Water Quantity Geodatabase Guide: Version 2

Prepared by

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The Ontario Ministry of Natural Resources - Water Resources Information Program

For

The Ontario Ministry of Natural Resources - Land and Water Services Section

The Ontario Ministry of the Environment - Source Protection Programs Branch

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1.1 BACKGROUND

The Ontario government introduced the Clean Water Act (CWA) in 2006 to protect drinking water at the source, as part of an overall commitment to human health and the environment. Production of locally developed, science-based assessment reports and source protection plans are a key focus of the legislation.

In the development of the Assessment Report (AR), the Water Budget and Water Quantity Risk Assessment process outlines the steps to:

1) Estimate the quantity of water flowing through a watershed;

2) Understand the pertinent processes and pathways that water follows; and

3) Assess the reliability of water supply sources from a water quantity perspective.

The goals of this assessment are to identify watershed communities where the reliability of water supplies is questionable and to highlight factors limiting the reliability, such that appropriate risk management measures can be implemented.

As part of the AR, Source Protection Committees must produce water budgets and assess the risks to water quantity within a tiered framework (illustrated in **Figure 1**). The first two tiers of this framework evaluate hydrological stresses within the watershed. The third tier assesses risks to water quantity and evaluates the ability of the water supply to meet the community's drinking water needs. Significant Groundwater Recharge Areas (SGRAs) are also delineated across the landscape as part of each tier.
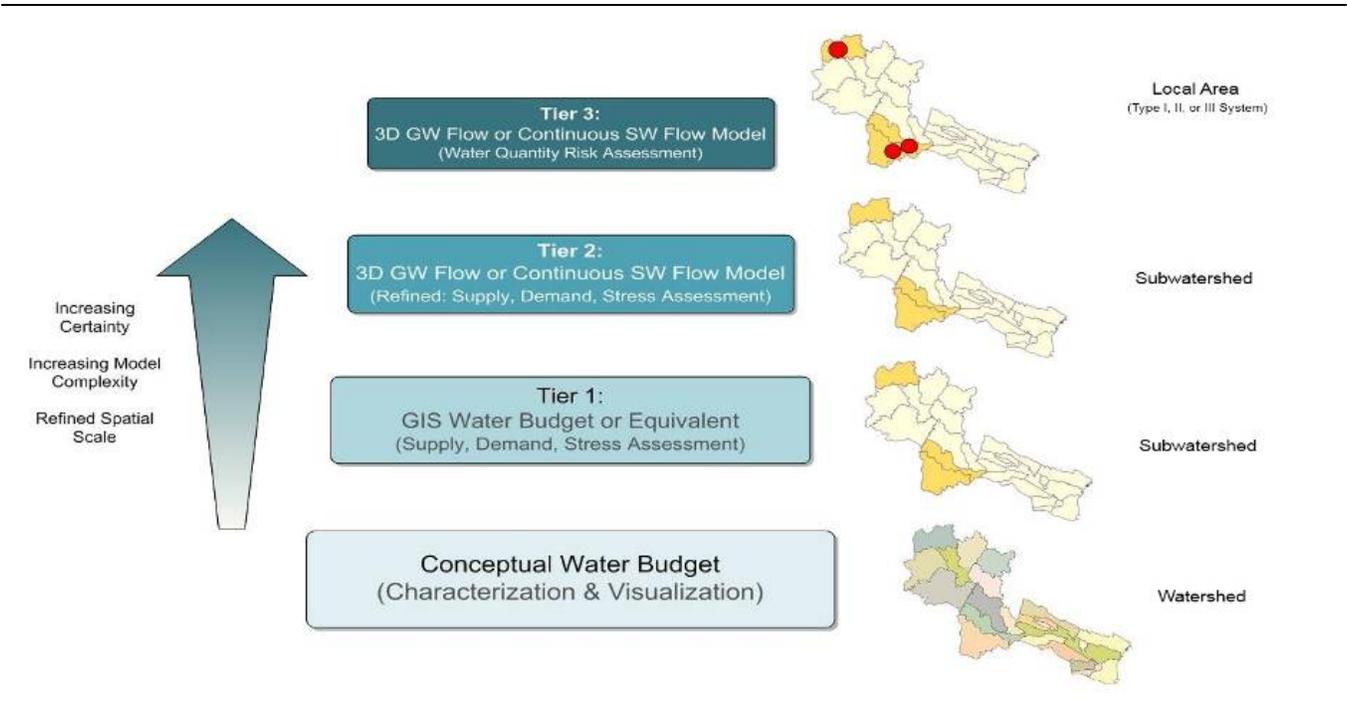

