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Quinte
Source Protection Region

TIER 1 WATER BUDGET

PEER REVIEW RECORD

(April, 2007 – January, 2009)

January 2009

To fulfill requirements of the Provincial Source Water Protection program Quinte Conservation has completed a Tier 1 water budget for the sub watersheds within it's Source Protection Region. As part of this process the scientific work, results, and reports are presented to a peer review team for review and comment.

The peer review team is shared between the Cataraqui Source Protection (SP) Area and the Mississippi-Rideau and Quinte Source Protection Regions. The four member core peer review team was chosen by staff from the three SP Region's based on the person's expertise and local knowledge. The members of the review team are listed below in Table 1.

In addition, to the core team, the peer review meetings were attended by representatives from the Ministry of Natural Resources, Conservation Ontario, and neighbouring Source Protection Regions including the Trent Conservation Coalition Source Protection Region.

Table 1: Members of the Peer Review Team

| Name | Expertise | Affiliation |
|------------------|--------------------------|--|
| Dr. W.E. Watt | Surface Water | Professor Emeritus, Queen's University |
| Bill Hogg | Climate | Retired from Environment Canada |
| Dr. Michel Robin | Hydrogeology, Academic | Professor, University of Ottawa |
| Darin Burr | Hydrogeology, Consultant | Dillon Consulting |

Four peer review meetings were held between April 2007 and June 2008 for which information on Quinte's Tier 1 water budget was presented. At some of the meetings presentations were also provided by other members of the group. The agenda and minutes from these meetings are provided in Appendix A with a brief summary given below in Table 2.

Table 2: Schedule of Peer Review Meetings

| Meeting | Date | Time | Purpose of Meeting | Status |
|-------------|-------------------|----------|---|----------|
| Meeting #9 | April 20, 2007 | 10am-3pm | Tier 1 Water Budget – methodology & preliminary modeling results | Complete |
| Meeting #10 | December 12, 2007 | 10am-3pm | Quinte Tier 1 Update – Groundwater recharge calculations & Significant Ground water Recharge Areas. | Complete |
| Meeting #11 | April 8, 2008 | 10am-3pm | Quinte Tier 1 Update – Groundwater recharge calculations for the Shield. | Complete |
| Meeting #12 | June 19, 2008 | 10am-3pm | Quinte Tier 1 Draft Report | Complete |

All the peer review meetings were held at the offices of the Cataraqui Region Conservation Authority except the Meeting # 11, which was held at Rideau Valley Conservation Authority.

Two draft versions of the water budget report were prepared and dated June 13, 2008 and November 6, 2008 respectively. The first draft was distributed to the peer review team for the June 19, 2008 meeting. From this meeting and input from the MNR it was found that additional work was required. This resulted in production of a second draft dated November 6, 2008. This report was distributed to each peer review member with comments submitted individually. Based on comments received a final draft report was prepared and dated January 7, 2009.

Peer reviewers were asked to provide written comments on the reports. Verbal comments were also recorded during meetings. Comments were provided by either inserting them directly into the Word document, by emailing them to the peer review leader, or verbally during discussions over the telephone and at peer review meetings. Comments are generally summarised on the enclosed table provided in Appendix B including the response of Quinte Conservation.

Status Update for Quinte

As of January 2009, Quinte Conservation has completed their peer review and is submitting their Final Draft Tier 1 Water Budget Report (January 7, 2009). The report has been completed with peer review comments incorporated from the meetings. The list of attached Appendices is listed below.

| Appendix | Name | Components |
|-----------------|----------------------|---|
| Appendix A | Agenda & Minutes | Meeting #9 Agenda & Minutes Meeting #10 Agenda & Minutes Meeting #11 Agenda & Minutes Meeting #12 Agenda & Minutes |
| Appendix B | Peer Review Record | Table of Peer Review Comments. |
| Appendix C | Peer Review Sign Off | Peer Review Correspondence |

Appendix A:

Agenda & Minutes

Cataraqui / Mississippi-Rideau / Quinte Source Protection Regions

WATER BUDGET PEER REVIEW TEAM

Meeting # 9

Date: Friday, April 20, 2007

Location: Cataraqui Region Conservation Authority Office
Kingston, Ontario
Lunch will be provided.

Proposed Agenda

| Item | Lead |
|--|---------------------------|
| <ul style="list-style-type: none"> • Welcome • Introductions • Approval of proposed agenda • Approval of previous minutes (Meeting 8 – Jan. 16, 2007) | Keith Taylor (Chair) |
| <ul style="list-style-type: none"> • Quinte – Tier 1 Water Budget <ul style="list-style-type: none"> a) Tier 1 requirements b) QC Tier 1 methodology c) Preliminary modeling results for test subwatersheds d) Ground truthing of results e) Implications for completion of Tier 1 watershed-wide | Bryon Keene Mark Boone |
| <ul style="list-style-type: none"> • Cataraqui <ul style="list-style-type: none"> a) Conceptual Water Budget Wrap-up b) Tier 1 Draft Work Plan | Sean Watt |
| <ul style="list-style-type: none"> • Terms of Reference Update | Sean Watt |
| <ul style="list-style-type: none"> • Other Business • Next Meeting • Adjournment | Keith Taylor |

**Minutes of Meeting
Source Protection Peer Review
Quinte, Cataraqui, MVC-RVC**

**Held at Cataraqui Region Conservation Authority
April 20, 2007 10:00 AM**

Present:

| Name | Agency | Name | Agency |
|----------------|------------------------|-----------------------|------------------------------|
| Sean Watt | CRCA | Mark Boone | Quinte Conservation |
| Titia Praamsma | CRCA | Bryon Keene | Quinte Conservation |
| Keith Taylor | Quinte Conservation | Sobhalatha Kunjikutty | Mississippi-Rideau SWP |
| Manon Lalonde | Mississippi-Rideau SWP | Clyde Hammond | Trent Conservation Coalition |
| Ed Watt | XCG Consulting | Darin Burr | Dillon Consulting |
| Bill Hogg | Reach Consulting | Michel Kearney | City of Ottawa |
| Michel Robin | University of Ottawa | Laura Landriault | MNR |
| Matthew Millar | Conservation Ontario | Sarah MacHardy | MNR - Kemptville |

Absent:

| Name | Agency | Name | Agency |
|-----------------|--|-------------------|----------------------|
| Brian Stratton | M-R SWP Region | Rob McRae | CRCA |
| Karyn Cornfield | M-R | Jennifer Havelock | Conservation Ontario |
| Sean Stirling | M-R SWP Region / Intera Engineering | Mike Garroway | MNR |

Welcome

Keith chaired the meeting, and opened by welcoming everyone.

Introductions were heard around the table.

Review and approval of the agenda

No changes were made.

Review and approval of the previous minutes

Minutes had been circulated after the last meeting, but given the elapsed time since then, additional copies were made for review over the meeting, with approval to be done at the end of the meeting.

Quinte Presentation – Tier 1 Water Budget

Tier 1 Requirements

Bryon gave a brief review of the Conceptual Water Budget, and then detailed the purpose and requirements of the Tier 1 work. The key difference of the Tier 1 Water Budget is considering a monthly time scale, and a subwatershed spatial scale. The Tier 1 work will be used to determine whether any subwatersheds should move on to Tier 2 work.

Tier 1 Methodology

Bryon explained the planned methodology for the Quinte's Tier 1 work. They will use their existing GIS model to evaluate the water budget on a monthly basis across the watershed using a 1 km² grid and subwatershed boundaries.

Using the model, they would determine the surface and groundwater supply, as well as evaluate consumptive water use.

The Water Quantity Risk Assessment would compare the supply to the use to determine the level of "stress", significant, moderate, or low. Significant and moderate "stress" conditions warrant further study.

The term "stress", and how it is used, was discussed in detail later on during the meeting.

The term "stress" is not specifically defined in the March 2007 Water Budget guidance module, though page 43 does list "screening level stress assessment (% water demand calculation)".

Page 134 details the "% Water Demand", which appears to be used interchangeably in the document as the "stress".

Preliminary Modeling Results

The preliminary results are confined to just the Moira River watershed.

Bryon presented the monthly flow data for the Moira River stream gauge stations.

Mark then took over to discuss estimation of monthly groundwater supply. The MOEE 1995 method appeared to be acceptable for the Conceptual work, but in general it is not a great estimator of recharge in a fractured rock system. It is better suited to porous media conditions (soils in unconfined aquifers).

Stream baseflow values are a good estimate of groundwater (GW) discharge (and therefore recharge) in general, but the 2 USGS/NWRI reports (USGS Baseflow in the Great Lakes Basin Report 2005-5217 and USGS Estimation of Shallow Ground-Water Recharge in the Great Lakes Basin Report 2005-5284) available that provide these estimates for the Great Lakes Basin area give a wide range of data for the area of interest. This makes it unclear as to which is correct, if either of them.

In areas near the Wellhead Protection Areas (WHPAs) the Quinte has 3-D GW flow models which can be used to quantify GW recharge values. But, in most of the SWP region, these also do not apply.

