FIGURES

TABLES

C1 CONCEPTUAL WATER BUDGET

C1.1 DATA RESOURCES

Using available data, the team should take into account the following elements:

- Climate;
- Geology/Physiography;
- Land Cover;
- Groundwater;
- Surface Water (including reservoirs and major discharges); and
- Water Demand.

The integrated conceptual assessments were undertaken where sufficient continuous data exists:

- Stream Gauge Network stream gauge stations (or HYDAT stations), with sufficient periods of record (generally >5 years of continuous data);
- Active or inactive Environment Canada (Water Survey of Canada);
- The climate data collected over 36 years (1960-1996) from the Oshawa airport and the Oshawa Water Pollution Control Plant; and
- Permitted Takings (*MOE-PTTW database, 2005*).

Available climate data obtained from the Environment Canada stations is available from the Oak Ridges Moraine Groundwater Program (ORMGP) database shared amongst the Coalition of Authorities on the Moraine (CAMC), the Regional Municipalities of York Peel and Durham, and the City of Toronto (YPDT). More recent data was queried online from the Environment Canada website by month and added to the historical data where possible. CLOSPA-owned climate station data was obtained from an in-house database, though migration of this data to the ORMGP database is underway.

Because most of the local Environment Canada operated stations were decommissioned over the past several years, the spatial distribution of current climate monitoring stations has been identified as a gap locally in the support of current and future local water budgeting, amongst other studies. CLOSPA is currently investigating, in partnership, the commissioning of a centrally located comprehensive climate station to supplement the existing network. It is anticipated that this station will also collect evaporation data.

Soil classifications are based on the National Soil Database data model for Detailed Soil Surveys found on the CanSIS website (http://sis.agr.gc.ca/cansis/nsdb/index.html). Where applicable, Ontario Soil data items follow the Canadian System of Soil Classification (2nd Edition) 1987, or the Canadian System of Soil Classification (3rd Edition) 1998.

To complement the thermal classification exercise, airborne thermography is used to collect the locations of springs and seepage areas. Potential springs and seeps in the Oak Ridges Moraine were mapped from Aerial Thermography collected between midnight and 3 a.m. on March 1, 1994. Data is extracted from thermal infrared images that show a contrast in surface temperatures on a cold winter night. In addition, warm areas on the thermal image may coincide with portions of streams and potential reaches of significant groundwater discharge locations noted as potential open water. Data are then digitized from NTS map sheets into vector format. This information will be combined with available discharge mapping to help increase understanding of groundwater discharge.

Stream gauging provides critical information needed for CLOSPA's flood forecasting and warning program. This information is also important to water budgeting analyses that are necessary for source water protection. Total flows, baseflows, mean daily flows, and mean monthly flows are derived from the raw level data and stream section survey information.

C1.2 Methods of Analysis

The purpose of water budget analyses is twofold. They aim to identify watershed communities where the sustainability of water supplies is questionable and to highlight key factors that may limit the sustainability, so that appropriate risk management activities can be completed. This analysis is phased or tiered to focus on areas in need, starting at a regional scale and successively focusing in on smaller areas if necessary. The purpose of the analysis is to:

- Estimate the quantity of water flowing through a watershed;
- Understand the pertinent processes and pathways water follows; and
- Assess the sustainability of water supply sources from a quantity perspective.

The first phase is a regional evaluation of all existing water-related data, focusing on various aspects including climate, land use, surface water, groundwater, and water use in each watershed. This phase is known as Conceptual Understanding and forms the basis for subsequent water quantity work.

The Tier 1 Screening Stress Assessment follows the Conceptual Understanding phase (

Figure C1. 1). Tier 1 estimates the amount of water that is used currently and will be needed in the future (demand), and compares this to the amount of water available (supply) minus a reserve quantity (demand/ (supply – reserve)). The reserve quantity represents the amount of water needed to sustain activities outside of drinking water, such as for maintaining groundwater discharge, supporting the ecosystem, diluting sewage treatment plant effluent, and maintaining navigation. Those areas where municipal drinking water supplies (demand) exceed a certain threshold will be subject to further investigations, namely a Tier 2 Refined Stress Assessment. All areas of the province are to conduct the Conceptual Understanding and Tier 1 analyses.

The subsequent Tier 2 analysis, should it be necessary, focuses on a smaller area (subwatershed) and will test the assessment results of Tier 1 using newly collected information and more sophisticated technical tools (e.g., numerical groundwater flow models). Should the Tier 2 results suggest that an area may be experiencing stress from a water quantity perspective, the area will then progress to a Tier 3 Risk Assessment for the local area.

The following sections describe the quantitative conceptual understanding undertaken to date by CLOSPA. The general steps undertaken to generate the estimates are summarized as follows:

- Description of the watershed conditions, including a summary of streamflow, total precipitation from local gauging stations as well as all other hydrological components;
- Estimation of the groundwater discharge component through hydrograph separations (a range of values dependent on methodology selected);

- Available regional geology models are currently used to determine potential areas of discharge. It is assumed that the amount of groundwater discharge equals groundwater recharge where the change in storage is considered to be negligible within the catchment area. Interflow is included in either of runoff or groundwater discharge;
- Comparison of evapotranspiration calculations to estimates provided in existing subwatershed, drainage or development plan proposals for sensitive areas where possible;
- Water budget output comprised of a watershed-based quantification of hydrological components prepared;
- The mean annual potential evapotranspiration (calculated by the Thornthwaite method);
- Calculate water surplus (infiltration and runoff) according to the methodology of Thornthwaite and Mather (1957). This was calculated using monthly mean temperature and precipitation data for 38 climate stations within or near the Region of Durham; and
- Partition the water surplus into runoff and infiltration according to the coefficient method outlined in Ontario Ministry of the Environment, 1995 utilizing soil characteristics, topography and vegetative cover.

There are also a number of water budget investigations being conducted within CLOSPA jurisdiction as part of the Regional ORMGP Groundwater Management Study. The methods being utilized include:

- HSP-F Models (Hydrological Simulation Program – Fortran);
- WABAS (Water Balance Analysis System; Clarifica Inc.); and
- MODFLOW, a three-dimensional numerical groundwater flow model (CAMC-Earthfx, 2004).

