conditions. These areas of upward gradient also correlate very well with areas where the watercourses have become incised, and are likely lowering the local water table. Areas where the watercourses are not incised (Upper Big Creek) do not show the same gradient. |
| CN | P. 129: It is important to note that there is no direct correlation between geological description and hydraulic conductivity. The term "till" is particularly difficult to match to a representative hydraulic conductivity. In some areas, till may act as an aquifer, in others as a tight aquitard. | text added |
| CN | P. 129: We question the suggestion that the model layers do not have a sufficient physical definition. There is no reason why model layers must conform to hydrostratigraphic units. Although this might make it more convenient to assign of hydraulic conductivity in areas where the distribution is relatively simple, there is no error introduced in designing simple horizontal layers of uniform thickness (for example), as long as representative hydraulic conductivity estimates are available and are assigned appropriately. | Agreed, this suggestion (layers of uniform thickness) was made in September to the Peer Review Committee. In interest of project deadlines we proceeded with the current layer structure - which does not necessarily reflect the conceptualization presented in Chapter 2. Text revised |
| CN | P. 129: It is indicated in the report that "the hydraulic connection with the underlying aquifer system is characterized as having uniform properties". Our understanding of the approach is quite different. Our understanding is that there is assumed to be a direct connection between the surface water features and the groundwater system; this implies that the flux to or from the surface water feature is controlled by the hydraulic conductivity of the finite element in which the surface feature lies. | Text revised |

| REVIEWER | REVIEWER COMMENTS | ACTION |
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| CN | P. 130: At the scale of the combined three conservation area watersheds, we would not expect perimeter flows to be a significant component of the overall water budget. This is confirmed by the relatively small values indicated on Table 6.3. We would see little value in extending the boundaries of the model to reduce the uncertainty. | No action required |
| CN | P. 130: Are any "carefully measured" water levels included as calibration targets for the groundwater model? | Only MOE WWIS |
| CN | P. 131: It is indicated in the report that calibration of groundwater discharge to baseflows "is generally targeted to be within an order of magnitude". What does this mean with specific reference to Figure 5.2? Does it mean a range from (simulated ¸ 10) to (simulated * 10), as shown here for the gauge at St. Thomas? | Revised text to indicate calibration of groundwater discharge to baseflows was "targeted to the expected range of observed baseflows" |
| RS | p. 131 end of top bullet – Where did you get the statement that "…calibration of groundwater discharge to baseflows is generally targeted to be within an order of magnitude." Even your data (Fig. 5.2) shows agreement to within a factor of 0.5. | Revised text to "targeted simulated baseflows to be within the expected range of observed baseflows" |
| RS | p. 133 section 6.2 – Where did the 555 mm/year number come from? (GAWSER)? Note: 955-204-195 = 556 mm (table 6.2 lists 194 not 195). | There is a difference due to rounding. |
| RS | p. 134 – Can you not compare the recharge value of 204 mm in Table 6.2 (Surface water GAWSER based) to the backed out value from Table 6.3 (FEFLOW) 164+32+5-14 = 187 mm? | Proper calculation of recharge is 164+14+32-5 = 205, which is ~=204 mm of recharge. Clarified table to show which component is flow in vs. out. |
| RS | p. 134 – Define the 'flow in ratio' and it's relationship to map 6.5. | Added formula to definition in Table 6.4 |
| CN | p. 153 - We have not been able to reproduce the calculations of the Flow In Ratio (FIR) reported on Table 6.5. In the report it is indicated that the FIR is calculated according to: $FIR(\%) = \frac{GW_{to\ streams} + GW_{consumptive\ takings}}{I} \times 100$ | Equation is 1-Outflows/Recharge Revised text to clarify |
| HW | p. 153 - To examine the behaviour of the GAWSER estimates of evapotranspiration, and thus provide a basis for a statement of possible limitations on the ability of the modeling to distinguish between net groundwater movements between subwatersheds and inaccuracies in evapotranspiration I suggest the following table be included for this subsection. The table would be for the subwatersheds shown in Table 6.5. For each subwatershed the table would give the mean-monthly potential evapotranspiration (mm), the mean monthly total actual evapotranspiration (mm) and the ratio of actual to potential. | Added table of average annual AET and PET on a subwatershed basis. The monthly variation was not included to table size constraints. Discussion was added on the relationship between subwatershed properties (clay, sand, etc…) and the AET/PET ratio. Discussion on uncertainty in ET estimates added |
| RS | p. 154 and 163 – last paragraph on p. 154 & your method not to 'double count' water demands seems at odds with your statement on p. 163 in regards to the groundwater assessment "Groundwater supply is calculated as the annual amount of recharge plus the amount of net groundwater flow in expressed …". | Revised Text |

