GROUNDWATER RESOURCES IN THE
TURTLE MOUNTAIN CONSERVATION DISTRICT

October, 1978
Winnipeg, Manitoba

Prepared by:
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Planning Branch
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>2  PHYSIOGRAPHY</td>
<td>2</td>
</tr>
<tr>
<td>2.1 Physiographic Areas</td>
<td>2</td>
</tr>
<tr>
<td>2.1.1 Upland</td>
<td>2</td>
</tr>
<tr>
<td>2.1.2 Escarpment</td>
<td>2</td>
</tr>
<tr>
<td>2.1.3 Loeland</td>
<td>2</td>
</tr>
<tr>
<td>3  GEOLOGY</td>
<td>3</td>
</tr>
<tr>
<td>3.1 geology and Groundwater</td>
<td>3</td>
</tr>
<tr>
<td>3.2 Bedrock</td>
<td>3</td>
</tr>
<tr>
<td>3.3 Surficial Deposits</td>
<td>4</td>
</tr>
<tr>
<td>3.3.1 Kinds of Surficial Deposits</td>
<td>4</td>
</tr>
<tr>
<td>3.3.2 Till</td>
<td>4</td>
</tr>
<tr>
<td>3.3.3 Fine Grained Lake Deposits</td>
<td>5</td>
</tr>
<tr>
<td>3.3.4 Coarse Grained Lake Deposits</td>
<td>5</td>
</tr>
<tr>
<td>3.3.5 Deltaic Deposits</td>
<td>5</td>
</tr>
<tr>
<td>3.3.6 Alluvium</td>
<td>5</td>
</tr>
<tr>
<td>3.3.7 Marsh Deposits</td>
<td>5</td>
</tr>
<tr>
<td>4  GROUNDWATER</td>
<td>6</td>
</tr>
<tr>
<td>4.1 Aquifers</td>
<td>6</td>
</tr>
<tr>
<td>4.1.1 Definition</td>
<td>6</td>
</tr>
<tr>
<td>4.1.2 Kinds of Aquifers</td>
<td>6</td>
</tr>
<tr>
<td>4.1.3 Sand and Gravel at Surface</td>
<td>7</td>
</tr>
<tr>
<td>4.1.4 Lenses of Sand and Gravel</td>
<td>7</td>
</tr>
<tr>
<td>4.1.5 Sandstone</td>
<td>8</td>
</tr>
<tr>
<td>4.1.6 Shale</td>
<td>8</td>
</tr>
<tr>
<td>4.1.7 Very Deep Aquifers</td>
<td>8</td>
</tr>
<tr>
<td>4.2 Groundwater Flow Systems</td>
<td>9</td>
</tr>
<tr>
<td>4.3 Recharge</td>
<td>11</td>
</tr>
<tr>
<td>4.4 Sustained Yield</td>
<td>12</td>
</tr>
<tr>
<td>4.5 Groundwater Mining</td>
<td>12</td>
</tr>
<tr>
<td>4.6 Quality</td>
<td>13</td>
</tr>
<tr>
<td>4.7 Groundwater Problem Areas</td>
<td>13</td>
</tr>
<tr>
<td>4.8 Availability</td>
<td>14</td>
</tr>
<tr>
<td>4.9 Present Consumptive Use</td>
<td>15</td>
</tr>
<tr>
<td>5  SUMMARY</td>
<td>17</td>
</tr>
<tr>
<td>APPENDIX A</td>
<td>18</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>20</td>
</tr>
</tbody>
</table>
ILLUSTRATIONS

Figure 1  Topographic and Subsurface Features
Figure 2  Physiographic Areas
Figure 3  Bedrock
Figure 4  Depth to Bedrock
Figure 5  Surface Deposits
Figure 6  Aquifers
Figure 7  Groundwater Problem Areas
1 INTRODUCTION

The purpose of this report is to provide a general outline of groundwater conditions in the Turtle Mountain Conservation District. The District comprises the municipalities of Brenda, Morton and Winchester.

The report is based on available information consisting of geological and soils reports and basic groundwater data in the files of the Water Resources Division of the Department of Mines, Resources and Environmental Management. The Water Resources Division has carried out groundwater investigations in the vicinity of Deloraine, Goodlands, Medora, Napinka and Waskada and on a Provincial campground in Turtle Mountain Provincial Park.
2 PHYSIOGRAPHY

2.1 Physiographic Areas

Based on major topographic features and characteristics of the landscape depicted in Figure 1 the District may be divided in three physiographic areas:

(1) the Upland,
(2) the Escarpment, and
(3) the Lowland.

The boundaries of the physiographic areas are outlined in Figure 2.

