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REGIONAL GROUNDWATER MODELLING STATUS REPORT

The Transportation and Works Committee recommends:

1. The presentation by Debbie Korolnek, General Manager, Water and Wastewater be received; and

2. The recommendations contained in the following report, February 7, 2006, from the Commissioner of Transportation and Works be adopted:

1. RECOMMENDATIONS

It is recommended that:

1. Regional Council receive the report entitled '*Groundwater Modelling of the Oak Ridges Moraine Area including the Yonge Street Aquifer and Toronto Region Conservation Watersheds'*.

2 Regional Clerk forward this report to the Clerks of the local municipalities for information.

2. PURPOSE

This report provides an update on the completion of the first Regional-Oak Ridges Moraine Groundwater Model undertaken in association with the York -Peel-Durham - Toronto (YPDT) Coalition and the Conservation Authorities Moraine Coalition (CAMC).

3. BACKGROUND

Groundwater is an important resource for York Region and supplies high quality water to over 200,000 residents. As growth increases, the demand on this resource will continue. York Region has long recognized the need to understand the regional geology and hydrogeology in order to manage groundwater in a sustainable manner.

Past modelling efforts provided limited insight in predicted effects of our water taking in the Yonge Street Aquifer due its large geographical coverage. In 2001, York Region initiated a project with the primary focus to develop a groundwater model to better understand the Yonge Street Aquifer in the regional context.

Groundwater modelling work was also initiated by two other separate agencies, namely Toronto Region Conservation Authority and Conservation Authorities Moraine Coalition.

It was quickly recognized by all agencies that there would be significant benefit in collaborating these efforts resulting in the formation of the York Peel Durham Toronto (YPDT) Coalition. Earthfx Incorporated was the consultant selected to develop the model.

The *Groundwater Modelling of the Oak Ridges Moraine Area including the Yonge Street Aquifer and Toronto Region Conservation Watersheds* report is the first document in local history to present a comprehensive, regional understanding of the hydrogeology of Oak Ridges Moraine including York Region and the TRCA watersheds. It also provides a summation of how the data was compiled, and interpreted, and how the predictive model for regional groundwater flow evolved.

With the finalization of this model, a presentation by the CAMC project team was made to the Toronto Region Conservation Authority on February 10, 2006.

4. ANALYSIS AND OPTIONS

4.1 Groundwater Modelling Report

There has been a substantial effort by the various partners in preparing this report. It has been through numerous revisions over the past two years. Considering the level of required understanding, and expectations on the functionality and applicability of the model, the current product has evolved through many iterations, reviews and interpretations. This effort has resulted in the current version of the document which is the most complete and current reference for the geology and hydrogeology for the Oak Ridges Moraine and surrounding areas. It has also addressed the objectives of the three modelling projects that were initiated in 2001. The report covers the following subject areas:

- Project History.
- Regional Geology.
- Regional Hydrogeology.
- Development of the Groundwater Flow Model
- Calibration of the Model.
- The Evolution of the Groundwater Flow Model.
- Appendices on Data Compilation and Modelling Methodology

4.2 Model Development Process

Although the groundwater flow model was the final deliverable of these projects, there were a number of important technical products produced that are fundamental to model development. They are grouped into three categories as follows:

- Creation of Comprehensive Database
- Data interpretation to identify hydrogeological layers of the Moraine

- Creation of the Groundwater Flow Model

A comprehensive relational database was developed from existing records stored in reports across the Region with the various agencies. Over 140,000 boreholes, 600,000 geological descriptions, 1.8 million water levels, stream flow records and climate data have been compiled. This tool is meeting the needs of a wide range of users, including field staff, data managers, hydrogeologists and numerical modellers. It allows interactive mapping, retrieval of borehole logs, drawing of cross sections and graphing of time series data. At regular intervals, the database is synchronized as agencies add new data and verify old data, which is fed back into the model to validate model predictions and provided to the agencies for their use. It is a very effective and efficient approach to data sharing and has proven to save considerable time and effort.

The second, and possibly the most critical product, is the creation of the various hydrogeological layers that comprise the Oak Ridges moraine and surrounding area and make up the framework of the model. Using the conceptual understanding of the geology from the Geological Survey of Canada and the MOE well record data, hydraulic conditions were interpreted by creating thousands of digital cross sections. In the end, seven layers were identified that represent a sequencing of aquifer and aquitard layers. This single sizeable task advanced the understanding of aquifer complexes in the Region.

The final outcome of this work is the groundwater flow model. To date, there have been two major evolutions of the groundwater flow model. Initially the groundwater flow model encompassed the watersheds that reside over the entire Oak Ridges Moraine. However, over time, a more detailed Core Model was created which includes all of the TRCA watersheds, York Region and parts of Durham and Peel. Future versions will include expansions to this detailed Core Model which will continue to cover larger areas of the moraine.

The work completed to date represents consolidation of available data, application of specialized expertise to interpret this data and what it may represent, and the creation of a mathematical model that attempts to recreate the processes and functions that occur in the natural environment. The current model is a valuable tool for increasing our understanding of geology and hydrogeology in York Region. It is, however, only one component, and its application must be considered in concert with other tools when used in the decision making process.