| REVIEWER | REVIEWER COMMENTS | ACTION |
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| DR | p. 170 - In the final classification of the level of stress, there may be some merit in considering an additional classification within the “Moderate” level that informs the user of whether it is close to a “High” ranking or closer to a “Low” ranking. A “High Moderate” and a “Low Moderate” for example might be useful. These are the regions that are most susceptible to the degree of uncertainty of the analysis and the ones that will change during sensitivity analysis. | The uncertainty analysis indicates areas that are so close to the threshold, that they are uncertain. This is now shown in the updated Stress Assessment maps. Breaking the stress assessment into additional categories may confuse the issue more so |
| CN | p. 170 - In our opinion the guidance provided regarding the interpretation of the stress assessment is excellent. | No action required |
| CN | p. 174 - The spatial scale of the analysis is revisited at the end of the report, Pages 174-175. It is indicated that the groundwater model has undergone a “regional calibration” and provides an effective tool for “subwatershed assessment”. Are we correct to interpret this as meaning that “regional” and “subwatershed” are synonymous in this context? We are puzzled by last paragraph on Page 174; after indicating that the model can be used for subwatershed assessment, the text then indicates that the results of the surface and groundwater modeling are consistent with the understanding of the key hydrologic and hydrogeologic processes at the watershed scale. We recommend that this discussion be clarified. | Added definitions of "regional", "subwatershed", "watershed" and "local". Revised elsewhere in text. |
| CN | p. 175 - With respect to the observations that are used to constrain the analyses, does “regional” mean spatially extensive but not particularly accurate, or does that judgement depend on whether we are evaluating streamflow data or groundwater information extracted from MOE water well records? Some of the subwatersheds are gauged, and we concur with the indication at the top of Page 175 that the GAWSER modelling has been calibrated to observations at the subwatershed scale. Can the same be said about the FEFLOW modelling? We did not note the use of any groundwater level data in the analyses that was of similar high quality (in particular, water level time series from dedicated observation wells and multi-well pumping tests). | Revised text to be more clear about stress assessment limitations |
| CN | p. 176 - We have conducted some spot-checks and the surface water stress assessments presented on Table 7.6 appear to be reproducible. A more substantive issue is whether any data are available to support the assignment of a **Significant** stress level for the North Creek subwatershed. Is there a stream gauge in this subwatershed? If there is not one, does this constitute a significant data gap? | Added text regarding the fact that there is no gauge within North Creek, and that this identification cannot be confirmed through measured streamflow estimates. Added qualitative confirmation that the creation of a IAC is an indication of a recognized issue in the area. |
| CN | p. 181 - We have conducted some spot-checks and the groundwater stress assessments presented on Table 7.7 appear to be reproducible. However, there is a significant typo on this table. The column marked “Groundwater Reserve” is actually the Groundwater Discharge, that is, the cumulative net flows from the groundwater system to the surface water features. The Groundwater Reserve is 10% of this quantity. | Table 7.7 has been updated. |
| CN | p. 184 - In our opinion, the methodology and results of the uncertainty assessment in Section 7.4 are appropriate. However, it is important to note the overall implications of uncertainty are relatively small. For four of the five subwatersheds assigned a result of “Uncertain”, the change in the stress assessment is from low to moderate. For the Lower Catfish Creek subwatershed, the result remains moderate even after uncertainty is accounted for. | Text was expanded to describe how the uncertainty analysis found the Stress Assessment to be fairly stable. |

| REVIEWER | REVIEWER COMMENTS | ACTION |
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| CN | p. 184 - There is one major uncertainty that is not addressed. What is the implication of a lack of data for each subwatershed? Is it possible to be anything other than uncertain in those subwatershed that are not gauged? | This analysis (with numeric modelling) is being done, explicitly because there are not streamgauges at every subwatershed outfall. Identifying any subwatersheds with no streamgauge data as uncertain would be self-defeating. |

# Appendix C-1

## Phase 2 Peer Review Meeting Minutes

- **Phase 2 Peer Review schedule**
- **March 19, 2009**

Wed 11/19/2008 3:20 PM

To the Kettle/Catfish/Long Point Water Budget Peer Review Committee:

Last week, Lorrie Minshall & I met with AquaResource Inc. to discuss timing for the preparation of a Phase 2 draft report. At this time, ARI are working towards a target circulation date for the draft report in early March 2009. With this date in mind, I have prepared the following tentative peer review schedule based upon the initial 8 week time frame set out in the Peer Review Terms of Reference:

| | |
|---|---|
| March 2 | Distribute draft report |
| | Report review period |
| March 19 | First meeting to allow ARI to present the results of the report and receive initial questions from the peer reviewers |
| | Comment period |
| April 1 | Submission of peer reviewer comments |
| | Consolidation of comments into a matrix by GRCA |
| April 7 | Circulation of comment matrix |
| April 9 | Second meeting to address peer review comments |
| | ARI revises report to address comments |
| | GRCA prepares revised matrix documenting how and where comments have been addressed |
| April 20 | Redistribution of the report with annotated comment matrix |
| April 27 | Peer reviewers sign off on the revised report |

Recognizing where this period sits within the March Break, Easter and university end of term, can I please receive comments regarding the availability of the peer review team to work to this schedule.

Sincerely,

James B. Etienne, P.Eng.

Senior Water Resources Engineer

Grand River Conservation Authority

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**Lake Erie Source Protection Region**

**Kettle/Catfish/Long Point Tier 2 Phase 2 Water Budget**

**Peer Review Committee Meeting**

**March 19th, 2009, GRCA Head Office**

**Minutes**

**Present:** *Peer Review Leader*

James Etienne – GRCA

*Peer Reviewers*

Hugh Whiteley – University of Guelph

Chris Neville – S.S. Papadopulos & Associates

Dave Rudolph – University of Waterloo

Rob Schincariol – University of Western Ontario

Bob Fields – Norfolk County

*Peer Review Representatives*

Scott Bates – Ministry of Natural Resources

Scott Lister – Conservation Ontario

*Project Team*

Lorrie Minshall, Stephanie Shifflett, Amanda Wong – GRCA

Heather Surette, Craig Jacques - LPRCA

Jennifer Dow - KCCA

Paul Martin, Sam Bellamy, Janna Hamilton – AquaResources Inc.

