

## 4 METHODOLOGY

### 4.1 Data Collection and Synthesis

The AENV groundwater database is the main source of groundwater data. The database includes the following:

- 1) water well drilling reports
- 2) aquifer test results from some water wells
- 3) location of some springs
- 4) locations for some water wells determined during water well surveys
- 5) chemical analyses for some groundwaters<sup>11</sup>
- 6) location of some flowing shot holes
- 7) location of some structure test holes
- 8) a variety of data related to the groundwater resource.

The main disadvantage to the database is the reliability of the information entered into the database. Very little can be done to overcome this lack of quality control in the data collection, other than to assess the usefulness of control points relative to other data during the interpretation. Another disadvantage to the database is the lack of adequate spatial information. Any duplicate water wells that have been identified within the County have been removed from the database used in this regional groundwater assessment.

The AENV groundwater database uses an area-land-based system with only a limited number of records having a value for ground elevation. The locations for records usually include a quarter section description; a few records also have a land description that includes a Legal Subdivision (Lsd). For digital processing, a record location requires a horizontal coordinate system. In the absence of an actual location for a record, the record is given the coordinates for the centre of the land description.

The present project uses the 10TM coordinate system based on the NAD27 datum. This means that a record for the NE ¼ of section 14, township 034, range 05, W5M would have a horizontal coordinate with an Easting of 28,052 metres and a Northing of 5,750,308 metres, the centre of the quarter section. If the water well has been repositioned by AAFC-PFRA using orthorectified aerial photographs, the location will be more accurate, possibly within several tens of metres of the actual location. Once the horizontal coordinates are determined for a record, a ground elevation for that record is obtained from the 1:20,000 Digital Elevation Model (DEM); AltaLIS Ltd. provides the DEM.

At many locations within the County, more than one water well is completed at one legal location. Digitally processing this information is difficult. To obtain a better understanding of the completed depths of water wells, a digital surface was prepared representing the minimum depth for water wells and a second digital surface was prepared for the maximum depth. Both of these surfaces are used in the groundwater query on the CD-ROM. When the maximum and minimum water well depths are similar, there is only one aquifer that is being used at a given location.

After assigning spatial control for the ground location for the records in the groundwater database, the data are processed to determine values for hydrogeological parameters. As part of the processing, obvious keying errors in the database are corrected.

<sup>11</sup> Since 1986, Alberta Health and Wellness has restricted access to chemical analysis data, and hence the database includes only limited amounts of chemical data after 1986.

Where possible, determinations are made from individual records in order to assign water wells to aquifers and to obtain values for the following:

- 1) depth to bedrock
- 2) total thickness of sand and gravel below 15 metres
- 3) total thickness of saturated sand and gravel
- 4) depth to the top and bottom of completion intervals<sup>12</sup>.

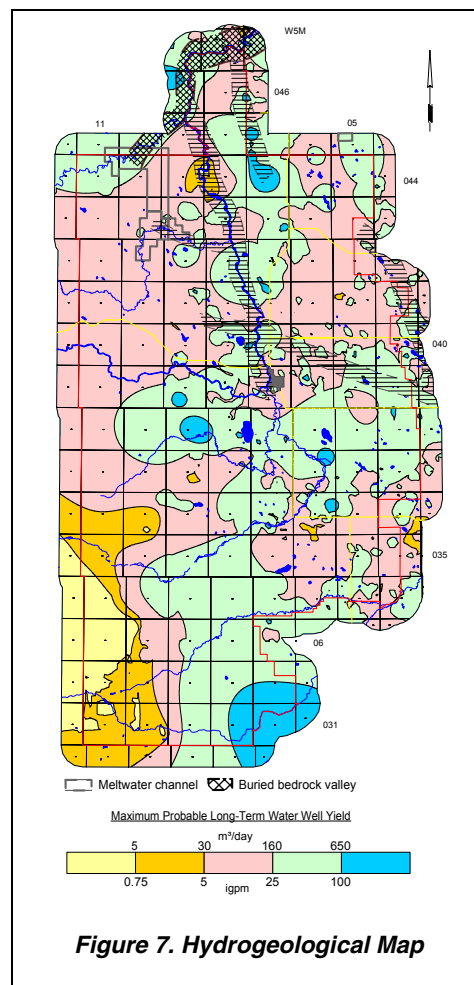
Also, where sufficient information is available, values for apparent transmissivity<sup>13</sup> and apparent yield<sup>14</sup> are calculated, based on the aquifer test summary data supplied on the water well drilling reports. Where valid detailed aquifer test results exist, the interpreted data provide values for aquifer transmissivity and effective transmissivity. Since the last regional hydrogeological map covering the northern two-thirds of the County was published in 1971 (Tokarsky, 1971), more than 2,400 values for apparent transmissivity and apparent yield have been added to the groundwater database. Since the last regional hydrogeological map covering the area of the County that includes townships 031 to 034, ranges 04 to 12, W5M was published in 1977 (Ozoray and Barnes, 1977), 150 values for apparent transmissivity and apparent yield have been added to the groundwater database. The median apparent yield of the water wells with apparent yield values in the County is 185 m<sup>3</sup>/day. Approximately 17% of the apparent yield values for these water wells are less than ten m<sup>3</sup>/day. With the addition of the apparent yield values, including a 0.1-m<sup>3</sup>/day value assigned to “dry” water wells and water test holes, a hydrogeological map has been prepared to help illustrate the general groundwater availability across the County (Figure 7 and page A-11). The map is based on groundwater being obtained from all aquifers and has been prepared to allow direct comparison with the results provided on the Alberta Research Council (ARC) hydrogeological maps. In general, the ARC map shows higher estimated long-term yields. The differences between the two maps may be a result of substantially fewer apparent yield values and the gridding method employed by ARC.

