

## 2015 PROGRAM OVERVIEW & 2016 WORK PLAN

**TO:** YPDT Executive Steering Team

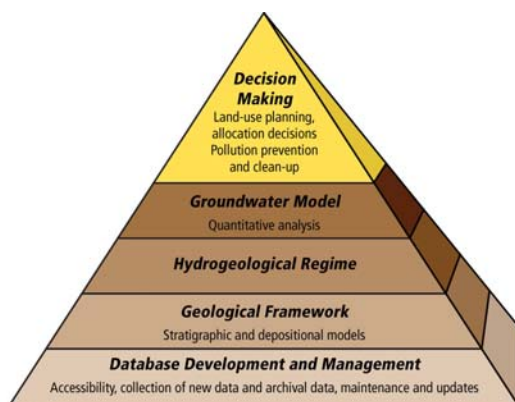
**FROM:** Steve Holysh & Rick Gerber

**DATE:** January 29, 2016

**RE:** **2015 Overview/2016 Work Plan – YPDT-CAMC (Oak Ridges Moraine)  
Groundwater Monitoring Program**

### Background

The YPDT-CAMC (Oak Ridges Moraine) Groundwater program was initiated in 2001, driven by the encroachment of development onto the Oak Ridges Moraine and the recognition of an absence of high quality environmental data and analyses, particularly with respect to groundwater. Since inception, the program has provided partner agencies with an actively managed water-related database and the regional geological and groundwater context for on-going day-to-day water resource management activities (e.g. development review, PTTW review, watershed management, source water protection, etc.). The framework for the program is succinctly summarized in the adjacent figure, taken from the Council of Canadian Academies 2009 report “The Sustainable Management of Groundwater in Canada.”



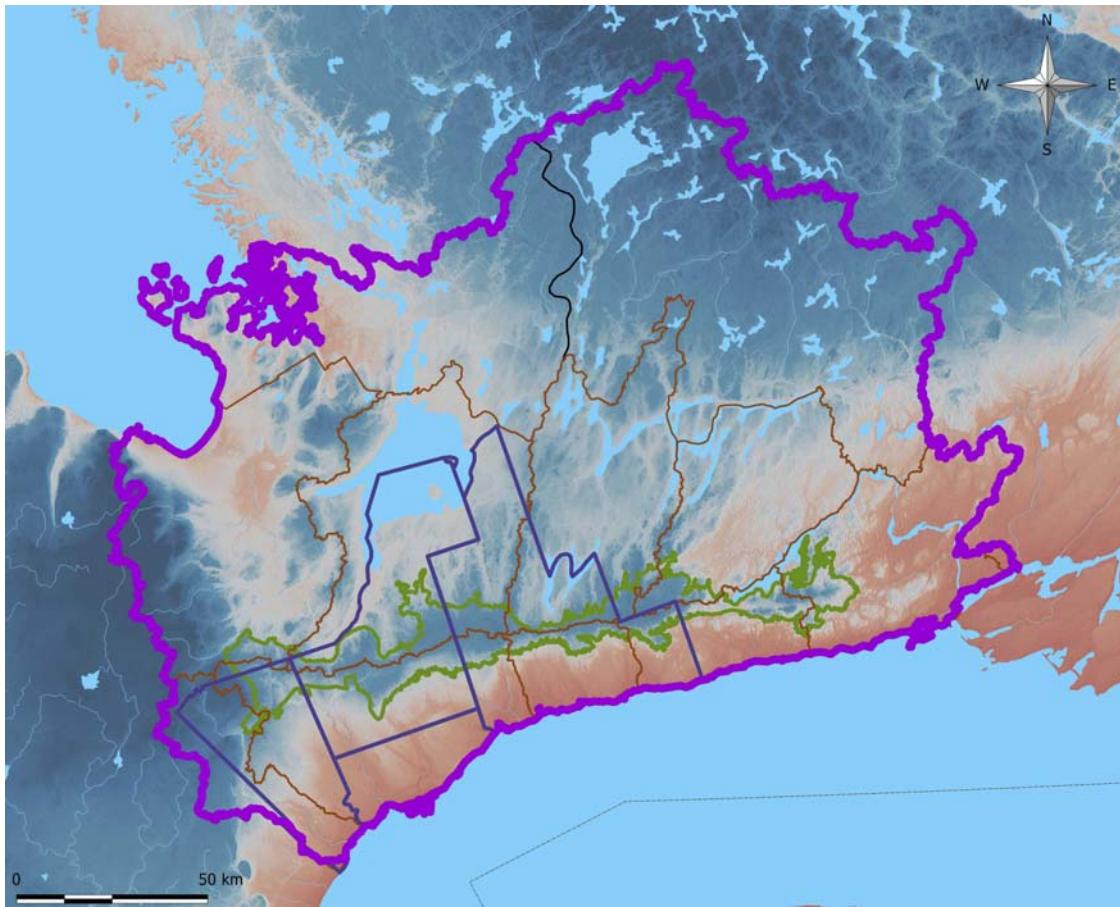
### Mandate

*The mandate of the YPDT-CAMC Groundwater Management Program partnership is to provide a multi-agency, collaborative approach to collecting, analyzing and disseminating water resource data as a basis for effective stewardship of water resources. The YPDT-CAMC Groundwater Management Program builds, maintains and provides to partnered agencies the regional geological and hydrogeological context for ongoing groundwater studies and management initiatives within the partnership area.*