Figure 1 - Water Budget Framework

Upon approval of the ARs, each Source Protection Authority (SPA) will be required to submit their data outputs, whereby the submitted data meets the standards identified by the province. In corresponding with these standards, this will ensure consistency across all SPAs, which will enhance provincial databases and ensure the data is aligned with other provincial government programs where applicable.

In order to support this standard collection of information from the tiered water budget process, a business analysis and data architecture exercise was initiated by the Ministry of Natural Resource's (MNR) Water Resources Information Program (WRIP) in 2008. The result of this exercise was a data model, which provided a logical representation of the many information outputs required by the Province upon completion of the water budget process. The logical data model provided a preliminary database design indicating the tables, fields, and relationships required.

Following this design phase was the development, testing, and validating of the physical data model, in which the elements of the logical data model (illustrated in **Figure 2**) were migrated into a physical database with the ability to store geospatial information. This database is known as the *Water Quantity Geodatabase* and is described in this guide.
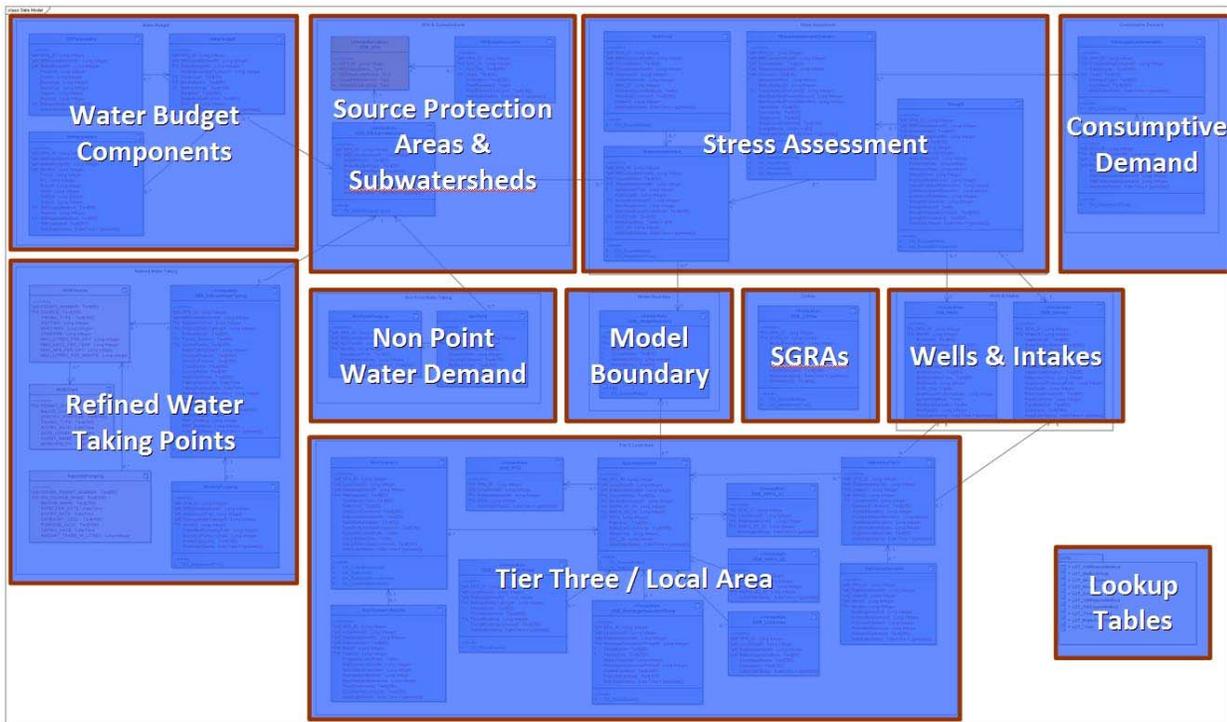