2.1.1 Upland: The Upland is the topographically high area along the International Boundary. The boundary of the area falls between the 600 m and 700 m (2000 - 2250 ft.) elevation contour lines. The most characteristic features of the Upland are hilly topography and numerous lakes.

2.1.2 Escarpment: The Escarpment is the slope between the Upland and the Lowland. The elevation in this zone drops some 100 m (330 ft.) and is about 500 m (1675 ft.) at the base of the escarpment. The most noticeable features of the Escarpment are numerous steep sided valleys eroded by intermittent streams.

2.1.3 Lowland: The Lowland is the slightly undulating to flat plain that occupies the rest of the District north and west of the Escarpment. A major feature of the Lowland is Whitewater Lake which occupies a large shallow depression at the base of Turtle Mountain.
3 GEOLOGY

3.1 Geology and Groundwater

Groundwater flows through and is stored in the openings formed by rock formations and the unconsolidated deposits overlying them. Hence, the geology of an area has a significant effect on the groundwater resources in it. Consequently, the features of the geological setting of the district that have a bearing on the groundwater resources in it are described.

3.2 Bedrock

In the northern half and southwestern corner of the District, as indicated in Figure 3, the bedrock is shale of the Cretaceous Riding Mountain Formation. The thickness of the shale formation is more than 500 m (1600 feet). The upper part of the shale formation commonly contains hard fractured zones which are considerably more permeable than the shale in general. In the vicinity of Kaskadi (Figure 3) the shale contains thin sandstone beds which may be water bearing.

In the Turtle Mountain upland the bedrock is composed of Cretaceous and Tertiary Kiessevin and Turtle Mountain formations consisting of sandstone interbedded with shale and minor lignite deposits. A section through the district indicating the main hydrogeological features is shown in Figure 1. The sandstone beds are permeable and constitute the most common aquifer in the Escarpment area.

In most of the Lowland and in the Escarpment area the depth to bedrock is less than 40 m (130 ft.). Indications are that buried bedrock valleys occur in the northeastern corner of the district (Figure 4). A deep buried bedrock valley, (Medora Buried Valley, Klassen et al, 1970) crosses the western part of the District. The depth to bedrock in the Medora Valley is up to 110 m (360 ft.). In most of the Upland the depth to bedrock is more than 100 m (330 ft.).
3.3 **Surficial Deposits**

3.3.1 **Kinds of Surficial Deposits**: Based on mode of origin and grain size, the following six main kinds of surficial deposits may be discerned in the District:

1. till;
2. fine grained lake deposits;
3. coarse grained lake deposits;
4. deltaic deposits;
5. alluvium; and
6. marsh deposits.

The thickness of the surficial deposits or drift ranges from zero to more than 100 m (330 ft.). As indicated on the depth to bedrock map (Figure 4) the surficial deposits are more than 100 m thick in the Upland area and, in general, less than 40 m (130 ft.) thick in the Escarpment and Lowland areas.

3.3.2 **Till**: Till or till covered with a thin veneer of other deposits is the dominant surface deposit in the District. The areal extent of the main kinds of surface deposits is indicated in Figure 5. Till also underlies most of the other surficial deposits in the area. In general, till is practically impermeable, and therefore it is not water bearing. However, fairly commonly it may contain pockets or lenses of sand and gravel that may yield water.

3.3.3 **Fine Grained Lake Deposits**: The fine grained lake deposits consisting mainly of clay and silt occupy a belt up to ten kilometres wide at the base of the Escarpment and occur in a few small areas in the northwestern part of the Lowland (Figure 5). The lake deposits have been divided into fine grained and coarse grained deposits mainly because their water bearing properties are different; the coarse grained lake deposits may contain water bearing zones but the fine grained lake deposits are not likely to yield water to wells.
3.3.4 Coarse Grained Lake Deposits: The coarse grained lake deposits consist mainly of sand. These deposits occur in a fairly extensive area in the northwest corner of the District and in a few small isolated areas elsewhere in the Lowland (Figure 5).

3.3.5 Deltaic Deposits: The deltaic deposits consist mainly of sand and gravel and occur in a narrow zone along the Souris Valley in the vicinity of Kapinka as shown in Figure 5. These deposits are highly permeable and are commonly water bearing.

3.3.6 Alluvium: The alluvial deposits have been laid down at the base of the Escarpment by the streams that cross the Escarpment, by the Souris River and other streams in the Lowland (Figures 2 and 5). Minor alluvial deposits also occur in the narrow stream valleys on the Escarpment but are too small to form mappable units on maps showing surficial deposits on a regional scale. The alluvial deposits comprise clay, silt, sand and gravel. Because the alluvial deposits include permeable materials such as sand and gravel, they may be water bearing at some locations.

