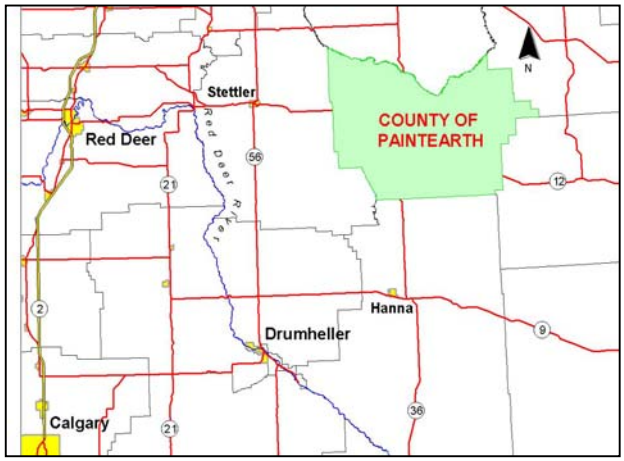
COUNTY OF PAINTEARTH

Water Well Verification and Testing Survey

In response to an historic lack of groundwater in many parts of Alberta's County of Paintearth, and the additional adverse effects of recent drought, pumping tests and water quality sampling were carried out on selected water wells using extra funding provided to the Rural Water Development Program (RWDP), an initiative administered by Agriculture and Agri-Food Canada's Prairie Farm Rehabilitation Administration (PFRA). Aqua Terre Solutions Inc. (Aqua Terre) was contracted to carry out the study and was directed to test 60-70 water wells located within the County of Paintearth.



Location Map

Study Objectives

The objective of the study was to collect additional pumping test and water quality data to improve the level of knowledge on aquifers underlying the County of Paintearth. Rationale for the study follows from recommendations presented in a regional hydrogeological investigation report prepared for the county by Hydrogeological Consultants Ltd. (HCL, 1999). The detailed well survey was intended to improve the level of knowledge available for future regional groundwater investigations and will assist with ongoing studies in the county. The study will also improve understanding and, ideally, serve as a catalyst for the management and protection of the county's groundwater resources.

Study Methodology

The overall objective of the program was to contact and obtain approval from approximately 60-70 domestic well owners in the county to gather field-verified information pertinent to their respective wells. The survey consisted of:

- Surveying the well location and elevation using Global Positioning System (GPS) technology.
- Placing a permanent tag on the well casing. The well tag included the "wellid" as recorded for that well in the provincial water well database managed by Alberta Environment.
- Taking a picture of each well site visited, and sketching the location of the well in relation to buildings and potential sources of contamination.
- Asking the well owner key questions on well performance and water quality.
- Conducting a pumping test on the water well using the existing well infrastructure (pump, discharge line or hydrant, etc). Where possible, pumping tests were usually four hours in length (two hours pumping and two hours recovery).
- Collecting a water sample, either during the pumping test or from a tap located close to the well (before any treatment system). Groundwater samples were analysed (in an accredited lab) for major ions and standard parameters. Based on a field assessment of the well construction and location relative to potential sources of contamination, selected samples were also tested for total coliforms and faecal coliforms.
- Collecting Biological Activity Reaction Test (BART™) samples to assess the well's potential to "biofoul" (basically plugging of the well intake zone by the growth of biological material). Biofouling can also affect water quality.

Distribution of Study Findings

Complete copies of the study results were provided to the County of Paintearth and to the local health unit. All well-specific results were returned to cooperating well owners. Well owners were also provided with a copy of the driller's water well log for their well and with a copy of the joint federal-provincial publication titled *Water Wells that Last for Generations*.

Copies of the study for public distribution (e.g. on the Internet) have key well owner data removed to protect owner confidentiality.