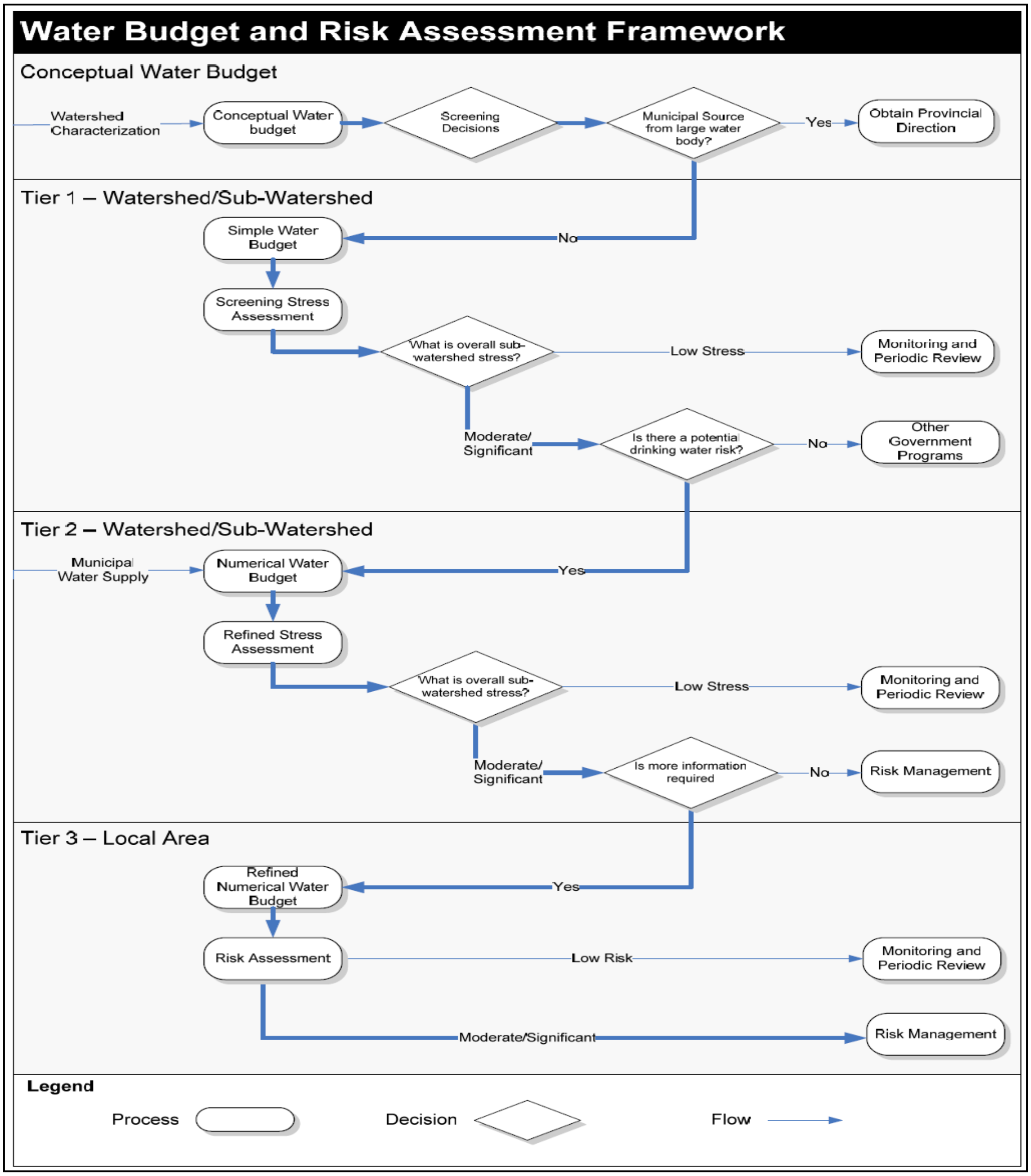

Figure C1. 1: Illustrates the Water Budget Framework (*Technical Rules*)

Noting the Required Screening Stress Assessment following Tier 1 and 2 Assessments Prior to Moving to the Next Level of Complexity of Analyses.

HSP-F is a numerical model that is capable of simulating hydrologic processes, pollutant generation and transport processes both within catchments and along watercourse networks. This tool has been used to assess the potential benefits of implementing stormwater management practices. The model was calibrated to streamflow, surface water quality and sewer discharge data.

Water budget estimates for both existing and future Official Plan land use scenarios have been conducted by Clarifica Inc. (2002; 2003a; 2003b) using the WABAS methodology (Graham *et al*., 1997) for the Upper Humber River watershed, the Petticoat Creek watershed and the Duffins Creek watershed. Inputs to the model include:

- Daily precipitation;
- Average or maximum daily temperature;
- Pan evaporation;
- Daily streamflow measurements; and
- Physical basin parameters, including imperviousness, interception abstractions, vegetation and soil characteristics.

The outputs from the model are time series of:

- Runoff;
- Infiltration;
- Evaporation; and
- Storage conditions within each water reservoir (pervious and impervious interception storage, surficial soil storage and snow pack storage).

With respect to the regional numerical groundwater flow model (MODFLOW), which encompasses the study area, initial estimates of applied net recharge on a regional scale were developed and used as input into the Regional Model developed for the Oak Ridges Moraine Groundwater Program Groundwater Management Study (Earthfx, 2004).

Data on land use, climate and soil properties were analyzed to provide the initial estimates of the spatial distribution of groundwater recharge. The primary influence on the recharge distribution was assumed to be the surficial geology as mapped by the GSC. The initial estimates used in the model were adjusted during model calibration. Additional calibration is required as the Core Model is applied over the study area. Recharge rates in the preliminary regional model assessment were highest over the Oak Ridges Moraine due to the sandy soils and hummocky topography (360 mm/a) and lowest in areas covered with lake sediments or organic deposits.

Groundwater discharge estimates from streamflow hydrograph separation basically involve removing the runoff or storm/melt events that form peaks on the hydrograph over relatively short durations (hours to days). The groundwater component is considered to be the more consistent contributor to streamflow with annual fluctuations seen as gradual changes in the hydrograph. The three-dimensional numerical groundwater flow model (MODFLOW) being constructed for the Oak Ridges Moraine is using groundwater discharge estimates from hydrograph separation as one of the flux calibration targets. From daily average streamflow measurements, the groundwater discharge component is assumed to be approximately equal to a 5-day running average of the 7-day running minimum daily average flow. This method is similar to that utilized by the WABAS method (Clarifica, 2002). However, the WABAS method focuses on the runoff component when calibrating the soil moisture balance model. The WABAS methodology was coupled with the MODFLOW model for a pilot water budget analysis for three watersheds within the Lake Simcoe Region Conservation Authority (Earthfx Inc. and Gerber Geosciences Inc.).

The reader is referred to the *Conceptual Water Budget Interim Report* for the CLOSPA jurisdiction prepared by CLOSPA (2007).

