



Credit Valley Conservation
 Nottawasaga Valley Conservation
 Toronto and Region Conservation
 Lake Simcoe Region Conservation
 Central Lake Ontario Conservation
 Kawartha Conservation
 Ganaraska Region Conservation
 Otonabee Conservation
 Lower Trent Conservation
 Conservation Halton

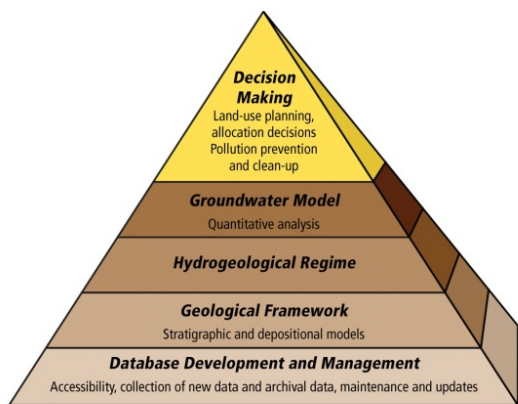


ANNUAL PROGRAM OVERVIEW (2021) & WORK PLAN (2022)

TO: ORMGP Executive Steering Team
 FROM: Steve Holysh & Rick Gerber
 DATE: April 18, 2021
 RE: **2021 Overview/2022 Work Plan – Oak Ridges Moraine Groundwater Program (ORMGP)**

Background

The Oak Ridges Moraine Groundwater Program (ORMGP) 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.



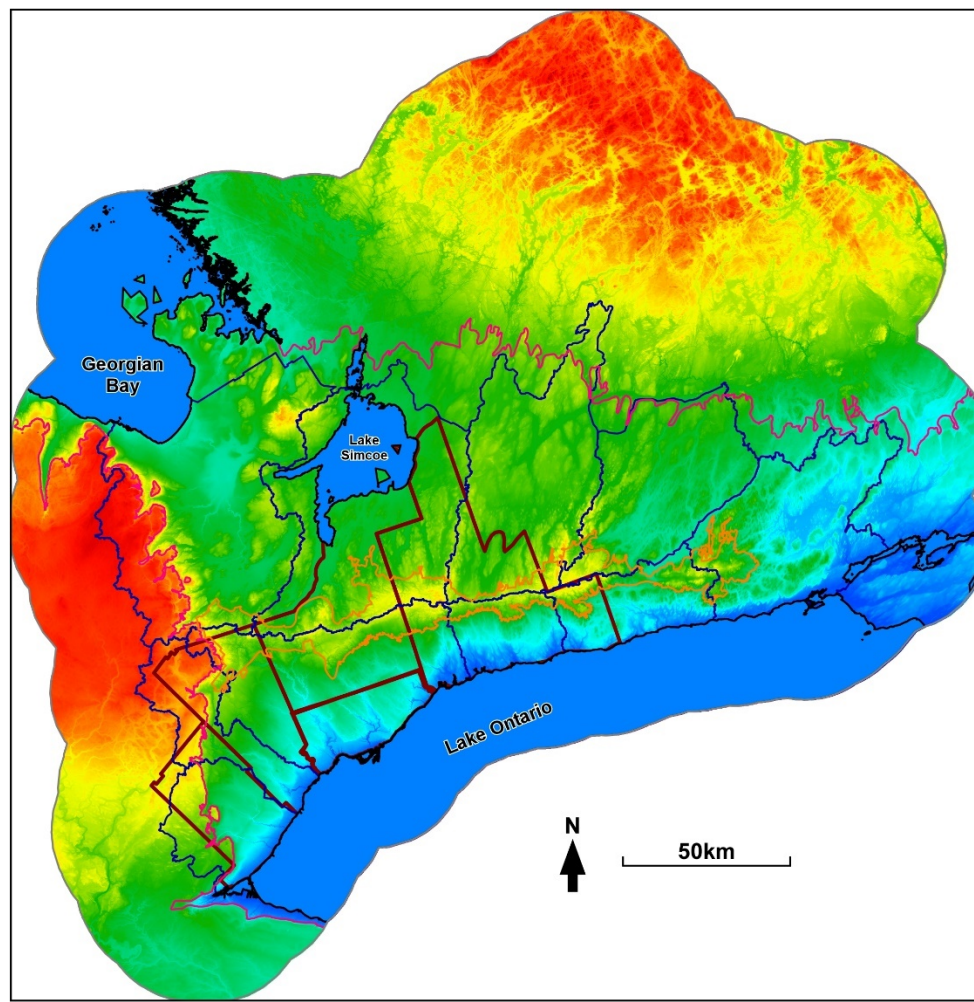
Mandate

The mandate of the ORMGP 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 ORMGP 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 interpreted subsurface layers that is accessible to all partner agencies;
- Build, maintain and disseminate numerical groundwater flow models 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 Drinking Water Source Protection teams to ensure that interpretations used in source protection technical work 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;
- Provide technical support to all partnered agencies for addressing other Provincial legislation.