3.3.7 Marsh Deposits: Extensive marshes occupy the Lowland around Whitewater Lake. The surficial deposits in the marsh area consist of decayed organic material underlain by lake deposits.
4 GROUNDWATER

4.1 Aquifers

4.1.1 Definition: In the discussion of the geology of the District it was indicated that some bedrock strata and some of the surficial deposits readily transmit and store groundwater. The rock formations and the surficial deposits that yield water to wells at a rate sufficient for water supply are called aquifers.

4.1.2 Kinds of Aquifers: Based on the kind of rocks and surficial deposits forming them and, in the case of sand and gravel aquifers, their occurrence and areal extent, the following four kinds of aquifers can be discerned in the District:

1. sand and gravel at surface,
2. lenses, of sand and gravel,
3. sandstone, and
4. shale.

The areal extent of the aquifers or the areas where they may occur are indicated on the map in Figure 6.

4.1.3 Sand and Gravel at Surface: These aquifers are formed by the deltaic deposits in the vicinity of Nipoka. The aquifers are fairly extensive and generally less than 5 m (15 ft.) below ground surface. The saturated thickness often is around one metre (3 feet) or less. The yield of the aquifers under normal precipitation condition is adequate for domestic and farm requirements. Because the saturated zone of these aquifers is thin, they may be severely affected by water level decline in periods of drought. Properly designed wells in the thicker and more permeable parts of these aquifers may yield up to 5 litres per second (15 I.G.F.M.) for short periods.
4.1.4 Lenses of Sand and Gravel: These aquifers are formed by deposits of sand and gravel interbedded in the till, or occurring at the base of it and, less commonly, by sand and gravel layers within lake deposits and alluvium. Some minor sand and gravel aquifers at surface, which are too small to show as separate map units may exist in the sand and gravel lens aquifer area, particularly in the coarse lake deposit areas (Figure 5). In contrast to the sand and gravel aquifers at surface, which are continuous over fairly extensive areas the lenses of sand and gravel generally are small in area and occur as isolated deposits randomly scattered throughout other surficial deposits. Hence, the aquifer map (Figure 6) only indicates the areas where these aquifers may occur and does not mean they exist at every point within the indicated areas. The lenses of sand and gravel may also occur in the surficial deposits in the shale and sandstone aquifer area. The intermittent yields of wells drawing water from the lenses of sand and gravel can range from 0.1 l/s to about 5 l/s (approximately 1 - 65 I.G.P.M.). Indications are that some fairly extensive buried sand and gravel aquifers may occur within the areas shown on the map (Figure 6) as areas where lenses of sand and gravel form the most common aquifer. The available data, however, are not sufficient to outline them. Indications are that major sand and gravel aquifers occur in the buried bedrock channel west of Washado and near F.I.H. No. 10 about 3 km north of the International Peace Gardens. On the other hand, in some places the surficial deposits are more than 100 m thick and contain no aquifers.

4.1.5 Sandstone: Sandstone layers interbedded with shale form the most common aquifers in the Escarpment area (Figure 6). The depth to the sandstone aquifers in the area indicated on the aquifer map generally is less than 40 m (130 ft.). The sandstone is fine grained, partially cemented and fairly silty. The thickness of the sandstone aquifers ranges from one to 20 m.
The yield of wells in the sandstone aquifer generally is 0.5 L/s (7 I.G.P.M.) or less. Where the sandstone beds are thick and it contains no silt the yields are considerably better and may be up to 5 L/s (65 I.G.P.M.). However, these exceptionally good conditions are rather rare. The sandstone aquifers extend under the Upland area (Figure 1) but usually are not developed, because there they are more than 100 m (330 ft.) below ground level and shallower aquifers are available. However, the sandstone aquifers could be considered as potential source of water in the Upland if the shallower aquifers do not exist. As the sandstone beds are more or less continuous over the whole sandstone aquifer area indicated in Figure 6, groundwater is available at almost any location in the area. However, yields and quality may be less than satisfactory at some locations.

4.1.6 Shale: The shale bedrock that underlies the Lowland constitutes the main and in large areas the only aquifer in the northern half of the District (Figure 6). The depth to the shale aquifer as indicated by the depth to bedrock map ranges from 10 m to 40 m (30 - 130 ft.). The fractured water bearing zones usually occur in the upper 30 m (100 ft.) of the shale. The yield of the shale aquifer in the district usually is low and most wells yield less than 0.5 L/s (7 I.G.P.M.). In extensive areas water in the shale aquifer is of very poor quality or salty and unpotable. Hence, in much of the northern part of the District potable groundwater is difficult to impossible to find. In the Lowland the shale aquifer underlies the sand and gravel aquifers and may be considered as a source of water where shallower aquifers do not exist.