**Regrets:** *Peer Reviewer*

Deborah Goudreau – Oxford County

John Warbick - OMAFRA

*Peer Review Representatives*

Clara Tucker – Ministry of the Environment

*Project Team*

Gregg Zwiers – GRCA

Peter Dragunas - CCCA

Dave VanVliet – AquaResources Inc

## Introduction

J. Etienne welcomed the Peer Review Team and explained the purpose of the meeting.

**Meeting Objective:** Present the findings of the Kettle/Catfish/Long Point Phase 2 Water Budget to the Peer Review team and allow the team to formulate their comments for submission and further discussion at the next meeting.

L. Minshall commented on the timing to complete the Tier 2 Water Budgets and Stress Assessments for the Grand and Kettle/Catfish/Long Point watersheds. The goal is to present the Stress Assessments to the Source Protection Committee this spring. An introductory presentation is being prepared for the April 2nd meeting. Lorrie noted the need to get a peer reviewed report to the province as soon a possible to address the outstanding "high water use designation" issue in Norfolk County.

## Presentation on the Grand River Water Budget and Stress Assessment

S. Bellamy provided a summary presentation of the Kettle/Catfish/Long Point Tier 2 Water Budget and Water Quantity Stress Assessment Report. No changes have been made to the 2008 version of the Water Budget report. Slides of the presentation are available on the AquaResource FTP site.

## Question and Answer Discussions

The presentation prompted discussion and a number of questions from the Peer Reviewers including:

- Lorrie M. asked the Peer Reviewers to use their professional judgement to critically assess the need for Tier 3 work in Tilsonburg due to a minor exceedance of the moderate stress threshold at 11%.
- Hugh W. noted that the exceedance may be close enough to warrant keeping a close eye on the subwatershed but does not justify the expense of Tier 3 work.
- The group discussed the approach to dealing with ecological needs as opposed to municipal water supply needs within stressed subwatersheds.
- The group considered the presentation of the SGRA delineations noting that the 55% average annual recharge rate subrule was not applies in the Kettle/Catfish/Long Point Stress Assessment report.
- Particle tracking results were presented but they are not currently included in the reports. It makes sense to include them in the Water Budget report.
- In general, ARI were able to integrate stress assessment comments from the February 2009 Grand Peer Review process into the preparation of the Kettle/Catfish/Long Point document.
- ARI have decided to go straight to a ten year drought scenario, noting that the two year scenario has little scientific basis.

- Lorrie M. referred to the efforts currently underway by ARI to identify a work planning exercise for a Tier 3 Terms of Reference. The Peer Review Team will be asked to approve the Terms of Reference before the project is sent out for consultant bids.

## Action Items

As a result of the meeting the following action items were generated:

- AquaResource will make the presentation slides available on their FTP site.
- J. Etienne will prepare meeting notes for circulation to all the Peer Review team members.
- Peer reviewers are asked to submit any comments or questions to J. Etienne by April 1st to allow for consolidation, preparation and circulation of a comment matrix prior to the next meeting.
- Peer Reviewers are asked to contact J. Etienne if comments can not be prepared by April 1st.

## Next Meeting

The next meeting, scheduled for the afternoon of April 7th. P. Martin suggested after the meeting that a teleconference may be an appropriate media for the next meeting to help reduce travel requirements. J. Etienne with survey the peer review team to see if they are in favour of a teleconference.

# Appendix C-2

# Phase 2 Peer Reviewer's Comments Matrix

| Chapter and Page | Raised by | Comment | Assigned to | Response |
|---|---|---|---|---|
| **1.0 Water Quantity Stress Assessment** | | **WATER QUANTITY STRESS ASSESSMENT REPORT** | | |
| **General** | Rob S. | Overall I find the report very well written and technically sound. Furthermore, the authors have carefully discussed uncertainty issues involving the Stress Assessment. | N/A | Okay |
| **General** | Dave R. | The Tier 2 draft report is very well written and logically structured. It is clear that the experience gained by the consulting team during the course of the Long Point study and other related source water protection work has advanced the methodologies, uncertainty assessments and the conclusions that are being drawn from the work. The results will clearly provide the Source Water Protection Committees with invaluable insight into the degree of stress on water quantities throughout the region. | N/A | Okay |
| **iii Executive Summary** | Dave R. | The text states that under the drought assessment, all municipal wells and intakes would likely be able to pump water under historical drought conditions. This sentence follows the conclusion that 4 municipal systems require Tier 3 assessment under existing conditions. This does not seem to be consistent. | ARI | Conclusions were drawn from the Technical Rules. Tillsonburg, Delhi, Simcoe & Waterford are not driven to Tier 3 by the drought criteria. Their potential stress is governed by water demand. Wording revised in the Executive Summary to indicate that no additional subwatersheds were identified based on the drought scenario done in accordance with the Technical Rules. |
| **Map Booklet** | Dave R. | The main physiographic features of the area play a major role in controlling where surface waters are more available, where the SGRAs are located and how the regions are | ARI | Additional maps from Water Budget of physiography were included in the map booklet of the stress assessment (Maps 3, 4, 5) and |