It was felt that the most accurate representation of GW recharge was by using actual field data from the Provincial Groundwater Monitoring Network (PGMN) wells. The Quinte has 31 PGMN wells across its SWP region, with 11 in the Moira River watershed.

Of the 11 wells in the Moira watershed, 3 are in Precambrian bedrock, 5 in Paleozoic bedrock, 2 in overburden, and 1 to the interface of overburden and bedrock. The historic data used ranges from 2002 to 2007, in general, though there is some data for specific wells from the 1970's.

Using the PGMN and precipitation data, and the Healy & Cook method, estimations of recharge could be calculated. And using the aquifer thickness, hydraulic gradient and hydraulic conductivity, and the Darcy flow tool in GIS software, an estimation of lateral GW flow could be made. The two together combine to represent the groundwater supply for a given subwatershed.

There was a question asked: Does each well only penetrate one aquifer, are they unconfined, and do they take into account the phreatic surface? The answer was yes, that the aquifer assessed is unconfined and is divided into Paleozoic limestone, Precambrian granite, and overburden.

Hydrographs (monthly averages) for two wells from the PGMN program were presented including historic data for these wells from the 1970's. Looking at the available data, it appears that in the 1970s, the wells only experienced recharge conditions in the spring, while in the 2000s, recharge occurred in both the spring and fall. Some suggestions to explain this are that there was a lack of fall rain in the 1970s, or that the 1970s years had earlier winters, freezing the ground, and not allowing recharge in the fall. Given the comment that the 1970s were in fact a relatively wet decade, the early winter case seems more plausible. There was a suggestion that the graphs include some temperature information to confirm or dispute this.

****On further review of the data after the meeting, it was seen that in the 2000's there is a higher surplus water available than for the years of record for the 1970's. Looking at the table "Groundwater Recharge from Hydrographs" (page 36) in the presentation, the early 2000's surplus is greater than the mid-1970s surplus. So, while the 1970's may have been a wet decade, so far the early 2000's appear to be wetter.

Radar data was also analyzed for the Nov 13 – 17 2007 precipitation event. The radar images were calibrated to the rain gauges, and daily totals were used for further analyses. In general, the lower part of the watershed received more rain than the upper watershed. The volume of precipitation in the subwatersheds was estimated, and compared to the volume of runoff at the stream gauge stations. It was found that between 70 and 78% of the precipitation was converted to direct runoff. It was assumed that given the time of year (late fall when ET would be minimal), the remaining precipitation was recharge into the aquifer.

Of the 11 wells in the watershed, only 5 were recording data at the time of the event. Comparing the timing of the precipitation to the timing of the rise in water level at the wells, there is a short time lag between the start of rain and the start of rise in the water level

The first day of rain was only around 2 mm. It was suggested that this amount would be taken up entirely by the initial abstractions, and therefore would not contribute to any rise in water level. The second day may also only contribute to increasing soil saturation (~8 mm). The third day was again minimal rainfall (~3 mm). The fourth day is when the large amount of rain fell (~25 – 45 mm).

It was suggested that other small rainfall events on the order of the first 3 days be examined with respect to the subsequent rise in water level at the wells. If no rise is seen, then these small rain events are unlikely to have any influence on well water levels.

The bedrock wells rose steadily during the rain events, but after the rain stopped, the well water levels experienced a steady decline. This is an indication of low aquifer storage.

There should be a note included regarding the limitations of radar data. In particular, that the sites of interest are at the outside boundary of the radar station, and that the data needs to be calibrated. In this case it had been calibrated to the rain gauge station data.

The overburden wells did not respond as steeply as the bedrock wells, and did not decline once the rain stopped, but rather kept rising. This was attributed to consecutive rainfall events and aquifer storage.

There was a second rain event, of similar or greater volume, that occurred only 2 weeks after the event of interest. This secondary event complicates the comparison of precipitation and water levels, and should be shown on all the graphs as an indication of events that affect the data, but were not included in the analyses. The hydrographs for the overburden wells would be better understood if the preceding rain events were included on the graph since the hydrograph was already rising prior to the November rain event.

It was suggested that a transfer function between precipitation and water levels be calculated.

There was also a suggestion to show all the water level graphs with a common Y-axis scale, so the rise in water level can be directly comparable between wells.

There was not as much water level change in the Precambrian bedrock wells (~0.2 m) compared to the Paleozoic bedrock wells (~1 m or more).

The question was asked: “How did you estimate the end of recharge?” In this case the maximum change in elevation was used. The aquifer is both filling and draining at the same time, so some of the volume of recharge could have been missed, and the actual recharge may be higher than estimated.

The table on Slide 32 uses “Porosity” in its title, where it should be “Specific Yield” instead.

It was noted that the runoff measured at the gauge station is integrated over the entire drainage basin, but is being compared to what happens at the well, which is not quite right. It was suggested that precipitation at the well specifically be used for comparison. Mark confirmed that precipitation at the well was used in the analysis.

It was also suggested that an abstraction model be incorporated into the beginning of the process, to remove that rain which will not contribute to recharge.

Slide 32 shows "Total Precip" and "Precip to Recharge" columns. It was felt that the actual precipitation that goes to recharge is probably somewhere between the values shown on this table. It was recommended that the abstractions model be used, as well as an allocation for filling of surface storage, to come closer to the correct value of recharge.

It was also suggested that perhaps a shorter rain event be used to estimate the recharge. It was felt that the longer an event, the larger the area over which the values were being averaged. However, with the consideration that the first 3 days of this 5 day event may not actually have contributed to the water level rise at all, this event may be reasonable.

A second larger event was suggested, the remnants of Hurricane Frances in Sept. 2004. This event was also subject to a radar calibration project.

Looking ahead, the question was asked, how important this particular exercise (estimating recharge) is to the project. Does it affect the "stress"?

The recharge exercise will be used to quantify monthly volumes of ground water which will be used to estimate "stress" in accordance with the guidance module.

There was concern with using this particular event. The concern was whether starting from a partially saturated condition is a problem because there is no indication of how much of the specific yield has already been filled by storage. It was suggested that starting in a drier time would give a better indication, however this also requires more detailed consideration of ET, and may not be possible given the data involved.

It was asked how close to the surface the water levels in the wells actually are. On average, the water level is around 6 m below ground surface, but in the spring the water level rises to around 3 m below the ground surface.

Consideration of the decay of the water levels will also be important to how the groundwater moves, and how recharge works in the region.

It was asked why there is any need to look at all 12 months to begin with. In the spring, the water level records show a long decay, indicating minimal recharge, and during the cold times of the year when the ground is frozen, the water levels also decline, again indicating minimal recharge. Seeing this from the start, why is there a need to quantify the recharge when it can be seen that it is minimal? The GW level and the streamflow are the decision makers in this case, not the amount of recharge, or the amount of rain.

Flow is also a surrogate of water well levels, as when the flow is high, generally the water well levels are high, and vice versa. This is in conflict to what is being recommended in the guidance, and it was suggested that unless the science says it should be done otherwise, the guidance be followed specifically. It was noted also that information should not be ignored just because it does not fit the guidance recommendations. Mark indicated that the effort to provide the monthly volumes for comparisons with water use was minimal once the methodology has been established. This is largely due to use of the GIS model.

It was suggested that the graphs of GW water level should include water level, temperature, precipitation (notation of snow and rain independently). The temperature and snow will show the influence of climate on the well levels and recharge.

The volumes of annual recharge as determined by the water table fluctuation method were compared with the results of the MOEE partitioning methodology. The two are not close in most cases. In most cases, the percent of "surplus water" that can be attributed to recharge is much lower than the MOEE 1995 method would have predicted.

It was suggested that all 31 wells be considered in this manner, and more revealing information may become evident.

It was also suggested that given the range of values from year to year, that more than one climate condition be considered, perhaps an average month and a particularly dry month.

There is a large variation in recharge from year to year, with the same "surplus water" value. This could be attributed to variation in individual precipitation events (intensity) and where the precipitation actually fell in the watershed, and the differences in slope, soils, and land cover in that particular area.

The "surplus water" values come from the Environment Canada Thornthwaite calculations at Belleville.

It was noted that if specific yield were reduced, then recharge should also fall, and vice versa, which would change how well the estimates compare to the MOEE 1995 values.

It was noted that the monthly "surplus water" should be compared with the runoff at the stream gauge stations.

It was noted that the location of the wells and the location of the station (Belleville) for which the "surplus water" calculations were made are in some cases quite a large distance apart. This brings in an additional spatial problem to the data, especially knowing that precipitation amounts fall as you move north away from Belleville.

It was suggested that perhaps this can be corrected through ET estimates in the GIS model.

Mark then showed a graph of estimated recharge per month. The highest was March at 25%, then November at 15%, May, September, and October were at around 10%, with all other months being around the 5% mark.

Mark then detailed the method to estimate GW flow in and out of the watershed using the Darcy tools in the GIS software.

The thickness of the aquifer was estimated using the depth of water found data in the Water Well Information System (WWIS).