Figure 2 - Water Quantity Geodatabase Overview Diagram

1.2   INTRODUCTION

The Water Quantity Geodatabase (WQGDB) is a standard framework designed to enable the Province to collect and coordinate the most relevant, accurately measured, and calculated data from the Tier One, Tier Two, and Tier Three Water Budget and Water Quantity Risk Assessment studies completed by all of the SPAs. In simple terms, the WQGDB is a database for storing and maintaining the results generated for the Assessment Report and will enable the SPAs to capture the water quantity information requirements in support of the Clean Water Act (CWA).

In addition to assisting SPAs with their obligation under the CWA, the WQGDB also provides a foundation for broader watershed management activities completed by the Province. As well, it can serve as a definitive database for water quantity that will assist water resource managers and decision makers at the Conservation Authorities and among multiple government Ministries.

The data deliverables listed in **Table 1** (summarized by spatial and non-spatial) can be captured and managed in the WQGDB. These deliverables contain water budget elements and water quantity assessment data, including but not limited to: precipitation, evapotranspiration, recharge, runoff, surface water flows, groundwater flows, consumptive water demand, stress assessment summaries, all required scenarios, risk assessment and identified water quantity threats.

Table 1 - Data Deliverables

Spatial	Tier One	Tier Two	Tier Three
Water Budget Subwatersheds	✓	✓	
Refined Water Takings	✓	✓	✓
Significant Groundwater Recharge Areas (SGRA)	✓	✓	✓
Municipal Wells and Intakes	✓	✓	✓
Model Boundaries		✓	✓
WHPA-Q1, WHPA-Q2, IPZ-Q			✓
Local Areas			✓
Consumptive Threats			✓
Recharge Reduction Threats			✓
Non-Spatial	**Tier One**	**Tier Two**	**Tier Three**
Subwatershed Water Budget Components	✓	✓	
Subwatershed Consumptive Demand (Existing and Future)	✓	✓	
Subwatershed Non-Point Water Takings	✓	✓	
Subwatershed Stress Assessment Scenarios & Stress Levels	✓	✓	
Record of Historical Stress Observations	✓	✓	
Drought Scenario Results for Municipal Wells and Intakes		✓	✓
Wells and Intakes – Existing and Allocated Pumping Rates			✓
Wells and Intakes – Safe Drawdown / Water Level			✓
Risk Scenarios & Results – Water Level / Flow (for Well / Intake)			✓
Local Area Risk Assessment & Risk Level			✓

1.3 TECHNICAL OVERVIEW

Given the broad water budget data requirements for the Assessment Reports and the extent of technical water budget studies combined with storing the results in a complex data structure, it is highly recommended that the WQGDB is populated by a combination of staff working together. This includes the GIS staff who will be able to provide the knowledge and expertise in managing the geodatabase and the Water Budget Lead who will be able to provide the water budget technical expertise as well as background and advice related to the data. Consultants may also be required for input if involved in the technical water budget studies.

The Water Quantity Geodatabase uses the ESRI Geodatabase framework for storing and maintaining the required water quantity information deliverables generated for the Assessment Report. It is used to collect both the tabular and spatial data into one packaged file (.mdb) and is designed to capture all of the data produced through the Tier 1 and Tier 2 water budget and stress assessment, as well as the Tier 3 local area risk assessment. Please note that the water quantity tabular data should be entered, queried, and analyzed in Microsoft Access, while the geospatial data requires using ESRI's ArcGIS.

1.3.1 Managing Data Locally

The organizing, populating, and editing of the water quantity data will occur at the SPA level. As well, this is where updates will take place and where the data will be managed overall. As SPAs are required to maintain the authoritative version of the Assessment Report data, this requires sound maintenance of the local editing environment. This will also ensure that data is rolled-up efficiently at the provincial level.

1.3.2 Software Requirements

The WQGDB has been designed in the following environment:

- *ESRI ArcGIS 9.3.1 (.mxd file) - Where required, a 9.2 compatible .mxd file can be provided.*

- *Microsoft Access 2007 (.mdb file with backward compatibility to MS Access 2003)*

1.3.3 Support

This guide and the database dictionary provide details on which objects are tabular versus geospatial and the database dictionary should be considered the primary reference to describe water quantity data requirements.

