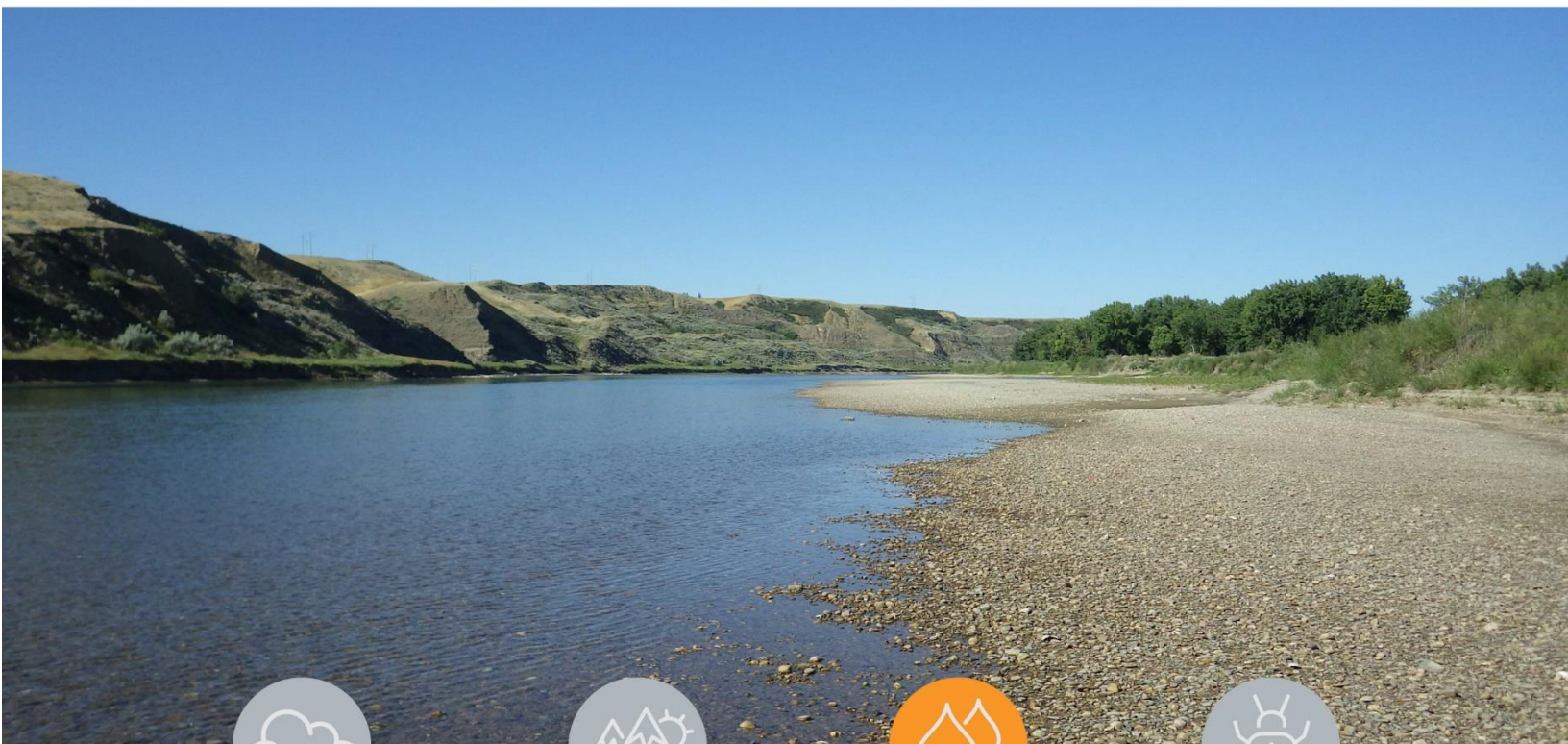


2017–2018 Status of Surface Water Quality

South Saskatchewan Region



Air



Land



Water



Biodiversity

Reporting on the South Saskatchewan Surface Water Quality
Management Framework for April 2017 - March 2018

2017-2018 Status of Surface Water Quality, South Saskatchewan Region, Alberta

Cecilia Chung, Dongnan Zhu, Natalie Kromrey and Jason Kerr

Cover photo: Ray Walker

This publication can be found at: open.alberta.ca/publications/9781460141649

Comments, questions, or suggestions regarding the content of this document may be directed to:

Ministry of Environment and Parks, Environmental Monitoring and Science Division

10th Floor, 9888 Jasper Avenue NW, Edmonton, Alberta, T5J 5C6

Email: EMSD-Info@gov.ab.ca

Website: environmentalmonitoring.alberta.ca

For media inquiries please visit: alberta.ca/news-spokesperson-contacts.aspx

Recommended citation:

Chung, C., Zhu, D., Kromrey, N. and Kerr, J. 2019. 2017-2018 Status of Surface Water Quality, South Saskatchewan Region, Alberta for April 2017 – March 2018. Government of Alberta, Ministry of Environment and Parks. ISBN 978-1-4601-4164-9. Available at: open.alberta.ca/publications/9781460141649.

© Her Majesty the Queen in Right of Alberta, as represented by the Minister of Alberta Environment and Parks, 2019.

This publication is issued under the Open Government Licence – Alberta open.alberta.ca/licence.

Published August 2019

ISBN 978-1-4601-4164-9

Alberta's Environmental Science Program

The Chief Scientist has a legislated responsibility for developing and implementing Alberta's environmental science program for monitoring, evaluation and reporting on the condition of the environment in Alberta. The program seeks to meet the environmental information needs of multiple users in order to inform policy and decision-making processes. Two independent advisory panels, the Science Advisory Panel and the Indigenous Wisdom Advisory Panel, periodically review the integrity of the program and provide strategic advice on the respectful braiding of Indigenous Knowledge with conventional scientific knowledge.

Alberta's environmental science program is grounded in the principles of:

- *Openness and Transparency.* Appropriate standards, procedures, and methodologies are employed and findings are reported in an open, honest and accountable manner.
- *Credibility.* Quality in the data and information are upheld through a comprehensive Quality Assurance and Quality Control program that invokes peer review processes when needed.
- *Scientific Integrity.* Standards, professional values, and practices of the scientific community are adopted to produce objective and reproducible investigations.
- *Accessible Monitoring Data and Science.* Scientifically-informed decision making is enabled through the public reporting of monitoring data and scientific findings in a timely, accessible, unaltered and unfettered manner.
- *Respect.* A multiple evidence-based approach is valued to generate an improved understanding of the condition of the environment, achieved through the braiding of multiple knowledge systems, including Indigenous Knowledge, together with science.