The values for all wells were tabulated, and the median value in each geologic unit was used for the calculations. The K values for the bedrock were estimated from consultant reports across the watershed prepared for subdivisions and landfills. Again, the median K value was used for the model. It was suggested that perhaps the Geometric Mean would be a more appropriate estimation of K.

It was noted that there is some bias in the data, given that a subdivision report would typically estimate on the higher end of K, to ensure enough water available for residents, and a landfill report would typically estimate on the lower end of K, to ensure minimal movement of contaminants. Based on this bias and range the use of the median value was thought to be appropriate.

A lengthy discussion took place on the difference between water table and piezometric level, confined and unconfined aquifers, and how they relate in a fractured bedrock setting.

LUNCH BREAK

Tier 1 Water Quantity Risk Assessment

After lunch, Mark continued with the Water Quantity Risk Assessment portion of the Tier 1 work.

The water use data from the PTTW list will be modified through a consumptive use factor provided by the province. There were some questions whether the factors were accurate. The discussion agreed that the factors were probably the minimum applicable, and higher factors could and should be used if warranted. The example was that during dry weather, a golf course's consumptive use was probably much higher than 70%, probably closer to 95% or 100%. It was suggested that comparing the given consumptive factors, as well as 100% consumption in some cases, would be a sensitivity analysis of the factors themselves, and how much they affect the overall water use estimates.

Continuing the golf course example, it was noted that the PTTW for a golf course would probably be set based on dry year conditions, but that actual use data would not necessarily coincide with a dry year, and therefore using actual taking data would underestimate the water use during a time of stress.

It was suggested that multiple conditions be considered for water use, a dry year or worst case scenario should be considered as well as the average condition as is recommended in the guidance.

The “stress” estimate has two components, flow or water level, and water use, and these two depend oppositely on climate conditions. During dry weather, flow and water levels are at a minimum, but water use will be at a maximum, and vice versa during wet weather.

It was noted that one of the reasons a single specific “stress” estimation is recommended is so province-wide comparisons can be made. However, it was suggested that in addition to these methods, other indicators more suitable to the specific watershed conditions should also be used.

There is reference to a reserve of 10% to be set aside for ecological protection purposes. The question was asked: “10% of what?” During the meeting, this was interpreted as “10% of the median streamflow”, which confused the PR Team, wondering why a percentage of a percentage would be prescribed to be used.

On further investigation, the guidance, page 132, Appendix A, Section 6, states “lower decile streamflow”, which equates to the flow which is exceeded 90% of the time. It does not specifically state whether this is the lower decile of all data, or the lower decile of that particular month.

It was also noted that the guidance states that storage is not to be considered in this phase of the Water Budget. It was suggested that not looking at storage is missing a large portion of the concept.

It was noted that there are 2 approaches to the work, follow the guidelines specifically, or consider the problems with the guidance, and what they infer with specific reference to the watershed of interest.

It was also noted that the use of the term “stress” in the guidance is misleading, and should instead perhaps be referred to as “sensitivity to demand”, or “screening assessment”.

The question was asked, is there a need to look at every month to assign a “screening assessment” to it, or can the worst case be immediately brought to the forefront (probably a summer month) and looked at exclusively.

The next consideration was GW “screening assessment”.

Again, there is to be no consideration of storage. There is also to be a reserve of 10% of the supply. In addition, the guidance suggests estimating an annual recharge value and dividing it by 12 to estimate recharge for each month. This caused a considerable amount

of concern, as it is quite obvious that this is wrong, and the recharge during particular months of the year is much less than this, and could in fact be zero. This overestimates the supply in summer, and underestimates the stress. It is much better to use a monthly estimate, but there is again a limitation in being correct due to the lack of consideration of storage.

It was also noted that the water use demand divided by the specific yield would also be an indication of the amount of storage and the "stress".

It was suggested that instead of using the monthly maximum, the worst case month should be used, or the month with the maximum ratio.

The next question was about how well use data would be applied, specifically over what area surrounding a well? There were two considerations, over the well capture zone, or over the cone of depression. The Tier 3 guidance apparently recommends using the cone of depression.

Then the question was how to define the cone of depression? It was suggested that the Theim equation be used, and the 90% rebound circle around the well be used as the cone of depression. It was also noted that the cone of depression approach may in fact include areas outside the capture zone of the well.

This was the end of the Quinte's presentation on their Tier 1 work so far.

The Peer Review team was satisfied that their work was on the right track, and could proceed, taking into account the suggestions and considerations made throughout the day.

Cataraqi Presentation – Conceptual / Tier 1 Water Budget

Conceptual Report

Sean noted that he had received some minor comments (mostly editorial in nature) from the Peer Review team, and had made modifications based on those comments. He noted that he wanted to discuss the specific changes with the team members before they left after the meeting, to make sure that the comments were properly addressed.

Laura Landriault noted that she had not yet finished a review or provided comments.

The team agreed that they sign off on the Cataraqi Conceptual Water Budget report, and the final steps for submission to the Province can proceed.

Tier 1 Work Plan

Sean went on to present his work plan for his Tier 1 effort (he had circulated a draft earlier in the week). His work will include a GIS effort, but not as integrated as what

Quinte has been using. Cataraqui is using the GIS framework to do investigations and is stitching results together within the framework of his report.

Darin wondered if there were any reported problems with the municipal drinking water systems. Sean pointed out that there are little reported problems that he is aware of.

Darin also noted that Sean is including analysis for potential future supplies. What defines the future? Is it concrete plans or merely potential?

Sean noted that there is one new municipal supply that was recently put in place due to well contamination. There are similar communities with equal density that it is conceivable that they may also wish to establish a municipal supply.

Sara (MNR) noted that she has heard the guidance documents are likely to restrict this to currently planned new systems.

Demand would be estimated based on current lots and 25 year growth. The theoretical well would be placed in the centroid and a two km radius placed around.

Clyde asked how we would look at future demand on non municipal systems. Laura pointed out that we are focussing on municipal systems. Industry may not grow based on the same rate as municipal growth.

Sean requested that the team review his proposed work plan and provide some comment back to him by Friday, May 11th. All agreed.

Terms of Reference Update

Sean brought up the Terms of Reference (dated June 2006) and the fact that some things had changed since then. Specifically the timelines of the project, and the members of the Peer Review Team, as well as the fact that the June version was written from a Conceptual Water Budget perspective, and goes into much detail on that process, but little detail on subsequent work.

Due to changes of MNR positions and some others it is necessary to amend the Peer Review team makeup. There was some discussion on how MNR positions for Source Protection are filled internally. Michel R suggested that we simply note that there will be a certain number of MNR positions. The Queens person will not be continuing on the team. He is still willing to provide some assistance.

Titia pointed out the magnitude of the Fractured Rock study that the Queens person is undertaking and that all CAs in the east are supporting and will benefit from.

The persons from the neighbouring CAs that are participating on the joint peer review team may float depending on the nature of the presentations. Thus, a position should be held and a person's name can be left out.

The peer review TOR should be changed by an addendum (~3 pages) rather than by rewriting the entire document to reflect the changed makeup of the team.

Michel R noted that we are acting as more of an advisory team than a peer review committee. The guidelines and legislation refer to this as a Peer Review Team and we may as well keep the terminology the same. This helps across the province.

Possibly the addendum could reflect the augmented role of the team. It was agreed.

Other Business

Sean requested for approval of the minutes. No clarifications were needed. Ed suggested that we adopt a pattern of requesting only corrections of minutes in the circulation of draft minutes. Otherwise assume no concerns. The minutes were accepted.

Next Meeting

The next meeting will be scheduled once the SWP Regions feel they have enough information to present. A request for at least 6 weeks notice of the next meeting was made.

Adjournment

The meeting was adjourned at 2:10 PM

***Note: The slides from Quinte's presentation have been transferred to the ftp site. They have been saved 6 to a page, as a pdf document.