As such the program will:

- *Build and maintain a master database of water related information that is accessible to all partner agencies;*
- *Build and maintain a digital geological construction of the subsurface layers that is accessible to all partner agencies;*
- *Build and maintain a numerical groundwater flow model(s) that can be used to address any number of issues that arise at any of the partner agencies;*
- *Coordinate and lead investigations that will acquire new field data that will strategically infill key data gaps;*
- *Provide technical support to Source Water Protection Teams to ensure that interpretations used in source water are consistent with the regional understanding;*
- *Provide technical support to planning authorities to ensure that Official Plan policies are developed in a manner which makes them consistent with up to date groundwater science as derived from the project; and*
- *Provide technical support to all partnered agencies for addressing other Provincial legislation.*

Further information regarding the program can be found at [www.oakridgeswater.ca](http://www.oakridgeswater.ca).



Program area - Note that for data management purposes the program area comprises the entirety of three SWP Regions: 1) Credit/Toronto/Central Lake Ontario (CTC); 2) Lake Simcoe - Southern Georgian Bay (SGBLS); and 3) Lower Trent (LTC). Focus of work is largely directed to the GTA municipalities (York, Peel, Durham, and Toronto) and their associated Conservation Authorities (CAs).

## Review – 2015 (Highlights)

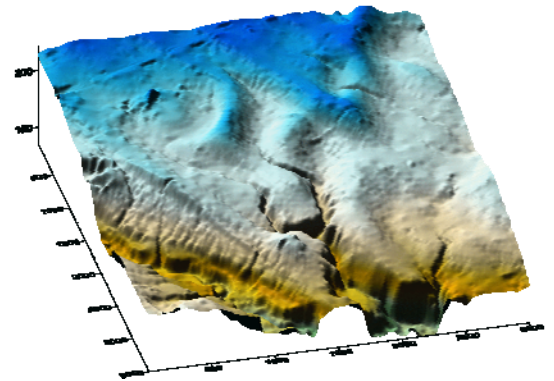


### Highlights – Database

- database selected to host ongoing Toronto Portlands subsurface investigation work (sufficiently up-to-date and rigorous);
- decision to replace database replication in favour of direct server access for partners;
- added in 2015 - 2,000 boreholes; 1,400 reports; 5 million temporal data records;
- institute a new backup system using Veeam Server;
- website set up to readily display database contents;

### Highlights – Analysis & Modelling

- Draft “Model Management Guidance” document prepared to support provincial direction regarding numerical model management and refinement;
- Obtain/inventory/archive and review of remaining 20 partner agency numerical groundwater flow models;
- Establish modelling file directory structure and set up storage system (NAS) system to store models;
- Set up model in CVC to investigate economic benefit of wetlands;
- Ensure that key model deliverables to partner agencies (e.g. WHPAs) are reproducible with delivered model files;



### Highlights – Other



- Further enhancements to pass-worded section of website ([www.oakridgeswater.ca](http://www.oakridgeswater.ca)) featuring library search, data search and cross-section capability; access provided to MOECC Central Region Technical staff;
- Technical support for the “Groundwater Quality” section of the 2015 CAMC Report Card;
- Continued monitoring of 20 field sites to assist with infilling of data gaps;
- Communications – continued technical collaboration with various agencies including OGS, MOECC, MNR, GSC, Hydro One, Richmond Hill, Trent Univ., Univ. of Waterloo; Univ. of Guelph; Clarington;
- Communications – authored or co-authored 2 journal papers; conference/network presentations

### Highlights – Budget

- Program delivered on budget;
- No planned increase for 2016;

Program Component	2015 Budget
Staff Costs (Wages + Benefits)	\$599,000
Office Costs + Disbursements	\$52,000
Computer + Software Costs	\$12,500
Consultant Costs	\$5,500
Contingency Allocation/Carryover	\$31,000
<b>Total</b>	<b>\$700,000</b>



## **Review – 2015 (Detailed Summary)**

In 2015 the YPDT program advanced on several fronts, particularly in terms of data accessibility and in terms of numerical model management. In January of 2015 the office moved from the Downsview Park location to the consolidated TRCA offices in Vaughan Ontario. This necessitated the shutting down and moving of the servers and associated functions (website, database access, etc.).

### **1. DATABASE**

Through 2015, the program's comprehensive database continued to be actively managed with new data incorporated and existing data upgraded and improved. The database continues to serve as a foundation for the partner agencies to use in reviewing the hydrogeology of their jurisdiction, and in particular in making day-to-day decisions related to daily work flow processes (e.g. development review, servicing plans, environmental assessments, Source Water Protection, etc.).

In January the servers were moved to the new TRCA offices and new independent internet connectivity for partner agency staff website and database access was re-established. The servers were configured so that they worked effectively and were accessible to program staff through the TRCA's network.

