

# Inorganic Water Chemistry of Saline Fens in Northeastern Alberta (NTS 74D)

# **Inorganic Water Chemistry of Saline Fens in Northeastern Alberta (NTS 74D)**

S.A. Stewart and T.G. Lemay

Energy Resources Conservation Board  
Alberta Geological Survey

May 2011

©Her Majesty the Queen in Right of Alberta, 2011  
ISBN 978-0-7785-8650-0

The Energy Resources Conservation Board/Alberta Geological Survey (ERCB/AGS), its employees and contractors make no warranty, guarantee or representation, express or implied, or assume any legal liability regarding the correctness, accuracy, completeness or reliability of this publication. Any reference to proprietary software and/or any use of proprietary data formats do not constitute endorsement by ERCB/AGS of any manufacturer's product.

If you use information from this publication in other publications or presentations, please acknowledge the ERCB/AGS. We recommend the following reference format:

Stewart, S.A. and Lemay, T.G. (2011): Inorganic water chemistry of saline fens in northeastern Alberta (NTS 74D); Energy Resources Conservation Board, ERCB/AGS Open File Report 2011-09, 6 p.

**Published May 2011 by:**

Energy Resources Conservation Board  
Alberta Geological Survey  
4th Floor, Twin Atria Building  
4999 – 98th Avenue  
Edmonton, AB T6B 2X3  
Canada

Tel: 780.422.1927

Fax: 780.422.1918

E-mail: [AGS-Info@ercb.ca](mailto:AGS-Info@ercb.ca)

Website: [www.ags.gov.ab.ca](http://www.ags.gov.ab.ca)

## Contents

Acknowledgments.....	v
Abstract.....	vi
1 Introduction.....	1
2 Occurrence and Distribution.....	1
3 Analytical Methods and Results.....	1
4 Summary.....	6
5 References.....	6

## Tables

Table 1. Saline fen sampling locations and field measurements.....	4
Table 2. Results of water sample analysis.....	5

## Figures

Figure 1. Location of the saline fen study area, approximately 10 km southeast of Fort McMurray.....	2
Figure 2. Locations of the saline fens in which field measurements and water samples were taken.....	3

## Acknowledgments

The Government of Alberta funded this project.

Thanks go to G.F. Huff, G. Jean and L.D. Andriashek, without whom this report would not have been possible.

Exova Group Ltd. laboratory in Edmonton performed the standard water analyses, and B. Eglington, manager of the Saskatchewan Isotope Laboratory at the University of Saskatchewan, determined the  $^{87}\text{Sr}/^{86}\text{Sr}$  isotope values. B. Barber, at Becquerel Laboratories Inc., Mississauga, Ontario, performed the neutron-activation analyses for chloride and bromide.

## **Abstract**

As part of the Alberta Geological Survey's ongoing springs project, staff took field measurements and sampled several fens that occur about 10 km south-southeast of Fort McMurray and about 3 km east of Highway 63.

Field measurements of pH, temperature and electrical conductivity were made and samples were taken for laboratory determination of major, minor and trace elements, extractable silica and silicon, and  $^{87}\text{Sr}/^{86}\text{Sr}$ .

The purpose of this report is to make available to government, industry and the public the results of the data collected.

## 1 Introduction

As part of an ongoing project to study springs in Alberta, the Alberta Geological Survey initiated a project in 2010 to evaluate saline fens in an area approximately 10 km south-southeast of Fort McMurray and about 3 km east of Highway 63. A fen is defined as a peat-forming wetland that receives nutrients from sources other than precipitation, usually from upslope sources through drainage from surrounding mineral soils and from groundwater movement (United States Environmental Protection Agency, 2009).

This report presents the results of field measurements taken at several of the fens, as well as the results of laboratory analysis of water samples collected from three of the fens in the study area.

## 2 Occurrence and Distribution

Figure 1 shows the location of the fens with respect to the city of Fort McMurray. Figure 2 displays the sites where field measurements and water samples were taken. Table 1 lists the precise locations of the sample sites. Access to the sampling area was along a power line right-of-way that runs southeast of Highway 63.