**Cataraqui / Mississippi-Rideau / Quinte
Source Protection Regions**

**WATER BUDGET
PEER REVIEW TEAM**

Meeting # 10

Date: Wednesday, December 12, 2007

Location: Cataraqui Region Conservation Authority Office
1641 Perth Road, Glenburnie, ON

Lunch will be provided

Proposed Agenda

| Time | Item | Lead |
|--------------------|---|--------------------------------|
| 10:00-10:15 | <ul style="list-style-type: none">• Welcome• Introductions• Approval of proposed agenda• Overview of Tier 1 Progress in Quinte and Cataraqui Regions | Chair |
| 10:15-12:00 | Mississippi-Rideau: Draft Methodology and Preliminary Results | Manon Lalonde Sean Sterling |
| 12:00-12:45 | LUNCH | |
| 12:45-2:15 | Mississippi-Rideau: continued | Manon Lalonde Sean Sterling |
| 2:15-2:30 | Cataraqui Tier 1 Update | Sean Watt |
| 2:30-2:45 | Quinte Tier 1 Update | Bryon Keene Mark Boone |
| 2:45-3:00 | <ul style="list-style-type: none">• Other Business• Next Meeting• Adjournment | Chair |

Minutes of Meeting #10 Source Protection Peer Review Quinte, Cataraqui, MVC-RVC

Date: December 12, 2007
Time: 10:00 am to 3:00 pm
Location: Cataraqui Region Conservation Authority

Present:

| Name | Agency | Name | Agency |
|----------------------------|-------------------------|-----------------------|-------------------------|
| Sean Watt (SW) | CRCA | Mark Boone (MB) | Quinte Conservation |
| Bryon Keene (BK) | Quinte Conservation | Darin Burr (DB) | Dillon Consulting |
| Brian Stratton (BS) | M-R SWP Region | Bill Hogg (BH) | Reach Consulting |
| Ed Watt (EW) | XCG Consulting | Michel Kearney (MK) | City of Ottawa |
| Sobhalatha Kunjikutty (SK) | MVC | Laura Landriault (LL) | MNR |
| Michel Robin (MR) | University of Ottawa | Bryan Sears (BS) | MNR |
| Sean Sterling (SS) | M-R SWP Region / Intera | Manon Lalonde (ML) | M-R SWP Region / Delcan |
| Clyde Hammond (CH) | TCC | | |

Absent:

| Name | Agency | Name | Agency |
|-------------------|----------------------|-----------------|----------------|
| Jennifer Havelock | Conservation Ontario | Karyn Cornfield | M-R SWP Region |
| Keith Taylor | Quinte Conservation | Mike Garraway | MNR |
| Titia Praamsma | CRCA | | |

MINUTES

| Item | Description | Action |
|------------|---|--------|
| 1.0 | Introduction | |
| 1.1 | Agenda | |
| | - The agenda as issued was accepted. | |
| 1.2 | Summary of Quinte and Cataraqui Status | |
| | - SW (Cataraqui) provided an overview of the status of their tier 1 progress. They anticipate having a draft report prepared by March. | |
| | - MB (Quinte) summarized their Tier 1 Water Budget status. Quinte is reviewing the groundwater findings for confirming their recharge numbers. They have the basis of the tier 1 budget largely completed. | |
| 2.0 | M-R SWP Presentation | |
| | Note that the handout provided on Dec. 12 does not include all slides. The complete power point presentation is available on-line at ftp://www.mrsourcewater.ca/ | |
| 2.1 | General | |
| | - ML thanked the committee for their previous input on the Draft Methodology document distributed at the end of October. Comments have been considered and methodology was adjusted accordingly. Additional peer review input is sought at this meeting in light of the preliminary water budgeting results that will be presented today. | |
| | - M-R SWP hopes to present a draft report in March 2008. | |
| | - Focus of the meeting will be on the tier 1 scope, water budgeting and understanding of the system. | |
| 2.2 | Overview of Physical Conditions in the M-R Region (slide 6 to 15) | |
| | - ... | |

2.3 Review of Conceptual Understanding of the Water Budget (slide 16)

- Evapotranspiration (ET) and recharge (R) were estimated using empirical models (Thornthwaite and MOEE 1995 Method)
- Empirical models were validated by comparing calculated ET with derived ET (5% difference - Region) and comparing calculated recharge with USGS BFLOW model baseflow (12% difference – Region).
- EW requested that the letter 'Q' for streamflow be used instead of SW_{out} because Q is more intuitive. Manon
- EW requested that the slide be revised to include measured Q as well. Manon
- Groundwater age within the Nepean Formation has been reported by Golder in a recent WHPA modelling study to be less than 50 years old (MK), which would suggest a simpler understanding on a true tier 1 approach (i.e. not completing more complicated Tier 2 analyses) is sufficient (DB). SS is completing stress assessments on a municipal well basis which goes beyond the guidance requirements for Tier 1 work, however LL (MNR) stated that it made sense to include the information that we already have and complete this work to better the product even if it enters into Tier 2 or Tier 3 data requirements.
- Discussion on adequacy of the MOEE 1995 Method: all agreed that while the method was found to be adequate to provide annual recharge estimates for the purpose of the conceptual understanding, the method may not be directly applied to monthly assessment.

2.4 Tier 1 Scoping – Time and Spatial Scale (slide 18 to 29)

- About the use of the 1971-2000 period to assess groundwater stress: BH cautioned that we are only looking at the wet years and are very liberal in our estimate of precipitation. We should be careful to consider that there have been very dry periods outside of the period considered. BH considers the 1971-2000 period to be much wetter than other longer periods.
- Tier 1 water budget results will be presented for the 16 gauged catchments within the M-R SWP region.
- SS selected two different scales to study the gw stress.
 1. Nepean Formation aquifer
 2. Individual Municipal Groundwater Supplies
- 1. Nepean Formation aquifer
- Using the groundwater contributing area for the entire Nepean aquifer assuming recharge is only occurring in the areas where the Nepean and the March formations outcrop at ground surface.
- Assuming no recharge is occurring in the overlying, less permeable (Oxford and Ottawa) formations will provide a conservative stress assessment. Consensus from the Peer Review Team supported this approach.
- Geologic boundaries are being used to define study areas for the regional Nepean aquifer analyses – CH was very supportive of this approach.
- CH suggested comparison to the pumping tests at the wells as they were well conducted to determine aquifer yields. This information can be requested from MOE under freedom of information requests.
- MR asked how the surface water reservoirs overlaying the Nepean aquifer would be considered (i.e. recharging the Nepean aquifer). SS agrees with the importance of this understanding, however the conservative approach for Tier 1 stress assessments will be to assume that the surface water bodies are not recharging the groundwater system and if no stress is triggered then no further investigation would be needed. MR and DB agreed with this approach.
- South Nation SWP area should consider groundwater takings within the M-R SWP region when completing a stress assessment on the Nepean aquifer since the source of the Nepean aquifer is conceptualized to be within the M-R SWP region (where Nepean and March Formations outcrop).
- 2. Municipal Groundwater Supplies
- The stress on each municipal wellhead will be completed by using existing capture zones delineated with previous MODFLOW models (All 7 municipal groundwater systems have a WHPA MODFLOW modelling study completed), supplemented with uniform flow methodology as required. They will extend the width of the capture zone

- upgradient to include the recharge lands.
- DB noted that it would be important to consider the major water users downstream of the municipal wellheads. SS agreed to look at the affect of major downstream users, however these would have likely been investigated during the original WHPA MODFLOW model construction. The agreed upon approach by the SWP Peer Review team was to use professional judgement to encompass sufficient area downgradient of the well and state assumptions. DB suggested all area where drawdown occurs, however this area is identifiable based on the existing WHPA studies because there were no modelling runs without municipal pumping wells to determine a static water level. MR suggested just using the existing capture zone extents downgradient.
 - None of the municipalities have reported water shortage concerns evidenced by wells running dry, therefore none of the municipal groundwater supplies are expected to show a stressed situation based on Tier 1 water budgeting work. Almonte reported a water shortage during the fighting of a nearby forest fire in the "Burnt Lands Area".
 - Historical water levels or pumping rates are not well documented at the municipalities or are not kept for long periods of time (< 5 years).
 - SS will be assuming that all the municipal wells are 100% consumptive (to the Nepean aquifer) since the discharge will not be recharged to the same aquifer due to the overlying confining layer. DB supported this conservative assumption.

2.5 Water Budgeting Exercise (slide 30 to 59)

- M-R SWP intends to quantify the separation of the water surplus between the groundwater recharge (R) and direct runoff (RO) components on a monthly basis in addition to quantifying other components. Estimating R on a monthly basis is in accordance with Section 3.1 of Module 7.
- Estimating the monthly recharge will improve the understanding of the system; monthly recharge estimates will not necessarily be used to calculate groundwater stress.

2.5.1 Delta Storage Calculations (slides 33 and 34)

- It was noted and agreed that setting the total storage variation to have the minimum storage equal to zero is an arbitrary choice, merely meant to have zero as a datum. All agreed that a total storage of zero does not mean that there's no storage left in the system.
- SK stated that the Mississippi and Rideau watersheds are known to have different reservoir operation and that this was not apparent when examining the 'delta storage' charts. SK inquired about whether the exercise would be more meaningful if we were to use available precipitation (P - snow storage) instead of precipitation. It was agreed that doing so would separate the snow storage effect from the other storage components and that this could be a way of carrying storage investigations further if needed.

2.5.2 Method to Estimate Monthly Recharge (slide 35 to 46)

- Slide 36 illustrates the process. The method involves incorporating snow storage (measured), surface storage (estimated), and component shifts from one month to another in order to represent various physical processes known to occur. A detailed description is provided in the Oct. 25 Draft Methodology document. Part of the method is referred to as "the modified MOEE 1995 Method" by M-R SWP.
- The groundwater shift is purely empirical and was observed to improve the fit of calculated water surplus with measured streamflows. A complex algorithm was not used for the groundwater effect, nor for the surface storage component.
- ML acknowledges that modifying the MOEE 1995 method has several limitations. The method described was developed based on judgement, using very simple techniques as a first trial. The method could be refined in several ways if required. Tests for two watersheds were conducted for the purpose of evaluating the modified method.
- Groundwater hydrographs are being used to calculate a time-lag for water level response after precipitation events. Quinte SWP region does not show any appreciable time-lag, while M-R SWP region shows a 5-7 day time-lag in one well. Further analyses to be completed on this topic.