Through most of 2015 four agencies continued to have direct accessibility to the database via the internet such that they could add new data to the database at their offices and the data would flow back to update the master database at the program's server situated at the TRCA's Vaughan offices. New data added by program staff also flowed to the partner agency in a similar fashion. With their migration to SQL 2014 in the fall of 2015, NVCA could no longer synchronize their database, leaving only three of the thirteen agencies with synchronization capabilities. Note that all partner agencies are provided with various forms of the database (e.g. standalone SQL, Access, Excel (summary of key data) at the technical meetings of the YPDT program (April and October in 2015) and can also request updated copies of the database at any time over the course of the year). As a result of the declining use of the "replication" process a decision was taken by partner agency staff at the October technical meeting to phase out the use of the replicating database. In addition to the declining use amongst the partner agencies, the SQL replication process was continuing to prove difficult to effectively manage and was also posing a cumbersome overhead in terms of connection speed and therefore work efficiencies when the database was linked with key program software packages. For these reasons, it has been proposed that replication be replaced with a more straightforward accessibility over the internet directly to the master database.

In December 2015 with the updating of the York Region temporal data the replication process became "hung up" and the use of the replicating database was officially terminated. A non-replicating copy of database was established as the "Master" program database. This database continues to be backed up nightly with off-site backups stored weekly. Partner agency access to the master database will temporarily be provided via remote desktop until the new methodology is established early in 2016.

During 2015 work related to the database was considerable. Tasks can be categorized into one of four areas:

- a) Additions;
- b) Corrections;
- c) Accessibility; and
- d) Software/Hardware Management.

#### **1a. Additions**

Over the course of 2015, over 2,000 new wells have been added to the database and over 1,400 new documents have been added to the library (in 2015 library updates involve student support). With respect to the temporal

data some 2 million new chemical analyses results, 133,000 pumping records, and nearly 5 million water levels were added to the database.

Of particular significance, in 2015 the program's database was adopted by Waterfront Toronto, a joint municipal, provincial and federal agency, as their day-to-day management tool for both pre-existing and newly collected subsurface data. This is in light of ongoing and future work to renew the Portlands area in the vicinity of the mouth of the Don River.

In 2015, the following significant data sets/initiatives were incorporated into the program's database:

- new boreholes, as well as the associated water level, chemistry, and soil chemistry data from various site investigations in Toronto's Portlands area;
- chemistry data from the MOECC Drinking Water Surveillance Program;
- chemistry data from the recent Ontario Geological Survey's background geochemistry project (Stuart Hamilton);
- water level and chemistry data for the PGMN wells (either downloaded from the MOECC website or acquired from the CA partners);
- water level, pumping and chemistry data from York, Peel and Durham Regions;
- water level data from various miscellaneous Conservation Authority owned wells;

### **1b. Corrections**

The following aspects of the database were either implemented for the first time or reviewed and corrected. Many of these corrections are linked to inaccuracies or errors within the MOECC WWIS. Simple yet effective querying of the database reveals such errors as screens/geological layers or borehole construction details that are either below the bottom of the well or above the top of the well.

- Borehole Depths (D\_Borehole) – for all wells (in particular this was needed for the MOECC WWIS wells) the depth has been corrected to tie into the deepest record associated with the well record (e.g. any borehole construction element (casing, screen, etc.) or geological layer);
- Location Elevations (D\_Location\_Elev) - reviewed and corrected (either surveyed or tied to the MNR DEM);
- The D\_Geol\_Layer table was corrected such that the tops and bottoms of each geological layer were checked to ensure that the bottom of one layer was not below the top of the next layer, etc.
- The reported screens in the D\_Interval\_Formation table were reviewed to ensure that each screen had a top and bottom and that the reported screen interval was above the bottom of the borehole; any duplicate screens were also resolved; the depth of each screen (both the top and the bottom) was added to the D\_Interval\_Monitor table;
- The bedrock elevations were recalculated and re-populated into the D\_Borehole table to make the querying of wells that reach bedrock easier to extract from the database;
- Correction of water levels to ensure they were not beneath the bottom of the well.
- Correction of elevation problems (geology);
- General correction of borehole geology (for water levels);
- Update of soil intervals (correction of depths);
- Modification of climate station names (in source tables);

### **1c. Accessibility**

Under this category, work was undertaken to improve partner agency staff access to the database. Much of the work here has involved a careful re-examination of the views held within the SQL database, and search/analysis capabilities of the partner access part of the program web site. In 2015, all of views within the database were reviewed and updated with design improvements made to: i) the relationships built between tables; ii) the indexing of records within the tables, and/or iii) the actual tables within the database. A significant improvement has been made to views that summarize temporal data. Previously, these views were very lengthy to run owing to their having to extract and summarize (e.g. average, maximum, minimum) data

from over nearly 100 million records. New summary tables which are periodically updated within the database are now used as intermediary steps leading to a much improved performance in the retrieval of information from these key temporal data-related views. At the request of partner agency staff, several new views have also been added to the database (e.g. adding pumping summaries). All of these changes have resulted in an improved overall database with views that come to completion much quicker. Work is currently under way to make the views readily accessible to partner agency staff via the program's website. This is planned for implementation in 2016.