| Chapter and Page | Raised by | Comment | Assigned to | Response |
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| | | subdivided for several aspects of the analysis. It would be very useful for the reader if the major units could be shown on one of the map sheets (e.g., Haldimand Clay Plain, Norfolk Sand Plain, glacial moraine features, Ekfried Clay Plain). | | were referenced in Sections 1.1.1, 1.1.2, and 1.1.3. |
| **4** | Rob S. | Section 1.1.2 - Line 3 (p. 4) should be: "… just ***west*** of Aylmer". | ARI | Editorial revisions made in Section 1.1.2. |
| **8** | Dave R. | Section 1.3.1 - Throughout the document, the definition of what a moderate or significant potential for stress on a groundwater supply actually is, was presented several different ways. For example, in the Exec. Summary it is referred to as "to cause a municipal well to be unable to pump water." On p. 8 the definition is "likelihood that groundwater levels could drop below the elevation needed to support a pumping well" something that is very site dependent. Page 44 has another quoted definition. There should be consistency in this classification. Most of these definitions are related more to geometric aspects of the pumping wells that are not available for evaluation in most cases. In fact, at one point, (p. 52) the assumption is made that all municipal wells have approximately 5 m of available drawdown. If this is derived from the regulations, this should be stated along with a definition of what is meant by "available drawdown". | ARI | Effort was expended in attempting to remove ambiguity in defining the drought assessment and how it affects the classification of the potential for stress in a subwatershed. An overview of the drought assessment was added in Section 1.3.1.3. This Section is placed in context with explanations of the rest of the Stress Assessment methodology to increase understanding of the process of determining potential for stress. Wherever the drought scenario is referenced in the document, an effort for consistency in wording was made. |
| **8** | Dave R. | Section 1.3.2 - It is acknowledged that the details regarding the model construction and calibration are covered in earlier documents and should not be repeated here. However, the main interpretive components in this document depend on the results derived from the GAWSER and FEFLOW models of the region. Many interested parties will depend | ARI | Introductory text to make the linkage between the conceptual understanding and modeling approach presented in the Water Budget and the results presented in the Stress Assessment was added. Section 1.4 is now a summary of modelling tools used. The need to reference |

| Chapter and Page | Raised by | Comment | Assigned to | Response |
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| | | on this document alone to provide guidance on the degree of water quantity stress that exists throughout the region. This area is of particular concern because of the limitation on water taking licenses due to the interpreted impact of agricultural water use.<br><br>As such, I believe it would be useful to provide a brief summary of how confident the consultants are with the 2 models they are going to use for this evaluation. How well were they calibrated? What are the main limitations? Are there areas were input data, for example, was particularly sparse and the results may not be as dependable? Someone picking up the document on its own, may not have the benefit of having read the previous work and this short initial section would set the stage for how representative the main tools of this aspect of the study are. This can be drawn almost directly from the earlier work. | | the Water Budget report was also stressed again in this section. |
| **2.0 Surface Water Stress Assessment** | | **WATER QUANTITY STRESS ASSESSMENT REPORT** | | |
| **17-18** | Craig J. | Section 2.4.2 – Agricultural projections; effects of climate shifts (difficult to predict) → but, possibility of a longer growing season, shift in crops, greater irrigation use? | ARI | Projections of agricultural use are uncertain, which is why they were only commented on and not estimated in the report. The effects of climate change cannot be commented on with any authority and were not included as a discussion point in the Technical Memo referenced in Section 2.3.2 and, therefore, aren't referenced in the Stress Assessment report. |

| Chapter and Page | Raised by | Comment | Assigned to | Response |
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| | | | | |
| **20-21** | Dave R. | Table 2.7 - Regarding the estimation of the variation in irrigation demand during the year, the assumption is made that there is substantial irrigation during the month of September. This assumption should be referenced, if possible. September irrigation is very crop dependant and as the area has seen a progression in soybean cropping, the estimations of September irrigation may be too high. In many cases, the September water takings for irrigation are significant and this should be considered carefully, especially considering the concern the Province has regarding the use of water for agriculture. | ARI | Reference for the June to September assumption was added in Section 2.7.1.1.<br>Paragraph added in Section 2.7.1.1 to suggest alternative reasons for irrigation in September. Paragraph also explains the conservative nature of the estimate.<br>More detailed study for irrigation demand (and additional reported values) can be considered during the Tier 3 process. |
| **25** | Hugh W. | Figure 2 – The significance of the high reserve percentage should be addressed. | ARI | ARI will do a proportional calculation for monthly long term mean supply compared to actual use, proportion reserved and proportion demanded in Figure 2. |
| **29** | Rob S. | Section 2.7 - As per Sam Bellamy's response to my comment at the meeting regarding "Consumptive Factor – 75%", this should read "Consumptive Factor – 100%". (i.e. this was stated as being a typographic error and in fact the factor was the same as previously used in section 2.6). | ARI | Editorial revisions made in new Section 2.5 (previously Section 2.7). |
| **3.0 Groundwater Stress Assessment** | | **WATER QUANTITY STRESS ASSESSMENT REPORT** | | |

| Chapter and Page | Raised by | Comment | Assigned to | Response |
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| **39** | Dave R. | Section 3.1.2 - The groundwater inputs are defined as being a combination of recharge from GAWSER and lateral inflow from FEFLOW along boundaries. For the lateral inflow, the method is stated as the sum of all positive flow vectors into the system. As this inflow infers it is coming from a neighboring subwatershed, it would seem that the negative flow vectors (outflow) would have to be removed from the sum to be completely accurate. I am sure that this is indeed being done, but it should be stated or else it might raise concern.<br><br>As the groundwater reserve depends on a % of the estimated groundwater discharge to the streams based on the FEFLOW results, it would be possible to compare these discharge values with those calculated by GAWSER. This would provide a way of assessing how well the 2 decoupled models handle this critical component of the hydrologic system and illustrate the confidence one would have in the model results. This may have been done in the earlier study, and I have forgotten the results. Wherever possible, the effort should be made to illustrate that the outputs from the 2 models agree fairly well with each other. | ARI | In Section 3.1.2, clarified that $Q_{IN}$ is the value being used, not the net flow of the subwatershed.<br><br>New Section 1.4.3 explains coupled, integrated modelling approach. |
| **42** | Dave R. | Table 3.4 - Should the last 2 columns of the table have the same title? | N/A | Different units are used in the two columns. No change required to Table 3.4. |
| **44** | Dave R. | Section 3.4 - Is it acceptable to omit the 2-year drought-screening scenario, as has been done for this region? If this screening scenario were included, where groundwater recharge is assumed to be zero for 2 years, one would anticipate that irrigation demand would go up substantially. Understanding that the irrigation model accounts for climate variation during the year, would the model also account for the extra demand on all water supply systems for irrigation during the droughts? | MNR | The 2-year drought scenario is meant to be a simple screening. 16-20 rainfall events would have to be modified in the modeling to achieve the desired results. Scott B. feels that a simple "on/off" scenario for recharge could be used. Scott has asked MOE to clarify this question and is waiting for a ruling. He will provide notification when the ruling is received. |