Preliminary Results for the Mississippi and Rideau Watersheds (slides 44 and 45)

- Comparison of calculated water surplus to measured streamflows were made for two scenarios: 1) with water surplus estimated from a simple P-ET calculation and 2) with water surplus calculated as per the methodology described above (i.e. including snow

storage and adjustment to the water surplus for frozen ground). Although the second scenario improves the fit, EW noted that this comparison does not constitute a validation of the method. EW suggested sensitivity on the storage assumptions. **Editor's note: Based on PR discussions that followed, spending more effort to improve the modified MOEE 1995 Method is not warranted as these monthly estimates of recharge will be used solely to improve the understanding of the system. The work done so far is sufficient in meeting Tier 1 scope for the purpose of understanding.**

- About the groundwater lag in the modified method: CH asked how groundwater storage was considered in this model. A groundwater effect was incorporated as a time lag; however, this is not exactly the same as storage. Groundwater storage does not seem to fit in the MOE method conceptualization. The maximum groundwater storage in this system could be pictured as the annual recharge estimate.

2.5.3 Baseflow Separation (slide 47 to 50)

- The Clyde River system, fed by the Canadian Shield, is more complicated. The measured BFI for this gauged catchment is 0.56, which is higher than 0.42 provided by the USGS BFLOW method. EW discussed the baseflow separation technique and stated it has no consideration for the watershed specific characteristics. For example, in the Clyde River system, there are several wet areas that have an effect similar to that of controlled reservoirs. This is likely the cause for a measured BFI higher than that provided by the USGS study. It was generally agreed that for the Clyde system, the BFI was not a measure of the groundwater discharge only.
- EW also pointed out that the Mississippi BFI_{BFLOW} (0.42) presented in the USGS study is a value representative of the entire watershed and blends in spatial variability of the index.
- Slide 50: Monthly recharge estimates (using the modified MOEE 1995 Method) for the Jock River were compared to the measured baseflows obtained via the separation exercise. Substantial differences were observed between the two sets of values, including an overestimation of estimated recharge in April and May and an underestimation in the Fall. For the Clyde River system, underestimation of recharge in April and May was not observed; however, this is likely due to an overestimation of the measured baseflow.

2.5.4 Uncertainties and Limitations with Method to Estimate Monthly Recharge (slide 51 to 55)

- Uncertainty in the modified MOE method is likely high because very simple models and assumptions were used to quantify the surface storage, the effect of frozen ground on water surplus and the groundwater storage / lag.
- The opportunity to validate and to some extent to calibrate the modified MOE method using measured baseflows from separation is also very limited as demonstrated with the Clyde River separation exercise. Separated baseflow does not strictly correspond to groundwater discharge. Furthermore, transposing measured baseflows to other controlled catchments would bring in additional uncertainty.
- Estimating baseflows using measured Q and BFI for intermediate catchments involves an additional error due to the propagation of error in net discharge calculations. Manon had estimated 260% and 50% for the Rideau River long-term net discharge at Ottawa for January and July respectively. MR pointed out the method used to calculate error was likely overestimating the error because covariance was not considered. Manon will contact MR to discuss this further.
- The modified MOE method could be improved in several ways; however, the exercise would be time consuming and tier 1 scope does not warrant such an effort for the M-R SWP Region unless there is consensus that these values are needed for the groundwater stress assessment. **The use of annual vs monthly recharge estimates was then discussed and this is reported later on in the text.**
- If the goal of estimating monthly recharges is strictly used for improving the understanding of the M-R SWP system and to report in the water budgeting exercise, it is generally felt that these estimates should be provided based on best judgement of the team. Improving the modified MOE method or transposing BFI results to other

controlled catchments is not warranted given the high degree of uncertainty associated with the method and scope of the work.

Intermediate Gauged Catchments (slide 52 to 54)

- M-R SWP is providing a water budget on a distinct gauged catchment basis, isolating catchments from upstream contributing areas that are gauged. Other regions are instead including all of the upstream area in the calculations and do not need to provide Q_{in} as this value is always zero. ML pointed out that using intermediate catchments has the advantage of isolating water budget components from sometimes a much larger upstream area and provides additional information about the system, for instance in the case of the Appleton (Mississippi Lake) catchment, it is revealed that the long-term Q_{in} is larger than Q_{out} indicating that the lake is likely used to recharge groundwater.

2.5.5 Observed Monthly Distribution of Baseflow (slides 57 and 58)

- ML pointed out that a simpler way to estimate the monthly recharge would be to use the generally accepted annual recharge estimates obtained at the conceptual phase and to simply distribute this value in a monthly series according to observed pattern. This method does not involve the use of calculated BFI nor measured streamflows.

2.6 Monthly vs Annual Recharge Estimate in Groundwater Stress Assessment - Discussion

- Annual recharge
- EW suggested that a spreadsheet be presented with various methods of estimating gw recharge and then use our professional judgement to select the appropriate method.
- EW suggested reviewing Moin and Shaw who completed a base flow separation for all gauged watersheds with a minimum of 20 years of data.
- Monthly Recharge
- The MOE Guidance Document recommends using annual groundwater recharge estimate divided by twelve for the monthly recharge term in the supply, however Peer Review members expressed need to consider monthly recharge estimate instead.
- ML suggested using the distribution of monthly baseflow learned from the separation work and apply the distribution to the annual estimate of recharge from the MOE methodology.
- DB noted that the MOE thresholds defining a "stress" were developed for the recommended approach of taking the annual recharge and dividing by 12 to get monthly values. Deviating from this methodology would require not using the same thresholds and should only be completed as a scoping exercise after the annual/12 approach is completed to meet the MOE requirements.
- Low storage coefficient is a good indicator of potential stress as a gw elevation can be very sensitive to changes in input.

2.7 High Volume Recharge Areas and Significant Recharge Areas (slide 64 to 71)

- Preliminary results from "High Volume Recharge" analyses using MOE methodology # 2 and # 3 for M-R SWP region were presented. Results showed sporadic areas which would not be well supported given the uncertainty in the spatial accuracy of the input data (precipitation, recharge estimates etc.). It was decided that professional judgement would obviously need to be utilized for this analyses and to determine "Significant Recharge Areas".
- LL (MNR) noted that Matagami SWP region included a lake as a significant recharge area.

2.8 Stress Assessment – Surface Water Supply (slide 72 to 75)

- ML presented results of a sensitivity analysis conducted on the period of record used in calculating the monthly median flow rate. Three periods were considered: 20, 30, and 50 years. The main observation is that for the summer months when the stress would be the highest, there's no noticeable difference in Q50 associated with different record periods.
- EW pointed out a clarification that the variable of interest is monthly flow as opposed to daily flow. We should be looking at the median of monthly flow not daily. Results of the sensitivity analysis will most likely be the same.
- BH cautioned that the climate is not stationary and some is cyclical. We have not moved out of the historical climate regime. The early thirties have 100 mm per year less precipitation. The previous 30 years is not a better predictor than the previous 100 years. A 70 year period would be preferable. Team agreed using a longer period is not

Manon

- practical because only one station has the complete streamflow record.
- Alternatively, stress could be calculated as a trial for a dry year. However, the thresholds for stress as stated in Module 7 would not apply, as these are applicable when a longer period is considered.

3.0 Cataraqui Update on Tier 1

- SW presented his understanding of groundwater in Cataraqui Region. Several maps and sections were shown that help the committee understand the geologic layering and how gw may be moving in and out of the watershed. Several graphs were presented showing the effect of precip on groundwater in two wells.
- Peer Reviewers supported the idea of using the well water levels and precipitation to estimate recharge.

4.0 Quinte Update on Tier 1

- MB presented current information on their tier 1 water budget. The topic of discussion related to the separation of surplus into recharge and direct runoff. Mark presented the results of specific yield in the limestone aquifer. MR suggested that these results would be very helpful to the M-R SWP region. Cataraqui would benefit as well. MR also suggested that Mark resolve the one or two wells in the Precambrian regions. The recharge results are below 100 mm per year – significantly less than that determined by MOE separation method.
- MB also presented the significant recharge maps per each method suggested by MOE guidelines. Darin suggested a 'depth to water table' map as a surrogate for recharge mapping. Depth to water is better than vertical gradient.