Other database accessibility improvements that have been implemented include:

- the re-design of the way in which the screen geological formation assignment is held within the database;
- the re-design of how the PTTW records are managed;
- the re-design of how locations within the database are assigned or linked to the partner agency geography with the use of a spatial framework (including indexing) that allows for on-the-fly extraction of locations that lie within a particular polygon. (This was previously undertaken through the use of the D\_Agency table). The newly designed Sitefx 6 (database management and analysis software) might negate the need for this change once it has been fully implemented;
- the preparation and implementation, in October 2015, of a database script to re-index the many million records in D\_Interval\_Temporal\_2 on a daily basis which has significantly reduced the time necessary for uploading logger files into the database;
- the assignment of random unique ID **ranges** to each partner agency to resolve an issue with conflicting records that was discovered in 2015. With database replication it was possible within some tables for the same unique IDs to be independently assigned to new data at different agencies; all data added by any agency will now be assigned random numbers within a confined range to avoid duplicate ID assignment;
- working with Maxxam Laboratories and Peel Region to develop a YPDT-CAMC friendly analytical reporting template that can be used by all partners (or consultants) to obtain digital water quality data directly from the lab in an importable format; and
- to better optimize the readability of data through the CLOCA GIS server (for the new website), several key tables were modified allowing for improvement in the website response.

#### **1d. Software/Hardware Management:**

In order to keep the database up-to-date and readily accessible to the partner agencies there is continual maintenance and review of the program's software and hardware capabilities. Through 2015 these activities continued and wound up being significantly more involved than in previous years owing both to the office move in early 2015 as well as to the October decision to remove replication from the database. This latter decision has resulted in the need to institute a new mechanism for partner agency staff to easily connect to the database. In 2015, the following tasks have been undertaken with respect to the program's software and hardware management:

- With the move from Downsview the program's FTP server was revamped to continue allowing partner agency staff access to program files and data; the office move also required the re-establishment of the program's wireless network;
- Implementation of a new, streamlined program backup system through the setup of a Veeam server;
- New router and firewall protection implemented (Fortigate);
- Installation of a new Network Attached Storage (NAS) unit to assist with storage of numerical modelling files;
- Initiation of a process to provide a dedicated GIS server (Ubuntu Server) initially for program staff use and subsequently for partner agency staff use in order to readily access all of the program's GIS layers in a single location;
- Unscheduled server maintenance due to memory (RAID) failure which required migration and re-establishment of affected virtual machines;

- With specific direction focused on replacing database replication, the following tasks were undertaken:
  - Software Related – Investigated and evaluated possible software packages (NoMachine, VMWare Horizon (including ESXi) XenDesktop (Citrix) AnyDesk, SparkView, VirtualBox Google Remote Desktop) that could assist with connecting partner agency staff to the database;
  - Hardware Related – review of the various server capabilities/memory storage enhancements/GRID (tied to speeding graphics capability)/solid state drives/RAM

The program's extensive database manual (approximately 800 pages) continues to be refined as new procedures and management aspects related to database management are integrated into the management of the database.

## **2. ANALYSIS & MODELLING**

2015 saw continued progress in terms of managing the many numerical models that emerged over recent years. The modelling sub-committee met in June 2015 to receive an update, discuss modelling issues and provide input into the program's modelling initiatives. At the completion of 2015 all numerical models (nearly 50 models in total) provided to the YPDT program by partner agencies have now been reviewed and summary reports are being finalized for partner agency staff. Similar to 2014, in 2015 the models that were reviewed were either provincially (Source Water Protection, Lake Simcoe Protection Plan) or municipally (wellhead capture zones, updates to previously constructed models, etc.) funded.

With support from the province, a "Model Management Guidance" report has been developed to document the best management practices that should be put in place to guide the province through the post-SWP era. As one of the few agencies within Ontario that is actively managing numerical models, program staff are in a solid position to lead this initiative. In addition to discussing some technical aspects of modelling, the document establishes a sound standardized directory structure to effectively store numerical modelling files, as well as providing direction on both governance and legal aspects of commissioning and managing models into the future.

2015 also saw program staff working with Ducks Unlimited and the CVC on an interesting, and potentially far reaching, project to investigate the value of wetlands in attenuating floods from high intensity storms. Within a modelling platform, precipitation from one such high intensity storm (August 2009) was introduced into the CVC watershed. Under various land use scenarios, and using cloud computing, the impact of wetlands (and their potential removal) on the landscape is being modelled using the Hydrogeosphere software code. Simulations will investigate how intense precipitation is re-distributed across the CVC landscape and the impact of wetland removal on the streamflow within the Credit River Watershed. Many components of this modelling study, from the initial conceptualization of the problem to the technical understanding of how different wetland settings contribute to precipitation re-distribution on the surface landscape (and potentially into the subsurface), can be transferred to other watersheds within the Oak Ridges Moraine Groundwater Program study area.

Technical assistance was provided to various partner agencies with respect to the following groundwater modelling related issues:

- Upper Humber River – as part of a climate change study Peel Region had asked TRCA to provide information with regards to potential baseflow changes that could be expected in the upper parts of the Humber River watershed. The York Tier 3 model was used to offer TRCA staff additional insights into the GW-SW linkages (and how they might change) in this part of Peel Region.
- York Region Wellhead Protection areas (WHPAs) – in efforts to assess WHPA delineations in York Region, Golder Associates was commissioned to evaluate how capture zone delineation using the York Region Tier 3 GSFLOW model compared with the original capture zones documented within the Regional OP that were derived from the Core Model. Program staff were asked to provide insight

from a numerical modelling perspective. To verify the results, new coding was written and the York Region WHPAs (both those derived using the original Core Model and using the York Tier 3 Model) were independently reproduced in-house using the model files that were transferred to the YPDT program and held on the program's servers. The WHPAs derived by staff were comparable to those produced by the consultants. Into the future, WHPAs will be updated at York Region based on new information (e.g. new pumping wells, new monitoring wells, etc.).

