

In Brief:

- One emulsion sample was analysed for oil and water properties, and metal concentrations in each fraction
- Oil from the Manson Field Melita-Reston-Amaranth-Lodgepole D pool is possibly migrated Lodgepole Formation oil
- Critical mineral concentrations were found in the analysed sample

Citation:

Fulton-Regula, P.J. 2025: Critical minerals in oil and produced water, Manson oil field, southwestern Manitoba (parts of NTS 62F14, 15, K2, 3); in Report of Activities 2025, Manitoba Business, Mining, Trade and Job Creation, Manitoba Geological Survey, p. 155–161.

Summary

To assess the metal content of produced fluid from the Manson oil field, an oil and water emulsion sample was collected from the well at L.S. 12, Sec. 1, Twp. 13, Rge. 27, W 1st Mer. (abbreviated 12-1-13-27W1; oil and gas well licence 9990) in the Melita-Reston-Amaranth-Lodgepole undifferentiated D (17 22D) pool in the Manson Field. The oil fraction returned an oil density (API gravity 29.1 °) and a sulphur concentration (1.76 wt. %) consistent with past sampling in the Manson Field but with V (6.60 ppm), Ni (4.58 ppm), Pb (2.47 ppm), Zn (1.58 ppm) and Cu (0.18 ppm) metal occurrences. The water fraction returned values consistent with known Mississippian Lodgepole Formation and Jurassic aquifers in the project area and had low Li concentrations (2.54 ppm) consistent with those previously reported for the Lodgepole to Lower Amaranth formations in Manitoba. The sample results suggest the oil found in the 17 22D pool likely migrated from the Mississippian Lodgepole Formation, and that metals such as V, Ni, Pb, Zn and Cu could have been carried by that oil. Further work is required to map metal concentrations within Manitoba's oil fields and to evaluate the carrying capacity of Manitoba's oil for critical minerals.

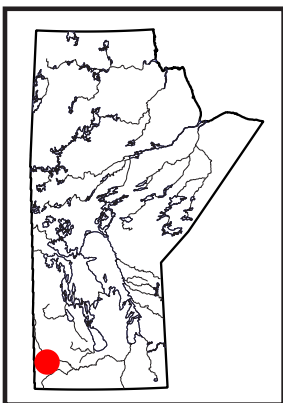
Introduction

In 2016, the Manitoba Geological Survey began a study on the Manson Field in southwestern Manitoba (Figure GS2025-16-1). This study was conducted to understand unusual stratigraphic discrepancies identified when doing downhole geophysical log correlations. To date, the study has focused on describing and sampling drillcore, conducting detailed geophysical log correlations and determining formation tops to better understand the complex geology of the project area (Fulton-Regula, 2024b). The next step for this study was to acquire and test the produced fluid from a well in the Manson Field.

Manitoba has produced over 80 million m³ (as of October 1, 2025, from Manitoba Oil and Gas Well Information System [MOGWIS], Manitoba Business, Mining, Trade and Job Creation internal database) of oil since 1951 from 13 oil fields. Oil has been produced from pools between the Devonian Torquay Formation and the Lower Melita Member of the Melita Formation (Figure GS2025-16-2).

A review of the Manitoba Business, Mining, Trade and Job Creation's petroleum technical well files (Manitoba Business, Mining, Trade and Job Creation, 2025b) and reservoir documents (Manitoba Business, Mining, Trade and Job Creation, 2025c) was completed to collate the results of oil analyses submitted to the Government of Manitoba under *The Oil and Gas Act*. Through this search, only standard oil analyses were found with no metal analyses reported. A compilation of standard oil analyses indicate that oil follows a linear trend from light (low density <875.7 kg/m³; high API gravity >29.6 °) low sulphur oil of the Bakken and Torquay formations in the Daly Sinclair Field, to heavy (high density >875.7 kg/m³; low API gravity <29.6 °) high sulphur oil of the Melita Formation in smaller pools in Other Areas (Figure GS2025-16-3a, b). The plots of API gravity versus sulphur weight percent (wt. % S) suggest an overall increase in oil sulphur content and oil density with reducing stratigraphic depth. Oil analyses from the Manson Field indicate the oil produced from this field has absolute densities from 804 to 890.5 kg/m³ (at 15–16.8 °C after cleaning; API gravity 44.47–27.30 °) and high sulphur values from 2.19 to 17.9 mg/kg (0.22–1.79 wt. % S). These high sulphur values coincide with the observation of minor amounts of primary and secondary pyrite, sphalerite and chalcopryrite in some core samples (Fulton-Regula, 2024b).