4.4 Key Findings

The modelling work has advanced our understanding of groundwater regimes in York Region. We are able to quantify the importance of the Oak Ridges Moraine as a regionally significant recharge area. The model suggests that the top of the Moraine is more critical to the recharge than the sloping till plains. And the hilly topography of the Moraine also plays an important role in the recharge process.

Model simulations also suggest that long term pumping rates by municipal wells are sustainable given that 90% of the recharge occurring in the study area discharges to the streams that reside north and south of the Moraine. Permitted groundwater pumping for municipal purposes equals less than 6% of the total recharge. Further work identified that pumping in the deeper aquifer systems, which is where most municipal wells are located, minimizes the influence in the shallow systems and thereby minimizes any influence on streams.

Through modelling and capture zone analysis, the Yonge Street Aquifer is further clarified to be a combination of three hydraulic conditions, a topographic basin, a tunnel channel and a bedrock valley. These key features play an important role in groundwater flow systems by acting as conduits for water flow.

Building on the research on the Oak Ridges Moraine by the Geological Survey of Canada, geologists have gained more knowledge about the inter-connection of the aquifers by tunnel channels, which act as pathway for water to leak from the upper aquifers into the lower aquifers. This connection is critical in understanding impacts on the shallow aquifer, which is where most private wells draw their water.

4.5 Limitations of the Model

A number of model limitations have been identified in the report.

As steady state model, it cannot account for changes in climate or water levels throughout the year. It can only provide an average condition over time. Work is underway to apply transient conditions in the near future.

The groundwater flow model was intended to provide a regional perspective. It was not designed for detailed small scale analysis without the additional support of local geological information. The geology is highly variable and generalizations made in the interpretations of the geological layers can be refined as more detailed data comes available.

The groundwater flow model does provide insight and predicts the potential impacts from our activities. However it is only part of the solution. The predictions from the model can help direct where additional monitoring should be undertaken. By directing the groundwater management plan, significant savings in investigation and resources can be achieved.

As with any numerical model, the quality of the prediction from the model is a mirrored reflection of the input data quality. One of the major challenges with the database is the quality of the MOE well record data, which is known to be highly variable in quality and historically prone to errors. Significant steps have been taken to validate data and improve data gathering techniques. The model is an evolutionary process and will improve as more predictions are validated through monitoring.

Despite these limitations, this groundwater model is a valuable tool and its applicability will improve over time.

4.6 Benefits to York Region

York Region is in a better position to manage water resources through the application of the model. We are able to apply the model to help predict the cumulative impacts of all water users in the Region and help direct and improve the monitoring and management programs. Modelling can be applied in the early phases of project planning to allow for a more proactive methodology. To date, staff have used the model to identify new water supply locations, for example the Mount Albert Exploration program, with great success. Other applications include predicting influences on stream headwater flows, and assessing effects of temporary dewatering activities on major construction projects such as the 16th Ave sewer and YDSS Interceptor. There are plans to use the model to optimize wellhead operations in the near future.

4.7 Future Direction

Although this report represents a substantial effort to date, ongoing work continues to add new data, interpretation and verification of the model outputs. Opportunities to expand the model boundaries further into the regions of Peel and Durham have already been initiated by the YPDT team.

In 2006, the model and this report will undergo a third party peer review. This will further validate the accuracy of the model and will support its use in addressing the needs proposed in the Clean Water Act, 2005. This Act provides a framework for protecting water at its source and is a component of ensuring a safe drinking water supply.

The model will be instrumental in supporting the technical studies required for source water protection planning as required by the Act. York Region is in a very enviable position in this regard since the work undertaken to develop the model will directly support the objectives of the Clean Water Act and places us well ahead of any other region in the Province.

A strategy to communicate with and inform regulatory agencies, local municipalities and the public about the key findings from this work is also planned for early 2006.

5. FINANCIAL IMPLICATIONS

This project was partially funded through the Ministry of Environment Groundwater Studies in 2001. On-going activities will be funded through the 10-year Capital plan and supplemented through Provincial grants when available. York Region's funding component for ongoing maintenance of the model is approximately $100,000 per year.

York Region staff have also submitted a proposal for funding which was recently announced by the Province concurrently with the release of the Clean Water Act in

support of source water protection. It is expected that additional funding to support the modelling activities will be secured through a $51 million dollar Provincial funding program that has been earmarked over the next 5 years.

6. LOCAL MUNICIPAL IMPACT

Local municipalities that are supported by groundwater based water supply will benefit considerably from the effort York Region and its partners have invested in understanding our groundwater system. However, they have had limited involvement in the program to date. York Region staff are implementing a communications program to present this information to the local municipalities.

7. CONCLUSION

The *Groundwater Modelling of the Oak Ridges Moraine Area including the Yonge Street Aquifer and Toronto Region Conservation Watersheds* report is a substantial achievement for York Region and its partners. This work has expanded our insight into the Regional groundwater system. It has identified potential influences and helped drive our groundwater management program. However, the model is only one part of the solution and must be used in combination with traditional hydrogeological techniques.

The creation of the hydrogeological model and its related products has provided the Region with the appropriate tools to help further support the protection and management of our groundwater resources.

The Senior Management Group has reviewed this report.