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| **45** | Dave R. | Section 3.4.1 - The actual water levels calculated by FEFLOW at each of the production wells is a regional value and does not represent the actual water level in the well, as it is not discretized to capture the drawdown cone. This is fine, as one is interested on the regional impact on the water levels as a result of the changes in conditions. It should be clearly stated what the FEFLOW results are providing. It could be inferred that the model is actually calculating levels in the pumping wells, which it is not (and does not have to). | ARI | Section 3.3.1 was modified to more clearly identify the capabilities of the FEFLOW model in estimating water level changes. |
| **46** | Rob S. | Section 3.4.2 - 3rd sentence "Subwatersheds already classified …." – consider rewording this sentence. Some may interpret it not as you intend (i.e. implies that already classified subwatersheds would not be affected by 'the drought scenario' which they would – it is just that these subwatersheds have already been classified). | ARI | Editorial revisions made to new Section 3.3.2 (previously Section 3.4.2). |
| **47-51** | Dave R. | Figures 8-14 - It is clear that there is very little difference between the simulated water levels using an average annual extraction rate for the agricultural water takings and a temporally varying rate. This is a good indication of the resilience of the groundwater supply system and should be stated as so, and also illustrates that the precise variation in groundwater extraction over the year is not such a sensitive parameter. I would suggest if possible, that one example plot of how variable the water taking values are relative to an average annual value, over the course of the year, would be very interesting for the reader. | N/A | Paragraph added at the end of Section 3.3.2 to stress the very small difference between the two water level curves in each of Figures 9 to 15 (Figures 8-14 in previous report).<br>New Figure 8 added in Section 3.3.1 to show the difference between average pumping value and monthly transient pumping rates. |
| **54** | Rob S. | Figure 15 - What is the reasoning for changing to a 2 year moving average annual recharge (p. 54) versus the 12 month moving average used in the drought scenario (p. 45)? Consistency would be better unless there is a reason. | ARI | Moving average line corrected on Figure 7 in Section 3.3.1. Two-year moving average line was shown on Figure 16 (Figure 15 in previous report) in Section 3.6.2 for illustrative purposes only and was removed to increase clarity/consistency. |

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| **55** | Rob S. | Section 3.5.3 - In final document you should shift the last paragraph on p. 55 (after Figure 16) forward a bit. Then the discussion of the figure will be on the same page as the figure being discussed. In this case a small change will greatly facilitate the reading. | ARI | Editorial revisions were made in new Section 3.6.3 (previously Section 3.5.3) to keep figures and text on the same pages. |
| **55-58** | Dave R. | Figures 16-22 – Upon examination, one first notes how different they are from the ones used to express the water demand variability for surface water sources (Fig. 2 or 4 for instance). A key point here is that the slope of the line is quite variable and indicates to some degree how sensitive the specific well is to these variations groundwater supply and demand. It might be useful to include not only the % months exceeding the 10% of discharge value, but also the % months exceeding the 20% of discharge for example. The data shown in Figs. 19 and 20 indicate that although the months exceeding 10% are about the same, those exceeding 20% are much different. This would help to understand how sensitive a specific system actually is. These data again indicate how much more resilient of forgiving the groundwater system is compared to the surface water systems for these cases. | ARI | In Section 3.6.3, a second threshold line was added to Figures 17 – 23 (Figures 16-22 in previous report) at 25% to illustrate the threshold for significant potential for stress. Reference in text made to the % of years passing this second threshold. Further conclusions drawn from this analysis aren't documented, as this process was simply to confirm the Stress Assessment results and is otherwise an untested process. |
| **61** | Rob S. | Section 3.7 - Consider adding a reminder statement that the groundwater stress thresholds change under 'average demand' to 'monthly maximum demand, scenarios, or shorter version of Table 1.5, in (or around) Table 3.9. I found myself pondering why Otter at Tillsonburg moved from a "Moderate" potential for stress under average demand to "Low" under monthly maximum demand while all other subwatersheds stayed the same or moved to a higher level of 'stress'. | ARI | Additional text added in Section 3.7 and a repeat Table 3.10 showing groundwater thresholds was added to provide a reminder and additional clarity.<br>To be consistent between chapters, Section 2.8 (which is the equivalent section in the surface water stress assessment chapter) was updated with additional text and a repeat Table 2.11 showing surface water thresholds. |
| **65** | Rob S. | Section 3.7.1.3 - *Lorrie Minshall's request that Peer Reviewers "…use their professional judgment to critically* | ARI | Rob S. identifies that Tillsonburg not only reaches the moderate stress level under future |