- Durham Region WHPAs – with the ability to derive capture zones from the models held within the YPDT program, the Region of Durham was also interested in examining how WHPAs produced by their 2007 Durham Region model compared against the WHPAs prepared in the late 1990s and early 2000s using very localized models. YPDT staff assisted in delivering the derived capture zones to Durham staff.
- Peel Region WHPAs – With drilling of a new well and the updated pumping regime, Matrix Resources was retained to update the WHPAs for the community of Caledon East. YPDT staff provide the technical support to: i) initially transfer the necessary modelling files (in an appropriate format) to the consultant; and ii) then to review the consultant report and provide Peel staff with technical modelling insights needed for them to better understand the report and to move forward.
- LSRCA – during 2015 work was undertaken to develop an improved methodology to incorporate Low Impact Development (LID) scenarios into a modelling framework. CA staff are confronted with LID applications on a routine basis and the recently introduced requirement to maintain recharge within the Lake Simcoe basin has focused attention on: i) how LID applications are being analysed by consultants; and ii) how such applications are being reviewed and approved by agency staff. The prepared code will be available on the program's website for incorporation into technical studies prepared by consultants working in the area.
- Miscellaneous CA support – various CAs requested technical assistance on a variety of smaller issues over 2015. An example of these inquiries includes:
  - Using multi-variate statistics (copula methods) to derive drought indices for TRCA staff;
  - Several CAs including CVC, TRCA and LSRCA were provide with technical assistance with the use of Viewlog (visualization and analysis software) or the preparation of files for incorporation into existing Viewlog projects;
  - WHPA E and F review (for GUDI) wells was provided to CVC in support of completing a SWP model review for their GUDI wells;
  - TRCA staff were assisted in evaluating the differences in groundwater discharge to various streams between the original Core Model and the York Region Tier 3 model;
  - LSRCA – staff provided technical assistance at various meetings with respect to modelling within the Lover's Ck. Watershed.

### **3. OTHER PROGRAM INITIATIVES**

2015 also saw contributions on a number of other initiatives:

**Website** – Work continued through 2015 on the re-design of the program's website, and in particular on the pass-worded section that is only available to technical staff at the partner agencies. In the fall, this work culminated in the launch of a revised site where agency staff can search for and download a number of different data sets from the database (e.g. PDF documents, cross-sections, stream profiles, well records, hydrographs, etc.). The site has been well received and will continue to be worked upon to ensure that it is user friendly and is meeting the needs of the partner agency staff. After discussing with partner agencies, in the fall of 2015 access was provide to the technical staff of the MOECC to foster a better working relationship between organizations.

**Field Work** – Staff continue to monitor a suite of approximately 20 wells to help in charactering specific hydrogeological settings that have been identified across the study area.



**Ontario Climate Advisory Committee** – as part of the task of considering the future use and updating of the available groundwater flow models across the program study area, staff have attended and contributed to this working group that advocates for best management practices in terms of collecting, managing and distributing climate information in Ontario.

**Isotope Project** – in collaboration with the University of Waterloo and York Region, staff continue to collaborate on a project to collect samples across the program study area for isotopic analyses. Results will be used to assist in groundwater flow system delineation with a view to providing independent field checks on numerical groundwater flow models.

### **Communications**

- Authored a paper entitled “A methodology for identifying ecologically significant groundwater recharge areas” that was published in the Canadian Water Resources Journal (Vol 40, No.2, - Summer 2015);
- Presented a paper entitled “Geological and hydrogeological models of the ‘Yonge Street’ aquifer, south- central Ontario at the 2015 International Association of Hydrogeologists (Canadian National Chapter) Conference in Waterloo, Ontario;
- Invited to present at the TRCA’s Lake Ontario Evening lecture series - “Toronto’s Other Lost Lake – A Glimpse into the Subsurface” was the title of the presentation;
- Presentation on south-central Ontario groundwater monitoring at the University of Guelph ORF Annual Meeting;
- Invited presentation at the Great Lakes Network meeting; and
- Invited student outreach presentations at Pleasantville Public School (Grade 4; Richmond Hill) and University of Toronto Scarborough (4<sup>th</sup> year).

### **Liaison with External Agencies**

In 2015 staff met and corresponded with various external agencies on behalf of the partners. These include:

- **CAMC** – Assisted in the production of the “Report card on the environmental health of the Oak Ridges Moraine and adjacent Greenbelt lands”, a report that was prepared in support of the 2015 Provincial review of the several pieces of Provincial legislation. Staff prepared the section entitled “Groundwater Quality” and made effective use of the water quality results held in the program’s database.
- **Ontario Geological Survey & Geological Survey of Canada** – program staff were invited to present at the 1-day symposium “Unifying Groundwater Science in Southern Ontario Workshop” held on March 6<sup>th</sup> at the University of Guelph; invited to present at follow-up “Workshop on Groundwater Data Framework and Hydrogeology Model, Southern Ontario” held at Grand River CA on November 27.
- **Ministry of the Environment and Climate Change** – presented an overview of the YPDT-CAMC GW Management Program to senior management, and subsequently to technical section of MOECC’s Central Region. In November, seventeen MOECC Central Region staff members were provided access to the pass-worded section of the program’s website to make use of the information in support of MOECC staff’s day-to-day workflow. Retired long time MOECC staff member Ross Hodgins was brought into the program as a technical advisor to: i) assist in forging better relationships with MOECC Central Region staff; ii) assist in geological and hydrogeological interpretations across the program’s study area; and iii) to transfer some of his vast knowledge into the program for the long-term benefit of all partner agencies.
- **Alberta Energy Regulator** – met with senior staff from this agency to discuss: i) model management, in particular their experience with the upkeep of models through the Deltares system; and ii) the administrative functioning of Ontario’s Conservation Authorities to support developing initiatives in Alberta surrounding public groups that are looking at ways to establish more formal watershed conservation agencies.