Further information regarding the program can be found at oakridgeswater.ca.



Program area - Note that for data management purposes the program area comprises: 1) the entirety of three Source Water Protection (SWP) Regions: a) Credit Valley/Toronto and Region/Central Lake Ontario (CTC); b) South Georgian Bay - Lake Simcoe (SGBLS); and c) Trent Conservation Coalition (TCC); and 2) the Halton Region and Conservation Halton portion of the Hamilton Halton SWP area. Focus of work is largely directed to the GTA municipalities (York, Peel, Durham, Halton and Toronto) and their associated Conservation Authorities (CAs).



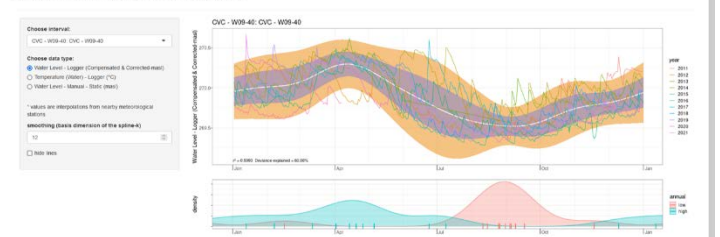
1. Database

- added this year – over 24,000 boreholes; 590 reports; 13 million temporal records;
- 2021 logins to website: Consultants = 4,439; Agency Staff = 5,300; Public = 3,738;
- New online version of Database Manual released (<https://owrc.github.io/database-manual/Contents/TOC.html>)
- Added Halton Region wells to database and identified/renamed municipal wells;

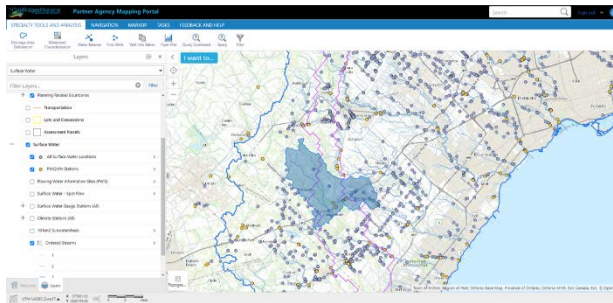
2. Analysis & Modelling

- long term (≥ 100 year) climate interpolations available anywhere in study area powered by the ORMGP Delft – FEWS system;
- ‘Area of Concern’ mapping in Vaughan;
- Continued work on geology ‘harmonization’ with incorporation of Halton and new Durham model layers
- Continued work on Oak Ridges Moraine focused chapter for an international Groundwater eBook;
- technical insights and contributions to modelling studies for Halton, Durham, Peel and CVC;

Annual variability/High-Low Occurrence



3. Other



- Communications – invited to present two talks at PGO Annual Symposium;
- DNAPL presentation to CTC and Cons. Ont. SWP teams;
- continued collaborative partnerships with consultant firms (18 firms in total);
- initiated work for MECP to investigate GW flux and salt loadings to L. Ontario;
- new theme maps on website ‘Hydrogeologic Properties’ & ‘Surface Water’

4. Budget

- Program delivered within available funds - no planned increase for 2022;

Program Component	2021
Staff Costs (Wages + Benefits)	\$729,900
Office Costs + Disbursements	\$82,208
Computer + Software	\$42,630
Consultant/Services	\$27,065
Administration	\$16,187
Total	\$897,990



Review – 2021 (Detailed Summary)

The following provides a more detailed overview of activities undertaken through the Oak Ridges Moraine Groundwater Program through 2021.

1. DATABASE/WEBSITE

Through 2021 the program's database structure/schema remained robust. The information contained within the database was refined and improved through 2021 with continued use of SQL 2016 to facilitate database management. The discussion of database and website issues has been broken into four categories: Additions; Corrections; Accessibility and Software/Hardware Management.

1a Additions

- An updated WWIS database was obtained in January 2021 from the MECP and 24,615 new well records (including decommissioning records and well upgrades) were brought into the database – at the time of this import the MECP wells were up to date as of about June 2020;
- New boreholes: i) tied to older City of Toronto geotechnical and hydrogeology reports; ii) wells required by Halton Region in order to add their temporal data (WLs, pumping, chemistry, etc.); iii) other miscellaneous BHs entered from documents in the report library were added to the database over 2021. In addition to the MECP wells, approximately 240 additional wells/boreholes were added in 2021;
- Approximately 590 new documents were brought into the library over 2021;
- The Provincial Water Quality Monitoring Network (PWQMN) data, consisting of some 800 new locations, was brought into the database to supplement the “Surface Water” theme map;
- In total approximately 13 million temporal records (chemistry, water levels, stream flow, etc.) were added in 2021 – this number reflects the import of regional data, updating of the PGMN water levels and chemistry, as well as the updating of climate and stream flow data from Environment and Climate Change Canada; and
- The database manual was revised/updated and a new version released - <https://owrc.github.io/database-manual/Contents/TOC.html>.