Questions regarding the Water Quantity Geodatabase should be directed to:

- Robert Arends, WRIP – Email: robert.arends@ontario.ca, or
- Scott Bates, MNR – Email: scott.bates@ontario.ca – Phone: (705) 755-1523

Water budget questions specific to SPA / SPR technical studies can be directed to your Region's Water Budget Program Analyst:

- Scott Bates, MNR – Email: scott.bates@ontario.ca – Phone: (705) 755-1523
- Laura Landriault, MNR – Email: laura.landriault@ontario.ca – Phone (705) 755-3189
- Lynne Milford, MNR – Email: lynne.milford@ontario.ca – Phone (705) 755-1227

In addition to the documentation provided and the support above, there are also water budget training resources available at www.waterbudget.ca and technical resources available online related to updating data sources for ESRI ArcGIS and MS Access.

2.0 Data Population

2.1 INTRODUCTION

This section provides instruction on populating the WQGDB. For detailed table and field descriptions, see the database dictionary and database diagram. SPAs are requested to populate the WQGDB (.mdb) file, including all feature class objects and tabular data that are relevant to their Assessment Report. Review Table 1 for a summary of related spatial and non-spatial data items required for Tier 1, Tier 2, and Tier 3 assessments.

2.2 OBTAINING THE GEODATABASE

The WQGDB Version 2 (July, 2011) will be made available from the Ministry of Natural Resources. A zipped file package containing the following files will be provided:

- Geodatabase (.mdb)

- User Guide (.pdf)

- Database Dictionary - Highlighted Changes (.pdf)

- Database Dictionary - Clean without Highlighted Changes (.pdf)

- Database Diagram (.pdf)

- Technical Bulletin - Version 2 Changes (.pdf)

- Questions & Answers (.pdf)

Revisions and updates to the Relationships diagram will be distributed separately from the main WQGDB Version 2 (July, 2011) package at a later date.

Once the compressed .zip file is downloaded, extract it to a preferred local workspace.

2.3 EXAMPLE DATA & ARCMAP FILE

The example data and ArcMap file provided with the WQGDB Version 1 has been removed from Version 2 of the geodatabase. The removal of the example data was performed in response to several questions received on the inability to remove the example data for final submission to the Province. If SPAs still wish to visualize the example data it is recommended that Version 1 of the WQGDB and User Manual be used for this purpose and that Version 2 of the WQGDB be used solely for the purpose of populating local water budget information.

2.4 DATA LOADING CONSIDERATIONS

The Water Quantity Geodatabase is a complex database based on its inclusion of geospatial and tabular data relationships which have been designed so that analysis can be performed. To assist users, this section provides a summary of data loading considerations and the sequential order for adding data into the WQGDB based on the parent-child relationships.

Once you begin organizing your water budget data and populating the geodatabase, the database diagram, database dictionary, and this user guide will be helpful documents to have available for quick reference. Initial considerations include:

- The SPA_ID is the regional identifier for each Source Protection Authority, which will be stored in each object. Appendix A contains SPA_IDs as they exist in the WQGDB. Every record needs to have the correct SPA_ID associated with it.

- SPAs are responsible for maintaining unique identifiers at the feature class level using a unique long integer field format. DO NOT use the Object Identifier created by ArcGIS. The Object ID is a dynamic ID and can change while editing, exporting, and importing. This does not provide a stable environment to manage features in the feature class. Because of this, the identifier will need to be manually or programmatically maintained.

- All flow units entered must be in cubic meters per day (m^3/day).

- All text should be entered as Title Case unless otherwise directed in the database dictionary (first letter capital if appropriate i.e. proper name, start of comment). Do not use CAPITAL CASE.

- As illustrated in the database diagram, only blue tables need to be populated; the orange table (GWB_SPA) is pre-populated; and the pink tables are for reference to other databases (e.g. MOE Permit to Take Water).

- When viewing objects in Microsoft Access, the water budget feature classes have a "GWB" prefix and lookup tables have a "LUT" prefix.