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| | | *assess the need for Tier 3 work in Tillsonburg due to a minor exceedance of the moderate stress threshold at 11%."* In my opinion it is logical that given the significant financial and human resources effort required of a Tier 3 assessment for the Otter Creek at Tillsonburg subwatershed that resources should be focused first on subwatersheds that appear to be under a greater stress (i.e. North Creek, Big Creek above Minnow Creek, Lynn River, Upper Nanticoke Creek). However, as stated in the Assessment Report, under the MOE Technical Rules, the Tillsonburg subwatershed did surpass the 10% groundwater potential stress level for the 25 year future projection and hence should proceed to a Tier 3 Water Quantity Risk Assessment. The real issue here is that there does not exist a separate category for placing a subwatershed on a 'watch list' when it surpasses the 'moderate' potential stress level only under future municipal demand conditions. This would be the best course of action for Tillsonburg as the largest consumptive demand is municipal and it is the municipality's growth projections that push the subwatershed into a Tier 3 category. Thus the municipality should have the ability to control growth to match its groundwater supply. However, I do not think that the Tillsonburg subwatershed should simply be deemed to fall under a 'low potential for stress' category. The additional sensitivity analysis (section 3.6) did show that the Tillsonburg subwatershed, under average current conditions, would be classified as having a moderate potential for stress (% water demand of 10% & 11%) if recharge decreased by 25% or demand increased by 25%. This shows that, given a realistic uncertainty in recharge and/or demand, it could move into a moderate stress level under current conditions. Thus, the Tillsonburg subwatershed not only moved into the 'moderate stress' category under future municipal demand conditions but also under average current conditions once an uncertainty/sensitivity analysis was performed. | | conditions but also is questionable under current conditions according to additional sensitivity analysis. Paul M. explains that the Technical Rules dictate the use of sensitivity results based on uncertainty for the current scenario, but he can prepare calculations and some text to assess this situation. Hugh W. does not think that a Tier 3 recommendation can be made in the report, but the report can identify when a decision must be made. Scott B. agrees that the conclusions of the report must be based upon the technical findings.<br><br>There was some discussion at the previous Peer Review meeting about delaying the need for Tier 3 work in Tillsonburg until the future demand projection becomes clearer. Deb G. notes that Oxford is concerned with how the timing of a decision for Tillsonburg may jeopardize access to the first round of Provincial funding for Tier 3 projects. Scott B. says that the Tier 3 question needs to be answered sooner or later. Deb B. notes that there is risk management aspect to communicating the results to the public. The communities in question may see the Tier 3 debate as a reason to pursue pipeline alternatives. |

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| | | Furthermore, it should be noted that while the subwatersheds Big Creek above Minnow Creek and Lynn River exceeded the 10% 'moderate' threshold for average water demand, their demand levels of 12% and 14% respectively may have more uncertainty than the demand for Tillsonburg (8%). This is because municipal demand, which is well characterized via municipal reported pumping rates, is a much larger component of demand in Tillsonburg. | | |
| **4.0 Significant Recharge Areas** | | **WATER QUANTITY STRESS ASSESSMENT REPORT** | | |
| **70** | Dave R. | Section 4.2 - As Kettle Creek and Catfish Creek include areas of contrasting physiography (sand plains and clay plains), should they be subdivided for the SGRA assessment as was done for the Long Point area? Based on the results of the analysis, does it matter very much if these areas use a broad average of recharge for the analysis or a more site-specific value? Can the consultants comment on that? | ARI | Given the size of the Kettle Creek and Catfish Creek Conservation Authorities, it was felt that further subdividing the area was inappropriate based on the regional nature of the modelling. |
| **71** | Dave R. | Section 4.2 - The actual % of area that is classified as a SGRA over the entire study is very high. This may put significant constraints on the water managers in the future. This needs to be carefully considered as the information is put forward in the report. It looks as though almost 2/3 of the area is ranked as a SGRA yet on P. 71 the statement is made that the recharge volume in the non SGRAs is higher than in the SGRAs. Somehow this does not add up. | ARI | See Technical Memo as provided to James Etienne by AquaResource. |

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| **5.0 Conclusions** | | **WATER QUANTITY STRESS ASSESSMENT REPORT** | | |
| **73** | Dave R. | Section 5.1 - Finally, as there is significant interest by the government to understand how stressed the water supply systems are with respect to future irrigation demands (permits to take water) a clear comment on the availability of the water resources for irrigation and the overall level of stress on water quantity should be included in the report at the end. | LPRCA<br>GRCA<br>Norfolk | The Stress Assessment report technical rules are geared towards making recommendations for additional Tier 3 work with respect to the sustainability of municipal drinking water supplies. GRCA, LPRCA and Norfolk County should work together to prepare a cover letter to the MOE that explains the uncertainty of the agricultural water use assumptions in generating the stress assessments. |

# Appendix C-3

## Phase 2 Peer Review Final Comments on May 2009 Water Quantity Stress Assessment Report

- **July 14, 2009 Phase 2 sign-off letter from Chris Neville**

**S. S. PAPADOPULOS & ASSOCIATES, INC.**
ENVIRONMENTAL & WATER-RESOURCE CONSULTANTS

July 14, 2009

Mr. James Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Rd.
P.O. Box 729
Cambridge, ON
N1R 5W6

**Subject:** **Long Point, Kettle Creek, Catfish Creek Water Budget Analyses**
Peer review sign-off letter

Dear Mr. Etienne:

We have completed our peer review of the companion final reports, **Long Point, Catfish Creek and Kettle Creek, Integrated Water Budget** (AquaResource, 2009a) and **Tier 2 Water Quantity Stress Assessment** (AquaResource, 2009b). In this letter we provide a sign-off for these reports.

Our sign-off peer review report is divided into five parts:

- Summary;
- General comments;
- Comments on the stress assessments;
- Comments on the delineation of significant recharge areas; and
- Final reservations.