C1.3 LIMITATIONS: DATA AND METHODS

Efforts were made throughout the conceptual water budget assessment to identify database management gaps, key analytical gaps and knowledge gaps. These gaps are being addressed where possible in facilitating the move forward activities.

C1.3.1 Database Management

Data management refinement arises when database structures are no longer functional for the required analysis, or are not scalable or linkable. In addition, gaps arise when database population or metadata tracking are required. Gaps are addressed recognizing the appropriate scale of the specific study being undertaken. Gaps have been identified for water budgeting purposes and are primarily related to (**Table C1. 1**):

- Streamflow stage-flow relationships;
- Hydrologic and water use database structure development; and
- Data loader and ArcHydro development.

Data Management			
WC Deliverable	**Data Set Name or Source**	**Data Problem**	**Comment**
Integrated Hydrologic Database	Hydrologic data	Requires update	ORMGP database data loader requires structure update.
Oak Ridges Moraine Groundwater Program Hydrogeologic Database	Various data sources	Requires update	Additional monitoring locations/data to be imported.
PTTW Database	MOECC PTTW data and field survey data	Requires update	Internal database to be developed/populated.

Table C1. 1: Data management identified

C1.3.2 Data Limitations

Data that are undergoing refinement have been identified for water budgeting purposes and are summarized in **Table C1. 2**. Identified items are generally consistent with those reported in the characterization report:

- Future development areas;
- Surface water thermal classifications;
- Seepage and springs delineation;
- Serviced/ unserviced areas and stormwater management facilities;
- Precipitation distribution, and evaporation; and
- Spatial and temporal distribution of low flows.

While some of these gaps have been dealt with in this revision, (e.g., thermal classification), several more will be addressed during the Tier 1 reporting.

Identified Data that is undergoing Refinement (not available at the time of reporting)			
Water Budget and Stress Assessment			
Component	**Data Set Name or Source**	**Data Problem**	**Comment**
Integrated Hydrologic Database	Hydrologic data	Requires update	ORMGP database data loader requires structure update.
ORMGP Hydrogeologic Database	Various data sources	Requires update	Additional monitoring locations/data to be imported.
PTTW Database	MOECC PTTW data and field survey data	Requires update re: actual takings data	Internal database to be developed/populated.
Gauge Database/Installations	CLOSPA data	Requires update	Internal database to be developed/populated.
Stormwater Management Facilities Map	Upper/lower tier municipalities. Field verification	Partially populated	Data requested.
Precipitation Distr. Map ET Zone Map (draft PRMS map included)	AES (CDCD), CLOCA data	Partially populated too sparse	Data gaps to be filled. Maps to be completed.
Seepage and Springs Map	TBD	Partially populated	Field surveying and digitizing required. Historical Thermography mapping is included.
Aggregate Resources Update	MNRF OGDE, MNDM, municipal, field surveys	Partially populated	Existing data requires orthophotography review to verify locations.
Integrated Monitoring Network Site Locations and Data Review	CLOCA, Durham Region studies	Requires update	A review of monitoring needs is required. Paucity of climate data to be addressed.
Refined Surface Water Features and Functions	FBS DEMv2, stream network	Partially populated	ArcHydro Model partially complete.
Water Well Information System (WWIS)	MOECC data and field survey data	Requires update	Data requested.

Knowledge Gaps
Refinement of aquifer characterization and flow system understanding including the orientation of bedrock valley systems and significant area recharge and discharge mapping;
Ongoing refinement of the existing surface water understanding (refining the tested PRMS model);
Ongoing refinement of the existing groundwater flow understanding (refining the existing Core MODFLOW model);
Understanding of the interaction of the surface water and groundwater flow, including wetlands, within the system;
Development of acceptable water use targets to protect both the resource and the aquatic ecosystem;
Development of methodology and tools to provide potential spills response analysis which will involve overland flow, stream travel and groundwater flow including the unsaturated zone transport; and
A more comprehensive understanding of the QDEMAND components of the water budget, including assessing the permits and actual water use.

Table C1. 2: Data limitations identified

Knowledge gaps identified relate to the analysis and tool adjustment required to quantify the water budget estimates and to understand how the flow system operates. These tools enable predictions of impacts from potential future changes such as climate or land use change. Identified knowledge gaps with respect to the conceptual (to date) include:

- Refinement of aquifer characterization and flow system understanding including the orientation of bedrock valley systems and significant area recharge and discharge mapping;
- Refinement of the existing surface water understanding (refining the tested PRMS model);
- Refinement of the existing groundwater flow understanding (refining the existing Core MODFLOW model);
- Understanding of the interaction of the surface water and groundwater flow, including wetlands, within the system;
- Development of acceptable water use targets to protect both the resource and the aquatic ecosystem; and
- Development of methodology and tools to provide potential spills response analysis which will involve overland flow, stream travel and groundwater flow including the unsaturated zone transport.

C1.4 References

Barth, C., Krause, P., Boyle, D.P., and Markstrom, S.L. (2005). Hydrologic Modelling of a Groundwater Dominated Watershed using a Loosely Coupled Modelling Approach. Friedrich Schiller University Jena, Department of Geoinformatics, Hydrology, and Modeling. Jena, Germany, 7p.

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C2 TIER 1 WATER BUDGET

C2.1 METHODS OF ANALYSIS

The Tier 1 Water Budget methodology assessed the existing hydrologic conditions within the watershed using both Conceptual Understanding and numerical modelling information developed through the Drinking Water Source Protection program and the Oak Ridges Moraine Groundwater Program study reporting. The conceptual model development involved the collection and analysis of baseline information related to climate, surface water and groundwater.

The purpose of a Tier 1 analysis is to estimate the hydrologic stress of subwatersheds in order to screen out areas that are unstressed from a water quantity perspective. Future efforts and resources (Tier 2 and Tier 3) can then focus on areas that are stressed. At Tier 1, for each subwatershed, the *Technical Rules* require the evaluation of two scenarios: (1) current conditions; and (2) 25-year future demand. The goal of the current conditions scenario is to identify subwatersheds that are under stress as a result of existing water takings. The goal of the 25-year future scenario is to identify additional watersheds that may become stressed as a result of additional drinking water requirements.

A planned subset of objectives specific to CLOSPA's Tier 1 numerical modelling is noted below:

- Quantify components of the hydrologic cycle;
- Apply tools for use in analysis;
- Improve understanding of the groundwater system;
- Define links between shallow and deeper flow;
- Assess changes due to groundwater/surface water withdrawal, urbanization, and climate change;
- Provide spatial mapping of hydrological components;
- Support an understanding of flow regimes in un-gauged watersheds or watershed with a paucity of data;
- Determine levels of stress (i.e., demand vs. available water); and
- Ultimately help identify risks to the watersheds in a process consistent with provincial guidance.