4.1.7 Very Deep Aquifers: In addition to the commonly developed aquifers that occur at a depth of less than 100 m (330 ft.) a considerably deeper water bearing zone exists in the District. It is formed by sandstone beds
of the Swan River Formation that underlay the shale bedrock. Oil
exploration test wells drilled in the District indicate that in the Lowland
the depth to this very deep aquifer is from 550 m to 650 m (1800 – 2150 ft.)
and more than 700 m (2300 ft.) in the Upland. The very deep sandstone
aquifers have been considered as potential source of water in those parts
of the Lowland where groundwater in the shallower aquifers is not available
or is very salty. Water samples from the deep aquifers, however, indicate
that the total dissolved solids concentration in it ranges from 5000 to 6000
mg/L. The main dissolved ions in the water are sodium and chloride or
dissolved salt. Because of the high salt concentration the water is not
potable. It may be acceptable for some kinds of livestock but even for livestock
the quality is poor to very poor. Hence, water from the very deep aquifers is
not likely to solve the water supply problems in the District.

4.2 Groundwater Flow Systems

Groundwater constitutes the underground component of the water that
flows through the District. Some of the groundwater that flows through the
District originates as precipitation outside it and enters it as subsurface
inflow. It may have originated hundreds of kilometres west or southwest of
the District and, therefore, it is called the regional flow system. The flow
systems that originate in the District, and, in some cases, just outside it
are called local flow systems; in areal extent they may cover a large part
of the District or less than one square kilometre. The main trends of groundwater
flow in a typical section through the District are indicated in the diagram in
Figure 1.

Because groundwater dissolves minerals in the strata through which
it flows, the water of the regional flow system, which has travelled a long
distance, is considerably more mineralized than water in the local flow systems.
The larger local flow systems originate in the Upland, and Escarpment areas and flow towards the lowland. Small local flow systems originate in the sandy and gravelly areas of the Lowland, e.g., in the deltaic deposit area at Napinka. Because water of the local flow systems has travelled only a short distance, generally it is fresh and its quality ranges from fair to excellent.

Because of the difference of groundwater quality in the flow systems, they have a strong influence on groundwater quality in the District; in areas or depth zones where the local flow systems are dominant it is fresh and where the regional system is dominant it is saline. In some parts of the District the local flow systems merge and mix with the regional flow system. In these areas groundwater is likely to be of poor quality or to vary considerably in quality from place to place or with depth below ground level.

The regional flow appears to influence groundwater quality in the Lowland area and likely is the cause of the salty and very poor quality water in that part of the District. In the vicinity of Deloraine and along the south shore of Whitewater Lake the highly mineralized water has intruded shallow aquifers.

The local flow systems dominate in the aquifers in the Upland and Escarpment areas. Hence, in these areas groundwater generally is fresh. A fairly extensive local flow system probably exists in the vicinity of Napinka where the flow likely is from the sandy and gravelly recharge area towards the Souris Valley. Minor local flow systems may exist at other locations in the Lowland and may be the source of good quality water in areas where, in general, only the highly mineralized water of the regional system is available.

It should be noted that the groundwater flow systems that exist in the District are interacting and that the conditions that exist are in
dynamic equilibriums. In some places, e.g., at the base of the Escarpment, the equilibrium could be very sensitive to slight changes in the flow system such as decreased recharge or increased discharge. Consequently changing groundwater flow systems artificially may result in noticeable change in the quality and, less likely, the quantity of groundwater. Because the local flow systems originate as infiltration from precipitation, changing the existing drainage may cause changes in groundwater quality; depending on local conditions it may be beneficial or detrimental, e.g., improved drainage could cause reduction in recharge that could result in deterioration of groundwater quality.

4.3 Recharge

In the discussion of the groundwater flow systems in the District it was indicated that fresh or potable groundwater exists only in local groundwater flow systems. Because water enters the local flow systems as precipitation that infiltrates the substrata within the District, the fresh groundwater supply in the district to a large extent depends on the infiltration of precipitation or aquifer recharge from precipitation in the District.

Under normal conditions groundwater recharge in Manitoba is mostly from snowmelt and early spring rains. Precipitation during the summer usually is returned to the atmosphere by evapotranspiration before it can contribute to the recharge of aquifers. Groundwater level observations, however, indicate that above normal rainfall in summer and early fall can be a significant factor in groundwater recharge.

It appears that the main recharge areas in the District are the Upland, the Escarpment and the sandy and gravelly areas in the northeast corner of the District. Hence, it can be assumed that the recharge area is about one half of the district or 1290 square kilometres (504 sq. miles).