In our previous peer review reports we have submitted a relatively large number of detailed comments. Our comments have largely been addressed through successive drafts of the reports. However, we would like to use this opportunity to add some comment of a more general nature. We appreciate that these comments are not readily adapted to a matrix format that contains relatively brief points.

## 1. Summary

The water quantity stress assessment builds directly on the results of the integrated water budget analyses. It is appropriate to consider the two reports together. In preparing an opinion on the reliability of the stress assessments, it is essential to examine the underlying reliability of the surface water and groundwater modelling that has been conducted to develop the water budgets.

In our opinion, the modelling analyses have been conducted at a high technical level and provide an excellent regional-scale synthesis of a complex study area. Further, in our opinion the assessments are consistent with the Technical Rules (December 2008) and the Source Water Protection Guidance Documents (October 2006) of Clean Water Act, 2006.

The results of the stress assessment are clear and consistent. In our opinion the results of the stress assessment and uncertainty analyses are appropriate.

In general, we concur with the final outcomes of the stress assessments. The following subwatersheds have been identified for Tier 3 water quantity assessments:

- North Creek subwatershed (Delhi Lehman Reservoir surface water intake);
- Big Creek subwatershed, above Minnow Creek (Delhi groundwater supply);
- Lynn River subwatershed (Simcoe groundwater supply); and
- Upper Nanticoke Creek subwatershed (Waterford groundwater supply).

As indicated in the report on the **Tier 2 Water Quantity Stress Assessment** (AquaResource, 2009b; p. 84), concerns have already been raised regarding the sustainability of surface water supplies for the Delhi Lehman Reservoir intake. The groundwater stress assessments for the Big Creek, Lynn River, and Upper Nanticoke Creek subwatersheds suggest the potential for moderate or significant stress under average and maximum existing conditions, and the three subwatersheds contain municipal supplies.

Tillsonburg is identified as having the potential for moderate or significant groundwater stress for future municipal demand. The estimated water demand of 11% for future average conditions is just over the threshold of 10%, and the estimated % demand for future maximum demand conditions is significantly lower than the threshold of 25%. Therefore, we recommend that a Tier 3 assessment be deferred for this subwatershed.

## 2. General comments

The final reports represent the culmination of a very significant effort, both in terms of analyses and reporting. During our involvement as peer reviewers we have examined the following documents:

- AquaResource Inc., 2007: Long Point Region, Kettle Creek, and Catfish Creek: Water Budget and Water Quantity Stress Assessment, Draft interim report, November 2007;
- AquaResource Inc., 2008: Long Point Region, Kettle Creek, and Catfish Creek: Water Budget and Water Quantity Stress Assessment, Interim report, March 2008;
- AquaResource Inc., 2009a: Long Point Region, Kettle Creek, and Catfish Creek: Tier 2 Water Quantity Stress Assessment, Draft report, March 2009;
- AquaResource Inc., 2009b: Long Point Region, Kettle Creek, and Catfish Creek: Integrated Water Budget, Final report, April 2009; and
- AquaResource Inc., 2009c: Long Point Region, Kettle Creek, and Catfish Creek: Tier 2 Water Quantity Stress Assessment, final report, May 2009.

Although some of these reports are indicated as “draft” and “interim”, all of these have been comprehensive and detailed documents. These documents provide extensive descriptions of analysis methodologies and presentation of detailed results. During our peer review we have prepared the following peer review documents:

- Comments on AquaResource Inc. (2007), January 16, 2008;
- Marked-up version of AquaResource Inc. (2007) report, January 16, 2008;
- E-mail to Paul Martin and Sam Bellamy, AquaResource Inc., May 9, 2008, with response by Sam Bellamy, May 29, 2009; and
- Notes to Paul Martin, AquaResource Inc., Suggestions for Model Acceptance, May 29, 2008.

During the review of the final reports we have deliberately limited our specific comments. The methodologies adopted during the preparation of the final reports have remained consistent, and in our opinion the additional represents a consistent refinement of the previous work.

## 3. Comments on the stress assessments

1. In general, the results of the March 2008 interim and the final stress assessments are the same (March 2008 Tables 7.5 and 7.6; May 2009 Tables 2.3 and 2.4).

2. In our opinion, it is clear that the North Creek subwatershed of Big Creek has a potential for a significant stress. This is also the only subwatershed in which there is a municipal water supply (Delhi). Concerns have already led to the formation of an Irrigation Advisory Committee. The next step is the installation of a streamflow gage along this waterway, and the start of continuous monitoring. In our opinion the most valuable aspect of the modelling is its suggestions of important data gaps. The modelling of the North Creek subwatershed is valuable, but is no substitute for the collection of long-term streamflow data. Going forward, these data are essential to monitor the level of stress.

3. The results of the March 2008 interim and the final stress assessments are the same (May 2009) reflect subtle refinements in the analyses; however, the conclusions are the same. Six subwatersheds are identified as having the potential for moderate stress under average demand conditions. The same six watersheds are identified as having a potential for moderate or significant stress under maximum demand conditions. In our opinion, these assessments are robust and defensible.