1b Corrections

- In moving forward with a review and update of the geological and hydrogeological surfaces, program staff continued to review and correct MECP wells with respect to: i) discrepancy between metric and imperial units and ii) poor geological interpretations; and iii) incorrect locations. Most of the unit issues have been corrected, however it is expected that future wells with more subtle unit issues will reveal themselves as they are inspected;
- With the development of the Hydrogeologic Properties themed map, over 2021 there was considerable work directed at evaluating the results of the specific capacity, hydraulic conductivity and transmissivity analyses. This exercise resulted in numerous additional corrections (including to water levels, units and location coordinates) to the data from the MECP WWIS database.

1c Accessibility

- Through 2021, 18 consultant companies are partnered with the ORMGP under consultant agreements (Azimuth, WSP, exp, Golder, GEMS, Dillon, Burnside, Hatch, IBI, Jacobs, Whitewater, Gaman, Terraprobe, Soil Engineers, Matrix, GHD, SLR, Aqua Insight);
- 384 individual accounts now exist for consultants;

- user accounts for technical agency staff remained relatively stable at 337 accounts - several staff turnover moves resulting in a small number of accounts deleted and others created;
- temporary accounts were created for the University of Guelph where the website was the focus of several required hydrology assignments for a 2nd year engineering course;
- On the public side of the website, the number of visits increased from 2,693 to 3,738 - the website continues to attract general users looking for water related information;
- Building upon the introduction of non-MECP (MOE) BH logs in .PDF format (go to Boreholes Map – choose “Boreholes with Supplementary Log”) to the website, around 400 new PDFs were uploaded and added in 2021 with the total of available non-MECP BH logs now reaching 2,697. This initiative allows for these consultant logs and other older logs from GSC or OGS staff to be readily accessed on the website;
- ORMGP began a process of building a new tool that would allow for staff at partner agencies to import logger data into the master database. A computer science student was hired in the summer months and progress was made in scoping a path forward and coding for the tool was initiated. Although the project was incomplete when the student had to leave early for health related reasons, it is expected that this initiative will be further developed, and hopefully finalized, in 2022.
- The many ‘R’ based statistical tools available for piper plots, as well as for climate and surface water analyses on the website have continued to be adjusted and refined to deliver high quality analyses to technical staff visiting the ORMGP website;
- in 2021 the Groundwater Hydrograph tool was adjusted to display rain and snowmelt as two separate parameters, thus over-riding the need for the term ‘Atmospheric Yield’ which was introduced in 2020. As discussed below, this was possible by undertaking a new approach for water budget related analyses using Delft-FEWS system. Hydrographs are now flexible in that users can decide whether to show (or not) the rainfall and snow melt individually on the hydrograph tool. The tool continues to allow for users to see several statistical elements related to the groundwater level as well as to directly compare responses in groundwater level to climatic drivers (i.e., rainfall/snow melt);
- The Citrix Xendesktop platform, which allows for partner agency staff and ORMGP staff to access the program’s database and ORMGP files continues to be one of the main ways for staff to interact and update the ORMGP database.
- In 2021, beginning with the Water Table discussion, staff began to develop GitHub based metadata sheets as well as ‘fact sheets’ that describe various analyses that have been performed to arrive at the final maps made accessible on the ORMGP website. This will continue through 2022 (see [ORMGP Metadata](#)).

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. No new purchases were required in 2021, however there was a software update through DHI that was required in order to maintain DHI software in working order (e.g., MikeShe, FeFlow, etc.).

Through 2021, with the ongoing Covid pandemic, ORMGP staff continued to work remotely as the offices at TRCA and CLOCA remained temporarily closed. Remote access to the Program’s servers, which are now largely operated out of CLOCA’s offices, was smooth and unhindered as remote work was the norm through 2021.

The following tasks continue to be undertaken with respect to the program’s software and hardware management:

- database management workflows that were reconfigured to work within Citrix platform in 2017 have continued to be used through the 2021 calendar year. As in the past, the backing up of the database continues to be a focus of the program and was unchanged in 2021:
 - The database resides on a server at CLOCA which is continually backed up through VEEAM backup system server software – should there be a power failure or database glitch, the database can be restored from a short-term backup in very short order; the VEEAM software stores multiple versions of the database which are eventually overwritten with subsequent, more recent backups;
 - on a weekly basis (every Sunday) the following steps are automatically transacted:
 - the database is backed up to a separate CLOCA based fileserver (this copy is dubbed the “weekly database”) and is subsequently made available: i) for use via the program’s website to share data with the outside community; and ii) as the ‘weekly’ database which may be accessed by the partners through the ORMGP Citrix machines. This database has both read and write access and can be used for training and testing purposes.
 - a copy of this backup is placed on a separate ORMGP server (newly introduced at CLOCA) that functions as a central storage facility holding database versions dating back in time. These older backups are available on a monthly basis. The previous eight weekly backups are also stored here.
 - this database is automatically transferred/written to an ORMGP server at TRCA’s offices (used by ORMGP staff to interact with, review and check the database);
 - over the long term, backup copies of the database are held off-site (along with backups at CLOCA) should they be required;
 - The primary numerical model archive (part of the model custodianship program) has been relocated to a server at CLOCA. A duplicate archive is kept off site and synchronized regularly. For added redundancy, two additional copies of the archive are also kept in separate locations off-site, however they are synchronized less regularly.
- To ensure partners have the ability at their own offices to use software products (e.g., Viewlog, Sitefx, and others) and to review/access/QA/evaluate their data held in the ORMGP database, a cut of each partner agency data set is usually distributed (in SQL and/or Access format) at the ORMGP technical meetings (i.e., usually twice per year or more often if requested). In 2021 this database access was provided remotely using Drop Box.