Learn more about the condition of Alberta's environment at: environmentalmonitoring.alberta.ca.

Acknowledgements

The authors thank technical staff in the Monitoring and Observation branch of the Environmental Monitoring and Science Division for data collection and sample processing. Thank you to Mina Nasr, Ph.D., Geospatial Scientist in the Science Branch, EMSD for the provision of geographic information system expertise. The authors would also like to thank the reviewers for their technical reviews and feedback, which have enhanced this work: J. Patrick Laceby, Ph.D., Watershed Scientist in the Science Branch, EMSD; and Emily Herdman, Ph.D., Science Team Lead in Cumulative Effects Assessment, Planning Branch.

Table of Contents

Alberta’s Environmental Science Program	3
Acknowledgements	4
Executive Summary	9
Background.....	9
Methodology.....	9
2017-2018 (April 1 – March 31) Results	10
South Saskatchewan Regional Plan	11
Monitoring Stations	12
Water Quality Indicators, Triggers and Limits	13
Water Quality Indicators.....	13
Water Quality Triggers	14
Water Quality Limits.....	14
Secondary Indicators	14
Statistically Significant Exceedances of Water Quality Triggers, 2017-2018	15
Exceedances of Water Quality Limits, 2017-2018	17
Secondary Indicators, 2017-2018	17
Appendix A	18
Descriptive Statistics for the Nine Long Term River Network Stations.....	18
Appendix B	46
Removal of Suspect Total Dissolved Phosphorus Value at Milk River at SH 880	46
References	49

List of Tables

Table 1 List of primary indicators for the SSR SWQMF.....	13
Table 2 List of secondary indicators for the SSR SWQMF.	13
Table 3 Median and 90 th percentile values for primary indicators exhibiting a statistically significant trigger exceedance (shaded in orange) in the SSR during 2017-2018.	16
Table A1 Median and 90 th percentile values for primary indicators in the Oldman River at Brocket.....	19
Table A2 Median and 90 th percentile values for secondary indicators in the Oldman River at Brocket.....	21
Table A3 Median and 90 th percentile values for primary indicators in the Oldman River at Hwy 3 in Lethbridge.....	22
Table A4 Median and 90 th percentile values for secondary indicators in the Oldman River at Hwy 3 in Lethbridge.....	24
Table A5 Median and 90 th percentile values for primary indicators in the Oldman River at Hwy 36.....	25
Table A6 Median and 90 th percentile values for secondary indicators in the Oldman River at Hwy 36.....	27
Table A7 Median and 90 th percentile values for primary indicators in the South Saskatchewan River at Medicine Hat - Hwy 1.....	28
Table A8 Median and 90 th percentile values for secondary indicators in the South Saskatchewan River at Medicine Hat - Hwy 1.....	30
Table A9 Median and 90 th percentile values for primary indicators in the Bow River at Cochrane.....	31
Table A10 Median and 90 th percentile values for secondary indicators in the Bow River at Cochrane.....	33
Table A11 Median and 90 th percentile values for primary indicators in the Bow River at Carseland.....	34
Table A12 Median and 90 th percentile values for secondary indicators in the Bow River at Carseland.....	36
Table A13 Median and 90 th percentile values for primary indicators in the Bow River at Cluny.....	37
Table A14 Median and 90 th percentile values for secondary indicators in the Bow River at Cluny.....	39
Table A15 Median and 90 th percentile values for primary indicators in the Bow River at Ronalane.....	40
Table A16 Median and 90 th percentile values for secondary indicators in the Bow River at Ronalane.....	42
Table A17 Median and 90 th percentile values for primary indicators in the Milk River at SH 880.....	43

Table A18 Median and 90 th percentile values for secondary indicators in the Milk River at SH 880.....	45
Table B1 median and 90 th percentile values for total dissolved phosphorus (TDP) at Milk River at SH 880 during the open water season, for the historical dataset as well as with and without the suspect TDP value.....	48

List of Figures

Figure 1 Location of the seven Land-Use Framework Regions in Alberta. The South Saskatchewan Region is the area shaded orange on the map.	11
Figure 2 Location of water quality station in the SSR, used in the SSR SWQMF.	12
Figure B1 Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations over time, as indicated by shape. The bold markers indicate the suspect samples.....	47
Figure B2 Total phosphorus (TP) concentrations as a function of total suspended solids (TSS) concentrations. The red circle indicates the suspect TP value with its associated TSS value.	47

Acronyms and Abbreviations

AEP	Alberta Environment and Parks
ALSA	<i>Alberta Land Stewardship Act</i>
EMSD	Environmental Monitoring and Science Division
EQGASW	Environmental Quality Guidelines for Alberta Surface Waters
GOA	Government of Alberta
LTRN	Long Term River Network
LUF	Land-Use Framework
SSRP	South Saskatchewan Regional Plan
SSR SWQMF	South Saskatchewan Region Surface Water Quality Management Framework

Executive Summary

Background

This report was prepared by the Environmental Monitoring and Science Division (EMSD) of Alberta Environment and Parks (AEP) to fulfill reporting requirements mandated by the South Saskatchewan Region Surface Water Quality Management Framework (SSR SWQMF; AESRD 2014c), which supports the South Saskatchewan Regional Plan (SSRP; AESRD 2014b).

The 2017 report is the third annual report for the South Saskatchewan Region. Previous annual reports for the status of environmental condition in the South Saskatchewan Region are accessible at: www.alberta.ca/south-saskatchewan-regional-planning.aspx.

Reporting requirements for the SSRP are determined by the Government of Alberta (GOA) and EMSD has a responsibility for monitoring, evaluation and reporting under the Environmental Management Frameworks, including the SSR SWQMF. This report communicates whether water quality triggers or limits were exceeded in 2017-2018.

Methodology

The SSR SWQMF includes 15 primary indicators and six secondary indicators. In 2017-2018 (April 1 to March 31 inclusive), these water quality indicators were measured monthly at nine water quality monitoring stations. Using methodology described in the SSR SWQMF, the resulting data for the 15 primary indicators and six secondary indicators were compared to the historical record to determine if the median and 90th percentile (peak) concentrations deviated in an undesirable direction from the historical median or peak trigger values. Values that deviated from historical triggers in an undesirable direction were statistically assessed for changes in the central tendency or peak concentration as per the SSR SWQMF: Statistical Methods Final Report (HDR 2011). 2017-2018 data for each primary and secondary indicator at each station were compared to historical data for both open water (April to October) and winter (November to March) seasons. In addition, the 2017-2018 medians for primary indicators were compared to water quality limits as defined in the SSR SWQMF, and the 2017-2018 medians for secondary indicators were compared to Environmental Quality Guidelines for Alberta Surface Waters where applicable (EQGASW; AESRD 2014a).