The EUB well database includes records for wells drilled for the oil and gas industry. The information from this source includes:

- 1) spatial control for each well site
- 2) depth to the top of various geologic units
- 3) type and intervals for various down-hole geophysical logs
- 4) drill stem test (DST) summaries.

Values for apparent transmissivity and apparent yield are calculated from the DST summaries.

Published and unpublished reports and maps provide the final source of information to be included in the new groundwater database. The reference section of this report lists the available reports. The only digital data from publications are from the Geological Atlas of the Western Canada Sedimentary Basin (Mossop and Shetsen, 1994). These data are used to support the geological interpretation of geophysical logs but cannot be distributed because of a licensing agreement.



**Figure 7. Hydrogeological Map**

<sup>12</sup> See glossary

<sup>13</sup> For definitions of Transmissivity, see glossary

<sup>14</sup> For definitions of Yield, see glossary

## 4.2 Spatial Distribution of Aquifers

Determination of the spatial distribution of the aquifers is based on:

- 1) lithologs provided by the water well drillers
- 2) geophysical logs from structure test holes
- 3) geophysical logs for wells drilled by the oil and gas industry
- 4) data from existing cross-sections.

The aquifers are defined by mapping the tops and bottoms of individual geologic units. The values for the elevation of the top and bottom of individual geologic units at specific locations help to determine the spatial distribution of the individual surfaces. Establishment of a surface distribution digitally requires preparation of a grid. The inconsistent quality of the data necessitates creating a representative sample set obtained from the entire data set. If the data set is large enough, it can be treated as a normal population and the removal of extreme values can be done statistically. When data sets are small, the process of data reduction involves a more direct assessment of the quality of individual points. Because of the uneven distribution of the data, all data sets are gridded using the Kriging method.

The final definition of the individual surfaces becomes an iterative process involving the plotting of the surfaces on cross-sections and the adjusting of control points to fit with the surrounding data.

## 4.3 Hydrogeological Parameters

Water well records that indicate the depths to the top and bottom of their completion interval are compared digitally to the spatial distribution of the various geological surfaces. This procedure allows for the determination of the aquifer in which individual water wells are completed. When the completion depth of a water well cannot be established, the data from that water well are not used in determining the distribution of hydraulic parameters.

After the water wells are assigned to a specific aquifer, the parameters from the water well records are assigned to the individual aquifers. The parameters include non-pumping (static) water level (NPWL), apparent transmissivity, and apparent water well yield. The NPWL given on the water well record is usually the water level recorded when the water well was drilled, measured prior to the initial aquifer test. In areas where groundwater levels have since fallen, the NPWL may now be lower and accordingly, the potential apparent yield would be reduced. The total dissolved solids, sulfate and chloride concentrations from the chemical analyses of the groundwaters are also assigned to applicable aquifers. In addition, chemical parameters of Nitrate + Nitrite (as N) are assigned to surficial aquifers and fluoride is assigned to upper bedrock aquifer(s). Nitrate + Nitrite (as N) concentrations are often related to well-specific data and may not indicate general aquifer conditions.

Once the values for the various parameters of the individual aquifers are established, the spatial distribution of these parameters must be determined. The distribution of individual parameters involves the same process as the distribution of geological surfaces. This means establishing a representative data set and then preparing a grid. The representative data set included using the available data from townships 031 to 047, ranges 04 to 11, W5M, plus a buffer area of at least 5,000 metres. Even when only limited data are available, grids are prepared. However, the grids prepared from the limited data must be used with extreme caution because the gridding process can be unreliable; for the maps, the areas with little or no data are identified.

On some maps, values are posted as a way of showing anomalies to the underlying grid or as a means of emphasizing either the lack of sufficient data or areas where there is concentrated hydrogeological data control.