2. ANALYSIS & MODELLING

The following initiatives were undertaken through 2021.

Technical Model Contributions

Through 2021, in addition to the numerous analyses highlighted below, ORMGP staff continue to communicate with software developers to discuss modelling code, at a high technical level, and to provide input regarding suggested fixes and/or improvements to existing software codes (e.g., discussions continue to be held with the developers of GSFLOW, HydroGeoSphere, Raven, and CSHS HydRology).

Durham Region Numerical Model

Through the early parts of 2021 ORMGP staff worked with the GeoProcess/S.S. Papadopoulos consulting team and Durham Region staff as the modellers worked towards preparing a final report. The process of delineating Environmentally Significant Recharge Areas was the topic of a few meetings as the modelling

project neared completion. ORMGP staff provided a review of the modelling report and files and met with the consulting team and Durham Region to address comments as the report was being finalized.

Peel Region Numerical Model

Peel Region's numerical modelling project, with a revised focus and a new modelling team (Aqua Insight) was also ongoing throughout most of 2021. The modelling initiative was revised to focus on the update/revision to the delineation of WHPAs for Peel's communities. ORMGP staff assisted Peel as required during these unanticipated events.

Storage of Gridded Data (FEWS)

Work within the Delft-FEWS environment progressed through 2021 with efforts advanced in refining water budgets in preparation for updates to the water budget tool (planned for 2022), and in being able to directly read/display FEWS results via the website. This allowed, for example, the previous 'Atmospheric Yield' values to be removed from the database. This provides for a more streamlined database and an improved rainfall/snow melt analysis to be served up directly to the ORMGP website (e.g., hydrograph tool, etc.). The program's ability to manage gridded sets of information continued to improve in 2021.

Specific Capacity, Hydraulic Conductivity and Transmissivity

In early 2021 work continued on implementing a database routine that determines the transmissivity (T) and hydraulic conductivity (K) of aquifers from Specific Capacity estimates, and in particular checking anomalous values to determine whether the digital data acquired from MECP (e.g. water level readings, units, coordinates, pumping test rates, etc.) was accurate. A new theme map "Hydraulic Properties" was introduced to the ORMGP Geocortex mapping in 2021.

Water Table/Potentiometric Surface/Potential Discharge Areas/Vertical Gradient

2021 saw an update to the ORMGP Water Table and associated maps. To provide more clarity in how the water table surface is being developed, two Water Table maps are now offered on the website, one that is largely data driven from the well record database and the second prepared by incorporating a number of supplemental data sources and processes (e.g., stream polygons, deeper wells in certain areas, etc.). Associated meta data and a description of the mapping construction was also updated (see [Water Table Metadata](#))

Time Series/sHydrology Analyses

Through 2021 the groundwater, surface water and climate time series analysis packages, including the graphs and statistics, that are currently running on the program's website have been continually enhanced and refined, based on the recommendations and needs of partner agencies. Stream flow and climate data from Environment and Climate Change Canada's website continues to be regularly uploaded into the program's database. As new data are regularly added nightly, the statistical analyses are automatically updated. Users continue to be able to select a stream gauge or climate station location and then undertake a wide variety of analyses of the data (e.g., seasonal and monthly trend analyses, baseflow analysis, return period, flow frequency, etc.). As an example of the applicability, website visitors can now quickly determine whether the previous month was either hotter/colder or wetter/drier than the long-term average.