Because most of the recharge area of the District is underlain by
likely is near the minimum for the recharge on the prairies. According to estimates by Mayboom (1966) groundwater recharge on the prairies, expressed as a percentage of the total annual precipitation ranges from less than one percent to 7.5 percent. Because the recharge conditions in most of the district appear to be poor it is assumed that recharge is one percent of the annual precipitation. Since annual precipitation in the area is approximately 47 cm (18.5 inches) the recharge then is 0.005 metres (0.02 feet) of water over the recharge area or $6.45 \times 10^6$ cubic metres a year (5200 acre feet per year). It is equal to a continuous recharge rate of 17 671 $\text{m}^3$ (3.8 million gallons) per day or 204 litres per second (2720 I.G.P.M.).

4.4 Sustained Yield

The sustained yield of aquifers, or the yield at which they could be pumped indefinitely, cannot exceed the rate of recharge. Because of natural discharge the sustained yield usually is considerably less than the recharge. Since the estimated total recharge of the fresh water aquifers in the area is $6.45 \times 10^6$ cubic metres ($\text{m}^3$) a year (5200 acre feet) or 204 litres per second (2720 I.G.P.M.) sustained recharge rate, the total sustained pumping rate of the aquifers cannot exceed these rates and more likely it is only one third to one half of the maximum rate, i.e., 70 to 100 L/s (900 - 1360 I.G.P.M.).

The sustained yields of most wells in the district are not likely to exceed 0.5 L/s (7 I.G.P.M.). Wells in some of the more extensive sand and gravel aquifers may have a sustained pumping rate of more than 10 L/s (130 I.G.P.M.). Hence, in most of the district the sustained yield of wells is adequate only for domestic and farm requirements. Only a few aquifers may yield enough for municipal or moderate industrial requirements.

4.5 Groundwater Mining

In some watersheds, where groundwater conditions permit, it can be advantageous to carry out groundwater mining.
than is recharged, while other sources of supply are developed. Because in the Lowland area fresh water aquifers are underlain by salty water and the yields of most aquifers in the Escarpment and Upland areas are low, groundwater mining is not likely to be a practical solution to water supply problems in the district.

4.6 **Quality**

Groundwater quality in the District ranges from good to unpotable. In general the quality is better in the Upland and Escarpment areas than in the Lowland. However, within each physiographic area the quality may vary considerably from place to place and depth to aquifer (Tables 1-3).

In the Upland and Escarpment areas the quality commonly ranges from fair to good (the quality description terms are defined in Appendix A), although high hardness and high sulphate ion concentrations may occur at some locations.

In the Lowland, potable groundwater generally is of poor to very poor quality and salty water is common in extensive areas. The salty water areas are indicated on the aquifer map (Figure 6). Because of favorable local recharge conditions in the sandy and gravelly areas in the northwest corner of the Lowland, groundwater there is likely to be of fair to excellent quality.

4.7 **Groundwater Problem Area**

A wide zone around Whitewater Lake and extending from there east and west to the District boundaries may be classified as a groundwater problem area. In some parts of this area, which is outlined in Figure 7, groundwater is salty and its quality is very poor. In other parts there is practically no groundwater available. In the problem area a satisfactory supply of groundwater would be difficult if not impossible to find.
### Table 1

#### Water Quality in Sand and Gravel Aquifers

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<th>LOCATION</th>
<th>ZONE PK</th>
<th>CATIONS mg/L</th>
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### Table 2

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<td>0.3</td>
<td>1.8</td>
<td>877</td>
<td>1119</td>
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<td>559</td>
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<td>10-15</td>
<td>0.3</td>
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<td>1.8</td>
<td>877</td>
<td>1119</td>
<td>40</td>
<td>559</td>
<td>733</td>
</tr>
</tbody>
</table>

### Table 3

#### Water Quality in Sandstone Aquifer

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>ZONE PK</th>
<th>CATIONS mg/L</th>
<th>ANIONS mg/L</th>
<th>DISG. mg/L</th>
<th>NITROGEN mg/L</th>
<th>ALKALI mg/L</th>
<th>F.C. (%)</th>
<th>SAMPLING DATES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CA</td>
<td>MG</td>
<td>Na+</td>
<td>K+</td>
<td>HCO₃</td>
<td>SO₄</td>
<td>Cl</td>
</tr>
<tr>
<td>NW-0-1-1W</td>
<td>0-5</td>
<td>0.3</td>
<td>1.8</td>
<td>877</td>
<td>1119</td>
<td>40</td>
<td>559</td>
<td>733</td>
</tr>
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<td></td>
<td>5-10</td>
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<td>1.8</td>
<td>877</td>
<td>1119</td>
<td>40</td>
<td>559</td>
<td>733</td>
</tr>
<tr>
<td>NW-0-2-1W</td>
<td>0-5</td>
<td>0.3</td>
<td>1.8</td>
<td>877</td>
<td>1119</td>
<td>40</td>
<td>559</td>
<td>733</td>
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<td>1119</td>
<td>40</td>
<td>559</td>
<td>733</td>
</tr>
</tbody>
</table>

* - Metres below ground level
Although very few analyses are available, the fact that water is often reported as salty or very salty indicates that the dissolved solids concentration in the salty water areas is likely several times higher than the acceptable limits. The dissolved solids concentration probably ranges from several thousand up to ten thousand mg/L. Because of favourable local recharge conditions, minor fresh water aquifers may occur in the problem area but they are not likely to be common. Furthermore, the fresh water of the minor aquifers may become salty by salt water intrusion when the fresh water is withdrawn.