## 4.4 Maps and Cross-Sections

Once grids for geological surfaces have been prepared, various grids need to be combined to establish the extent and thickness of individual geologic units. For example, the relationship between an upper bedrock unit and the bedrock surface must be determined. This process provides both the outline and the thickness of the geologic unit.

Once the appropriate grids are available, the maps are prepared by contouring the grids. Appendix A includes page-size maps from the text, plus additional page-size maps and figures that support the discussion in the text. A list of maps and figures that are included on the CD-ROM is given in Appendix B.

Cross-sections are prepared by first choosing control points from the database along preferred lines of section. Data from these control points are then obtained from the database and placed in an AutoCAD drawing with an appropriate vertical exaggeration. The data placed in the AutoCAD drawing include the geo-referenced lithology, completion intervals and non-pumping water levels. Data from individual geologic units are then transferred to the cross-section from the digitally prepared surfaces.

Once the technical details of a cross-section are correct, the drawing file is moved to the software package CorelDraw! for simplification and presentation in a hard-copy form. Eight cross-sections are presented in Appendix A of this report and as poster-size drawings forwarded with this report; only one (G-G') is included in the text of this report. The cross-sections are also included on the CD-ROM; page-size maps of the poster-size cross-sections are included in Appendix D of this report.

## 4.5 Software

The files on the CD-ROM have been generated from the following software:

- Acrobat 5.0
- ArcView 3.2
- AutoCAD 2002
- CorelDraw! 11.0
- Microsoft Office XP
- Surfer 8

## 5 AQUIFERS

### 5.1 Background

An aquifer is a permeable rock unit that is saturated. In this context, rock refers to subsurface materials, such as sand, gravel, sandstone and coal. If the NPWL is above the top of the rock unit, this type of aquifer is a confined or artesian aquifer. If the rock unit is not entirely saturated and the water level is below the top of the rock unit, this type of aquifer is a water-table aquifer. These types of aquifers occur in one of two general geological settings in the County. The first geological setting includes the sediments that overlie the bedrock surface. In this report, these sediments are referred to as the surficial deposits. The second geological setting includes aquifers in the upper bedrock. The geological settings, the nature of the deposits making up the aquifers within each setting, the expected yield of water wells completed in aquifer(s) within different geologic units, and the general chemical quality of the groundwater associated with each setting are reviewed separately.

### 5.2 Aquifers in Surficial Deposits

The surficial deposits are the sediments above the bedrock surface. These include pre-glacial materials, which were deposited before glaciation, and materials deposited directly or indirectly as a result of glaciation. The *lower surficial deposits* include pre-glacial fluvial<sup>15</sup> and lacustrine<sup>16</sup> deposits. The lacustrine deposits include clay, silt and fine-grained sand. The *upper surficial deposits* include the traditional glacial sediments of till<sup>17</sup> and ice-contact deposits. Pre-glacial materials are expected to be mainly present in association with linear bedrock lows. Meltwater channels are associated with glaciation.

#### 5.2.1 Geological Characteristics of Surficial Deposits

While the surficial deposits are treated as one hydrogeologic unit, they consist of three hydraulic units. The first unit is the sand and gravel deposits of the lower surficial deposits, when present. These deposits are mainly saturated. The second and third hydraulic units are associated with the sand and gravel deposits in the upper surficial deposits. The sand and gravel deposits in the upper surficial deposits occur mainly as pockets. The second hydraulic unit is the saturated part of these sand and gravel deposits; the third hydraulic unit is the unsaturated part of these deposits. For a graphical depiction of the above description, please refer to Figure 5, page 9 and to page A-9. While the unsaturated deposits are not technically an aquifer, they are significant as they provide a pathway for soluble contaminants to move downward into the groundwater.

The base of the surficial deposits is the bedrock surface, represented by the bedrock topography as shown on Figure 8 in the following page. Regionally, the bedrock surface varies between 750 and 1,850 metres AMSL. The lowest elevations occur mainly in the north-central part of the County, as shown on Figure 8 and page A-20.

Over the majority of the County, the surficial deposits are less than 30 metres thick (see CD-ROM). The exceptions are mainly in the north-central part of the County where the buried bedrock valley and meltwater channels are present and in the southwestern half of the County, where the deposits can have a thickness of more than 50 metres.

The Buried Drayton Valley (Carlson, 1971a) is a southwest-northeast-trending linear bedrock low that it is occupied by the present-day North Saskatchewan River, which forms the extreme northern border of the County. In the County, the Buried Drayton Valley ranges approximately from four to eight kilometres wide, with local bedrock relief being less than 100 metres. Sand and gravel deposits can be expected in association with the bedrock low, but the thickness of the sand and gravel deposits is expected to be mainly less than five metres.

<sup>15</sup> See glossary

<sup>16</sup> See glossary

<sup>17</sup> See glossary