The following aspects of the time series/mapping analyses or what is being internally referred to at ORMGP as the "sHydrology" toolkit, were worked on in 2021:

- work was initiated to develop a tool to visually investigate gaining and losing reaches of streams, using both the results of spot flow surveys, as well as the results of numerical modelling studies;
- work has been initiated to build upon the Piper Plot tool to more readily present the results of water quality analyses (both SW and GW);
- the search of intervals (well screens) has been expanded such that monitoring nests can be detected and the data from all intervals tied to a nest can be displayed;
- groundwater level variability continues to be investigated with mapping anticipated in 2022;

- the Delft FEWS system was utilized to obtain long term (100 year) spatially and temporally interpolated climate data from anywhere in the ORMGP study area (to obtain results users can right click at any location on any theme map within the Geocortex mapping portal);
- a drainage delineation tool has been developed that allows for the drainage area to any point to be shown on the map (to obtain results, users can right click at any location on any theme map within the Geocortex mapping portal);

Geological Layer Harmonization

2021 saw work advanced to incorporate geological layers through the Halton area. Tier 3 related numerical models were received from Conservation Halton, and the geological layers that were available within those models were incorporated/appended to the existing 2018 surfaces to create a revised set of 2021 ‘master’ surfaces. At the same time the new Durham model surfaces were also incorporated into this 2021 set of surfaces. At the end of this exercise, the geological layers now extend to the Hamilton area and they encompass the new ORMGP study area in its entirety. The layers have been uploaded to the Cross Section tool on the website and are fully accessible via the ORMGP website.

Groundwater eBook

Through 2021 work continued on an Oak Ridges Moraine focused chapter (the only Canadian contribution) to an international Groundwater eBook that is slated to be an anchor for the “Groundwater Project”. This is an international effort led by Dr. John Cherry to provide educational groundwater related materials to the global community. This will provide an opportunity to showcase the collective ORMGP efforts to a broad audience.

“Areas of Concern” Mapping/Analyses

In 2021 work continued on the “Areas of Concern” mapping. Work in Vaughan was finalized in August 2021 and a new initiative in Whitchurch-Stouffville was initiated. In general, this work has a focus on the artesian conditions that naturally exist on the slopes of the Oak Ridges Moraine. This condition occurs as a result of the pinching out of the Oak Ridges Moraine aquifer sediments in moving away from the crest of the moraine as the elevation declines. The Oak Ridges Aquifer pinches out between the overlying surficial aquitard layers (e.g., Halton Till) and the underlying Newmarket Till. Excavations or wells drilled along this part of the moraine, should they breach the upper confining aquitard, can lead to considerable groundwater problems that cost significant time and money to resolve. Mapping is prepared that shows areas where proposed developments/excavations might result in ‘unexpected’ groundwater problems (and associated costs).

Miscellaneous technical support

Due to the Covid work at home directives, support and communication with partner agency staff was conducted via phone and/or on-line through 2021.

York

- along with York technical staff, presented to York senior management (Growth Management Committee), an overview of ORMGP and its effectiveness in York Region;
- provided hydrogeological and geological technical support on Vaughan and Whitchurch-Stouffville “Areas of Concern” mapping, and for Ballantrae and Nobleton water supply investigations;
- attended York-MECP liaison meeting to discuss various issues;
- attended liaison meeting with York staff to exchange ideas and hear of ongoing work plans at York Region;
- met at York offices to review/log drill core from Ballantrae MW 23;
- imported monitoring data from York database into ORMGP Database.

Peel

- provided technical support and comments to help address and move forward with new direction for regional numerical modelling initiative;
- assisted Peel staff in ensuring their monitoring data was checked and uploaded to the database throughout the year.

Durham

- continued support to Region and Burnside staff to ensure process for migration of monitoring data into database is working and accessible for uploading of data;
- continued to provide technical support and comments with respect to the regional modelling initiative.

Toronto

- continued to input reports and boreholes from Toronto into the ORMGP database;

Halton

- worked with Halton staff to identify key wells in the ORMGP database that are important for the Region;
- reviewed and provided input into the Terms of Reference document for the Tier 3 numerical model update study;
- reviewed and provided support for Halton Program to enhance the monitoring of surface water quality;
- working with modelling team (Aqua Insight) to provide/exchange data and knowledge;

TRCA

- continued to link to TRCA database thus allowing all TRCA surface water stations to have statistical analyses performed via the program website;
- assisted staff in ensuring monitoring data (Seaton, PGMN, etc.) was brought into database properly and is accessible on the website;
- brought spot flows into the database and initiated work on a routine to map gaining/losing reaches of streams based on spot flow measurements and on numerical modelling results;
- assisted in TRCA's Etobicoke Ck watershed study contributing to technical discussions and with numerical modelling to investigate how different future land use scenarios might influence water budget components within the watershed;

CLOCA

- continued to provide technical support with respect to the Ontario Hydro One facility (i.e., establishment and operation of long-term groundwater monitoring location) in the Municipality of Clarington;
- provided overview of ORMGP program to Board of Directors.

CVC

- provided an overview of the ORMGP to Board of Directors;
- provided technical support for delineating Highly Vulnerable Aquifers (HVA);
- continued to provide technical support for: i) MIKE SHE water quality focused modelling being undertaken in cooperation with University of Guelph; and ii) groundwater flood mapping for the CVC "Flood Risk Management and Return on Investment Tool";

LSRCA

- provided technical support regarding the use of the drainage delineation tool, and for incorporating new wells into WHPA updates;

LTRCA

- provided overview of the ORMGP to the Board of Directors.