4.2 Availability

The availability of groundwater in an area depends on the kind of aquifers that exist there, groundwater quality and well yields. Because the aquifer map (Figure 6) outlines aquifers and salty groundwater areas, it can be used to indicate groundwater availability in the District.

Based on the various aspects already discussed dealing with groundwater occurrence the availability of groundwater in the District is as follows:

1. Groundwater for domestic and farm requirements is available in the sandstone aquifer area on the escarpment, in the sand and gravel aquifer area in the vicinity of Napinska and in the saline aquifer area outside the salty water areas. The intermittent pumping rates of wells in these areas generally are less than one litre per second (1/3 I.G.P.M.). At a few locations in the sandstone and sand and gravel areas aquifer conditions may be somewhat better and pumping rates may be 5 L/s (55 I.G.P.M.) or more. On the other hand, in some places adequate supply for domestic requirements may be difficult to find.

2. In large parts of the Lowland and in the Upland area the most common and in fact the only aquifers are lenses of sand and gravel.
Because these aquifers are discontinuous, groundwater may not be available at every point in these areas. Hence, at some locations considerable test drilling may be required to find a satisfactory supply. The yields of these aquifers in the District generally are low and pumping rates are less than one litre per second (13 I.G.F.M.). Indications are that some fairly extensive buried sand and gravel aquifers may exist in the Upland area; the yield of these aquifers could be more than 10 l/s (130 I.G.F.M.). A fairly large sand and gravel aquifer occurs in the Medora buried bedrock valley (Figure 4) west of Waskada.

1. In about one half of the Lowland area groundwater supply is marginal to non-existent because of salty water or lack of aquifers. This area occupies much of the northern half of the District and is shown as groundwater problem area on the map in Figure 7.

4. In general, groundwater supply in the District, where it is available at all, is adequate only for domestic and farm requirements. Only a few higher yield aquifers suitable for moderate municipal, industrial or similar requirements exist in the District.

4.7 Present Consumptive Use

At present, groundwater in the District is used mainly for domestic and farm supply. The only municipality using groundwater for municipal water supply is the Village of Waskada. The municipal supply for Boissevain and Deloraine is from surface water reservoirs.

The population of the District using groundwater for water supply is 3507*. Assuming a water consumption of 250 litres per person per day, which
is about average according to statistics for small towns, the total consumption for domestic requirements then is approximately 900 cubic metres per day (195,000 gallons per day). This is equal to a sustained pumping rate of 10 litres per second (135 I.G.P.M.).

The approximate consumption by livestock is as follows:

<table>
<thead>
<tr>
<th>Livestock Type</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle, Feeders</td>
<td>$319 \text{ m}^3/\text{d}$ (54 L x 4294.5)</td>
</tr>
<tr>
<td>Cattle, Dairy</td>
<td>$149 \text{ m}^3/\text{d}$ (135 L x 1101)</td>
</tr>
<tr>
<td>Pigs</td>
<td>$131 \text{ m}^3/\text{d}$ (18 L x 7279)</td>
</tr>
<tr>
<td>Sheep</td>
<td>$10 \text{ m}^3/\text{d}$ (7 L x 1386)</td>
</tr>
<tr>
<td>Poultry</td>
<td>$29 \text{ m}^3/\text{d}$ (0.3 L x 97447)</td>
</tr>
</tbody>
</table>

Total $2638 \text{ m}^3/\text{d}$ (cubic metres per day) (586,000 gallons per day)

As some of the livestock likely use surface water it is assumed that the groundwater consumption by livestock is at the most 2000 $\text{m}^3/\text{d}$ (440,000 I.G.P.D.).

No irrigation or industrial groundwater users have been licenced in the District.

The total estimated consumptive groundwater use in the District is:

<table>
<thead>
<tr>
<th>Use Type</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>$900 \text{ m}^3/\text{d}$</td>
</tr>
<tr>
<td>Livestock</td>
<td>$2000 \text{ m}^3/\text{d}$</td>
</tr>
</tbody>
</table>

Total $2900 \text{ m}^3/\text{d}$ (440,000 I.G.P.D.)