5.0 Next Meeting

- Next meeting to be held at Rideau near end of February (after 25th).
- Quinte will be presenting their draft Tier 1 Assessment.

| | | |
|------------------|---|-------------------------|
| Revision Number: | 0A | Date: December 21, 2007 |
| Prepared By: | Bryon Keene, Manon Lalonde, Sean Sterling | |

Minutes of Meeting #11

Source Protection Peer Review

Quinte, Cataraqui, Mississippi-Rideau

Date: April 8, 2008
Time: 10:00 am to 3:00 pm
Location: Rideau Valley Conservation Authority

Present:

| Name | Agency | Name | Agency |
|-----------------------|----------------------|----------------------------|-------------------------|
| Michel Kearney (MK) | City of Ottawa | Sobhalatha Kunjikutty (SK) | M-R SWP Region |
| Michel Robin (MR) | University of Ottawa | Paul Lehman (PL) | MVC |
| Ed Watt (EW) | XCG Consulting | Manon Lalonde (ML) | M-R SWP Region / Delcan |
| Laura Landriault (LL) | MNR | Emily Saumure (ES) | M-R SWP Region |
| Clyde Hammond (CH) | TCC | Brian Stratton (BS) | M-R SWP Region |
| Sean Watt (SW) | CRCA | Sean Sterling (SS) | M-R SWP Region / Intera |
| Mark Boone (MB) | Quinte Conservation | Dru Heagle (DH) | Intera |

Absent:

| Name | Agency | Name | Agency |
|----------------|---------------------|----------------|----------------------|
| Darin Burr | Dillon Consulting | Bryon Keene | Quinte Conservation |
| Bill Hogg | Reach Consulting | Bryan Sears | MNR |
| Keith Taylor | Quinte Conservation | Mike Garraway | MNR |
| Titia Praamsma | CRCA | Representative | Conservation Ontario |

All handouts provided during the meeting are available on-line at <ftp://www.mrsourcewater.ca/>

MINUTES

| Item | Description | Action |
|------------|--|--------|
| 1.0 | Introduction | |
| 1.1 | Agenda The agenda as issued was accepted. | |
| 2.0 | M-R SWP Presentation | |
| 2.1 | General The Mississippi-Rideau SWP Group has prepared a First Draft report for the Tier 1 Water Budget (WB) and Stress Assessment, which was provided to Peer Reviewers on April 1 st . The purpose of the meeting is to present the report to the Peer Review Committee. ML noted that it became clear after the December 12 Peer Review meeting what components of the Work Plan were to meet essential requirements of the Tier 1 WB and Stress Assessment (as per provincial guidance) and what components were part of "improving the understanding" of the system. The following approach is then taken: <ul style="list-style-type: none"> • The main body of the report will consist of the essential Tier 1 requirements (to help make report consistent with others across Ontario). • Additional information to improve system understanding will be put in appendices or in | |

a separate addendum.

- The focus of the meeting is on the “essential requirements” only. Additional material is not presented at this time.

2.2 Water Budget – Report Section 4.0

ML presented the methodology. A key point is illustrated on Slide 7 and pertains to the introduction of a groundwater out term “GWout” in the water budget equation, which is introduced for consistency with the conceptual model, representing the recharge to the deep aquifer (Nepean Sandstone Aquifer). Wherever the Nepean and March rock formations outcrop near the ground surface, it is assumed that infiltration through these surfaces (estimated using the MOEE 1995 method) recharges the deep aquifer and does not return to the surface stream system. This net GWout term at the boundary of the Region becomes an input to the adjacent South Nation and Raisin SPR. Summary results for the WB exercise were then presented for selected subcatchments.

Questions / comments that were recorded are listed below.

PL (in relation to Slide 8): asked why three of the GWout values were zero (Marble Lake, Fall River, and Clyde River). ML explained that there is no March/Nepean rock formation outcropping in those areas, and therefore, no associated infiltration to the deep aquifer. Infiltration to the fractured rock system in these areas will occur to some degree; however, this infiltration is assumed to be to the shallow groundwater system that eventually discharges water back to the stream. Infiltration to the shallow aquifer in these areas is accounted for in the streamflow term (Qout).

EW pointed out that it's okay to assume that GWout is zero unless there's evidence to the contrary. In the MR SPR, knowledge of the geology is good evidence. The report text could be improved to better explain that. ML SS

PL (in relation to Slide 9): asked what proportion of the “delta storage” could be associated with surface storage, and if there was any way to determine it. ML responded that there was no simple way to determine this. There are several features that contribute to the surface storage components (human-regulated lakes and streams, unregulated lakes, wetlands, etc.). While the storage in human-regulated features can be calculated from reservoir characteristics and monitored water levels, the storage in other unregulated features is difficult to quantify. Knowledge of surface storage quantities is not required as part of Tier 1 WB exercise.

SK pointed out that the graph shown on Slide 10 (Appleton) does not match up with the table values. ML agreed, and will check the values that go with this graph. *Editor's Note: Table is right; figure will be revised.* ML

2.3 High Volume and Significant Recharge Mapping – Report Section 5.0

SS presented High Volume Recharge Mapping results following the three methods defined in the guidance document. Comments on the method and results are listed below.

PL asked if there was any data available for cold water streams. SS said that the request for data was put in to both CA's; however, no data was available.

BS asked where exactly the Significant Groundwater Recharge Areas (SGRAs) are located. SS explained that the SGRAs are conceptualized as two higher permeability areas that supply groundwater to municipal wells: [1] the polygons where Nepean and March bedrock Formations are the uppermost bedrock units, and [2] where sand and gravel deposits exist at surface. These polygons will be highlighted in the final figures. The red lines in Figure 6.4-1 would be the maximum.

SS asked if other areas could be brought in that are not considered significant (eskers, cold water streams). LL will ask if cold water stream areas (and others) can be brought in separately from municipal. MR agreed that it was important to show both. SS explained

that the information for HVRA would exist in the report and any additional information that is available in the future can easily be incorporated into the SGRA mapping.

CH commented that there are a lot of areas in the shield, when the MOEE 1995 method 3 is used, and that he does not have a lot of confidence in this method. SS agreed that the MOEE 1995 methodology sometimes overestimates the recharge and is therefore providing a conservative estimation.

BS commented that 95% of our region will be shown as highly vulnerable areas (HVA). SS agreed, but said that we are focused on municipal systems, so there is less attention paid to HVRA's. CH mentioned that the MOE is not doing vulnerability scoring for HVRA's on a regional basis anymore, and will only be looking at significant areas.

SS suggested that the final report will contain: [1] a compilation map that shows the HVRA results from all 3 MOE methodologies, although this map will be too cluttered and not much use, it will emphasize why method 1 was chosen, [2] a separate map showing the actual HVRA's from MOE method 1 (surficial geology) plus high permeability bedrock formations at surface. This map will also show which of these HVRA's are "significant".

2.4 Groundwater Stress Assessment – Report Sections 6.0, 7.0, and 8.0

SS informed the audience that the groundwater stress calculations provided in the report were erroneous and that a revised assessment was not available for the presentation. He went on to present the overall approach for groundwater stress assessment calculations including maximum capture zones for municipal wells and water demands. All reviewers agreed with the overall approach. The questions and comments that were recorded are listed below.

***Editor's Note:** The corrected groundwater stress assessment calculations significantly changed the stress assessments for all municipal wells and therefore questioned the applicability of comparing the Maximum Capture Zone Methodology stress assessments with the MOE threshold values. Discussions with the MNR (May 22) revealed that the published threshold values in the MOE Guidance Module were developed for a groundwater stress assessment calculated on a quaternary surface watershed basis without any consideration for geology, and therefore each SWP region was required to follow these assumptions. Although SS does not agree with this approach it was agreed that the Tier 1 WB report will include these calculations in order to provide groundwater stress assessment values that can be compared to the MOE threshold values. In addition, the MNR agreed that the Maximum Capture Zone approach, based on geology, was a much more sophisticated and accurate approach for upper-tiered water budget calculations, and they will recommend that other SWP regions follow this approach for future studies – however that was not the intent of Tier 1 WB report. SS indicated that this work will be included in an Appendix in the Tier 1 report to document the work already completed.*

Two municipal groundwater supplies appeared to show stress based on the calculations using MCZ approach: [1] Westport and [2] Almonte.

[1] WESTPORT - BS stated that the updated Westport Wellhead Protection Area modelling study is not yet complete and asked whether this will delay or effect the stress assessment. SS explained that it may change the area shown and therefore change the stress calculations.

[2] ALMONTE - It was noted that the MCZs for the NE side of the Mississippi River in Almonte do not follow the regional groundwater flow direction, but rather the conceptualized local conditions. Looking at a regional scale for the groundwater stress assessment and what groundwater is actually sourcing the Almonte municipal wells, it appears that the boundary conditions and assumptions used during the Almonte Wellhead Protection Area (WHPA) modelling are different compared to the groundwater stress assessment assumptions. SS explained that Intera completed the initial WHPA study and that complex faulting near the Mississippi River and along the northeast model boundary made it difficult

to fully understand the groundwater flow system. The uncertainty with boundary conditions influenced by these data gaps was discussed in the original WHPA study and it was previously recommended that additional field data be collected by drilling in this area. No additional work was completed and it appears that this data gap is proving to be an important issue for the groundwater stress assessment as well. Therefore it was agreed that it is necessary to fill these data gaps in order to better understand the groundwater flow system near Almonte since this additional data may influence the WHPA capture zones. Further discussion on this matter is needed between SS, MR and BS and a plan to move forward as part of Tier 2 WB would be discussed.