   Stress assessments for average demand conditions

| Subwatershed | Interim Assessment (March 2008) | Final Assessment (May 2009) |
|---|---|---|
| Big Creek above Kelvin | Moderate (21 %) | Moderate (17 %) |
| Big Creek above Delhi | Moderate (12 %) | Moderate (10 %) |
| North Creek | Moderate (17 %) | Moderate (16 %) |
| Big Creek above Minnow | Moderate (14 %) | Moderate (12 %) |
| Lynn River | Moderate (14 %) | Moderate (14 %) |
| Upper Nanticoke Creek | Moderate (23 %) | Moderate (21 %) |

Stress assessments for maximum demand conditions

| Subwatershed | Interim Assessment (March 2008) | Final Assessment (May 2009) |
|---|---|---|
| Big Creek above Kelvin | Moderate (45 %) | Significant (50 %) |
| Big Creek above Delhi | Moderate (35 %) | Moderate (44 %) |
| North Creek | Moderate (28 %) | Moderate (34 %) |
| Big Creek above Minnow | Moderate (34 %) | Moderate (44 %) |
| Lynn River | Moderate (29 %) | Moderate (40 %) |
| Upper Nanticoke Creek | Significant (64 %) | Significant (79 %) |

4. Three of the subwatersheds identified above as having a potential for moderate or significant stress contain a municipal groundwater supply, Big Creek above Minnow (Delhi), Lynn River (Simcoe), and Upper Nanticoke Creek (Waterford). We concur that these three subwatersheds meet the requirements to proceed with a Tier 3 Water Quantity Risk Assessment.

5. The subwatershed Otter Creek at Tillsonburg has been identified as having a potential for moderate stress under future average water demand. The estimated %water demand of 11% is just over the threshold of 10%. This subwatershed contains a municipal groundwater supply at Tillsonburg, and therefore meets requirements to proceed with a Tier 3 Water Quantity Risk Assessment. However, the estimated %water demand for maximum demand conditions of 18% is significantly lower than the threshold of 25%. Considering that the threshold is just exceeded for average conditions, and well beneath the threshold for maximum demand conditions, we recommend that a Tier 3 assessment be deferred for this subwatershed.

6. We have also reviewed the technical memorandum, **Delineation of Significant Groundwater Recharge Areas in the Long Point Sands Region** (AquaResource, April 21, 2009). Some, but not all, of its contents are included in Section 4 of the final report on the Water Quantity Stress Assessment. In our opinion, the memorandum is an excellent stand-alone document. This document includes a very useful discussion of the implications of the choice of method to delineate significant recharge areas, and should serve as a reference for all future delineation of significant recharge areas in Ontario.

7. A key point from the analyses documented in the memorandum is that mean values may not always be the most appropriate measure of the central tendency of a recharge distribution. It is indicated on Page 8 of the memorandum that this is likely the case "in areas of relatively homogeneous surficial geology". This requires some clarification. The surficial geology over the study area is not homogenous over the study area (see AquaResource 2009a; Maps 2.8a,b,c). Rather, there are large areas of similar surficial geology such that the distribution of recharge is "clumped" rather than distributed more-or-less randomly over the study area.

## 4. Final reservations

In our opinion, the analyses are appropriate for the intended purpose: a screening-level evaluation for directing particular subwatersheds to Tier 3 evaluations. Although we are prepared to sign-off on the final reports, we do have some reservations regarding the application of the results beyond the intended purpose.

1. We have a concern regarding the expectations placed on the analyses. In our opinion, the conclusion of the description of the groundwater modelling is particularly appropriate, "…application beyond the purpose for which it is designed is cautioned [against] due to the uncertainty associated with predictions at a smaller scale" (AquaResource, 2009a; p. 146). In our opinion, the spirit of appropriate model use is violated in the presentation of results of the groundwater drought scenario (AquaResource, 2009b; p. 58).

   In the report on the groundwater modelling it is indicated clearly that the analyses are developed for subwatershed analyses at the regional scale. From AquaResource (2009a; p. 138), we infer that this scale is in excess of 5 km. In contrast, the results presented on Table 3.6 of the stress assessment are applied at the scale of individual production wells. We appreciate that these calculations are mandated for watershed assessment under the Clean Water Act. However, we submit that under no circumstances should the results be regarded as anything but preliminary. In our opinion, the presentation of results on Table 3.6 to three significant figures may provide a misleading impression of the reliability of the calculations. As a minimum, we recommend that the results of the analysis should be reported to the nearest 1 m.

2. In our opinion, the number of significant figures used in reporting the results in some places in the final reports may provide a misleading impression of the accuracy of the results. For example, referring to the Surface Water Stress Assessment, the format of the values on Table 2.2 of the final stress assessment (Surface Water Supply Flows) is probably preferable to that of Table 7.3 of the March 2008 interim stress assessment. However, the large number of significant figures has the potential to obscure the fact that these values are estimates, and not exact quantities.

3. In the final integrated water budget report, reference is made to details of the groundwater modelling presented in Appendix A (p. 133, 134, 136). However, the Appendix A that we accessed at the ftp site contained only the Permits to Take Water, and no details on the modelling.

**Closing**

We hope that are comments are helpful, and we thank you for the opportunity to participate in this interesting and important study.

Sincerely,

S. S. PAPADOPULOS & ASSOCIATES, INC.

Christopher J. Neville, M.Sc., P.Eng.
Vice President, Senior Hydrologist

CJN/cjn
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**References**

AquaResource Inc., 2007: Long Point Region, Kettle Creek, and Catfish Creek: Water Budget and Water Quantity Stress Assessment, Draft interim report, November 2007.

AquaResource Inc., 2008: Long Point Region, Kettle Creek, and Catfish Creek: Water Budget and Water Quantity Stress Assessment, Interim report, March 2008.

AquaResource Inc., 2009a: Long Point Region, Kettle Creek, and Catfish Creek: Tier 2 Water Quantity Stress Assessment, Draft report, March 2009.

AquaResource Inc., 2009b: Long Point Region, Kettle Creek, and Catfish Creek: Integrated Water Budget, Final report, April 2009.

AquaResource Inc., 2009c: Long Point Region, Kettle Creek, and Catfish Creek: Tier 2 Water Quantity Stress Assessment, final report, May 2009.