ORCA

- met with ORCA SW staff to review SW graphs/statistics on ORMGP website and to seek input as to additional ways that data can be analysed to support ORCA staff;

Barrie

- provided technical support regarding issue of deep foundations and the interconnecting of aquifers in the Barrie area.

MECP

- worked with MECP staff on project to investigate groundwater discharge to Lake Ontario (both direct and indirect) as well as the potential contaminant (salt) loading to the lake.

3. OTHER PROGRAM INITIATIVES

Over the course of 2021 a number of other initiatives also formed part of the overall work program.

Website – Partnership agreements with consulting firms were initiated in early 2018 and have continued, with the end of 2021 marking the third full year of this program. Through 2021 there were eighteen consulting firms partnered with the ORMGP whose staff are now actively using the password protected side of the website. ORMGP staff track the number of consultant logins to the website by each consulting firm and provide that information back to the consulting firm so they can be kept apprised of the value they receive from their ORMGP partnership.

The ongoing partnership between ORMGP and the GIS staff from Central Lake Ontario Conservation Authority (CLOCA) continued with a focus on enhancing the program’s mapping section of the website. Enhancements to the Geocortex mapping tool on the website continue to improve the ability of users to efficiently explore the vast data and information sets assembled under the program.

In 2021, some of the more significant updates to the website included the following:

- introduction of new ‘Hydraulic Properties’ theme map showing specific capacity, hydraulic conductivity and transmissivity results;
- introduction of new ‘Surface Water’ theme map allowing users to view ordered streams as well as other surface water related data and information on one map;
- changes in the list of available information from the Pop Up box when users select a well.

Memorandum of Understanding (MOU) – In early 2021 the MOU was signed by all partners in the program. The MOU will guide the ORMGP through to the end of 2030. Given the lateness of Halton Region’s (and Conservation Halton’s) intent to join the ORMGP partnership, there are two separate MOUs, the first being signed by the original 13 partner agencies, and the second slightly revised version, being signed by Halton Region and Conservation Halton. Both MOU documents were circulated to all partners in early summer 2021.

Report Library – in 2021, with the shut down of office work places, opportunities for any partner agency to hire summer students to help inputting reports and data to the ORMGP were limited. As a result the number of reports entered into the library continued to be limited, never-the-less, some 590 reports were added to the program library over 2021.

Lake Ontario Flux Project – through 2021, staff worked on a project to assist the MECP in characterizing groundwater movement to Lake Ontario, as well as with estimating the salt flux to the lake via groundwater. Owing to both: i) the large number of groundwater chemistry analyses held in the program’s files; and ii) the availability of the many numerical models within the ORMGP, it was reasonable that this task be undertaken within the program.

Field Work – Staff continue to monitor a suite of approximately 40 wells to help in characterizing specific hydrogeological settings that have been identified across the study area. Some of these monitoring locations have continuous measurements extending back to 1994.

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, in 2021 staff continued to attend and

contribute to this working group that advocates for best management practices in terms of collecting, managing and distributing climate information in Ontario.

Standards Council of Canada – Being recognized as leaders in environmental data management, ORMGP staff were invited to serve on the SCC’s technical committee for drafting data standards for automated meteorological stations in Canada.

Great Lakes Water Quality Annex – ORMGP staff were invited to assist the Province with the updating of Groundwater Annex report within the Federal Great Lakes Water Quality Agreement. Specific work has focused on the chapter that is addressing urban groundwater issues. A draft chapter was submitted in summer 2021.

Communications/Analyses

In 2021 ORMGP staff were invited to present or meet with various external agencies on behalf of the partner agencies.

- Assisted with the organization of the annual Ontario Geological Survey (OGS)/Geological Survey of Canada (GSC)/Conservation Authority Open House held online in February 2021;
- Continued to be active in SoSmart and continued joint initiative to obtain stream temperature database from MNR;
- Assisted with TA training and set up ORMGP website accounts for students at University of Guelph enrolled in a fall 2021 on-line engineering hydrology course;
- Agreed to be part of STORM on-line video series to assist with outreach and education of groundwater issues on the Oak Ridges Moraine;
- Provided in person or on-line ‘Lunch and Learn’ or similar talks to the following groups to promote increased use of the ORMGP website: Jacobs, Hatch, GHD, and IBI Group,
- Met on several occasions with City of Ottawa staff to provide technical support to their Groundwater Information Project (GIP);
- Contributed two talks to the Professional Geoscientists of Ontario (PGO) Annual Symposium, which was held on-line in April, 2021. Titles of talks were “Water management and big data – are we there yet?” and “Groundwater resource decision making – the power of the collective”;
- Presented on contaminant (DNAPL) hydrogeology to the CTC Source Protection Committee and subsequently to the Conservation Ontario Drinking Water Source Protection Committee;
- Continued to contribute to the Greenbelt Foundation by serving on the Advisory Committee that reviews incoming proposals;
- Joined Canadian Hydrological Model Stewardship (CHyMS): a Canadian collaboration/web server hosted by the National Research Council Canada to assist in the development of the Raven model.