2017-2018 (April 1 – March 31) Results

A significant exceedance of the following trigger values occurred:

- The median specific conductivity trigger at South Saskatchewan River at Medicine Hat during the open water and winter seasons.
- The peak sulphate trigger at Bow River at Cochrane during the open water and winter seasons.
- The peak nitrate trigger at Bow River at Carseland during the open water and winter seasons.
- The peak nitrate trigger at Bow River at Cluny during the open water and winter seasons.
- The peak specific conductivity trigger at Bow River at Ronalane during the open water and winter seasons.
- The peak total dissolved solids trigger at Bow River at Ronalane during the open water and winter seasons.

As defined in the SSR SWQMF, median specific conductivity and median total dissolved solids concentrations at Milk River at SH 880 exceeded water quality limits during the winter season. The median selenium concentration (a secondary indicator) at Milk River at SH 880 during the winter season exceeded the EQGASW (AESRD 2014a). The median selenium concentration at South Saskatchewan River at Medicine Hat (1.00 µg/L) during the winter season was equivalent to the guideline value (1 µg/L) and is not considered an exceedance.

South Saskatchewan Regional Plan

The South Saskatchewan Regional Plan (SSRP; AESRD 2014b) applies to the South Saskatchewan Region (SSR), an area of approximately 83,764 square kilometres in size located in southern Alberta (Figure 1). The SSRP is a regional plan developed by the Government of Alberta (GOA) under the Land-use Framework (LUF; GOA 2008). The plan sets outcomes that describe what the GOA wants to accomplish at a regional level, and is given legislative authority under the *Alberta Land Stewardship Act* (ALSA; GOA 2009). EMSD is responsible for monitoring, assessing and reporting on the condition of the environment in the SSR, while other parts of the GOA are responsible for management of activities and resources in response to environmental conditions.

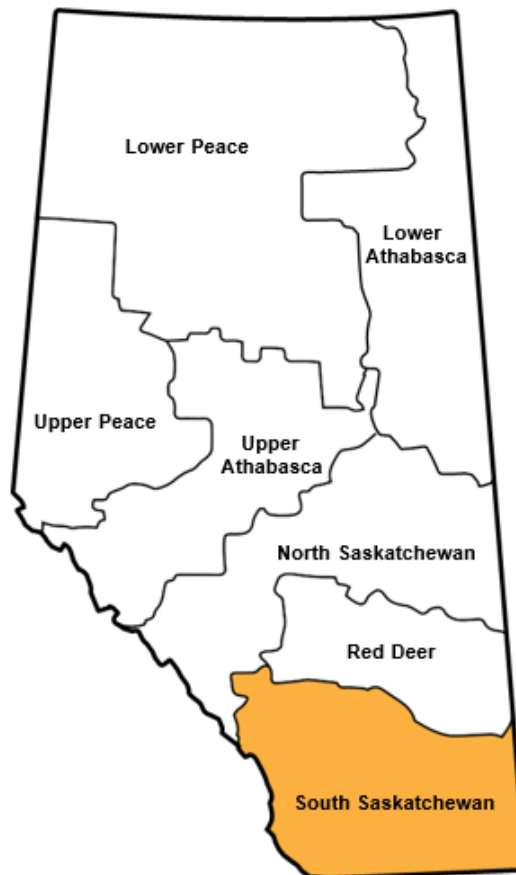


Figure 1 Location of the seven Land-Use Framework Regions in Alberta. The South Saskatchewan Region is the area shaded orange on the map.

Monitoring Stations

In this report, water quality in the SSR is assessed based on data derived from monthly water quality sampling at nine Long-Term River Network (LTRN) stations within the SSR (Figure 2). The nine LTRN stations are located within four major river systems:

- **The Bow River:** Bow River at Cochrane, Bow River at Carseland, Bow River at Cluny and Bow River at Ronalane.
- **The Milk River:** Milk River at SH 880.
- **The Oldman River:** Oldman River at Brocket, Oldman River at Hwy 3 in Lethbridge and Oldman River at Hwy 36.
- **The South Saskatchewan River:** South Saskatchewan River at Medicine Hat – Hwy 1.

Additional details on the four major river basins and the nine LTRN stations are given in the South Saskatchewan Region: Surface Water Quality Management Framework (SSR SWQMF; AESRD 2014c).

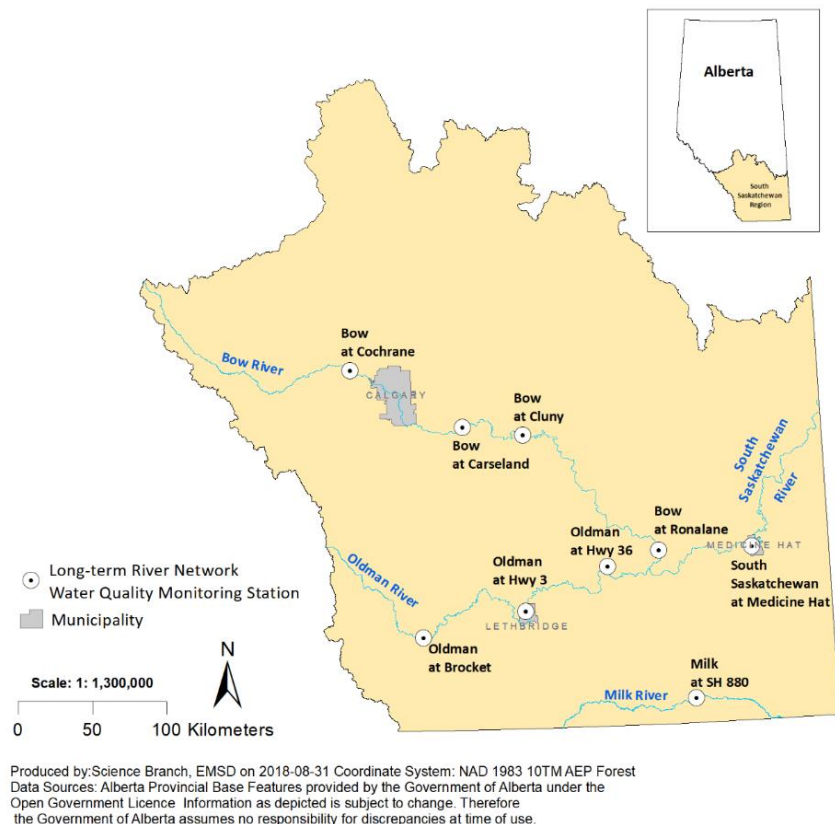


Figure 2 Location of water quality station in the SSR, used in the SSR SWQMF.