## 3 Analytical Methods and Results

We selected 18 sites for field measurements, three of which were chosen for water sampling and analysis. Field parameters measured were pH, electrical conductivity and temperature. The pH measurements were taken using a Fisher Scientific accumet® portable AP62 pH/mV meter. The meter was calibrated for buffer solutions of pH 4, 7 and 10. The same meter and probe measured the water temperature. Conductivity was measured using an Orion 05A+ meter, which was calibrated with 1413 µS/cm standard solution. We used the meter in “No Temperature Compensation Mode,” as salinity and total dissolved solids were not recorded.

Sampled fens were selected based on

- elevated electrical conductivity to ensure the source of the water was not simply surface runoff, and
- lateral discontinuity from other sampled locations to reduce the possibility of duplication from a single source. Samples were taken in accordance with Lemay (2002).

Table 1 displays the results of field measurements and the exact locations of the sites. Note that the elevation, latitude and longitude are based on hand-held Garmin GPS readings using the NAD 83 datum.

Table 2 provides the analytical results of the water samples from the fens that were sampled. Exova Group Ltd. Laboratory, in Edmonton, analyzed the routine water chemistry and total and dissolved metals using standard reference methods (Clesceri et al., 1998). Becquerel Laboratories Inc., in Mississauga Ontario, analyzed the bromide and chloride using neutron activation.

B. Eglinton of the Saskatchewan Isotope Laboratory, University of Saskatchewan, determined the  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios. Analysis followed standard ion-exchange protocols for Sr, and clean aliquots were run on a Triton mass spectrometer in static mode normalized to a value of 0.1194 for  $^{86}\text{Sr}/^{88}\text{Sr}$ . Multiple analyses of a National Institute of Standards and Technology 987 standard, run during the past few years (and during the period our samples were run), provide an average of  $0.710259 \pm 11$  (2 standard errors of measurement<sup>1</sup>).