Following the Conceptual Understanding phase is the Tier 1 Screening Stress Assessment. Tier 1 estimates the amount of water that is used currently and will be needed in the future (demand), and compares this to the amount of water available (supply) minus a reserve quantity (demand/(supply – reserve)). The reserve quantity represents the amount of water that is deemed necessary to sustain other activities outside of drinking water use such as for maintaining groundwater discharge, to support the ecosystem, to dilute sewage treatment plant effluent, to maintain navigation, etc. Those areas where municipal drinking water supplies (demand) exceed a certain threshold will be subject to further investigations, namely a Tier 2 Refined Stress Assessment.

The schematic shown in **Figure C2.1** depicts the processes used by the numerical models. A modified Precipitation-Runoff Modelling System (PRMS: surface water model) code developed by the United States Geologic Survey (USGS) was used to estimate quantitatively the various water budget fluxes such as precipitation, interception, evaporation, potential and actual evapotranspiration, snowmelt, runoff, and groundwater interflow and infiltration (EarthFx, 2007). The model integrates watershed characteristics, such as slope, aspect, elevation, soils, land use and cover, precipitation, snowpack, temperature, and solar radiation. Square cells, 25 metres on a side, were used to represent the distribution of the characteristics within the watershed, and a daily water balance was calculated for each cell for the simulation period. Daily averages were then averaged over a 19-year simulation period to determine the long-term average annual millimetres per year (mm/yr) for each water budget component. The model was calibrated to total surface water flow data and baseflow estimates from stream gauging, and to the groundwater flow model simulations.

The groundwater model, referred to as the “East Model,” was used to simulate groundwater budget components, such as groundwater levels and groundwater discharge to streams (EarthFx, 2007) (**Figure** C2. 1). The model integrates data on the physical, geologic, and hydrologic features that govern groundwater flow in the watershed. Calibration was conducted in a trial-and-error process where results of successive model runs were primarily matched to hydraulic heads and flows interpolated from observed static water levels obtained from the MOECC Water Well Information System (WWIS). Matching baseflow in the watershed was a second calibration target. A post-processing programme was used to determine lateral groundwater inflows and outflows (underflows) across the watershed boundaries. These underflows were used to adjust the calibration of both the PRMS model and the simulated groundwater discharge from the MODFLOW model.

A surface water model such as PRMS, due to its simplified representation of the groundwater flow processes, may not calibrate properly to observed streamflow if the watershed is gaining or losing significant quantities of groundwater underflow across the watershed boundary. For instance, if the stream gauge data when normalized to the drainage area above the gauge indicates higher rates of normalized flow than recorded at other gauges outside of the watershed, it may indicate that the additional flow is attributable to groundwater inflow from outside the watershed. If this groundwater inflow is not accounted for, the surface water model would need to be adjusted to account for additional groundwater recharge in the watershed. Iteratively calibrating the surface water model (PRMS) to the groundwater flow model (MODFLOW) provides a check on the simulated rates of recharge. For example, if the PRMS model computes recharge rates that are higher in an area than the groundwater system can transmit, the MODFLOW model will simulate groundwater levels to be much higher than observed. Conversely, if recharge rates are too low, the simulated groundwater levels will also be low. This cross-calibration exercise between the two models also provides a method of determining the net underflow across watershed boundaries. These flows can be subtracted from the observed flows measured at the stream gauge to re-estimate recharge within the watershed. This type of coupling of models is termed “loosely coupled” as they are not directly connected to each other.

The reader is referred to the *Tier 1 Water Budget Report* for the CLOSPA jurisdiction prepared by *CLOSPA (2008).*

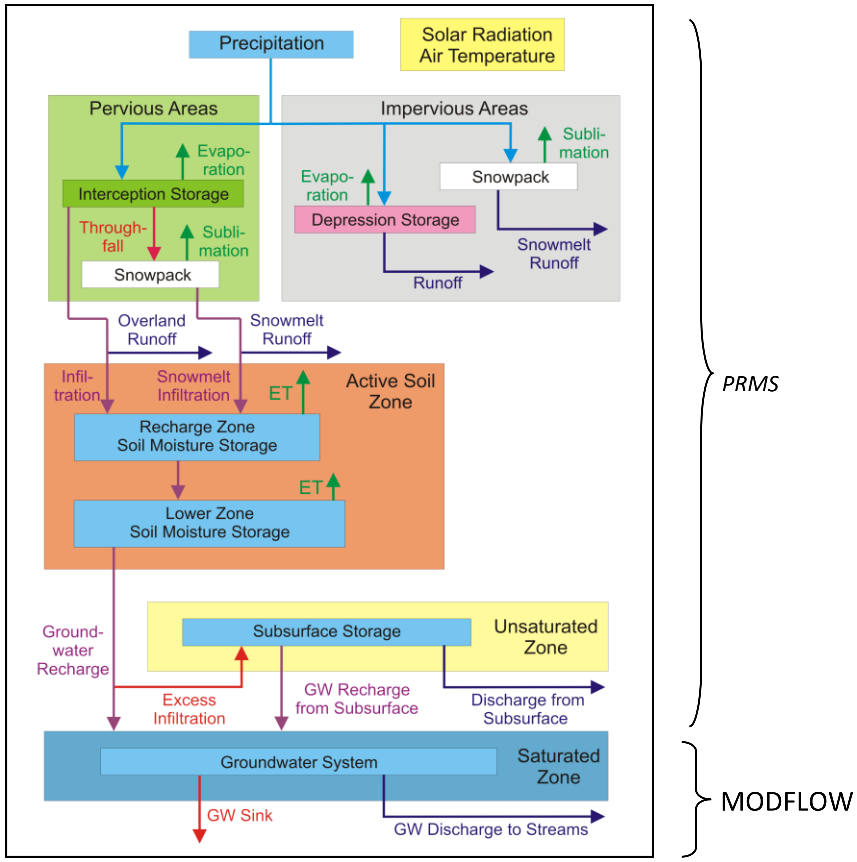

Figure C2. 1: PRMS/MODFLOW model process integration (EarthFx, 2007)

The terminology of the water budget parameters used in this chapter consist of Precipitation (P), Net Precipitation (Pnet or precipitation minus interception), Interception (I), Actual Evapotranspiration (AET), Groundwater Infiltration (GWI), Groundwater Lateral (underflow) in (GWLin) and out (GWLout) of the watershed, Discharge to Streams or Groundwater Discharge (GWD) and Runoff (RO). For the purposes of this chapter, GWI is assumed to include groundwater interflow to streams and groundwater recharge to the saturated zone.