The high sulphur values in the oil and the presence of secondary sulphides in core prompted an independent assessment of the oil, water and metal contents of produced fluid from the Manson Field. The analytical results from one emulsion sample of produced oil and water from the well at 12-1-13-27W1 (oil and gas licence 9990, Manitoba Business, Mining, Trade and Job Creation, Winni-



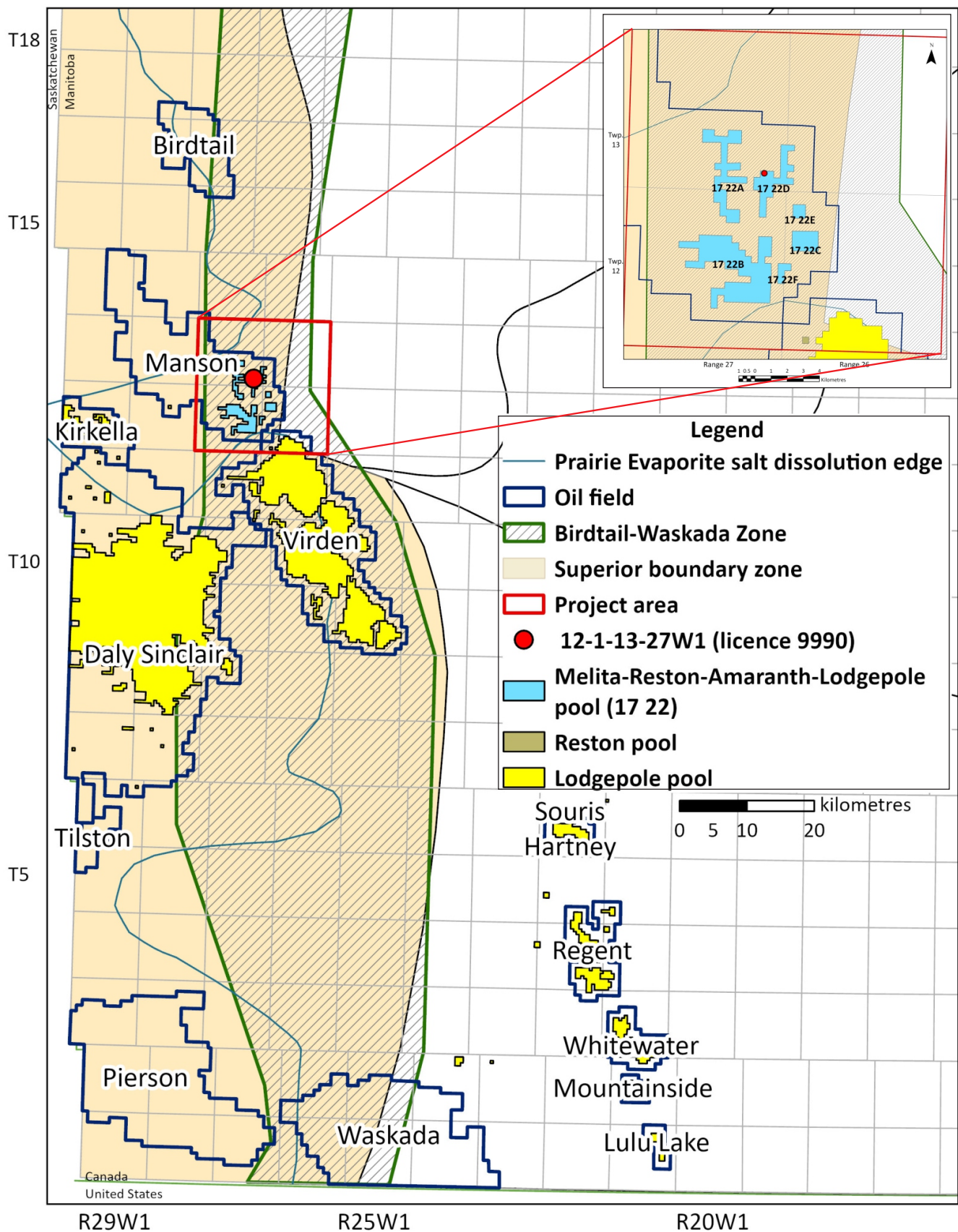


Figure GS2025-16-1: Location map showing the project area and oil field boundaries (Fulton-Regula, 2024a) in southwestern Manitoba in relation to the Superior boundary zone (Manitoba Geological Survey, 2024), Birdtail-Waskada Zone (McCabe, 1967, 1971; Nicolas and Barchyn, 2008; Nicolas, 2012) and Prairie Evaporite salt dissolution edge (Nicolas, 2015). Inset map shows Manson 17 22 oil pools (Fulton-Regula, 2024a) and the location of the well sampled for fluid analysis.

Williston Basin Stratigraphy, Manitoba		
ERA	PERIOD/EPOCH	FORMATION
Cenozoic	Quaternary	Glacial drift
	Neogene	
	Paleogene	Turtle Mountain
Mesozoic	Cretaceous	Boissevain
		Pierre Shale*
		Carlile*
		Favel*
		Ashville
		Swan River
		Success
	Jurassic	Waskada
		Melita•
		Reston•
		Amaranth•
Paleozoic	Permian	St. Martin Complex
	Pennsylvanian	Charles
	Mississippian	Mission Canyon•
		Lodgepole•
		Bakken•
	Devonian	Torquay•
		Birdbear*
		Duperow*
		Souris River*
		Dawson Bay*
Prairie Evaporite		
Winnipegosis*		
Elm Point		
Ashern		
Silurian	Interlake Group*	
Ordovician	Stonewall	
	Stony Mountain*	
	Red River*	
	Winnipeg*	
Cambrian	Deadwood	
Precambrian		

STUDY AREA
MEMBER
Lower Melita•
Upper Amaranth•
Lower Amaranth•