- **Great Lakes Executive Committee** - Staff contributed technically to the report “Groundwater Science relevant to the Great Lakes Water Quality Agreement: A status report” which was prepared by the Annex 8 Subcommittee on the Great Lakes.
- **Geological Survey of Canada** – working jointly with GSC staff on a paper (Canadian Journal of Earth Sciences) describing the geology and hydrogeology of the Yonge Street aquifer; provided background data and reports for areas in Simcoe County to support a research project.
- **Town of Richmond Hill** – continued to provide technical expertise and peer review regarding development proposals in sensitive area of artesian pressures on the flank of the Oak Ridges Moraine;
- **Hydro One** – continued with providing technical oversight and facilitation between different parties with respect to groundwater issues (including establishing a long term monitoring program) surrounding the construction of a transformer station on the Oak Ridges Moraine in the Town of Clarington;
- **Trent University** – provided background geological and hydrogeological information to Trent University researchers in support of their continued research on groundwater recharge and discharge on the Oak Ridges Moraine.

#### **4. BUDGET SUMMARY**

The four senior partners (City of Toronto, Regional Municipalities of York, Peel and Durham) each contributed \$175,000 in 2014 (Total of \$700,000). The program’s expenses for the 2015 are summarized in Table 1.

<b>Program Component</b>	<b>2015 Budget</b>
Staff Costs (Wages + Benefits)	\$599,000
Office Costs + Disbursements	\$52,000
Computer + Software Costs	\$12,500
Consultant Costs	\$5,500
Contingency Allocation/Carryover	\$31,000
<b>Total</b>	<b>\$700,000</b>

The program was completed on budget in 2015 and no budget increase is projected for 2016.

## **2016 WORK PLAN – ONGOING/UPCOMING TASKS**

### **1. DATABASE RELATED**

#### **Task 1.1- Migration to SQL 2014**

The database is being prepared for migration to SQL 2014. The last task that needs to be undertaken is a test on the new structure to ensure that it is compatible with the database management and analysis (e.g. Sitefx) software. Once completed, the database will be converted to SQL 2014.

- **Benefits:** the migration of the DB to SQL 2014 will allow the application of Cloud (and other remote or at-arms-length) technologies to support alternate means of partner access to the database.
- **Estimated Timeline:** February 2016

#### **Task 1.2 Investigation of Replication Replacement**

For the past few years, the database was set up such that data added to any of the partner databases was replicated back to the master database on the YPDT server. The replication process has proven to be cumbersome in that it imposes a significant overhead both in terms of database performance and in terms of memory requirements. There are also issues with respect to variable partner IT situations related to security and software versioning. As an alternative to replication, and given the current ability to quickly access information over the web, staff proposed at the October 2015 YPDT meeting to investigate whether there are improved, secure, on-line options that can be used to provide easy and fast database accessibility with increased functionality to partner agency staff.

- **Benefits:** Considerable database performance improvements are anticipated with a switch to a non-replicating database. Because of replication all activities undertaken in the database are slowed down. And although scripts and routines have been implemented to by-pass these issues (e.g. scheduling them to non-intensive time periods; incorporating and expanding the use of summary tables), the presence of background replication processes slows access to the database. To be effective, database speed is critical. In addition, removal of replication is anticipated to reduce the involvement of each partner's IT staff. The current requirement of a level-of-expertise at the partner agency with regard to software and hardware (e.g. Microsoft SQL Server as opposed to Microsoft Access; dedicated servers) would also be reduced.
- **Estimated Timeline:** Complete review/search – February 2016

#### **Task 1.3 – Implementation of revised partner agency database access**

Once the review of options outlined above is completed, then implementation of the preferred connectivity option will be implemented. Options under review include: i) storage of the database in the “Cloud”; ii) database connectivity through a web-based connection; iii) database connectivity through a “remote desktop” type application however with improved performance and interface.

- **Benefits:** Ensures continued partner access of the database.
- **Estimated Timeline:** March/April 2016.

#### **Task 1.4 – Improved migration of consultant data into the database**

To date the importing of newly collected consultant data (including all data from borehole geology information to water levels and water quality data) has been inefficient. Improvements can be made by offering standard data formatting templates (in both Microsoft Excel or Access formats) on the website. Contract documents from any of the thirteen partner agencies can be drafted to explicitly require the use of YPDT-CAMC templates from the website as a requirement of winning any particular groundwater related project.