Water withdrawals are represented by groundwater use or surface water use. These water budget components represent the key items discussed in this chapter. Long term average annual values of Pnet, I, AET, GWI, GWD and RO are reported at a watershed and subwatershed scale, along with mapping of areas of GWI and GWD.

Water budget estimates are typically normalized to units of millimetres of water distributed over a drainage area per year (mm/yr or mm/a). This is accomplished by converting flow or accumulation rates (e.g., m^3/s or L/s) to total volumes per year, and then dividing by the contributing drainage area.

In the absence of MOECC issued Permit to Take Water recorded in these watersheds, domestic water consumption was generated using the water well information in the MOECC WWIS database. Other water uses were assessed qualitatively, as reasonable quantitative estimates were difficult to calculate with any degree of certainty.

While efforts have been made to accurately present the findings reported in this chapter, factors such as significant digits and rounding, digitizing and data interpretation may influence results. For instance, in data tables no relationship between significant digits and level of accuracy is implied, and values may not always sum to the expected total.

C2.2 Limitations: Data and Methods

Empirical methods used to analyze simple functions of physical systems have identified limitations, such as relying on limited available data, or in the application of scale. These methods either simulate at a point or simulate a large area as a single value limiting the ability to scale down to a local area or to distribute water reservoir estimates spatially (Ely, 2006). Process-based numerical models that compute distributed water budgets are used to simulate hydrologic processes at varying scales using generally readily available data (Ely, 2006). Numerical models are generally deterministic meaning they are based on physical theories and equations, and are generally referred to as physically based models. Lumped models simplify physical characteristics by treating catchments as singular response areas using spatially averaged parameters over each area. Distributed models discretize the spatial variation of physical features into a grid or cell-type representation (Barth, 2005). The lumped approach is generally used in conceptual models, whereas distributed physically based models are used for more detailed spatial and temporal analysis and scenario testing.

C2.3 Uncertainty, Data and Knowledge

Uncertainty is inherent in the water budget estimation process. The accuracy of estimates relies on the:

- Quantity and quality of the input data (e.g., related to streamflow, climate, groundwater well records);
- Conceptual understanding of the watersheds; and
- Modelling calculation methodology.

Overall, the issues related to uncertainty, data and knowledge gaps are complex and highly qualitative. There is a degree of uncertainty associated with every aspect of the water budget analyses. However, it is impossible to provide a quantitative assessment of the level of uncertainty. Rather, one can only say, in very general terms, that the level is low, moderate or high.

The *Technical Rules* suggests that it would be reasonable to expect a low level of uncertainty in areas where data density is high, where hydrogeologic studies have been conducted, and where numerical models have been developed. This study generally satisfies all three of these criteria. It is recognized, however, that all hydrogeologic analyses have an intrinsic level of uncertainty, because one can never have enough data to fully know how conditions vary in the subsurface.

Development of the Oak Ridges Moraine Groundwater Program Core Model entailed a comprehensive process of (1) collecting and filtering the large amount of water well, monitoring well, and other geologic data; (2) interpreting the geologic logs as best as possible and building a conceptual geologic model; (3) assigning initial estimates of aquifer properties and recharge rates and then refining the estimates through model calibration; and (4) performing statistical and sensitivity analyses to demonstrate the validity of the model calibration. The report by Kassenaar and Wexler (2006) documents the procedures and focuses a great deal of attention on answering the questions related to assessing model uncertainty.

While these independent review comments increase the comfort level with the results of the modelling process, there is still the recognition that geologic data are always incomplete and that the WWIS data used in a large part to develop the models has a high degree of error and uncertainty. Data obtained from municipal monitoring networks and other high-quality sources have less uncertainty and have provided useful information in the vicinity of the municipal wellfields. The number of wells and spatial coverage of high-quality data are limited compared to the WWIS data, however. It is recommended that CLOSPA continue to improve its monitoring network over time and incorporate the available high quality data, especially within the higher stressed watersheds, and thereby reduce the level of uncertainty associated with the numerical models.

One task at the end of Tier 1 is to identify and list data gaps that will require further assessment as part of Tier 2. Without operating municipal wells, a Tier 2 assessment will not be necessary in the CLOSPA watersheds. CLOSPA is committed to improving their understanding of the watersheds, and as such has developed a list of data and knowledge gaps for their watersheds (CLOCA, 2007). Most significant of these, from a water budget perspective, is a more comprehensive understanding of the Q_{DEMAND} components of the water budget, including assessing the permits and actual water use.

Computer models are a simplification of the real world, built from limited and potentially erroneous data, so their results should be considered with care and independently verified. It should be recognized that the passage of time affects the information provided. Environmental conditions can change. Computer simulations are based upon information that existed at the time the data and model was formulated.

C2.4 Conclusions

On a more general level, this analysis has demonstrated the benefits of an integrated assessment of groundwater and surface water resources. Lateral groundwater movement between catchments is significant, and in particular, lateral inflows from outside the CLOSPA watersheds form an important component of the flow system, both from a water volume and significant groundwater recharge aquifer protection perspective. Particularly surprising is that particle tracking suggests that groundwater recharge north-east of CLOSPA flows in deep aquifers under Soper Creek before discharging in Bowmanville Creek. The groundwater and surface water catchments are significantly different.

Also important is the quantitative insight into the variability in groundwater recharge, both on a yearly and monthly basis. Many of the CLOSPA watersheds exhibit a net outflow of water during the summer months, indicating that storage is a significant factor in the overall groundwater supply situation. Understanding the relative role of storage, and distribution of wells in storage sensitive aquifers, should be considered in conjunction with long-term monitoring of water levels.

C2.5 Stress Assessment Summary

The surface water supply (current and future conditions) values for each subwatershed by month are provided in **Table C2.1**, the groundwater monthly (current) reserve values are in Error! Reference source not found., and the estimated groundwater monthly (future) demand values are in **Table C2.3**.

The following notes pertain to Error! Reference source not found..