Water Quality Indicators, Triggers and Limits

Water Quality Indicators

Twenty-one water quality parameters measured at the LTRN stations are indicators in the SSR SWQMF (AESRD 2014c). Fifteen primary indicators (Table 1) and six secondary indicators (Table 2) were used to assess 2017–2018 water quality at the nine LTRN stations. Justification for indicator selection is given in the SSR SWQMF (AESRD 2014c).

Table 1 List of primary indicators for the SSR SWQMF.

Total Ammonia	Specific Conductance
Chloride	Total Dissolved Solids
Nitrate	Total Organic Carbon
Total Nitrogen	Total Suspended Solids
Total Dissolved Phosphorus	Turbidity
Total Phosphorus	pH
Sulphate	<i>Escherichia coli</i>
Sodium Adsorption Ratio (SAR)	

Table 2 List of secondary indicators for the SSR SWQMF.

Mercury	Dicamba
Selenium	Methylchlorophenoxyacetic acid (MCPA)
2,4-Dichlorophenoxyacetic acid (2,4-D)	Mecoprop (MCP)

Water Quality Triggers

Median and 90th percentile values from the historical record (1999–2009¹) are the “median triggers” and “peak triggers” in the SSR SWQMF. Exceedances of peak triggers reflect changes in the frequency of observed extreme values in relation to historical data while exceedances in median triggers are used to identify shifts in the central tendency of annual data relative to the historical record. Both are intended to act as early warning systems of potential changes in surface water quality and a signal to do statistical assessments. In this report, seasonal 2017–2018 medians and 90th percentiles were first compared with historical trigger values to determine if they deviated from the triggers in an undesirable direction. If an indicator deviated from its trigger value in an undesirable direction, a statistical assessment was then performed. A median trigger exceedance was defined as a significant shift in the central tendency (mean or median) of the 2017-18 data relative to the historical record. A peak trigger exceedance was reported when the frequency of observations in the 2017-18 data, which exceeded the trigger value, was higher than the expected frequency given no significant change. All statistical methods used in this report are described in the SSR SWQMF: Statistical Methods Final Report (HDR 2011) and Smith et al. (2001). Statistical assessments were performed using custom statistical software developed by GranDuke Geomatics² as outlined in Figures 6 and 7 of HDR (2011).

Water Quality Limits

Surface water quality limits were derived from the Canadian Council of Ministers of the Environment (CCME) and provincial water quality guidelines for nine of the 15 primary water quality indicators. Details of the specific water quality limits used for each indicator are provided in the SSR SWQMF.

Secondary Indicators

Medians of secondary indicators were compared against existing guideline values where applicable. For the 2017-18 report, guidelines were taken from EQGASW.

¹ The historical dataset for some indicators were based on shorter time series. See the SSR SWQMF (AESRD 2014c) for a description of the specific time period used for each indicator at each station

² Now FarmersEdge (<http://www.farmersedge.ca/>)

Statistically Significant Exceedances of Water Quality Triggers, 2017-2018

Table 3 compares median and 90th percentile values from the 2017-18 data with the historical record (1999-2009) at stations where significant median or peak trigger exceedances occurred. Trigger exceedances during 2017–2018 were observed at five stations for four primary indicators. A significant exceedance of the median trigger value was observed for specific conductivity in the South Saskatchewan River at Medicine Hat during both the open and winter seasons. Significant exceedances of peak trigger values were observed for sulphate at Bow River at Cochrane, nitrate at Bow River at Carseland, nitrate at Bow River at Cluny and both specific conductivity and total dissolved solids at Bow River at Ronalane, with peak triggers for all indicators occurring during both the open water and winter seasons. There were no trigger exceedances for any of the other stations or indicators. Summary statistics of 2017–2018 data for the remaining stations and indicators are shown in Appendix A.

Table 3 Median and 90th percentile values for primary indicators exhibiting a statistically significant trigger exceedance (shaded in orange) in the SSR during 2017-2018.

Station	Indicator	Period	Season	Median	90 th Percentile	n
South Saskatchewan River at Medicine Hat	Specific Conductivity (µS/cm)	1999-2009 (trigger)	open	369	436	68
			winter	462	519	48
		2017-18	open	380	448	7
			winter	520	540	5
Bow River at Cochrane	Sulphate (mg/L)	1999-2009 (trigger)	open	33.6	40.4	70
			winter	42.2	45.8	50
		2017-18	open	39.0	45.2	7
			winter	52.0	54.2	5
Bow River at Carseland	Nitrate (mg/L)	1999-2009 (trigger)	open	0.601	0.990	69
			winter	1.130	1.403	50
		2017-18	open	0.670	0.972	7
			winter	1.600	1.880	5
Bow River at Cluny	Nitrate (mg/L)	1999-2009 (trigger)	open	0.520	0.837	59
			winter	1.195	1.455	40
		2017-18	open	0.837	1.36	7
			winter	1.455	2.60	5
Bow River at Ronalane	Specific Conductivity (µS/cm)	1999-2009 (trigger)	open	386	431	70
			winter	448	499	49
		2017-18	open	420	514	7
			winter	540	558	5
Bow River at Ronalane	Total Dissolved Solids (mg/L)	1999-2009 (trigger)	open	228	260	70
			winter	263	291	49
		2017-18	open	240	288	7
			winter	310	320	5

Exceedances of Water Quality Limits, 2017-2018

Median values for nine of the fifteen primary indicators were compared to the surface water quality limits described in the SSR SWQMF. Median specific conductivity (1100 $\mu\text{S}/\text{cm}$) and total dissolved solids (640 mg/L) concentrations at Milk River at SH 880 exceeded water quality limits during the winter season. There were no other exceedances of surface water quality limits as defined in the SSR SWQMF.