- When adding polygon data, ensure it does not contain curve feature types (i.e. True Curves or Bezier Curves). Ensure the Buffer tool in ArcToolbox was not used to create polygons as the output creates curve feature types. (A way to check if your data contains curves, is to export the layer to a shapefile and then re-import back into the geodatabase.)

- Using the UTM projection native to your SPA, ensure the projection and datum is defined in your feature classes before adding the data to the personal geodatabase.

- The data dictionary provides more detail on required data, pre-populated data, data types, constraints (data validation), primary/foreign key fields, and relationships.

- In order to honour the parent-child relationships, the data must be populated in sequential order. The following list provides a logical order for populating data for all Tiers.

Tier One & Two

1. **GWB_SPA** (Populated already)
   - WBStudyDocuments
   - GWB_WBSubwatersheds
2. **GWB_Wells**
3. **GWB_Intakes**
4. **GWB_SGRAs**
5. **GWB_ModelBoundary**
6. **GWB_RefinedWaterTaking**
   - MonthlyPumping
7. **WaterBudget**
   - GWParameters
   - SWParameters
8. **ConsumptiveDemandInfo**
   - ConsumptiveDemand
9. **StressAssessment**
   - Historical
   - StressAssessmentScenario
     - Drought

Tier Three

1. **GWB_IPZQ**
2. **GWB_WHPA_Q1**
3. **GWB_WHPA_Q2**
4. **RiskAssessment**
   - GWB_LocalArea
   - GWB_ConsumptiveThreats
   - GWB_RechargeReductionThreat
5. **RiskScenario**
   - RiskScenarioResults
6. **WellIntakeTier3**
   - WellIntakePumping

2.4.1 Populating Geospatial Data (Personal Geodatabase)

Note: Feature classes are located in the feature dataset called "geospatial", located within the geodatabase. Example data is provided and can be used as reference to how the data can be populated.

Please consider the following steps when loading geospatial data using ArcCatalog:

Step 1 – Open ArcCatalog and navigate to the location where you have saved a copy of the geodatabase.

Step 2 – Open the geodatabase and scroll to the feature class you want to load.

Step 3 – Right-click the desired layer to load. Click Load, Load Data

Step 4 – Open Load Data Dialogue

Step 5 – Cross reference local data with required data. Make sure to check that all the fields are getting populated otherwise you will be missing data.

Standard Coordinate System

The standard coordinate system used for the feature classes in the personal geodatabase is the Universal Transverse Mercator (UTM), where Lat/Long are measured in meters and coordinates must be on the NAD 83 datum. If transformed from another datum, transformation must be done according to the current GO-ITS standard (NTv2).

Duplicate Geospatial Entry

In situations where feature class data is unchanged from a previous Tier, data will need to be entered a second time and labelled as Tier 2 (please refer to the data populating guidance details in the data dictionary. This will ensure that generated queries will return the correct and expected results.

2.4.2 Populating Non-Geospatial Data (MS Access Database Tables)

Please consider the following steps when populating tabular data using MS Access:

Step 1 – Organize your data, using the database dictionary as a guide to prepare your data.

Step 2 – Open the database in MS Access.

Step 3 – Working through the previously mentioned sequential order (based on parent – child relationships), import your data into the geodatabase using your preferred approach for importing data into MS Access.

Step 4 – Cross reference local data with required data. Ensure that all the fields are getting populated – check if you are missing any data.

2.4.3 Editing the Geodatabase

Due to the restrictions imposed by the personal Geodatabase file structure and composite primary keys in place to maintain data integrity, the following steps must be taken if feature class edits are required to the Water Quantity Geodatabase**.**

Note: It is recommended to add all tabular data using MS Access due to the required step(s) of removing and replacing primary keys. Failure to properly replace the primary keys can introduce extensive data inconsistencies that are very difficult to correct.

Step 1 – Open the geodatabase in MS Access and view the database relationships.

Step 2 – Remove the primary key(s) from the feature class object that needs to be edited Be sure to take note of these keys as they will need to be reestablished later.

Step 3 – Close MS Access and open the feature class as a layer in Arc Map.