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Flossie Lake•
Whitewater Lake•
Viriden•
Scallion•

•

Producing oil

*

Oil and gas shows

**Figure GS2025-16-2:** Stratigraphic column (adapted from Manitoba Business, Mining, Trade and Job Creation, 2025a) for the Williston Basin in southwestern Manitoba and the study area. Formations/members producing oil or with oil and gas shows are indicated.

peg) in the Melita-Reston-Amaranth-Lodgepole undifferentiated D (17 22D) pool are presented in this report.

## Project area and sample location

The project area is located in southwestern Manitoba along the northeastern edge of the Phanerozoic Williston Basin in parts of the Viriden and Manson oil fields, in Twp. 12–13, Rge. 26–27, W 1st Mer. (Figure GS2025-16-1). Underlying the Phanerozoic strata in this area are rocks of Precambrian age, which fall within the Superior boundary zone (SBZ; Manitoba Geological Survey, 2024), a major crustal suture or fault (Figure GS2025-16-1). On a seismic survey from the SBZ, Dietrich and Magnusson (1998) and Dietrich et al. (1999) observed reactivated faults that originated in the Precambrian basement and extended into the overlying Phanerozoic strata as far upsection as Mississippian strata. Overlying the SBZ is a Devonian feature referred to as the Bird-

tail-Waskada Zone (BWZ). The BWZ is the result of preferential dissolution of the Prairie Evaporite caused by effects from the underlying SBZ on the overlying strata (McCabe, 1967, 1971; Nicolas and Barchyn, 2008; Nicolas, 2012). The SBZ and the BWZ underlie the oil fields in southwestern Manitoba and under the project area (Figure GS2025-16-1).