Secondary Indicators, 2017-2018

The median seasonal concentrations of secondary indicators at each site were compared to chronic guidelines where available. Median selenium concentrations at Milk River at SH 880 during the winter season (1.1 $\mu\text{g}/\text{L}$) exceeded the EQGASW Protection of Aquatic Life chronic guideline, which is set at 1 $\mu\text{g}/\text{L}$. The median selenium concentration at South Saskatchewan River at Medicine Hat during the winter season measured at 1.00 $\mu\text{g}/\text{L}$; this is equivalent to the guideline (not above the guideline value) and thus not considered an exceedance. There were no other exceedances of chronic guideline values. Summary statistics for all secondary indicators are provided in Appendix A. Note that summary statistics shown for secondary indicators are for information purposes only as there are no triggers or limits assigned to these indicators.

Appendix A

Descriptive Statistics for the Nine Long Term River Network Stations

Table A1 Median and 90th percentile values for primary indicators in the Oldman River at Brocket.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
Total Ammonia (mg/L)	1999-2009	open	0.010	0.060	91
		winter	0.010	0.039	52
	2017-18	open	0.008	0.021	7
		winter	0.008	0.008	5
Chloride (mg/L)	1999-2009	open	0.9	1.8	70
		winter	1.2	1.9	50
	2017-18	open	1.2	1.3	7
		winter	1.9	2.1	5
Nitrate (mg/L)	1999-2009	open	0.078	0.128	91
		winter	0.092	0.132	52
	2017-18	open	0.057	0.076	7
		winter	0.160	0.160	5
Total Nitrogen (mg/L)	1999-2009	open	0.23	0.35	70
		winter	0.19	0.32	50
	2017-18	open	0.22	0.25	7
		winter	0.29	0.30	5
Total Dissolved Phosphorus (mg/L)	1999-2009	open	0.003	0.006	91
		winter	0.003	0.005	52
	2017-18	open	0.002	0.003	7
		winter	0.002	0.002	5
Total Phosphorus (mg/L)	1999-2009	open	0.007	0.018	91
		winter	0.005	0.010	52
	2017-18	open	0.007	0.020	7
		winter	0.005	0.005	5
Sulphate (mg/L)	1999-2009	open	22.1	29.4	70
		winter	29.6	36.0	50
	2017-18	open	21.0	25.6	7
		winter	34.0	37.6	5
Sodium Adsorption Ratio	1999-2009	open	0.16	0.22	70
		winter	0.18	0.20	50
	2017-18	open	0.15	0.18	7
		winter	0.18	0.19	5

Specific Conductance (μS/cm)	1999-2009	open	276	313	91
		winter	308	342	52
	2017-18	open	270	298	7
		winter	330	356	5
Total Dissolved Solids (mg/L)	1999-2009	open	156	181	70
		winter	179	202	50
	2017-18	open	140	164	7
		winter	180	200	5
Total Organic Carbon (mg/L)	1999-2009	open	2.0	3.7	70
		winter	1.6	2.2	50
	2017-18	open	2.1	2.9	7
		winter	1.0	1.9	5
Total Suspended Solids (mg/L)	1999-2009	open	3	10	84
		winter	1	6	47
	2017-18	open	2	11	7
		winter	1	3	5
Turbidity (NTU)	1999-2009	open	4.5	18.8	91
		winter	2.3	8.5	52
	2017-18	open	5.0	14.0	7
		winter	2.2	5.2	5
pH	1999-2009	open	8.26	8.35	91
		winter	8.26	8.34	52
	2017-18	open	8.38	8.42	7
		winter	8.24	8.34	5
<i>Escherichia coli</i> (cfu/100ml)	1999-2009	open	3	14	70
		winter	2	27	49
	2017-18	open	4	13	7
		winter	7	20	5

Table A2 Median and 90th percentile values for secondary indicators in the Oldman River at Brocket.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
2,4-D (µg/L)	1999-2009	open	0.0025	0.0032	39
		winter	0.0025	0.0025	4
	2017-18	open	0.0025	0.0071	4
		winter			
Dicamba (µg/L)	1999-2009	open	0.0025	0.0068	39
		winter	0.0025	0.0025	4
	2017-18	open	0.0025	0.0025	4
		winter			
MCPA (µg/L)	1999-2009	open	0.0025	0.0025	39
		winter	0.0025	0.0025	4
	2017-18	open	0.0025	0.0025	4
		winter			
Mecoprop (µg/L)	1999-2009	open	0.0025	0.0025	39
		winter	0.0025	0.0025	4
	2017-18	open	0.0025	0.0025	4
		winter			
Total Mercury (ng/L)	1999-2009	open	0.30	1.40	18
		winter	0.33	0.62	8
	2017-18	open	1.36	1.88	7
		winter	0.33	0.62	5
Total Recoverable Selenium (µg/L)	1999-2009	open	0.52	0.76	14
		winter	0.73	0.85	7
	2017-18	open	0.60	0.61	7
		winter	0.73	0.85	5

Table A3 Median and 90th percentile values for primary indicators in the Oldman River at Hwy 3 in Lethbridge.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
Total Ammonia (mg/L)	1999-2009	open	0.020	0.070	94
		winter	0.020	0.059	52
	2017-18	open	0.008	0.028	7
		winter	0.015	0.071	5
Chloride (mg/L)	1999-2009	open	1.5	3.2	70
		winter	2.1	3.0	50
	2017-18	open	2.1	9.5	7
		winter	3.9	9.4	5
Nitrate (mg/L)	1999-2009	open	0.023	0.138	94
		winter	0.219	0.348	52
	2017-18	open	0.008	0.067	7
		winter	0.260	0.370	5
Total Nitrogen (mg/L)	1999-2009	open	0.25	0.64	72
		winter	0.40	0.59	50
	2017-18	open	0.22	0.48	7
		winter	0.39	0.70	5
Total Dissolved Phosphorus (mg/L)	1999-2009	open	0.003	0.009	93
		winter	0.003	0.006	52
	2017-18	open	0.004	0.007	7
		winter	0.002	0.006	5
Total Phosphorus (mg/L)	1999-2009	open	0.012	0.151	94
		winter	0.008	0.022	52
	2017-18	open	0.007	0.140	7
		winter	0.006	0.024	5
Sulphate (mg/L)	1999-2009	open	35.8	52.1	70
		winter	45.0	58.0	50
	2017-18	open	34.0	40.6	7
		winter	51.0	72.0	5
Sodium Adsorption Ratio	1999-2009	open	0.42	0.59	70
		winter	0.46	0.60	50
	2017-18	open	0.32	0.41	7
		winter	0.51	0.66	5