Study Findings

Well owner comments – Results of the field-verified survey indicated the following:

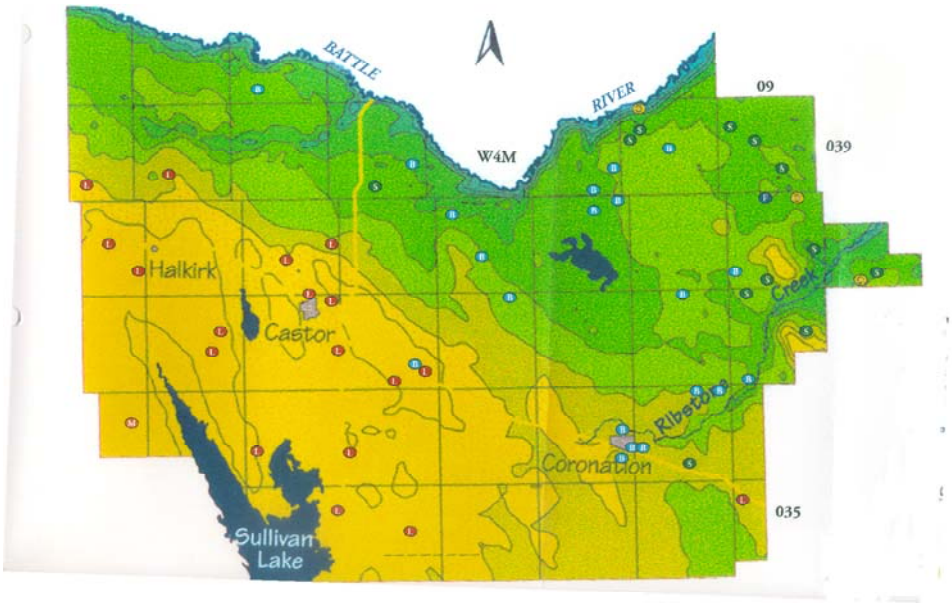
- Approximately 60 per cent of the participants drink bottled water.
- Most participants believe their wells are not productive enough and do not meet their expectations in terms of quantity of water available.
- Each well inspected was active and in fair to good working condition, although regular maintenance is not generally undertaken, which may lead to reduced water quality and well performance.
- Due to location and / or relatively shallow completion depths, a number of wells (about 50 per cent) are potentially susceptible to contamination associated with fuel storage tanks, livestock, and tile fields.

Numbers of wells tested – A summary of the field-verified well survey is presented below.

Geological Unit/ Formation	# of Water Quality Analyses	# of Pumping Tests	# of Water Wells in that unit in the County
Surficial	12	7	285
Middle Horseshoe Canyon	2	1	32
Lower Horseshoe Canyon	15	12	940
Bearpaw	27	18	623
Oldman	3	1	41
Foremost	1	0	3

See Figure 1 for well test locations. Sixty-five wells were inspected, of which 60 were sampled for water quality and 39 underwent pumping tests.

Figure 1



Pumping Test Results

The well testing program was hampered by the relatively short duration of the pumping period. This resulted in a higher level of uncertainty associated with the estimate of the long-term well yield (i.e. Q20).

The general patterns and trends in well yield appear to be similar to that defined by the regional hydrogeological mapping for the area (HCL, 1999). The data showed the following general trends:

- Non-pumping static water levels (February 2002) generally have not changed significantly from the date of original well completion. Several wells show declines of approximately 5 m, perhaps locally reflecting over-use conditions.
- Collectively (i.e., surficial units to Foremost Formation), the groundwater flow system exhibits a highly variable hydraulic character with transmissivity values ranging from less than one to 243 m^2/day, but generally $\underline{<2}$ m^2/day. Within each hydrostratigraphic unit, variations of up to two orders-of-magnitude in transmissivity were noted.
- Potential long-term well yields were generally $\underline{<2}$ m^3/day (about 0.3 imperial gallons per minute, igpm) but ranged from less than one to 1,196 m^3/day.
- Most results are consistent with the regional groundwater studies in the area, with the exception of several very high-yielding wells.
- Most well yields calculated from the short-term pumping tests in February 2002 are much less than those recorded on the original log, but are still adequate for domestic and stock purposes. The reason for the difference is unknown. In some wells, the difference may be due to deterioration of the intake zone (e.g. plugging of the well screen or perforated line by biofouling, encrustation) over time since the well was first installed.
- Higher-yielding wells at several locations suggest that higher-yielding haul well locations can be located in the county.