The total consumption is equal to a sustained pumping rate of 34 L/s (440 I.G.P.D.) for a total yearly consumption of about one million cubic metres (810 acre feet).

The above figures indicate that the present groundwater consumption is about one sixth of the total available groundwater of about six million cubic metres per year (4860 acre feet) or a sustained pumping rate of 220 L/s (2700 g.p.m.).
5 SUMMARY

1. In the Turtle Mountain Conservation District groundwater is more readily available in the southern half than in the northern half of the area.

2. In the southern half the aquifers are formed by extensive sandstone beds and by lenses of sand and gravel in till; water in these aquifers generally is fresh and quality ranges from poor to good.

3. In the northern half aquifers are formed by fractured zones in the shale bedrock and lenses of sand and gravel; water quality in these aquifers is very poor to fair.

4. In an extensive belt extending from the western boundary to the eastern boundary of the District through the northern half of it potable groundwater is salty, of very poor quality or in very limited supply.

5. Most aquifers in the District yield only enough for domestic and farm wells.

6. Only a few moderately high capacity aquifers appear to occur in the District.

7. The supply of fresh groundwater in the district appears to be minimal and development requiring large quantities of water could not be met by groundwater resources in the District.

8. The total supply of groundwater in the District is adequate for present requirements and moderate new development.
APPENDIX A

GROUNDWATER QUALITY DESCRIPTIONS

To describe groundwater quality the terms excellent, good, fair, poor and combinations and modifications of them are used in this report. Unless other uses are specified these terms indicate how acceptable the water is for domestic use. The quality description is based on the total dissolved solids, the concentration of the common ions that affect quality, hardness, appearance, taste and odour of the water.

The meaning of the terms used for groundwater quality description is as follows:

1. **Excellent**: The water has no objectionable properties and treatment of it to improve quality is not necessary; the total dissolved solids concentration is less than 500 mg/L and hardness less than 250 mg/L.

2. **Good**: The water has higher mineral concentration than the excellent water and is rated less than excellent mainly because of higher hardness; the total dissolved solids concentration ranges from 500 to 1000 mg/L and hardness is from 250 to 500 mg/L. The hardness is likely to cause incrustation of kitchen utensils. The water can be used without treatment or, if desired, the hardness can be readily reduced.

3. **Fair**: The water has one or more objectionable properties and fairly commonly may require treatment to improve quality. The most common undesirable property is high hardness; it ranges from 500 to 1000 mg/L. The hardness can be reduced to acceptable level with conventional water softeners. The water may have high enough sulphate, iron and chloride ion concentrations to slightly impair its taste or, in the case of sulphate, have a
solids concentration of the water is from 1000 to 2000 mg/L.

4. Poor: The water has one or more serious undesirable properties and it is difficult to impossible to improve the water quality by conventional water treatment. The water commonly is very hard (more than 1000 mg/L) and it may be difficult (also expensive) or impractical to reduce the hardness with conventional water softeners. The water may also have a very high sulphate ion concentration (500 to 2500 mg/L). In some places the water may be rated as poor quality because of high sodium chloride (salt) concentration, which makes it taste salty. The water may be also less than desirable in appearance and may have unpleasant odour.

5. Very Poor: The undesirable properties of the water are just below a tolerable limit.
REFERENCES


1. The yields of most of the aquifers ranges from 0.1 to 1.0 litres per second. The yield of properly designed wells in some of the sandstone and sand and/or gravel aquifers may be up to 5 litres per second.

2. Water quality outside the salty groundwater area ranges from poor to good.

3. In areas where more than one aquifer exists, the map shows the best aquifer in respect to quantity, quality and ease of development.

4. In the sandstone and shale aquifer areas, water bearing sand and gravel may occur within the surficial deposits.

5. The boundaries of the aquifers and the salty water area are approximate.

NOTES:

SCALE: 5000:1 KIOMIERS

LEGEND:

- **Sand and/or gravel at surface**: Fairly extensive but thin aquifers, usually less than 5 metres below ground surface
- **Lenses of sand and/or gravel**: These aquifers are formed by scattered deposits of sand and gravel within the surficial deposits; includes minor sand and gravel aquifers at surface.
- **Sandstone**: The thickness of the sandstone aquifers ranges from less than one metre to more than ten metres.
- **Shale**: The aquifers extend south of the indicated area but are at more than 100 metres below ground level. The aquifers usually occur in the upper 30 metres of the shale bedrock, shale aquifers may exist in the adjacent sand and gravel aquifer area.
- **Salty groundwater area**: Water in the aquifers indicated on the map and other aquifers that may occur in the area is salty. Local exceptions may occur particularly in shallow aquifers.