The oil pools within this area have produced 2.1 million m³ oil and 26.9 million m³ water since 1956 from three separate zones (as of September 2, 2025, MOGWIS). The oldest production comes from the Lodgepole Formation pools of the Viriden Field. More recent production comes from the Bakken-Torquay and Melita-Reston-Amaranth-Lodgepole pools of the Manson Field and a Reston pool in the Viriden Field. In the project area, Bakken-Torquay pools have produced 71 900 m³ oil and 351 600 m³ water, Reston pools have produced 49 m³ oil and 839 m³ water and Melita-Reston-Amaranth-Lodgepole pools have produced 978 000 m³ oil and 22 800 m³ water (as of September 2, 2025, MOGWIS).

The well at 12-1-13-27W1 was selected for further analysis because minor quantities of chalcopyrite were observed in core. This well is located over the SBZ and BWZ, where salt from the Prairie Evaporite has been completely dissolved (Nicolas, 2015). This vertical well was drilled by Elcano Exploration Inc. in 2014. It was cored from 537.0 to 550.8 m true vertical depth (TVD), cased for production from surface to 590 m TVD and tubulars were installed from surface to 550.78 m TVD. The well was perforated at 539.0–541.4 and 542.0–545.0 m TVD. As of August 17, 2025, this well had produced 3531.9 m³ oil and 3839.7 m³ water (MOGWIS). This well is currently operated by 10101906 Manitoba Ltd. (MOGWIS).

## Methodology

Producing wells in the study area were assessed for their oil to water ratio and presence of sulphides in core. Wells with an oil-water ratio of 1 (50% oil, 50% water) were selected as possible candidates for further testing. In June 2025, a sample of oil and water emulsion fluid was taken from the wellhead at 12-1-13-27W1. Wellhead sampling was chosen to minimize the interaction and mixing between the produced fluid from different wells and the well, flowline and battery infrastructure. This produced fluid was collected in glass jars, the temperature recorded and, after 24 hours, the fluid refrigerated. The sample was sent for analysis to Core Laboratories Canada Ltd. (Core Lab; Calgary, Alberta).

At Core Lab, the oil portion of the emulsion sample was tested using a routine oil analysis for density, API gravity, sulphur, viscosity, water, sediment, pour point, colour and by inductively coupled plasma–atomic emission spectrometry (ICP-AES) for metals. The water portion of the sample was tested by extended water analysis at Core Lab for cations, anions, pH, resistivity, refractive index, specific gravity and calculated total dissolved solids (TDS). The water portion of the sample was then sent to ALS Environmental (Calgary, Alberta) and tested for Li and total



**Figure GS2025-16-3: a)** Chart of oil API gravity versus sulphur content by oil field; **b)** chart of oil API gravity versus sulphur content by producing formation(s)/member (Fulton-Regula, 2025; Manitoba Business, Mining, Trade and Job Creation, 2025b, c). Heavy high sulphur oil on the left and light low sulphur oil on the right. The oil sample from the well at L.S. 12, Sec. 1, Twp. 13, Rge. 27, W 1st Mer. (abbreviated 12-1-13-27W1; oil and gas well licence 9990), southwestern Manitoba, is denoted by a star.

metals by collision/reaction cell, inductively coupled plasma–mass spectrometry (CRC ICP-MS). Neither the bottom sediment nor impurities from the oil and water samples were tested, nor was the effect of cleaning the oil sample in the lab evaluated.

Results

The full oil and water emulsion fluid analyses results can be found in Data Repository Item DRI2025026 (Fulton-Regula, 2025¹). Table GS2025-16-1 shows a summary of selected chemical analyses results. The oil API gravity versus sulphur wt. % analysis results from this well are plotted in Figure GS2025-16-3 with oil analysis results from other producing areas in Manitoba.