---

<sup>1</sup> standard error of measurement =  $2\sigma/\sqrt{n}$

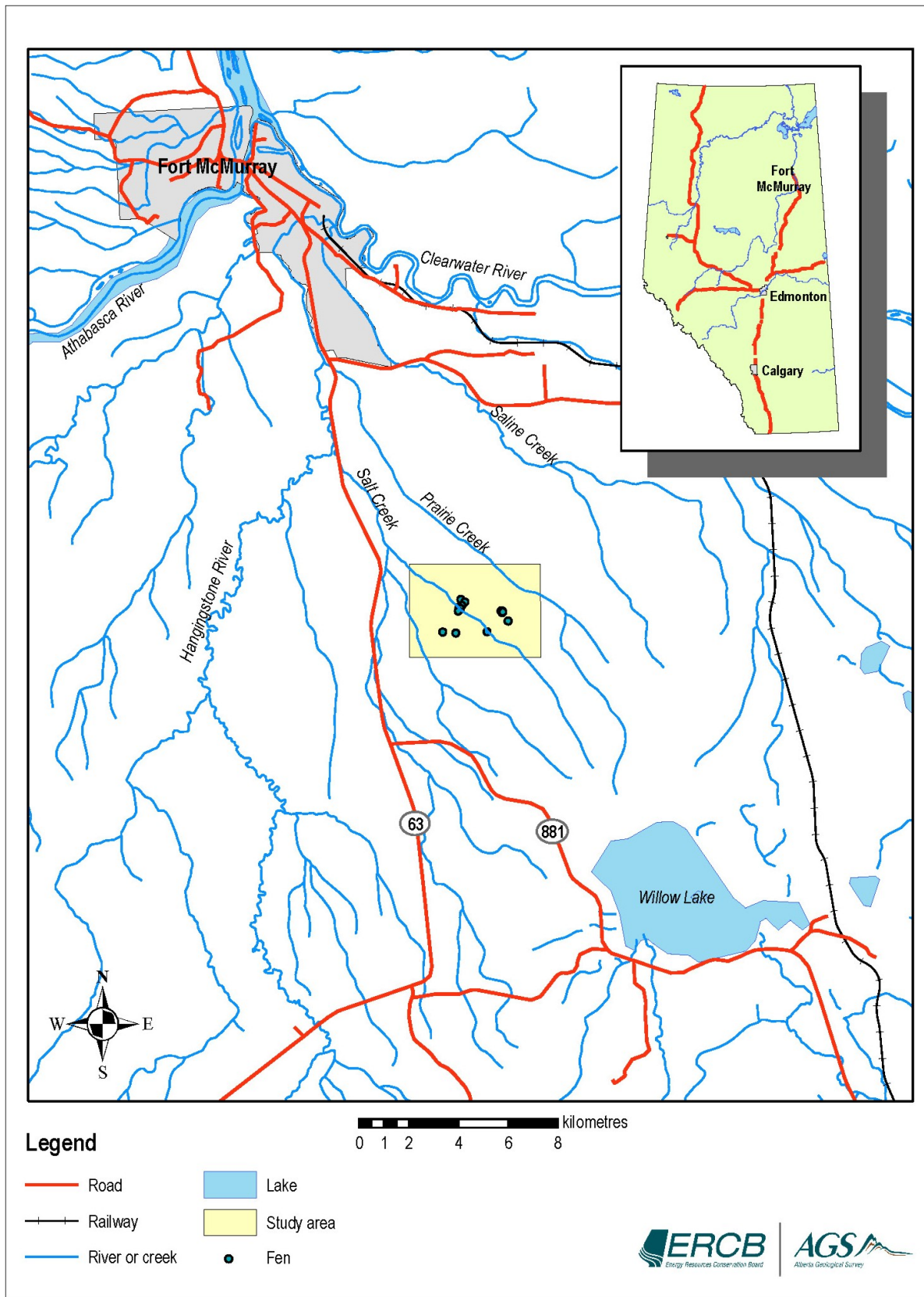


Figure 1. Location of the saline fen study area, approximately 10 km southeast of Fort McMurray.