- **Benefits:** With the movement to the digital collection of logger files via hand held devices, it would be beneficial to all agencies if consultants could readily transfer collected information directly into a standard template that would facilitate the importing of data into the database.
- **Estimated Timeline:** Posting of templates to website – May 2016; Drafting of key contract clauses to incorporate into future contracts by partner agencies – August 2016.

### **Task 1.5 - Continued improvement and expansion to the database**

The database is now 50 gigabytes in size and continues to grow as new information is appended. 2016 will see the harmonization of the York Region “operational” database with the YPDT database such that database updates will be seamless. An update of the MOECC WWIS into the database will also be undertaken in 2016. In addition database files received as part of any of the numerical model files will continue to be reviewed for additional key sources of data that can be imported to the database. Work will continue to entice staff from Central Region MOECC Office to make use of the program’s data (via the website) and to encourage them to contribute additional data into the program.

- **Benefits:** Improved data quality and additional data input to the database will enhance any studies/work that would be undertaken in support of development or construction activities.
- **Estimated Timeline:** Ongoing.

## **2. ANALYSIS & NUMERICAL MODEL RELATED**

### **Task 2.1 – Model Management/Archiving**

The YPDT program has been charged with storing and maintaining the models that have been produced by the consulting community over the past 10 years. The task has involved:

- obtaining all of the relevant modelling files from the partner agencies;
  - reviewing the files to ensure all necessary model input files have been delivered and are not corrupted;
  - opening and running the model to ensure that the model runs to completion and that it can be opened and run in the future;
  - if necessary, assisting partner agencies in retrieving missing or corrupt files from the consultant that undertook the original work;
  - design of a centralized model archiving system – the system includes data redundancy in that copies of archived models will also be stored off-site to ensure preservation of original files/data.
- **Benefits:** The benefits of this task include:
    - documented inventory of all model projects and files to ensure no loss of work/insights captured in different modelling projects;
    - ready access to any model files stored in one centralized location that can be immediately distributed for future needs;
  - **Estimated Timeline:** Completion - February 2016

### **Task 2.2 – Numerical Model Guidance Manual**

The Province has requested that the YPDT assist in the preparation of a guidance manual to help steer the management of numerical models that have been prepared through the Source Water Protection program. The manual is to discuss technical, legal and governance aspects of model management.

- **Benefits:** The document will provide partner agencies with a practical guidance manual that can be used when commissioning future numerical modelling studies. From preparing legal contract documents to seeking technical guidance on what type of model to request from a consultant the document will seek to be the “go-to” reference guide for numerical modelling studies.
- **Estimated Timeline:** Completion – March 2016

### **Task 2.3 Geological Layer Consolidation**

As one of the key building blocks for numerical groundwater modeling the geological/hydrostratigraphic layers need to be refined to incorporate any beneficial changes/insights obtained during the various modelling studies.

- **Benefits:** This task will see the consolidation of many phases of geological interpretation into a common “authoritative” set of surfaces that will extend across the entirety of the Oak Ridges Moraine drainage area. For each agency, this will continue to prove to be a significant benefit in that they can confidently provide a set of information and interpretive layers to any ongoing capital works project that involves subsurface excavation or tunneling. When provided to consultants, the set of layers allows for all parties (including staff and consultants working in adjacent agencies) to speak with a common language when referring to the subsurface stratigraphy. This task will greatly reduce the cost for future modelling work as these layers will not have to be entirely reproduced.
- **Estimated Timeline:** Completion – Oct 2016

### **Task 2.4 - Mapping of Known Groundwater Problem Areas**

A wealth of information exists within the program information and analysis system to better inform projects regarding subsurface conditions prior to commencement. This task will build on a presentation at a Canadian Geotechnical Society symposium regarding groundwater issues related to excavations to prepare regional mapping of various hydraulic settings that contain conditions pertinent to any subsurface works such as groundwater under pressure (i.e. flowing conditions) and other high-capacity confined aquifer settings. The hydraulic head and water table surface maps for the various hydrostratigraphic units will be updated to incorporate all observed data.

- **Benefits:** By having an understanding of subsurface conditions prior to project commencement partner agency staff can provide preliminary knowledge regarding overall project cost and necessary efforts. The regional maps will provide a screening tool prior to the detailed work necessary for project design.
- **Estimated Timeline:** December, 2016.

### **Task 2.5 – Low Impact Development (LID) Modelling Tools**

With the onset of many new Low Impact Development initiatives across the southern Ontario landscape, an opportunity has emerged, with SWP funding, to prepare a numerical modelling tool for addressing, at a localized scale, the potential for LID development to assist in water budget maintenance. Existing model packages do not adequately address the antecedent moisture conditions and restrictions caused by a shallow water table and therefore may over-predict the benefits expected from LID development.

- **Benefits** – Currently there are pressures on the technical staff at partner agencies to review and approve LID proposals that are based on model packages that are possibly inadequate for the task. The intent is to have the script open sourced and readily available via the YPDT website. By having a modelling script that can be incorporated into existing models, staff will be able to provide the script to consultants for use in assessing the proposed development. This will lead to improved assessment of LID proposals.
- **Estimated Timeline:** Completion - March 2016

### **Task 2.6 – Benefit of Wetlands**

In partnership with Ducks Unlimited, staff are leading a sophisticated, leading edge modelling study that will assist in determining the economic benefit of wetlands. The modelling exercise is geared at understanding the role of wetlands in alleviating flooding, in particular during intense climate events.