NOTES:	$Q_{RECHARE}$ is 1/12th of the simulated annual average recharge Q_{INFLOW} is 1/12th of the simulated annual average lateral inflow Q_{SUPPLY} is $Q_{RECHARGE}$ + Q_{INFLOW}. $Q_{RESERVE}$ is 1/10th of the simulated annual average groundwater discharge to streams (divided into 12 equal monthly amounts) Q_{DEMAND} is the current groundwater demand for the month. Results are reported in m^3/S PWD (Percent Water Demand) = Q_{DEMAND}*100/(Q_{SUPPLY}-$Q_{RESERVE}$)

Watershed	Detailed Monthly Surface Water Assessment by Catchment												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lynde Creek	Q_{SUPPLY}	1.059	0.967	1.418	1.315	0.631	0.201	0.068	0.048	0.185	0.445	1.374	1.509
	$Q_{RESERVE}$	0.605	0.477	0.726	0.795	0.379	0.114	0.039	0.020	0.067	0.174	0.729	0.973
	Q_{DEMAND}	0.088	0.088	0.088	0.011	0.025	0.025	0.039	0.025	0.025	0.024	0.054	0.088
	PWD	19	18	13	2	10	29	134	89	21	9	8	16
Pringle Creek	Q_{SUPPLY}	0.202	0.167	0.234	0.207	0.108	0.032	0.010	0.004	0.033	0.085	0.230	0.273
	$Q_{RESERVE}$	0.115	0.083	0.112	0.120	0.063	0.017	0.005	0.002	0.01	0.030	0.12	0.172
	Q_{DEMAND}	0	0	0	0	0	0	0	0	0	0	0	0
	PWD	0	0	0	0	0	0	0	0	0	0	0	0
Corbett Creek	Q_{SUPPLY}	0.093	0.089	0.114	0.091	0.046	0.014	0.004	0.001	0.007	0.023	0.085	0.116
	$Q_{RESERVE}$	0.050	0.037	0.048	0.050	0.027	0.008	0.002	0	0.002	0.009	0.034	0.069
	Q_{DEMAND}	0	0	0	0	0	0	0	0	0	0	0	0
	PWD	0	0	0	0	0	0	0	0	0	0	0	0
Goodman Creek	Q_{SUPPLY}	0.080	0.063	0.091	0.078	0.041	0.013	0.005	0.003	0.020	0.043	0.102	0.112
	$Q_{RESERVE}$	0.046	0.033	0.042	0.045	0.025	0.007	0.002	0.001	0.006	0.015	0.060	0.070
	Q_{DEMAND}	0	0	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0	0
	PWD	0	0	4	6	12	35	92	135	15	7	0	0
Oshawa Creek	Q_{SUPPLY}	0.891	0.806	1.167	1.155	0.558	0.171	0.051	0.034	0.139	0.399	1.272	1.311
	$Q_{RESERVE}$	0.515	0.412	0.610	0.699	0.334	0.098	0.029	0.015	0.049	0.152	0.694	0.849
	Q_{DEMAND}	0.001	0.001	0.001	0.011	0.011	0.011	0.011	0.011	0.011	0.009	0.006	0.001
	PWD	0	0	0	2	5	15	49	58	12	4	1	0
Harmony Creek	Q_{SUPPLY}	0.300	0.238	0.391	0.368	0.183	0.054	0.014	0.005	0.038	0.110	0.373	0.440
	$Q_{RESERVE}$	0.168	0.115	0.167	0.205	0.106	0.028	0.007	0.002	0.011	0.040	0.165	0.274
	Q_{DEMAND}	0	0	0	0	0	0	0	0	0	0	0	0
	PWD	0	0	0	0	0	0	0	0	0	0	0	0
Farewell Creek	Q_{SUPPLY}	0.249	0.211	0.332	0.312	0.155	0.046	0.012	0.003	0.031	0.104	0.347	0.381
	$Q_{RESERVE}$	0.143	0.103	0.150	0.178	0.091	0.024	0.006	0.001	0.008	0.035	0.167	0.243
	Q_{DEMAND}	0	0	0	0	0	0	0	0	0	0	0	0
	PWD	0	0	0	0	0	0	0	0	0	0	0	0
Robinson Creek	Q_{SUPPLY}	0.038	0.032	0.044	0.040	0.020	0.006	0.001	0.000	0.001	0.006	0.030	0.046
	$Q_{RESERVE}$	0.020	0.015	0.020	0.022	0.012	0.003	0.001	0.000	0	0.003	0.009	0.027
	Q_{DEMAND}	0	0	0	0	0	0	0	0	0	0	0	0
	PWD	0	0	0	0	0	0	0	0	0	0	0	0

Tooley Creek	Q_{SUPPLY}	0.079	0.061	0.089	0.077	0.038	0.011	0.003	0.001	0.007	0.022	0.077	0.099
	$Q_{RESERVE}$	0.042	0.031	0.043	0.044	0.022	0.006	0.002	0	0.002	0.008	0.035	0.063
	Q_{DEMAND}	0	0	0	0	0	0	0	0	0	0	0	0
	PWD	0	0	0	0	0	0	0	0	0	0	0	0
Black Creek	Q_{SUPPLY}	0.189	0.155	0.236	0.218	0.108	0.032	0.010	0.003	0.038	0.102	0.289	0.297
	$Q_{RESERVE}$	0.110	0.083	0.115	0.129	0.064	0.017	0.005	0.002	0.009	0.035	0.169	0.187
	Q_{DEMAND}	0	0	0	0	0	0	0	0	0	0	0	0
	PWD	0	0	0	0	0	0	0	0	0	0	0	0
Darlington Creek	Q_{SUPPLY}	0.124	0.099	0.141	0.123	0.061	0.018	0.006	0.002	0.016	0.045	0.136	0.167
	$Q_{RESERVE}$	0.067	0.051	0.071	0.070	0.035	0.010	0.003	0.001	0.004	0.016	0.067	0.104
	Q_{DEMAND}	0.000	0.000	0	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.000
	PWD	0	0	0	9	18	57	185	514	37	16	7	0
Bowmanville Creek	Q_{SUPPLY}	0.815	0.713	1.221	1.246	0.564	0.202	0.085	0.085	0.228	0.487	1.262	1.219
	$Q_{RESERVE}$	0.471	0.369	0.632	0.807	0.347	0.114	0.048	0.034	0.092	0.192	0.778	0.795
	Q_{DEMAND}	0.000	0.000	0.000	0.002	0.002	0.002	0.00	0.002	0.002	0.002	0.002	0.000
	PWD	0	0	0	1	1	3	6	5	2	1	0	0
Westside Creek	Q_{SUPPLY}	0.036	0.028	0.042	0.035	0.018	0.005	0.001	0	0.002	0.009	0.034	0.045
	$Q_{RESERVE}$	0.019	0.014	0.018	0.019	0.010	0.003	0.001	0	0	0.003	0.013	0.028
	Q_{DEMAND}	0	0	0	0	0	0	0	0	0	0	0	0
	PWD	0	0	0	0	0	0	0	0	0	0	0	0
Soper Creek	Q_{SUPPLY}	0.656	0.537	0.849	0.808	0.370	0.111	0.038	0.018	0.122	0.292	0.870	0.933
	$Q_{RESERVE}$	0.369	0.294	0.442	0.503	0.215	0.062	0.021	0.008	0.031	0.109	0.499	0.610
	Q_{DEMAND}	0.000	0.000	0.000	0.010	0.028	0.028	0.035	0.028	0.022	0.005	0.005	0.000
	PWD	0	0	0	3	18	58	207	286	25	3	1	0
Bennet Creek	Q_{SUPPLY}	0.060	0.052	0.064	0.052	0.024	0.006	0.002	0	0.002	0.008	0.035	0.058
	$Q_{RESERVE}$	0.032	0.031	0.038	0.030	0.013	0.003	0.001	0	0	0.004	0.012	0.038
	Q_{DEMAND}	0	0	0	0	0	0	0	0	0	0	0	0
	PWD	0	0	0	0	0	0	0	0	0	0	0	0
Lake Catchments	Q_{SUPPLY}	0.150	0.148	0.178	0.138	0.069	0.022	0.007	0.003	0.018	0.044	0.137	0.181
	$Q_{RESERVE}$	0.080	0.063	0.086	0.077	0.040	0.012	0.004	0.001	0.005	0.017	0.062	0.109
	Q_{DEMAND}	0.613	0.613	0.613	0.618	0.618	0.618	0.618	0.618	0.618	0.618	0.613	0.613