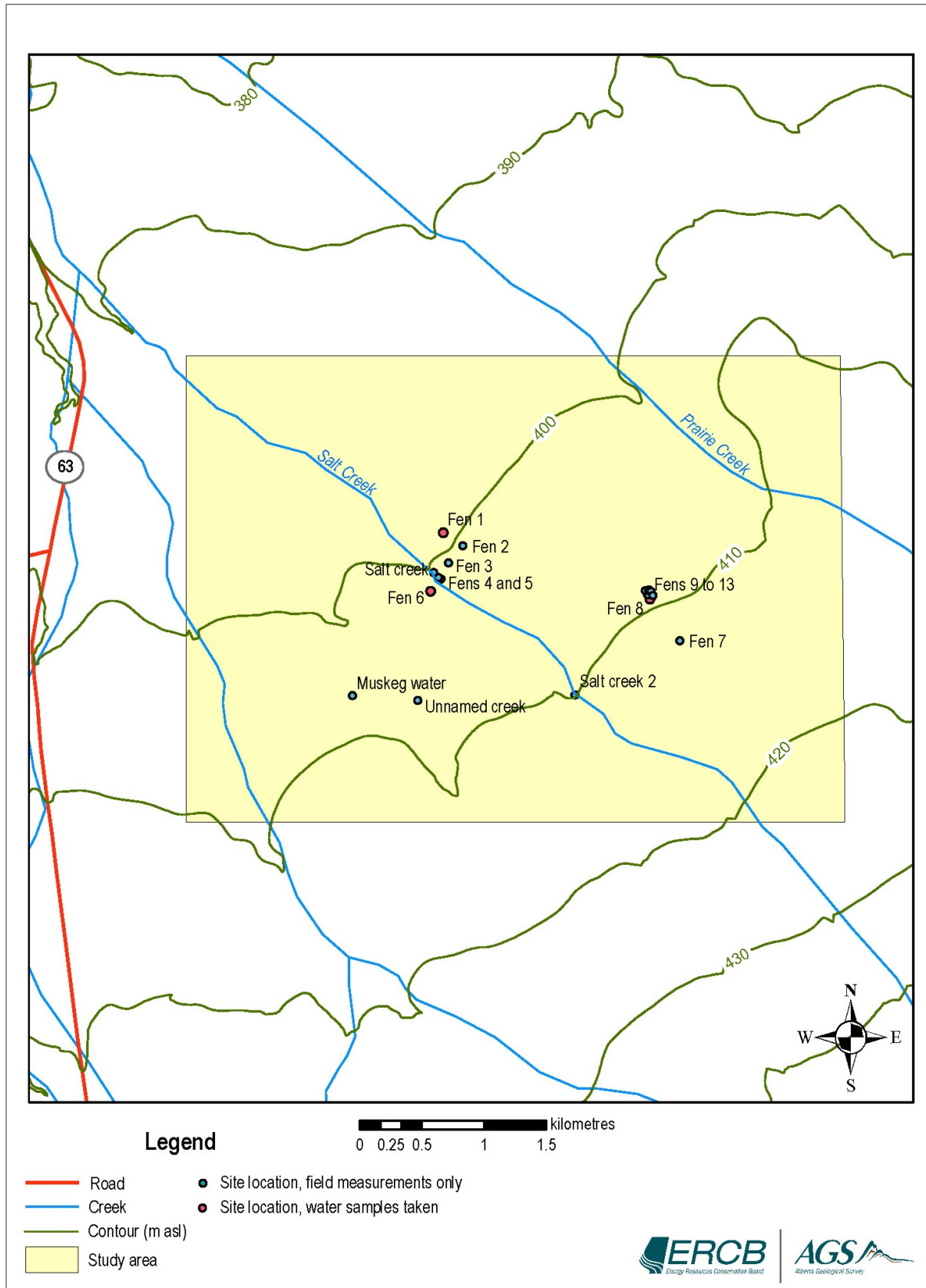


Figure 2. Locations of the saline fens in which field measurements and water samples were taken.

**Table 1. Saline fen sampling locations and field measurements.**

Field Name	Temp. (°C)	Electrical Conductivity (µS/cm)	pH	Elevation (m asl)	Location (NAD 83)		Notes
					Latitude	Longitude	
Fen1	8.0	22300	9.33	398	56.5689	111.26961	Sampled for routine, total and dissolved metals, <sup>87</sup> Sr/ <sup>86</sup> Sr and Br
Fen2a	14.8	23700	7.5	398	56.56789	111.26714	No water samples taken
Fen2b	14.7	25400	8.8	398	56.56783	111.26714	No water samples taken
Fen3	10.1	43400	7.7	396	56.56671	111.26914	No water samples taken
Fen4	10.8	14200	8.8	399	56.56559	111.27023	No water samples taken
Fen5	11.0	10400	7.61	399	56.5657	111.27055	No water samples taken
Fen6	12.4	10830	8.25	400	56.56475	111.27168	Sampled for routine, total and dissolved metals, <sup>87</sup> Sr/ <sup>86</sup> Sr and Br
Fen7	15.2	13020	8.83	421	56.5602	111.23946	No water samples taken.
Fen8	14.0	35200	8.65	415	56.56332	111.24306	Sampled for routine, total and dissolved metals, <sup>87</sup> Sr/ <sup>86</sup> Sr and Br
Fen9	17.0	38700	8.4	413	56.56364	111.24335	No water samples taken
Fen10	12.5	16020	7.1	412	56.56394	111.24363	No water samples taken
Fen11	17.2	27800	7.6	411	56.56398	111.24313	No water samples taken
Fen12	15.0	34000	8.1	411	56.56386	111.24287	No water samples taken
Fen13	15.0	36200	8.2	412	56.56357	111.24265	No water samples taken
Salt Creek	8.0	1691	8.4	397	56.56607	111.27113	No water samples taken
Salt Creek 2	-1.1	1090	7.91	411	56.55671	111.25355	No water samples taken
Unnamed creek	1.5	369	7.06	415	56.55693	111.27414	No water samples taken
Muskeg water	6.5	135.4	7.06	409	56.55753	111.28261	No water samples taken