Step 4 – Use the editing toolbar, make any necessary changes in Arc Map. Once all changes are complete, close Arc Map.

Step 5 – Open the Geodatabase in MS Access and repair the primary keys of the feature class (remembering the primary key changes from Step 2).

If, for some reason, the entire feature class needs to be replaced, it may be easiest to import a new version of the feature class **after** removing the original version in need of replacement. To do this, following the following steps:

Step 1 – Open the geodatabase in MS Access and view the database relationships.

Step 2 – Remove the primary key(s) and any relationship from the feature class object that is going to be removed. Be sure to take note of these as they will need to be reestablished later.

Step 3 – Close MS Access and open the Water Quantity Geodatabase in Arc Catalog.

Step 4 – Navigate to the feature class in Arc Catalog and delete it.

Step 5 - Using a copy of the original template Geodatabase, follow the steps identified in section 2.4.1 to load the current spatial data into a new version of the desired feature class.

Step 6 – Copy this newly created feature class using Arc Catalog to the geospatial location of the desired database and close Arc Catalog.

Step 7 – Open the Geodatabase in MS Access and repair any primary keys and relationships to the new version of the feature class from Step 2.

Editing tabular data is much more straightforward and can be done easily by opening the Water Quantity Geodatabase directly in MS Access. Changes can then be made to the desired table, limited only by the data type, format and constraints imposed by the Geodatabase (see the database dictionary for assistance).

2.4.4   Queries

Due to the modifications made for Version 2 of the WQGDB many of the queries built for Version 1 of the WQGDB require update. These queries are currently being updated and will be distributed at a later date to assist with the quality control process. If so desired, the existing queries in Version 1 of the WQGDB could be reviewed and locally built within your respective SPA for quality control purposes.

2.5   SUBMITTING THE WATER QUANTITY GEODATABASE

Once staff have finished populating the WQGDB and verifying it is reflective of the data used for the Assessment Report, it should be made available to the MNR for review using the existing transfer protocol for water budget reports (e.g. CA ftp site). A notification email should be directed to Robert Arends robert.arends@ontario.ca and Scott Bates scott.bates@ontario.ca and include details for pick-up (e.g. IP address, password). If required, an alternate method can also be requested and arranged.

The file should be zipped and use a file name format as outlined below, where SPA could be SPR and date format is the date of submission, which should correspond with the email notification date:

"SPAName_WQGDB_yyyy-mm-dd.zip"

Appendix A – List of Source Protection Authorities

SPR_ID	SPA_ID	SPA Name	Lead SPA
11	15	Credit Valley	No
28	36	Otonabee-Peterborough	No
25	25	Lakes Simcoe & Couchiching/Black River	Yes
25	35	Nottawasaga Valley	No
10	10	Ausable Bayfield	Yes
28	16	Crowe Valley	No
18	31	Mississippi Valley	No
25	47	Lake Simcoe	No
14	21	Hamilton	No
18	39	Rideau Valley	Yes
27	43	St. Clair Region	No
28	28	Lower Trent	Yes
23	40	Saugeen Valley	Yes
23	48	Northern Bruce Peninsula	No
15	19	Grand River	Yes
27	27	Lower Thames Valley	No
22	42	South Nation	No
19	32	Niagara Peninsula	Yes
28	18	Ganaraska Region	No
15	26	Long Point	No
14	14	Halton	Yes
20	34	North Bay-Mattawa	Yes
25	46	Severn Sound	No
27	45	Upper Thames River	Yes
23	20	Grey Sauble	No
15	23	Kettle Creek	No
10	29	Maitland Valley	No
24	41	Sault Ste Marie	Yes
15	12	Catfish Creek	No
11	44	Toronto	Yes
17	30	Mattagami	Yes
29	0	Undecided / Official Name	No
22	38	Raisin Region	Yes
12	11	Cataraqui	Yes
11	13	Central Lake Ontario	No
13	17	Essex	Yes
16	24	Lakehead	Yes
26	33	Nickel District	Yes
28	22	Kawartha-Haliburton	No
21	37	Quinte	Yes

Note: Ensure the correct number is entered for your SPA_ID; the SPR_ID is provided here for reference only