Water Quality Results

Water quality data was based on a single "snapshot" sampling of water from the specific wells. Although some variation within and between the hydrostratigraphic units was evident from the data, further investigation would be required to establish whether any temporal trends exist. However, the general chemical patterns and trends appear to be similar to that defined by the regional hydrogeological mapping for the area (Hydrogeological Consultants, 1999). The water quality data showed the following general trends:

- There is a wide range in water quality in the wells tested. Differences in chemical constituents between wells generally involved bicarbonate, sulphate, sodium, calcium, and / or magnesium.
- TDS concentrations are generally greater than 500 mg/L and, as expected, the groundwater generally shows an increase in TDS with increasing depth (also reflected in increasing electrical conductivity with depth).
- The pH for samples collected from the lower bedrock units showed moderately high alkaline trends.
- Water hardness ranged from very soft to very hard; softer waters were typically associated with the bedrock aquifers.
- Chloride concentrations are generally low but, where elevated, may reflect recent well chlorination.
- Other major ions including sulphate and sodium, although generally exceeding their respective Canadian Council of Ministers for Environment (CCME, 1999) water guidelines, are interpreted to represent naturally occurring levels of salts.
- Groundwater within surficial deposits is particularly susceptible to impacts from surface activities as evidenced by elevated nitrate concentrations in selected wells.
- Dissolved iron and manganese concentrations were variable and commonly exceeded their respective (CCME, 1999) drinking water quality aesthetic objectives. The iron and manganese concentrations may be leading to water staining and an orange color.
- Fluoride concentrations were generally less than the CCME (1999) drinking water health guideline of 1.5 mg/L.
- BART™ tests demonstrated the susceptibility of each hydrostratigraphic unit to biofouling and, in particular, to sulphate and iron-reducing bacteria. Biofouling is likely occurring in many wells, thereby reducing well yields.

- Coliform bacteria (faecal and total) were not identified in samples collected; however, re-testing is necessary for selected wells.
- DOC concentrations were typically less than 15 mg/L and ranged from 1.1 to 25.6 mg/L – at higher DOC levels the potential exists for trihalomethanes (THMs) to be generated due to well chlorination (i.e. well shocking).
- There appears to be no widespread groundwater quality impacts, with the exception of one well where nitrate levels are a concern.

Recommendations for Future Studies

Based on the program results, the following recommendations are made for future field-verified surveys:

- Prior to commencing with the program, allow adequate "lead time" to inform local residents and community leaders.
- Use county resources to update domestic well owner lists.
- Arrange scheduling in the spring, summer or fall.
- Given the short holding times for laboratory bacteriological analysis (< 24 hours), in some instances it may be preferable to schedule sampling for bacteriological analysis separately from the pumping test. Emerging technology (e.g. Aquasure 3000™) may permit testing to be done in the field.
- Modify the length of the pumping tests (i.e. 2 -24 hours) depending on the objectives of the test.

In addition, consideration should be given to the development of a Groundwater Management Plan (GMP) in the county, aspects of which have been completed to varying degrees. Conceptually, the GMP would address the following:

- Definition of the groundwater resources, focusing on improving understanding of the extent, characteristics and limit of the resource.
- Identification of potential sources of groundwater contamination.
- Strategies for groundwater monitoring.
- Strategies for groundwater resource management and protection, with the specific focus on implementing strategies to ensure the protection of groundwater quantity (e.g. well yields) and groundwater quality (e.g. nitrate and / or bacteriological impacts).

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Report Aqua Terre Solutions Inc., March 2002, County of Paintearth No. 18, Water Well Survey (3 volumes total), Prepared for Agriculture and Agri-Food Canada.