PROVINCE OF MANITOBA
DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT
WATER RESOURCES DIVISION

TURTLE MOUNTAIN CONSERVATION DISTRICT

AQUIFERS

PREPARED M.R.
DRAWN M.K.K.
CHECKED M.K.K.
APPROVED M.R.

SCALE AS SHOWN
7809 20
6 OF 7

FIG. 6

90-07-082
GROUNDWATER RESOURCES IN THE TURTLE MOUNTAIN
CONSERVATION DISTRICT

ADDENDUM
TO 1978 REPORT

July, 1986
Winnipeg, Manitoba

Prepared by:
M. Rutulis, P. Eng.
Hydrogeology Section
1. **Introduction**

In 1986, the Turtle Mountain Conservation District which then comprised the Rural Municipalities of Morton, Winchester and Brenda was expanded to the Souris River by including the southeastern corner of Rural Municipality of Arthur in the District. This addendum deals with groundwater resources in the added area. The illustrations for the added area are on the same scale and the same map symbols are used as in the 1978 report.

2. **Physiography and Geology**

The entire added area lies within the lowland of the Conservation District. It is an almost flat area with a gentle slope towards the Souris River.

The bedrock in the area is mainly shale of the Cretaceous Riding Mountain Formation. In the eastern part of the area, as indicated in Figure 1.a, the shale contains some sandstone beds. In most of the area as shown in Figure 1.b, the depth to bedrock ranges from less than 20 m up to 40 m. However, in a deep northerly trending buried bedrock valley in the eastern part of the added area the depth to bedrock is up to 120 m.
The surficial deposits in most of the area consist of glacial till with a few pockets of sand and gravel. Within the buried bedrock valley the surficial deposits consist of clay, silt and, at least in some parts of it, thick and fairly extensive sand and gravel beds.

3. AQUIFER

As indicated in Figure 1.c the aquifers in the area are formed by hard fractured shale beds and lenses of sand and gravel. In the central and western part of the added area, i.e., west of the buried bedrock valley, only minor widely scattered fractured shale and sand and gravel aquifers are found. In general, the yield of these aquifers is low and water quality is poor to very poor. Consequently much of this area as outlined in Figure 1.d. is classified as a groundwater problem area. Aquifers formed by lenses of sand and gravel are fairly common within the buried bedrock valley and in the area east of it.

The most significant aquifer in the added area is formed by thick sand and gravel deposits in the buried bedrock valley near the northeastern corner of the added area. The total thickness of the sand and gravel deposits there is up to 40 metres. Water quality in it is unusually good for this area. The municipal well for the Village of Waaskada draws water from this aquifer. The areal extent of the aquifer has not been defined. Indications are that it might be more or less continuous south to the international boundary.
Most of the minor aquifers that exist in the area likely are recharged locally by infiltration from the surface in the area underlain by the aquifers and in the immediate vicinity. The sand and gravel aquifer in the buried valley, commonly known as the Waskada Aquifer, has not been adequately investigated to indicate its recharge system. It seems that it is local but some regional flow is also likely to contribute to its recharge.

4. GROUNDWATER AVAILABILITY

In general, only a very limited groundwater supply is available in most of the added area. The yield of the aquifers generally is adequate only for minimal domestic and farm supply.

The only aquifers in the area that can sustain fairly high intermittent pumping rates are the sand and gravel aquifers in the buried bedrock valley, particularly in the area just southeast of Waskada. The intermittent yield of wells completed in these aquifers could be up to 50 L/s. Groundwater level of the Waskada Aquifer has declined some 10 m since the municipal well was installed in 1977 (A. Pedersen, M.W.S.B.). The available information is not adequate to indicate the cause of the groundwater level decline or to define the long term potential yield of the Waskada aquifer. As the Waskada aquifer is the only major source of groundwater in the surrounding area, monitoring of water levels in the Waskada aquifer and field investigation to define its areal extent and cause of water level decline would be advisable.
5. UNDERWATER PROBLEM AREAS

In much of the added area a satisfactory supply of groundwater is difficult to impossible to find because of minimal yield and very poor quality caused by high hardness and high sulphate content. The groundwater problem area is indicated in Figure 1.d.

6. PRESENT GROUNDWATER CONSUMPTION

The only major user of groundwater that pumps water from the added area is the Village of Waskada. The Village pumps some 135 cubic metres per day from the Waskada aquifer. This is equal to a sustained pumping rate of 1.6 L/s. The water consumption by Waskada was included in the 1978 estimate of total groundwater consumption in the District.

Most of the domestic and farm wells in the added area are located outside the Waskada aquifer and draw water from small isolated aquifers. The total domestic and farm water use in the added area will add some 100 cubic metres per day to the total groundwater consumption in the District. Withdrawal of water from the minor aquifers is not likely to have an effect on the Waskada aquifer.