Table C2. 1: Detailed Monthly Surface Water Stress Assessment - Current and Future Conditions

Watershed	Detailed Monthly Groundwater Assessment by Catchment - Current Demand												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lynde Creek	$Q_{RECHARGE}$	0.677	0.677	0.677	0.677	0.677	0.677	0.677	0.677	0.677	0.677	0.677	0.677
	Q_{INFLOW}	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202
	Q_{SUPPLY}	0.879	0.879	0.879	0.879	0.879	0.879	0.879	0.879	0.879	0.879	0.879	0.879
	$Q_{RESERVE}$	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068
	Q_{DEMAND}	0.122	0.122	0.118	0.068	0.087	0.087	0.087	0.087	0.084	0.078	0.118	0.122
	PWD	15	15	15	8	11	11	11	11	10	10	15	15
Pringle Creek	$Q_{RECHARGE}$	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111
	Q_{INFLOW}	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
	Q_{SUPPLY}	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153
	$Q_{RESERVE}$	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
	Q_{DEMAND}	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	PWD	3	3	3	3	3	3	3	3	3	3	3	3
Corbett Creek	$Q_{RECHARGE}$	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
	Q_{INFLOW}	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
	Q_{SUPPLY}	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
	$Q_{RESERVE}$	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	Q_{DEMAND}	0	0	0	0	0	0	0	0	0	0	0	0
	PWD	0	0	0	0	0	0	0	0	0	0	0	0
Goodman Creek	$Q_{RECHARGE}$	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
	Q_{INFLOW}	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
	Q_{SUPPLY}	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061
	$Q_{RESERVE}$	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	Q_{DEMAND}	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	PWD	1	1	1	1	1	1	1	1	1	1	1	1
Oshawa Creek	$Q_{RECHARGE}$	0.589	0.589	0.589	0.589	0.589	0.589	0.589	0.589	0.589	0.589	0.589	0.589
	Q_{INFLOW}	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197
	Q_{SUPPLY}	0.786	0.786	0.786	0.786	0.786	0.786	0.786	0.786	0.786	0.786	0.786	0.786
	$Q_{RESERVE}$	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065
	Q_{DEMAND}	0.025	0.025	0.025	0.029	0.033	0.033	0.033	0.033	0.033	0.033	0.029	0.025
	PWD	3	3	3	4	5	5	5	5	5	5	4	3

Harmony Creek	$Q_{RECHARGE}$	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176
	Q_{INFLOW}	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081
	Q_{SUPPLY}	0.257	0.257	0.257	0.257	0.257	0.257	0.257	0.257	0.257	0.257	0.257	0.257
	$Q_{RESERVE}$	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
	Q_{DEMAND}	0.008	0.008	0.008	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.008
	PWD	3	3	3	4	4	4	4	4	4	4	4	3
Farewell Creek	$Q_{RECHARGE}$	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158
	Q_{INFLOW}	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
	Q_{SUPPLY}	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267
	$Q_{RESERVE}$	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
	Q_{DEMAND}	0.009	0.009	0.009	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.009
	PWD	3	3	3	4	4	4	4	4	4	4	4	3
Robinson Creek	$Q_{RECHARGE}$	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
	Q_{INFLOW}	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
	Q_{SUPPLY}	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
	$Q_{RESERVE}$	0	0	0	0	0	0	0	0	0	0	0	0
	Q_{DEMAND}	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	PWD	7	7	7	7	7	7	7	7	7	7	7	7
Tooley Creek	$Q_{RECHARGE}$	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
	Q_{INFLOW}	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
	Q_{SUPPLY}	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
	$Q_{RESERVE}$	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	Q_{DEMAND}	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	PWD	6	6	6	6	6	6	6	6	6	6	6	6
Black Creek	$Q_{RECHARGE}$	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124
	Q_{INFLOW}	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
	Q_{SUPPLY}	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191
	$Q_{RESERVE}$	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
	Q_{DEMAND}	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
	PWD	3	3	3	3	3	3	3	3	3	3	3	3
Darlington Creek	$Q_{RECHARGE}$	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070
	Q_{INFLOW}	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
	Q_{SUPPLY}	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092
	$Q_{RESERVE}$	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	Q_{DEMAND}	0.003	0.003	0.003	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.003

	PWD	4	4	4	24	24	24	24	24	24	24	24	4
Bowmanville Creek	$Q_{RECHARGE}$	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615
	Q_{INFLOW}	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305
	Q_{SUPPLY}	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920
	$Q_{RESERVE}$	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082
	Q_{DEMAND}	0.023	0.023	0.023	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.023
	PWD	3	3	3	3	3	3	3	3	3	3	3	3
Westside Creek	$Q_{RECHARGE}$	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
	Q_{INFLOW}	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
	Q_{SUPPLY}	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
	$Q_{RESERVE}$	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Q_{DEMAND}	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	PWD	4	4	4	4	4	4	4	4	4	4	4	4
Soper Creek	$Q_{RECHARGE}$	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415
	Q_{INFLOW}	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
	Q_{SUPPLY}	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615
	$Q_{RESERVE}$	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
	Q_{DEMAND}	0.016	0.016	0.016	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.016
	PWD	3	3	3	3	3	3	3	3	3	3	3	3
Bennet Creek	$Q_{RECHARGE}$	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027
	Q_{INFLOW}	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021
	Q_{SUPPLY}	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
	$Q_{RESERVE}$	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	Q_{DEMAND}	0.009	0.009	0.009	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.009
	PWD	4	4	4	4	4	4	4	4	4	4	4	4
Lake Catchments	$Q_{RECHARGE}$	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
	Q_{INFLOW}	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
	Q_{SUPPLY}	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185
	$Q_{RESERVE}$	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
	Q_{DEMAND}	0.002	0.002	0.002	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.002
	PWD	1	1	1	2	2	2	2	2	2	2	2	1