**Table 2. Results of water sample analysis.**

Name	Fen1	Fen6	Fen8
Sample date	30-Sep-10	30-Sep-10	30-Sep-10
pH	8.71	8.07	8.52
Temperature (°C)	20.5	20.4	20.2
Conductivity (µS/cm)	22000	9980	31000
TDS (mg/L, dried @180°C)	17200	6620	25500
TDS (mg/L, calculated)	17800	6430	23200
Ca (mg/L)	312	98	314
Mg (mg/L)	160	53	201
Na (mg/L)	6000	2260	8520
K (mg/L)	9	5	27
Fe (mg/L)	<0.2	<0.1	<0.2
Mn (mg/L)	<0.1	<0.05	<0.1
Cl (mg/L)	10800	3840	13400
SO <sub>4</sub> (mg/L)	460	120	643
HCO <sub>3</sub> (mg/L)	110	127	185
NO <sub>3</sub> - N (mg/L)	<0.5	<0.2	<0.51
NO <sub>2</sub> - N (mg/L)	<0.2	<0.1	<0.2
NO <sub>3</sub> + NO <sub>2</sub> - N (mg/L)	<0.7	<0.3	0.51
OH (mg/L)	<5	<5	<5
CO <sub>3</sub> (mg/L)	14	<6	17
T-AlkalinityL <sup>1</sup> (as CaCO <sub>3</sub> , mg/L)	114	104	180
P-AlkalinityL <sup>2</sup> (as CaCO <sub>3</sub> , mg/L)	12	<5	14
Hardness (as CaCO <sub>3</sub> , mg/L)	1400	460	1610
IOC <sup>3</sup> (mg/L)	19.3	22.3	35.8
Relative density (@ 15°C)	1.013	1.005	1.017
Ion balance (%)	92	96	102
Charge balance (%)	-4.3	-2.3	1.2
Br (mg/L)	2.53	0.9	4.37
Cl (mg/L)	15802.8	6331.5	23797.8
Sr (mg/L)	19.4	6.16	24.8
S (mg/L)	0.017	0.016	0.013
Si (mg/L)	<2	<1	<2
Li (mg/L)	0.54	0.22	0.89
<sup>87</sup> Sr/ <sup>86</sup> Sr	0.707665	0.707666	0.707618

<sup>1</sup> amount of carbonate and hydroxyl alkalinity present as calcium carbonate (reported when pH is between 4.3 and 8.3)

<sup>2</sup> amount of carbonate and hydroxyl alkalinity present as calcium carbonate (reported when pH >8.3)

<sup>3</sup> inorganic carbon

## 4 Summary

Eighteen sites were visited within the study area, and field measurements were taken at each of these sites. At three of the sites, AGS staff collected water samples for additional chemical analysis. It is the intent of this report to present the results of the sampling completed during the field trip to the study area.

## 5 References

Clesceri, L.S., Greenberg, A.E. and Eaton, A.D., editors (1998): Standard methods for the examination of water and wastewater (20<sup>th</sup> edition); American Public Health Association, 1220 p.

Lemay, T.G. (2002): Sampling of surface water and spring water in the Athabasca Oil Sands (in situ) area, Alberta, 1999–2002 – a compilation of protocols and methods; Alberta Energy and Utilities Board, EUB/AGS Geo-Note 2002-09, 43 p.

<[http://www.ags.gov.ab.ca/publications/abstracts/GEO\\_2002\\_09.html](http://www.ags.gov.ab.ca/publications/abstracts/GEO_2002_09.html)> [February 2011].

United States Environmental Protection Agency (2009): Fens; United States Environmental Protection Agency, URL <<http://water.epa.gov/type/wetlands/fen.cfm>> [February 2011].