Discussion

Oil density and sulphur content

The density and sulphur content for 12-1-13-27W1 oil is consistent with other oil density and sulphur reports for the Melita-Reston-Amaranth-Lodgepole pools in the Manson Field (Figure GS2025-16-3). These results indicate oil from the Melita-Reston-Amaranth-Lodgepole pools is lighter (higher API gravity) with a lower sulphur content than Melita Formation oil, but heavier (lower API gravity) with a higher sulphur content than Bakken Formation oil (Figure GS2025-16-3). The sample from this study plots within the range of values seen in the Lodgepole

**Table GS2025-16-1:** Select metal and compound concentrations in the sample from L.S. 12, Sec. 1, Twp. 13, Rge. 27, W 1st Mer. (abbreviated 12-1-13-27W1; oil and gas well licence 9990), southwestern Manitoba. Conversions used: 1 kg/m³ = 0.001 g/ml; mg/L = solution density × mg/kg; 1 mg/L = 1 ppm; absolute density (g/mL) = specific gravity.

Fluid	API gravity at 15.6 °C (°)	Specific gravity at 15.6 °C	Calculated absolute density ¹ (g/mL)	pH at 25 °C	Resistivity at 25 °C (Ohm-metres)	TDS (g/L)	Element/compound	Concentration (ppm)	Concentration (mg/kg)
Water	n/a	1.0256	1.0256	7	0.203	35.535	Li	2.54	–
							Na ⁺	11432	–
							K ⁺	187	–
							Mg ²⁺	361	–
							Ca ²⁺	1050	–
							SO ₄ [–]	3487	–
							HCO ₃ [–]	1505	–
							S	n/a	–
							V	<1.00	–
							Ni	<1.00	–
							Zn	<6.00	–
							Cu	<1.00	–
							Pb	<0.10	–
Oil	29.1	n/a	0.8804	n/a	n/a	n/a	Li	n/a	n/a
							Na ⁺	22.46	21.9
							K ⁺	n/a	n/a
							Mg ²⁺	0.10	0.1
							Ca ²⁺	2.67	2.6
							SO ₄ [–]	n/a	n/a
							HCO ₃ [–]	n/a	n/a
							S	15.50	17.6
							V	6.60	7.5
							Ni	4.58	5.2
							Zn	1.58	1.8
							Cu	0.18	0.2
							Pb	2.47	2.8

¹ After cleaning  
Abbreviations: TDS, total dissolved solids; n/a, not analyzed

¹ MGS Data Repository Item DRI2025026, containing the data or other information sources used to compile this report, is available online to download free of charge at <https://manitoba.ca/iem/info/library/downloads/index.html>, or on request from [minesinfo@gov.mb.ca](mailto:minesinfo@gov.mb.ca), or by contacting the Resource Centre, Manitoba Business, Mining, Trade and Job Creation, 360-1395 Ellice Avenue, Winnipeg, Manitoba R3G 3P2, Canada.

Formation, between the heavy (lower API gravity) and higher sulphur oil of the Lodgepole Formation in the Kirkella Field and the lighter (higher API gravity) and lower sulphur content of the Lodgepole Formation oil in the Virden Field. This suggests oil from the Melita-Reston-Amaranth-Lodgepole pools in the Manson Field may be migrated Lodgepole Formation oil.

### **Water composition**

The concentration of 35.535 g/L TDS for the produced water is consistent with the findings of Palombi (2008) for the Mississippian Lodgepole Formation and Jurassic aquifers in this area. The concentrations for the cations  $\text{Na}^+$ ,  $\text{K}^+$  and  $\text{Mg}^{2+}$  are also consistent with the recorded values in Palombi (2008) for Mississippian and Jurassic aquifers within the Williston Basin. The  $\text{Ca}^{2+}$ ,  $\text{SO}_4^-$  and  $\text{HCO}_3^-$  concentrations are low but fall within the wide variability in concentrations discussed in Palombi (2008) for Mississippian and Jurassic aquifers in the Williston Basin.