Specific Conductance (µS/cm)	1999-2009	open	323	397	91
		winter	358	437	52
	2017-18	open	310	340	7
		winter	410	452	5
Total Dissolved Solids (mg/L)	1999-2009	open	182	224	69
		winter	217	256	50
	2017-18	open	160	200	7
		winter	230	260	5
Total Organic Carbon (mg/L)	1999-2009	open	2.4	3.9	70
		winter	1.7	2.5	50
	2017-18	open	2.1	2.6	7
		winter	1.3	3.0	5
Total Suspended Solids (mg/L)	1999-2009	open	9	189	93
		winter	7	34	52
	2017-18	open	2	224	7
		winter	3	8	5
Turbidity (NTU)	1999-2009	open	10.0	153.0	91
		winter	6.3	27.5	52
	2017-18	open	2.5	68.2	7
		winter	3.3	9.0	5
pH	1999-2009	open	8.34	8.57	91
		winter	8.20	8.28	52
	2017-18	open	8.35	8.44	7
		winter	8.22	8.30	5
<i>Escherichia coli</i> (cfu/100ml)	1999-2009	open	13	71	72
		winter	2	13	48
	2017-18	open	36	112	7
		winter	6	20	5

Table A4 Median and 90th percentile values for secondary indicators in the Oldman River at Hwy 3 in Lethbridge.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
2,4-D (µg/L)	1999-2009	open	0.0060	0.0310	46
		winter	0.0025	0.0025	4
	2017-18	open	0.0080	0.0173	4
		winter			
Dicamba (µg/L)	1999-2009	open	0.0025	0.0100	46
		winter	0.0025	0.0025	4
	2017-18	open	0.0025	0.0025	4
		winter			
MCPA (µg/L)	1999-2009	open	0.0025	0.0100	46
		winter	0.0025	0.0025	4
	2017-18	open	0.0025	0.0120	4
		winter			
Mecoprop (µg/L)	1999-2009	open	0.0025	0.0028	46
		winter	0.0025	0.0025	4
	2017-18	open	0.0025	0.0025	4
		winter			
Total Mercury (ng/L)	1999-2009	open	0.30	2.06	18
		winter	0.30	1.35	8
	2017-18	open	1.03	7.24	7
		winter	0.62	1.50	5
Total Recoverable Selenium (µg/L)	1999-2009	open	0.61	0.85	14
		winter	0.90	1.20	7
	2017-18	open	0.60	0.76	7
		winter	0.90	1.14	5

Table A5 Median and 90th percentile values for primary indicators in the Oldman River at Hwy 36.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
Total Ammonia (mg/L)	1999-2009	open	0.020	0.110	91
		winter	0.030	0.134	57
	2017-18	open	0.008	0.046	7
		winter	0.043	0.156	5
Chloride (mg/L)	1999-2009	open	4.0	6.1	70
		winter	6.0	8.1	50
	2017-18	open	3.5	1.8	7
		winter	6.8	29.2	5
Nitrate (mg/L)	1999-2009	open	0.006	0.140	91
		winter	0.317	0.495	57
	2017-18	open	0.027	0.083	7
		winter	0.370	0.460	5
Total Nitrogen (mg/L)	1999-2009	open	0.31	0.75	70
		winter	0.59	0.96	55
	2017-18	open	0.32	0.47	7
		winter	0.63	0.95	5
Total Dissolved Phosphorus (mg/L)	1999-2009	open	0.003	0.010	91
		winter	0.003	0.007	57
	2017-18	open	0.004	0.005	7
		winter	0.006	0.012	5
Total Phosphorus (mg/L)	1999-2009	open	0.015	0.173	91
		winter	0.009	0.019	57
	2017-18	open	0.008	0.114	7
		winter	0.009	0.031	5
Sulphate (mg/L)	1999-2009	open	44.8	61.4	70
		winter	58.1	77.4	50
	2017-18	open	42.0	55.4	7
		winter	64.0	71.0	5
Sodium Adsorption Ratio	1999-2009	open	0.56	0.78	70
		winter	0.65	0.80	50
	2017-18	open	0.42	0.59	7
		winter	0.61	1.08	5

Specific Conductance (µS/cm)	1999-2009	open	357	425	91
		winter	414	502	52
	2017-18	open	330	378	7
		winter	450	518	5
Total Dissolved Solids (mg/L)	1999-2009	open	200	243	70
		winter	246	296	50
	2017-18	open	180	216	7
		winter	250	298	5
Total Organic Carbon (mg/L)	1999-2009	open	2.9	4.4	70
		winter	2.2	3.0	55
	2017-18	open	1.6	2.8	7
		winter	2.2	2.8	5
Total Suspended Solids (mg/L)	1999-2009	open	11	200	90
		winter	3	17	57
	2017-18	open	5	226	7
		winter	3	11	5
Turbidity (NTU)	1999-2009	open	9.9	180.0	91
		winter	4.9	19.9	52
	2017-18	open	3.3	66.4	7
		winter	2.6	8.1	5
pH	1999-2009	open	8.37	8.52	91
		winter	8.21	8.33	57
	2017-18	open	8.43	8.48	7
		winter	8.17	8.32	5
<i>Escherichia coli</i> (cfu/100ml)	1999-2009	open	14	151	70
		winter	3	17	53
	2017-18	open	21	354	7
		winter	14	15	5

Table A6 Median and 90th percentile values for secondary indicators in the Oldman River at Hwy 36.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
2,4-D (µg/L)	1999-2009	open	0.0135	0.0802	44
		winter	0.0025	0.0025	4
	2017-18	open	0.0160	0.0249	4
		winter			
Dicamba (µg/L)	1999-2009	open	0.0025	0.0117	44
		winter	0.0025	0.0025	4
	2017-18	open	0.0025	0.0025	4
		winter			
MCPA (µg/L)	1999-2009	open	0.0025	0.0184	44
		winter	0.0025	0.0025	4
	2017-18	open	0.0025	0.0092	4
		winter			
Mecoprop (µg/L)	1999-2009	open	0.0025	0.0070	44
		winter	0.0025	0.0025	4
	2017-18	open	0.0025	0.0025	4
		winter			
Total Mercury (ng/L)	1999-2009	open	0.43	2.37	18
		winter	0.80	1.73	8
	2017-18	open	1.11	6.44	7
		winter	0.75	1.14	5
Total Recoverable Selenium (µg/L)	1999-2009	open	0.59	1.00	14
		winter	1.12	1.25	7
	2017-18	open	0.70	0.87	7
		winter	0.90	1.12	5