- **Benefits:** Not only is the study assisting Ducks Unlimited and CVC (as well as all Conservation Authorities) to better understand the role of wetlands in flood attenuation, but the study has also

proven to be of benefit to the overall program direction by allowing a first experimentation with, and transitioning to, cloud computing through the University of Toronto's SciNet computing centre. The study has also allowed staff to gain skills in modelling individual climate events. Intense climate events are likely to be a topic of considerable interest as a new dynamic introduced through climate change.

- **Timeline:** July 2016

### **Task 2.7 – Investigation into Online Model Executables**

There has been an interest in ensuring that the numerical models developed over recent years are made available for more widespread use than is currently the case. One possible solution is to develop an on-line executable (e.g. input pumping rate, location, and aquifer – model run would return drawdown at a municipal well) that would allow for non-modelers to gain insights from models for various water management decision-making and quickly assess potential impacts to their water supply.

- **Benefits:** This tool, if developed, would allow for technical staff from partner agencies to gain insights from already constructed models thus extending the benefit of the models into the future.
- **Estimated Timeline:** Ongoing

### **Task 2.8 – Yonge Street Aquifer Characterization**

In co-operation with staff from the Geological Survey of Canada and York Region, the geology and hydrogeology of the Yonge Street Aquifer is being assessed. Given the preponderance of data that has been collected over the years, it is surprising that this feature remains poorly described and understood. It is proposed that a paper that better characterizes the Yonge Street Aquifer geologically, as well as hydrogeologically, be submitted to a special upcoming issue of the Canadian Journal of Earth Sciences (Surficial Geology of Southern Ontario and Applications to Groundwater).

- **Benefits:** It is hoped that the Yonge Street Aquifer and the insights from the paper will equally apply to other similar channelized deep flow system (e.g. Thorncliffe Formation) related features found both to the east and west in the Regions of Peel, York and Durham and beneath the City of Toronto (e.g., Uxbridge, Grasshopper Road, etc.).
- **Timeline:** August, 2016

## **3. OTHER PROGRAM INITIATIVES**

A key initiative in our application, communication and outreach activities will focus on enhancing the program's web site to deliver information in an easily accessible manner. Over 2016 the goal for the website is to make it much more dynamic with data being made more accessible, (both to the public and to partner agency staff) in a variety of user friendly formats (charts, graphs, etc.). The website will also be used to enhance the technical content currently available by providing additional technical insight pieces that succinctly summarize different hydrogeological analyses that have made effective use of the vast store of data in the database. The program's information search and analysis tools available on the website will reduce the need for extensive knowledge regarding how to use various individual software packages (e.g. Sitefx, GIS, SQL Management Studio, etc).

### **Task 3.1 – Web Site Cross-sections**

The cross-section tool that is currently available on the partnered website page will be expanded such that cross-sections will be available beyond the core model area – to include much of the entire study area extending from the Credit to the Trent River watersheds. The tool will be moved to the public part of the website and made available to the public.

- **Benefits:** Making a cross-section tool available to the public will allow for consultants to undertake checks of the geology beneath properties they are working on. By making use of the conceptualized geological model that has been developed under the program, it is hoped that this will lead to a consolidation of the model as the standard across the program study area.
- **Estimated Timeline:** Completion – April 2016

### **Task 3.2 – Web Site Hydrographs**

There is an abundance of information that has been assembled into the program's database. One key attribute of the database is the storage of long term water levels and water chemistry information. To make the data more available it is proposed that a new page be developed for the website where a series of hydrographs and chemographs will be made available by selecting a well on a map.

- **Benefits:** Access to a series of hydrographs across the geographical extent of the program area will enable visitors to the site to examine the long term groundwater level patterns and water quality trends associated with various aquifers and geographical locations across the program area. This will assist in minimizing any misperceptions pertaining to the long term pumping impacts on the groundwater quantity of pumping. This will allow partner agency staff to quickly direct members of the public or senior management to a spot for ready "one stop shopping" related to groundwater information.
- **Estimated Timeline:** June 2016

### **Task 3.3 – Web Site Database Access**

In order to make more effective use of the program's database, it is proposed that access to the database including "Tables" and "Views" be provided to partner agency staff through the website. Access will be provided through a Microsoft Access or SQL Management Studio interface as well as through a searchable mapping interface.

- **Benefits:** having on-line access to the database will allow staff from both partner agencies as well as YPDT staff to show and search for information while at meetings away from the office. This capability allows outside agencies (e.g. consultants, environmental groups, provincial agencies, etc.) to gain an understanding as to the comprehensive nature and magnitude of the database. They will appreciate how it can change work patterns at many agencies across the study area.
- **Estimated Timeline:** June 2016

### **Task 3.4 – Web Site Report Library**

The reports in the library have been processed with optical character recognition (OCR) technology such that the text within a report can be searched on the website search engine. Certain reports have also been re-scanned to improve readability. There are still some issues with respect to the report file naming convention (i.e. unrecognized characters, file names too long, etc.) that are being standardized.

- **Benefits:** The switch to using Microsoft Sharepoint for the website has allowed for the scanned PDF reports to be more effectively searched within the library using key words contained within the report itself. The improvement to the file naming structure and the improved file management system will ensure that all available reports are effectively searched and made accessible through the website.
- **Estimated Timeline:** June 2016