4. BUDGET SUMMARY

With Halton Region joining the program for 2021, there were five senior partners (City of Toronto, Regional Municipalities of York, Peel, Durham and Halton) that each contributed \$175,000 in 2021 (Total of \$875,000). In addition, the program received \$79,900 from consultant subscriptions to the program. The program’s expenses for the 2021 are summarized below. 2020 costs, as well as estimated 2022 costs are also provided.

Program Component	2020	2021	2022 (est.)
Staff Costs (Wages + Benefits)	\$689,500	\$729,900	\$751,000
Office + Disbursements	\$49,200	\$82,208	\$68,000
Computer + Software	\$21,900	\$42,630	\$36,000
Consultant/Services	\$25,600	\$27,065	\$60,000
Administration	\$17,700	\$16,187	\$18,000
Total	\$803,900	\$897,990	\$933,000

The program was completed within an acceptable budget in 2021. Cost increases in 2021 were partially related to additional work being undertaken in Halton Region, both by Central Lake Ontario CA staff as well as by an additional part time service contract that was extended to an individual in the fall of 2021 to assist ORMGP staff. Given the tight budget conditions in 2020, and that staff costs/benefits rise by a minimum of the cost of living, staff initiated the process of adding a 'cost of living' adjustment to the ORMGP budget for 2021. Covid derailed this attempt in 2020 and with Halton Region joining the program in 2021, the need for this became less pressing and it was temporarily pushed back. Staff will be looking to add this cost of living adjustment to the requested funds from the funding partners going forward.

2022 WORK PLAN – ONGOING/UPCOMING TASKS

As in previous years, key initiatives for 2022 will relate to enhancing: i) the program's database; and/or ii) communication and outreach. Tasks will generally focus on continued enhancement of the program's website to deliver data, information and knowledge in an easily accessible manner. The long-term goal for the website is to build upon earlier successes by offering newer and better ways to access, view and analyze data, all to benefit technical staff in improving decision making. The technical content currently available on the website will continue to be enhanced by providing additional insight pieces that succinctly summarize different hydrogeological analyses that have made effective use of the vast store of data in the database. An ongoing goal of the program's website continues to be to reduce the need for extensive knowledge of various individual specialized software packages (e.g. Sitefx, GIS, SQL Management Studio, etc.).

With no suggestions as to the order of importance, through 2022 work will take place on the following aspects of the program.

Work Area 1 – Halton Region Data

Throughout 2021 work was undertaken to either rename or enter borehole records that were of interest to Halton Region. With this effort largely complete, and with Halton embarking on a renewed Tier 3 numerical modelling effort, 2022 will see continued work with Halton Region to populate temporal data (water levels, pumping data, and water quality data into the database).

- **Benefits:** Provides data so that hydrographs can be accessed/viewed on ORMGP website.

Work Area 2 - Continued improvement and expansion to the database

The database is now about 90 gigabytes in size and continues to grow as new information is appended. Up-to-date climate and streamflow data are regularly acquired from Environment and Climate Change Canada and input to the database. As updates are made available from the Province the WWIS, PGMN data and PTTW will be updated in 2022. Temporal data from the partner agencies will also be updated through the year.

- **Benefits:** Improved data quality and additional data input to the database will enhance any work undertaken in the ORMGP area, whether it is in support of development, construction activities, or other.

Work Area 3 – Report Library Capture

In 2022 program staff will resume to work with Hunter GIS staff to input additional reports into the library. The reports cover a broad geographic range and will help to infill many areas where no previous work has yet been made available. In addition, if students are retained by partner agencies, ORMGP staff will also assist with training and the processing of consulting or other relevant reports. Data capture from these documents into the database will also continue.

- **Benefits:** Improved access to and availability of subsurface information across program area.

Work Area 4 – Fostering and Enhancement of Partner Agency and Consultant Website Use

Over the course of 2022, staff will continue to monitor external partner agency use of the program website and encourage further use of the site. With the anticipated re-opening of office spaces in spring 2022, staff will be exploring means (on-line or face to face) for developing and implementing additional training for technical staff at both consulting companies and partner agencies. A series of shorter training videos, each explaining one specific aspect of the website, is a current topic of discussion for 2022. Staff will continue to encourage other companies to join the partnership. Partner agency staff are also urged to encourage consulting companies to make use of the ORMGP.

- **Benefits:** This task, especially training/education initiatives, will help to ensure that consultant partners remain engaged in the program in a meaningful way, allowing them to maximize their use of the website and to contribute to the program.

Work Area 5 – Geological Layer Harmonization

With over 80 numerical models having been generated across the geographical study area of the program, staff continue to work towards a single “authoritative” geological framework across the study area by incorporating insights from these models. In the longer term, ORMGP staff are working to consolidate geological picks and polylines (e.g. ground surface constraint polylines, pinch out polylines, etc.) that might have been used by consultants in creating geological surfaces. Depending upon the consultant teams that have undertaken specific modelling studies, this information has either been submitted along with model files, or it has been withheld by the consulting team. 2022 will see work done to document and assemble a master list of geological data (picks and polylines) so that the geological layers can be re-kriged from the original data.