Table C2. 2: Detailed Monthly Groundwater Stress Assessment - Current Conditions

Watershed	Detailed Monthly Groundwater Assessment by Catchment - Future Demand												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lynde Creek	$Q_{RECHARGE}$	0.677	0.677	0.677	0.677	0.677	0.677	0.677	0.677	0.677	0.677	0.677	0.677
	Q_{INFLOW}	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202	0.202
	Q_{SUPPLY}	0.879	0.879	0.879	0.879	0.879	0.879	0.879	0.879	0.879	0.879	0.879	0.879
	$Q_{RESERVE}$	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068
	Q_{DEMAND}	0.123	0.123	0.119	0.069	0.088	0.088	0.088	0.088	0.085	0.080	0.120	0.123
	PWD	15	15	15	9	11	11	11	11	10	10	15	15
Pringle Creek	$Q_{RECHARGE}$	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111
	Q_{INFLOW}	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
	Q_{SUPPLY}	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153
	$Q_{RESERVE}$	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
	Q_{DEMAND}	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	PWD	3	3	3	3	3	3	3	3	3	3	3	3
Corbett Creek	$Q_{RECHARGE}$	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
	Q_{INFLOW}	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
	Q_{SUPPLY}	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
	$Q_{RESERVE}$	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	Q_{DEMAND}	0	0	0	0	0	0	0	0	0	0	0	0
	PWD	0	0	0	0	0	0	0	0	0	0	0	0
Goodman Creek	$Q_{RECHARGE}$	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
	Q_{INFLOW}	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
	Q_{SUPPLY}	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061
	$Q_{RESERVE}$	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	Q_{DEMAND}	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	PWD	1	1	1	1	1	1	1	1	1	1	1	1
Oshawa Creek	$Q_{RECHARGE}$	0.589	0.589	0.589	0.589	0.589	0.589	0.589	0.589	0.589	0.589	0.589	0.589
	Q_{INFLOW}	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197
	Q_{SUPPLY}	0.786	0.786	0.786	0.786	0.786	0.786	0.786	0.786	0.786	0.786	0.786	0.786
	$Q_{RESERVE}$	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065
	Q_{DEMAND}	0.026	0.026	0.026	0.030	0.034	0.034	0.034	0.034	0.034	0.034	0.030	0.026
	PWD	4	4	4	4	5	5	5	5	5	5	4	4
Harmony Creek	$Q_{RECHARGE}$	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176
	Q_{INFLOW}	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081
	Q_{SUPPLY}	0.257	0.257	0.257	0.257	0.257	0.257	0.257	0.257	0.257	0.257	0.257	0.257
	$Q_{RESERVE}$	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
	Q_{DEMAND}	0.009	0.009	0.009	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.009
	PWD	4	4	4	4	4	4	4	4	4	4	4	4
Farewell Creek	$Q_{RECHARGE}$	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158
	Q_{INFLOW}	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
	Q_{SUPPLY}	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267
	$Q_{RESERVE}$	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
	Q_{DEMAND}	0.009	0.009	0.009	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.009
	PWD	4	4	4	4	4	4	4	4	4	4	4	4
Robinson Creek	$Q_{RECHARGE}$	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
	Q_{INFLOW}	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
	Q_{SUPPLY}	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
	$Q_{RESERVE}$	0	0	0	0	0	0	0	0	0	0	0	0
	Q_{DEMAND}	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	PWD	7	7	7	7	7	7	7	7	7	7	7	7

Tooley Creek	$Q_{RECHARGE}$	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
	Q_{INFLOW}	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
	Q_{SUPPLY}	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
	$Q_{RESERVE}$	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	Q_{DEMAND}	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	PWD	7	7	7	7	7	7	7	7	7	7	7	7
Black Creek	$Q_{RECHARGE}$	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124
	Q_{INFLOW}	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
	Q_{SUPPLY}	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191
	$Q_{RESERVE}$	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
	Q_{DEMAND}	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
	PWD	4	4	4	4	4	4	4	4	4	4	4	4
Darlington Creek	$Q_{RECHARGE}$	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070
	Q_{INFLOW}	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
	Q_{SUPPLY}	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092
	$Q_{RESERVE}$	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	Q_{DEMAND}	0.004	0.004	0.004	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.004
	PWD	4	4	4	24	24	24	24	24	24	24	24	4
Bowmanville Creek	$Q_{RECHARGE}$	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615
	Q_{INFLOW}	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305
	Q_{SUPPLY}	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920
	$Q_{RESERVE}$	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082
	Q_{DEMAND}	0.024	0.024	0.024	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.024
	PWD	3	3	3	3	3	3	3	3	3	3	3	3
Westside Creek	$Q_{RECHARGE}$	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
	Q_{INFLOW}	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
	Q_{SUPPLY}	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
	$Q_{RESERVE}$	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Q_{DEMAND}	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	PWD	4	4	4	4	4	4	4	4	4	4	4	4
Soper Creek	$Q_{RECHARGE}$	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415
	Q_{INFLOW}	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
	Q_{SUPPLY}	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615
	$Q_{RESERVE}$	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
	Q_{DEMAND}	0.016	0.016	0.016	0.018	0.019	0.019	0.019	0.019	0.018	0.018	0.018	0.016
	PWD	3	3	3	3	3	3	3	3	3	3	3	3
Bennet Creek	$Q_{RECHARGE}$	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027
	Q_{INFLOW}	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021
	Q_{SUPPLY}	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
	$Q_{RESERVE}$	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	Q_{DEMAND}	0.009	0.009	0.009	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.009
	PWD	4	4	4	4	4	4	4	4	4	4	4	4
Lake Catchments	$Q_{RECHARGE}$	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
	Q_{INFLOW}	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
	Q_{SUPPLY}	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185
	$Q_{RESERVE}$	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
	Q_{DEMAND}	0.002	0.002	0.002	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.002
	PWD	1	1	1	2	2	2	2	2	2	2	2	1

Table C2. 3: Detailed Monthly Groundwater Stress Assessment - Future Conditions