Table A7 Median and 90th percentile values for primary indicators in the South Saskatchewan River at Medicine Hat - Hwy 1.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
Total Ammonia (mg/L)	1999-2009	open	0.020	0.060	70
		winter	0.090	0.253	48
	2017-18	open	0.030	0.054	7
		winter	0.058	0.117	5
Chloride (mg/L)	1999-2009	open	6.4	9.8	70
		winter	12.6	19.9	48
	2017-18	open	7.7	11.8	7
		winter	25.0	27.2	5
Nitrate (mg/L)	1999-2009	open	0.103	0.497	69
		winter	1.015	1.258	48
	2017-18	open	0.220	0.404	7
		winter	1.300	1.300	5
Total Nitrogen (mg/L)	1999-2009	open	0.55	1.01	70
		winter	1.33	1.72	48
	2017-18	open	0.62	1.01	7
		winter	1.60	1.60	5
Total Dissolved Phosphorus (mg/L)	1999-2009	open	0.004	0.009	70
		winter	0.004	0.010	48
	2017-18	open	0.004	0.010	7
		winter	0.003	0.004	5
Total Phosphorus (mg/L)	1999-2009	open	0.023	0.098	70
		winter	0.011	0.042	48
	2017-18	open	0.079	0.168	7
		winter	0.007	0.012	5
Sulphate (mg/L)	1999-2009	open	56.5	76.9	70
		winter	62.4	77.6	48
	2017-18	open	60.0	78.0	7
		winter	75.0	80.6	5
Sodium Adsorption Ratio	1999-2009	open	0.60	0.79	70
		winter	0.59	0.88	48
	2017-18	open	0.63	0.74	7
		winter	0.69	0.77	5

Specific Conductance (µS/cm)	1999-2009	open	369	436	68
		winter	462	519	48
	2017-18	open	380	448	7
		winter	520	540	5
Total Dissolved Solids (mg/L)	1999-2009	open	221	252	70
		winter	268	316	48
	2017-18	open	220	254	7
		winter	300	310	5
Total Organic Carbon (mg/L)	1999-2009	open	2.7	4.0	34
		winter	1.7	3.0	13
	2017-18	open	2.1	2.6	7
		winter	1.2	1.5	5
Total Suspended Solids (mg/L)	1999-2009	open	19	105	70
		winter	5	32	48
	2017-18	open	77	292	7
		winter	3	4	5
Turbidity (NTU)	1999-2009	open	16.4	80.5	70
		winter	4.0	28.3	48
	2017-18	open	34.0	58.8	7
		winter	2.7	3.4	5
pH	1999-2009	open	8.32	8.47	70
		winter	8.14	8.27	48
	2017-18	open	8.32	8.40	7
		winter	8.20	8.31	5
<i>Escherichia coli</i> (cfu/100ml)	1999-2009	open	13	99	68
		winter	1	7	48
	2017-18	open	21	73	7
		winter	2	3	5

Table A8 Median and 90th percentile values for secondary indicators in the South Saskatchewan River at Medicine Hat - Hwy 1.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
2,4-D (µg/L)	1999-2009	open	0.0245	0.1049	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0165	0.0211	4
		winter			
Dicamba (µg/L)	1999-2009	open	0.0025	0.0170	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0071	4
		winter			
MCPA (µg/L)	1999-2009	open	0.0025	0.0168	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0113	4
		winter			
Mecoprop (µg/L)	1999-2009	open	0.0025	0.0132	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0134	4
		winter			
Total Mercury (ng/L)	1999-2009	open	0.55	2.61	18
		winter	0.30	0.41	5
	2017-18	open	4.53	9.61	7
		winter	0.30	0.41	5
Total Recoverable Selenium (µg/L)	1999-2009	open	0.57	0.85	14
		winter	1.00	1.07	4
	2017-18	open	0.59	0.88	7
		winter	1.00	1.07	5

Table A9 Median and 90th percentile values for primary indicators in the Bow River at Cochrane.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
Total Ammonia (mg/L)	1999-2009	open	0.005	0.041	70
		winter	0.008	0.025	50
	2017-18	open	0.008	0.042	7
		winter	0.008	0.020	5
Chloride (mg/L)	1999-2009	open	1.9	2.9	70
		winter	2.0	2.6	50
	2017-18	open	2.4	2.8	7
		winter	3.1	29.5	5
Nitrate (mg/L)	1999-2009	open	0.074	0.108	69
		winter	0.109	0.130	50
	2017-18	open	0.093	0.118	7
		winter	0.160	0.498	5
Total Nitrogen (mg/L)	1999-2009	open	0.18	0.40	70
		winter	0.17	0.23	50
	2017-18	open	0.16	0.23	7
		winter	0.22	0.62	5
Total Dissolved Phosphorus (mg/L)	2004-2009	open	0.002	0.004	35
		winter	0.002	0.004	25
	2017-18	open	0.002	0.006	7
		winter	0.002	0.003	5
Total Phosphorus (mg/L)	2004-2009	open	0.005	0.009	35
		winter	0.003	0.006	25
	2017-18	open	0.004	0.016	7
		winter	0.002	0.003	5
Sulphate (mg/L)	1999-2009	open	33.6	40.4	70
		winter	42.2	45.8	50
	2017-18	open	39.0	45.2	7
		winter	52.0	54.2	5
Sodium Adsorption Ratio	1999-2009	open	0.07	0.12	70
		winter	0.07	0.10	50
	2017-18	open	0.08	0.10	7
		winter	0.09	0.57	5

Specific Conductance (µS/cm)	1999-2009	open	289	317	70
		winter	330	349	50
	2017-18	open	310	328	7
		winter	360	466	5
Total Dissolved Solids (mg/L)	1999-2009	open	165	190	70
		winter	190	200	50
	2017-18	open	160	180	7
		winter	200	264	5
Total Organic Carbon (mg/L)	1999-2009	open	1.0	1.6	34
		winter	0.8	0.9	14
	2017-18	open	0.6	1.0	7
		winter	0.3	0.6	5
Total Suspended Solids (mg/L)	1999-2009	open	2	8	70
		winter	1	2	50
	2017-18	open	1	17	7
		winter	1	1	5
Turbidity (NTU)	1999-2009	open	1.8	10.1	70
		winter	0.8	1.7	50
	2017-18	open	2.1	17.2	7
		winter	0.4	0.8	5
pH	1999-2009	open	8.23	8.38	70
		winter	8.17	8.30	50
	2017-18	open	8.33	8.36	7
		winter	8.27	8.29	5
<i>Escherichia coli</i> (cfu/100ml)	1999-2009	open	2	13	70
		winter	1	2	49
	2017-18	open	3	54	7
		winter	1	21	5