To date recent work has been focused on: i) appending new areas onto the existing master surfaces (e.g. Halton Region, Simcoe County); or ii) replacing existing geological surfaces with new interpretations from updated models (e.g. Durham Region). Along these lines, in 2022 staff will investigate the possible incorporation of geological layers from the OGS South Simcoe study, the results of which were released in early 2020. Staff will also look into incorporating the bedrock geological layering from the recent modelling work undertaken by the OGS and the GSC.

- **Benefits:** This task continues efforts to consolidate geological frameworks from various initiatives as well as new data into an “authoritative” set of surfaces that will extend across the entirety of the study area. For each agency, this will continue to prove to be a significant benefit in that they can confidently provide a set of interpretive geological 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.

Work Area 6 – Addition/Refinement of Geocortex Web Portal

Over the course of 2022 several planned initiatives will be moved forward to enhance the mapping portal on the ORMGP website. These include:

- **Clip and Ship** – this tool will allow users to clip layers and data from the website into an exportable package that can then be used external from the ORMGP website. The exported layers could be used for a number of purposes, for example to create cross-sections or to build localized numerical models. Although, this kind of tool has been in discussion for a few years, a technical breakthrough suggests that it can be accomplished in 2022. The tool will be designed such that it is functional only at an appropriate scale (~1:10:000).
- **Gaining/Losing Stream Reach Delineation** – using both the CA spot flow data, as well as numerical model results, a tool is under development that will allow for gaining or losing reaches of streams to be evaluated and mapped.
- **Chemistry** – although preliminary work has been undertaken on a new tool to better extract and display results of water quality tests, the tool has not been sufficiently developed to enable on the website. Work will continue in 2022 to get this tool website ready.
- **Water Budget** – in 2022, making use of newly developed Delft FEWS system, efforts will be extended to work on a renewed water budget tool that will extend water budget coverage to the entire new Halton area.
- **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. A possible solution is to develop on-line executables (e.g. input pumping rate, location, and aquifer – model run would return drawdown at a municipal well; run particle tracking

routines, etc.) that would allow for non-modellers to gain insights from models for various water management decision-making and quickly assess potential impacts to their water supply

- **Integrated Planning Map**

In discussions with planners over the past couple of years, it has become apparent that the ORMGP Geocortex website, with its many different themed maps, offers the possibility to assist planners with making better land use change decisions from a water management perspective. By overlaying maps such as the surficial geology, depth to water table, and flowing wells it may be possible to colour code certain areas as being either more or less suitable for different types of land use change proposals. ORMGP staff will investigate the possibility of developing an effective planning themed map that can sit on the Geocortex website.

- **Dynamic Maps** – recent breakthroughs are enabling dynamic maps to be embedded into websites at different locations. In 2022, ORMGP will look to take advantage of this trend by incorporating dynamic maps at strategic website locations.

Benefits: all actions directed to the website will be focused on providing smarter and easier ways to explore the data within the database and associated analyses/estimates, thereby reducing the time needed to acquire data for decision making.

Work Area 7 - Mapping of Known Groundwater Problem Areas

Mapping of groundwater “Areas of Concern”, (i.e., those areas where subsurface construction works could lead to considerable problems and excessive costs), was initiated in 2019. In 2022 mapping will continue in Whitchurch-Stouffville and a new initiative will commence in Uxbridge Township. There has been an indication from partner agencies that this kind of mapping is beneficial.

- **Benefits:** By having an understanding of subsurface conditions prior to project commencement, partner agency staff (both consultants and government) can provide preliminary knowledge regarding overall project cost and necessary efforts. Such regional maps can provide a screening tool prior to the detailed work necessary for project design.

Work Area 8 – eBook

Through 2022 work will be ongoing to wrap up the eBook contribution to the Groundwater Project. The eBook will synthesize much of the hydrogeology of the Oak Ridges Moraine area and will be unique in that it will directly link to the ORMGP website allowing readers to explore data as they read through the book.

- **Benefits:** As the only Canadian chapter contribution to the Groundwater Project’s overview eBook, the opportunity exists to showcase the work of the program and the partner agencies that have contributed to the program over the years.

Work Area 9 –Website Metadata

Building upon the 2021 initiation of GitHub built metadata and ‘fact sheets’, 2022 will see the continued development of additional metadata/fact sheet writeups. This will provide technical visitors with assurance and documentation as to how specific map products have been produced.

- **Benefits:** having metadata available on the website will allow users to see data sources and how specific maps and analyses that are available on the website were created. This will provide additional confidence and support to website users such that they are more reliant on using the website’s products.

Of course, as in past years, should resources be requested by other partner agencies for specific tasks, ORMGP staff will adjust tasks to assist as required.