### **Metal concentrations in water and oil**

Analyses of the metal concentrations in the produced fluid sample appear to show a preference for some metals to be concentrated in the water fraction whereas others are concentrated in the oil fraction. The  $\text{Na}^+$  and  $\text{Mg}^{2+}$  concentrations are preferentially higher in the water fraction whereas V, Ni, Pb, Cu and Zn concentrations are preferentially higher in the oil fraction (Table GS2025-16-1).

The Li concentration of the water fraction is 2.54 ppm. This is consistent with the findings of Nicolas (2017), where values of 0.258–7.320 ppm were reported in brines from the Lodgepole to the Amaranth formations in Manitoba.

The oil fraction has concentrations of V at 6.60 ppm, Ni at 4.58 ppm, Pb at 2.47 ppm, Zn at 1.58 ppm and Cu at 0.18 ppm. It is common for Ni, Pb, Zn and Cu to occur as contaminants from oil field machinery but they are also known to occur in uncontaminated crude oils (Reynolds, 2001; Mohammad et al., 2012; Fetter et al., 2019; Sanz-Robinson and William-Jones, 2019). The well at 12-1-13-27W1 was completed using J55 coiled steel tubing, which does not contain Ni, Cu, Pb or Zn (American Petroleum Institute, 2023), and it was drilled in 2014 prior to the production of 3531.9 m³ oil and 3839.7 m³ water. The oil extracted from this well appears to be uncontaminated by wellbore operations or by oil field machinery. The metals found in this oil are thought to originate from the oil source, the rocks along the oil migration pathway and/or the reservoir. This is supported by the presence of sulphide minerals in core. In order to evaluate the variability of metals within oils in the region, additional sampling from other oil fields is recommended.

### **Conclusions**

These test results confirm low concentrations of Li are present in produced water in the Manson Field and critical metals such as V, Ni, Zn and Cu are present in the produced oil from the 17 22D pool in the Manson Field. In addition, the oil found in the

17 22D pool may be Mississippian Lodgepole Formation oil, and critical metals such as V, Ni, Zn and Cu may be carried by Lodgepole Formation oil in the Manitoba subsurface.

### **Future work**

The presence of critical minerals in the oil fraction of this sample suggests critical minerals may occur in produced fluids and within sedimentary rocks in Manitoba's Williston Basin. The following next steps are recommended:

- 1) Further research to understand
  - a) critical mineral leaching into crude oil and precipitation as a function of temperature, pH, density, percent sulphur and pressure;
  - b) the resource potential of critical minerals in crude oil; and
  - c) the metal content of crude oil as an exploration tool for critical minerals in sedimentary strata.
- 2) Further sampling and analysis of oil samples for critical minerals by field and pool.
- 3) Mapping of metal concentrations in crude oil to determine the association of critical minerals as a function of depth, temperature, pH, percent sulphur, density and proximity to structural features, such as the SBZ and faults.

### **Economic considerations**

This study has shown the critical minerals V, Ni, Zn and Cu can be found in crude oil from the 17 22D pool in the Manson Field. The presence of critical minerals in this oil suggests there may be opportunities to explore for critical minerals, using produced fluids to identify target areas within the sedimentary strata in southwestern Manitoba. The minerals V, Ni, Zn and Cu are used in a wide variety of applications from catalysts and coatings to steel manufacture, superconductors, battery technology, electrical power transmission, electronics and many other applications.

### **Acknowledgments**

The author thanks the staff at 10101906 Manitoba Ltd., Manitoba Regulatory Services and the Manitoba Geological Survey. Specifically, B. Rinn (10101906 Manitoba Ltd.), W. Baker and M. Langlois (Manitoba Regulatory Services) for enabling the collection and delivery of this sample, C. Epp and P. Belanger for logistical support and M.P.B. Nicolas and E. Enaworu (Manitoba Geological Survey) and J. Dawson for their edits to this report.

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