CH inquired about long-term municipal water levels and any trends that were noted. SS indicated that municipal water level data was only available for the past 5 year period and therefore trends could not be determined. However, none of the municipalities had reported any shortages in the past.

EW commented that it might make sense to look at stress on an annual target, since the target for annual is 10% (rather than 25% with monthly). It was also suggested to take a close look at uncertainties.

2.5 Surface Water Stress Assessment – Report Sections 6.0, 7.0, and 8.0

ML presented the methodology and results of the surface water stress assessment. A key item was the decision not to include permits pertaining to the Ducks Unlimited wetlands in the consumptive water demand (Slide 20). All reviewers agreed with this method. To be concise, results presented on slides do not consider the wetlands, but the report presents the two conditions (with and without the wetlands). Comments and questions are listed below.

In relation to the wetland permits:

- EW mentioned that there are some wetlands that may be drained for maintenance from time to time. ML agreed, but noted that in the Mississippi-Rideau Region this type of wetland is not encountered.

- CH commented that while we think of a permitted taking normally as pumping, the legislation states that a permitted taking can be any sort of diversion of water. This is why permits to take water do not necessarily all correspond to a consumptive taking.

In relation to Slide 23 (Summary of Permitted Water Use – Carleton Place Municipal Intake Catchment):

- The Fish Ponds permitted taking amount seems quite high. MK remarked that we should look more closely at the Fish Ponds number given its magnitude. This may be a case of diversion. ML will take a closer look at this permit. **Editor's Note:** *More information was obtained on the fish pond which show that this facility is similar in nature to the Ducks Unlimited wetlands (flow diversion). The large permitted water taking is related to the one time filling during initial construction of the berm and associated design of the outflow / overflow structure for a given design event. However, no details could be obtained on whether or not pumping was involved to maintain certain water levels in the pond. Due to recreational nature of the facility, subsequent taking for the purpose of maintenance cannot be ruled out; therefore, the consumptive water taking (based on a 0.25 consumption factor) will be retained for the stress assessment.*

ML

CH commented that some of the takings appear to have a groundwater component (e.g. pits/quarries). ML explained that permits in the MOE database are identified as taking water from the "surface", the "groundwater" or "both". To be on the conservative side, permits classified as "both" were included in the surface water and groundwater stress assessments. It was noted that in some instances, local surface runoff is diverted to a pit or quarry and this may be the reason for the permit.

In relation to Future Water Demand Estimates:

- EW noted that the "Other Permitted" use was not forecasted into the future. ML agreed, and explained that this is how the Guidance Document tells us to proceed (Other Permitted use is extrapolated into the future only if sufficient data exists). ML noted that a sensitivity analysis of the impact of increased consumptive water demand on stress was conducted (results presented at the end) that helps put in perspective the water demand numbers.

In summary, the highest Percent Water Demand for surface water were for future conditions, as follows:

- Carleton Place Municipal Intake Catchment: 5%
- Perth Municipal Intake Catchment: 4%
- Smiths Falls Municipal Intake Catchment: 7%

BS asked what is the threshold for Percent Water Demand to be indicative of potential stress (and that would trigger a Tier 2 analysis). ML replied that the threshold is 20% for surface water, and therefore all municipal catchments are quite below that. For added assurance, a sensitivity analysis has been done on Tay at Perth subcatchment given that the public has in the past shown interest in the OMYA plant water takings. Even for unlikely water demand scenarios, (100% consumptive demand, equal to permitted amount), the Percent Water Demand still remains below the 20% threshold value.

In relation to the water supply:

-PL brought up the point that there is a level of uncertainty with regards to the regulation of water management structures. Many of our rivers and lakes are regulated, which helps to bring down the potential stress level by increasing water supply during low flow conditions. However, there is the risk that these structures may not be able to sustain the same water supply to the downstream areas in the future. There is also some pressure out there to take away some of the regulation for these structures. This needs to be clearly communicated in the report. EW agreed, and said that we may want to state that the current stress level assumes that the current water regulation regime will stay as it is (which may or may not be the case).

ML

2.6 Need for Future Work (Slide 46)

MK said that there is a low probability of Richmond having a new water taking. BS agreed, and also said that Manotick village will likely be on private wells / connected to the City of Ottawa system. For the time being, only Lanark should be included as a new municipal system.

SS

ML noted that getting all of the "essential requirements" completed as per the Guidance Document was a priority for the team. The extent to which the additional analyses part of "improving the understanding" of the system will be completed will largely depend on time and budget constraints. These constraints will be re-assessed once the team has received comments back on the First Draft report.

EW asked what else (beyond what is in the current draft) will be shown in the Final Draft. ML responded that the final draft would also include uncertainty, data gaps, and recommendations (improved Sections 9 & 10). EW asked whether the "recommendations" section is required under the Guidance Document. If it is not required, perhaps it could be put in a separate section.

3.0 Cataraqui Update on Tier 1

SW provided an overview of long-term annual and monthly water budget in the CSPA. They anticipate the need for Tier 2 analysis in some locations.

SK commented that March ET is usually zero. SW explained that the Penman method was used, which changes the estimates a bit in the colder times of the year. Also, it was noted that this region is slightly warmer than the Mississippi-Rideau.

4.0 Quinte Update on Tier 1

MB provided an overview of the Quinte water budgeting exercise. Comments noted are provided below.

MR noted that there was an increased storage value on the shield. MB explained that this was due to the water holding capacity. It was believed that the value was underestimated at first, so the value was increased, which improved the GIS model.

It was noted that there may be a need to gather more data (2003-2004 data), as currently there are only 2 wells shown.

EW commented that usually there is no recharge in January (and other winter months). MB responded that they had looked at this, and realized that there were some months historically that did have recharge. They will likely think about this further.

5.0 Next Steps

The Mississippi-Rideau SWP team will revise groundwater stress calculations and will provide a revised First Draft report. Peer reviewers are asked to hold their written comments until they get the revised First Draft report. SS

Mississippi-Rideau anticipates not needing an additional Peer Review meeting to wrap up the Tier 1 analysis. They could potentially present Sections 9 and 10 when Quinte or Cataraqui will present their Tier 1 analysis.

Peer reviewers will be notified in advance by e-mail on the next meeting place and date.

| | | |
|------------------|------------------------------|---------------------|
| Revision Number: | 0A | Date: June 12, 2008 |
| Prepared By: | Manon Lalonde, Sean Sterling | |

**Cataraqui / Mississippi-Rideau / Quinte
Source Protection Regions**

**WATER BUDGET
PEER REVIEW TEAM**

Meeting # 12

Date: Thursday, June 19, 2007

Time: 10 am to 3 pm

Location: Cataraqui Region Conservation Authority Office
1641 Perth Road, Glenburnie, ON

Lunch will be provided

Proposed Agenda

| Time | Item | Lead |
|--------------------|---|---------------------------|
| 10:00-10:15 | <ul style="list-style-type: none">• Welcome• Introductions• Approval of proposed agenda | Chair |
| 10:15-12:00 | Cataraqui: Tier 1 Report Presentation | Colin Clarke Sean Watt |
| 12:00-12:45 | LUNCH | |
| 12:45-2:30 | Quinte: Tier 1 Report Presentation | Mark Boone Bryon Keene |
| 2:30-3:00 | <ul style="list-style-type: none">• Other Business• Next Meeting• Adjournment | Chair |

Minutes of Meeting Source Protection Peer Review Quinte, Cataraqui, MVC-RVC

**Held at Cataraqui Region Conservation Authority
June 19, 2008 10:00 AM**

Present:

| Name | Agency | Name | Agency |
|-----------------------|-----------------------|-----------------|------------------------------|
| Manon Lalonde | Mississippi Valley CA | Clyde Hammond | Trent Conservation Coalition |
| Sean Watt | CRCA | Michel Robin | University of Ottawa |
| Bryon Keene | Quinte Conservation | Darin Burr | Dillon Consulting |
| Colin Clarke | XCG Consulting | Bill Hogg | Reach Consulting |
| Mike Hulley | XCG Consulting | Steve Knechtel | CRCA |
| Mark Boone | Quinte Conservation | Jennifer Putman | South Nation |
| Laura Landriault | MNR | | |
| Sobhalatha Kunjikutty | MVC | | |

MNR

Absent:

| Name | Agency | Name | Agency |
|----------------|----------------|------|--------|
| Michel Kearney | City of Ottawa | | |
| Ed Watt | XCG Consulting | | |

Manon Chaired the meeting.

Introductions were heard around the table.

Agenda was approved.

Cataraqui Presentation

Sean Watt introduced the Cataraqui Tier 1 Water Budget report.

Sean discussed how water use was estimated from the PTTW database. Local knowledge was employed to interpret the permits. The understanding of water availability was also augmented by local knowledge of flows at conservation authority dams.

Colin presented the water budget results. GW flow was assumed to be zero (having no GW flow data).

Question on differing sampling period for ET and met data – what is the significance of the differing periods on the results? Colin thought it was not significant and stated that they used the data available.

Question on GW supply and reserve – why are we using the 10% as reserve? Stick to the guidelines! Quite some discussion took place on defining reserve and stress. Where is the science behind the answer? It was agreed that there should be a high uncertainty with the result and a flag should be placed on the answer for stress.

A lengthy discussion took place over water usage derived from PTTW database and residential usage. It was concluded that there is a significant uncertainty in actual takings.

It was requested that the report contain a breakdown of water use categories similar to the Quinte report. Sean agreed to supply that information in an appendix.

Cataraqui noted that stress was indicated by inclusion of the DU wetland permits. It was investigated for stress after removing the wetland permits and noted that stress was significantly reduced. Varying methodologies of challenging the data sensitivity were employed to see what systems may verge on stress within high uncertainty levels.

Municipal well hydrographs should be included in the report. Catchment should be included in report.

Laura recommended that Cataraqui staff meet with MNR to discuss the systems that they are recommending for elevation to Tier 2.

Mississippi Rideau

Manon updated the peer review team on the changes made to their methodology for definition of wellhead catchments. When they recalculated the stress based on new catchment they discovered almost all were stressed. This did not seem right to them based on their knowledge. With some discussion M-R agreed that they would recalculate the stress based on strict adherence to guidelines. It was felt by M-R that a tier 2 analysis for most of the wellheads would not be reasonable.

The meeting paused for lunch at 12:30

Quinte Presentation

Mark outlined the analysis and presented summaries of water budgets for selected catchments.

Bryon discussed surface water finding and stress recommendations.

Mark presented groundwater analysis. It was requested that Quinte clarify how each value was calculated in table 8.4 in a footnote in the report. It was suggested that Quinte look at the pixel imbalance on the Darcy flux model.

It was recommended that uncertainty can be handled by dealing with a range of values to come up with 'high' or 'low'. This involves a best guess and a worst guess.

Deloro Well not showing a stress on the watershed, but does if use capture zone. Water level data does not suggest a stress. Not recommended for Tier 2

Tweed Well not showing a stress on the watershed scale, but does if use only capture zone. Water level reading is short term, but does not show indication of potential for stress.

Madoc Well not showing stress on watershed scale, nor does stress indicate if using the capture zone. However, well ran dry in 2007 and hydrograph shows evidence of potential mining.

Suggestion to place Word file on server for peer reviewers to place comments in document. These can be 'accepted' or 'rejected' by each.

Comments due by July 12.

M-R revised tables are forthcoming. Then peer reviewers can comment on the revised version.

Next Meeting

A next meeting would only be called if committee members felt if after the review of the three source protection documents there was a need to meet.

The meeting was adjourned at 3:30 PM

Appendix B:

Peer Review Record

| Meeting | Material Presented | Peer Review Comments | Response |
|---------------------------|--|---|---|
| Meeting # 9 Apr 20'07 | Presented Methodology For the Tier 1 water budget including preliminary analysis as well as analysis of a specific storm event | <ul style="list-style-type: none"> Suggested to look at a smaller rain fall event for the analysis with more of a discrete cutoff. Suggested a disclaimer regarding limitations of the use of radar data, Suggested a transfer function between precipitation and water levels be calculated, Initial abstraction needs to be considered in calculating depth of rainfall available for runoff, Questioned the applicability of a specific rainfall event for calculating recharge Questioned accuracy of consumptive factors in determining water use, Suggested that multiple conditions be used in calculating stress (i.e. dry year as well as an average year | <p>This work was not included in the Tier 1 Report</p> <p>This work was not included in the Tier 1 Report</p> <p>This work was not included in the Tier 1 Report</p> <p>This work was not included in the Tier 1 Report</p> <p>This work was not included in the Tier 1 Report</p> <p>Factors were taken from Guidance Document</p> <p>This is to done in subsequent Phases of Water Budget</p> |
| Meeting # 10 Dec 12'07 | Presented Methodology of calculating ground water recharge and mapping of significant recharge areas | <ul style="list-style-type: none"> Share results of this analysis with other CAs Complete similar assessment for Canadian shield even though there are not a large number of wells in the area, Try a depth to water table map to determine SGRA Typically recharge does not occur in the winter months | <p>Complete</p> <p>Complete</p> <p>Complete - but did not prove useful</p> |
| Meeting # 11 Apr 8'08 | Presented results of ground water recharge calculations for the Shield | <ul style="list-style-type: none"> Clarify how each value in Table 8-4 was calculated Suggested that the pixel imbalance on the darcy flux model be reviewed Recommended that uncertainty be expressed as high or low without a moderate level | <p>For tier 1 purposes recharge was divided evenly over the 12 month period.</p> <p>Table 8-4 was removed from the report and results presented in a different way (i.e recharge equally divided over 12 months),</p> <p>The Darcy flux was not included in the Tier 1 report</p> <p>This has been completed</p> |
| Meeting # 12 Jun 19'08 | Presented results of the Tier 1 water budget and Draft Report | <ul style="list-style-type: none"> Page 1: Suggest tense (e.g. "is developing", etc.) be changed to past as it should be in the final report Page 2, 5: Comprise is a transitive verb. Page 2&3: Ground water on p. 2 and elsewhere, but groundwater on p. 3 Page 5: Quinte Conservation, 2006 is cited here, but not included in the References on p. 75. | <p>Done</p> <p>Changed</p> <p>Completed</p> <p>Completed</p> |

2nd Draft Comments

Nov 6'08

Appendix C:

Peer Review Correspondence

Mark Boone

From: Michel J. L. Robin [Michel.Robin@uottawa.ca]
Sent: 10 December 2008 22:30
To: Mark Boone
Subject: RE: Quinte Tier 1 Water Budget

Hi Mark,

I just finished reviewing the report. Sorry about the delay, this has been an extremely busy term for me (thankfully, winter is looking better).

I found the report is extremely well written and technically sound. I particularly liked your analyses of specific yield. I also fully support your assessment of the methodology provided by the ministry that divides annual recharge and demand into twelve equal monthly values as inadequate when the monthly values are available.

Job well done! Congratulations.

Michel JL Robin, PhD, PGeo
Associate Professor of Hydrogeology
Department of Earth Sciences
University of Ottawa
140 Louis Pasteur
Ottawa Ontario, Canada, K1N 6N5
Tel (613) 562-5800 Ext. 6852
Fax (613)562-5192
michel.robin@uottawa.ca

From: Mark Boone [mailto:mboone@quinteconservation.ca]
Sent: 5-Dec-08 8:37 AM
To: Michel J. L. Robin
Subject: RE: Quinte Tier 1 Water Budget

Thanks Michel. It's still not too late as we value your comments. Look forward to hearing from you.

Mark

Mark Boone, P.Geo.
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Mark Boone

From: Watt, Edgar [edw@XCG.com]
Sent: 25 November 2008 09:55
To: Mark Boone; Bryon Keene
Subject: Quinte Tier 1 Water Budget Report

Hi Mark,

1. My comments are attached. As noted, "I found the report nicely laid out, clearly presented and generally easy to follow".

2. I do not think that another meeting is necessary. If you have any questions about my comments, please feel free to call me.

Ed

<<Comments on Quinte Region Tier 1 Water Budget Report 2nd Draft by Ed Watt.doc>>

Ed Watt
Senior Consultant

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Mark Boone

From: Burr, Darin [dburr@dillon.ca]
Sent: 02 December 2008 07:49
To: Mark Boone
Subject: Peer Review of Tier 1 Water Budget - Quinte Conservation

Mark, I have reviewed both my 1st Draft comments of June 20, 2008 for the 1st Draft, and the new November 7, 2008 2nd Draft. All of my comments have been addressed.

Regards. Darin

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11/12/2008

Mark Boone

From: bill.hogg [bill.hogg@xplornet.com]
Sent: 03 December 2008 14:34
To: Mark Boone
Subject: RE: Quinte Tier 1 Water Budget

Hi Mark

The report arrived just before I departed on a golf trip to Hilton Head. I've had a quick look and don't see anything I need to comment on. Sorry for the delay.

Bill Hogg
45 Applewood Cove
RR#1 Bath ON K0H 1G0
Ph: 613-373-8818 Fax: Phone first
For courier add: Hwy 33 - Bayshore Road, Adolphustown

From: Mark Boone [mailto:mboone@quinteconservation.ca]
Sent: Wednesday, December 03, 2008 1:48 PM
To: bill.hogg@xplornet.com
Subject: Quinte Tier 1 Water Budget

Hi Bill:

Hope all is well with you. A while back we sent you a copy of the 2nd draft of the Quinte Region Tier 1 Water Budget Report. We hope that you have received it okay. We had provided a deadline for comments of November 28, 2008. If you have a chance could you please send us a note if you have any comments or if you have none and are satisfied with the submission. I know this is a busy time of year and we will appreciate hearing from you.

Thanks,

Mark

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