Table A10 Median and 90th percentile values for secondary indicators in the Bow River at Cochrane.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
2,4-D (µg/L)	1999-2009	open	0.0025	0.0025	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0025	4
		winter			
Dicamba (µg/L)	1999-2009	open	0.0025	0.0100	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0025	4
		winter			
MCPA (µg/L)	1999-2009	open	0.0025	0.0025	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0025	4
		winter			
Mecoprop (µg/L)	1999-2009	open	0.0025	0.0025	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0025	4
		winter			
Total Mercury (ng/L)	1999-2009	open	0.30	0.92	22
		winter	0.34	0.50	10
	2017-18	open	0.70	1.42	7
		winter	0.33	0.46	4
Total Recoverable Selenium (µg/L)	1999-2009	open	0.50	0.59	18
		winter	0.61	0.80	9
	2017-18	open	0.40	0.54	7
		winter	0.60	0.96	5

Table A11 Median and 90th percentile values for primary indicators in the Bow River at Carseland.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
Total Ammonia (mg/L)	1999-2009	open	0.045	0.160	70
		winter	0.250	0.472	50
	2017-18	open	0.036	0.061	7
		winter	0.150	0.196	5
Chloride (mg/L)	1999-2009	open	7.6	13.1	70
		winter	12.7	20.4	50
	2017-18	open	11.0	16.0	7
		winter	29.0	61.8	5
Nitrate (mg/L)	1999-2009	open	0.601	0.990	69
		winter	1.130	1.403	50
	2017-18	open	0.670	0.972	7
		winter	1.600	1.880	5
Total Nitrogen (mg/L)	1999-2009	open	1.02	1.72	70
		winter	1.68	2.17	50
	2017-18	open	1.00	1.28	7
		winter	2.00	2.34	5
Total Dissolved Phosphorus (mg/L)	2004-2009	open	0.007	0.016	35
		winter	0.017	0.028	25
	2017-18	open	0.008	0.010	7
		winter	0.029	0.032	5
Total Phosphorus (mg/L)	2004-2009	open	0.021	0.083	35
		winter	0.030	0.062	25
	2017-18	open	0.015	0.042	7
		winter	0.041	0.075	5
Sulphate (mg/L)	1999-2009	open	42.9	51.5	70
		winter	53.9	58.0	50
	2017-18	open	49.0	57.4	7
		winter	66.0	71.4	5
Sodium Adsorption Ratio	1999-2009	open	0.30	0.45	70
		winter	0.39	0.58	50
	2017-18	open	0.39	0.46	7
		winter	0.61	1.17	5

Specific Conductance (µS/cm)	1999-2009	open	346	398	69
		winter	422	443	50
	2017-18	open	370	416	7
		winter	500	586	5
Total Dissolved Solids (mg/L)	1999-2009	open	201	232	70
		winter	246	260	50
	2017-18	open	220	244	7
		winter	280	324	5
Total Organic Carbon (mg/L)	1999-2009	open	2.0	3.6	34
		winter	1.5	1.9	14
	2017-18	open	1.3	1.6	7
		winter	1.0	1.6	5
Total Suspended Solids (mg/L)	1999-2009	open	6	64	70
		winter	5	14	50
	2017-18	open	6	41	7
		winter	5	18	5
Turbidity (NTU)	1999-2009	open	4.0	48.4	70
		winter	2.6	9.3	50
	2017-18	open	1.8	17.3.9	7
		winter	1.3	7.2	5
pH	1999-2009	open	8.20	8.39	70
		winter	8.06	8.20	50
	2017-18	open	8.32	8.46	7
		winter	8.10	8.14	5
<i>Escherichia coli</i> (cfu/100ml)	1999-2009	open	28	144	67
		winter	10	25	47
	2017-18	open	27	84	7
		winter	4	16	5

Table A12 Median and 90th percentile values for secondary indicators in the Bow River at Carseland.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
2,4-D (µg/L)	1999-2009	open	0.0075	0.0260	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0083	0.0273	4
		winter			
Dicamba (µg/L)	1999-2009	open	0.0025	0.0100	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0025	4
		winter			
MCPA (µg/L)	1999-2009	open	0.0025	0.0071	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0064	4
		winter			
Mecoprop (µg/L)	1999-2009	open	0.0050	0.0167	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0058	0.0181	4
		winter			
Total Mercury (ng/L)	1999-2009	open	0.30	4.81	22
		winter	0.35	0.69	10
	2017-18	open	0.99	3.34	7
		winter	0.66	1.61	5
Total Recoverable Selenium (µg/L)	1999-2009	open	0.59	0.88	18
		winter	0.83	0.98	9
	2017-18	open	0.60	0.68	7
		winter	0.70	0.80	5

Table A13 Median and 90th percentile values for primary indicators in the Bow River at Cluny.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
Total Ammonia (mg/L)	1999-2009	open	0.025	0.120	71
		winter	0.195	0.372	48
	2017-18	open	0.019	0.122	7
		winter	0.098	0.154	5
Chloride (mg/L)	1999-2009	open	8.0	13.0	71
		winter	13.0	20.9	43
	2017-18	open	12.0	17.6	7
		winter	27.0	39.6	5
Nitrate (mg/L)	1999-2009	open	0.520	0.837	59
		winter	1.195	1.455	40
	2017-18	open	0.710	1.090	7
		winter	1.600	1.900	5
Total Nitrogen (mg/L)	1999-2009	open	0.94	1.52	71
		winter	1.68	2.07	48
	2017-18	open	0.95	1.36	7
		winter	2.00	2.60	5
Total Dissolved Phosphorus (mg/L)	2004-2009	open	0.005	0.014	35
		winter	0.012	0.020	22
	2017-18	open	0.005	0.010	7
		winter	0.017	0.032	5
Total Phosphorus (mg/L)	2004-2009	open	0.017	0.128	35
		winter	0.017	0.025	22
	2017-18	open	0.014	0.076	7
		winter	0.031	0.129	5
Sulphate (mg/L)	1999-2009	open	47.9	58.1	48
		winter	57.2	63.1	32
	2017-18	open	54.0	61.4	7
		winter	70.0	72.0	5
Sodium Adsorption Ratio	1999-2009	open	0.35	0.58	48
		winter	0.42	0.72	32
	2017-18	open	0.41	0.50	7
		winter	0.58	0.84	5

Specific Conductance (µS/cm)	1999-2009	open	360	425	47
		winter	441	490	32
	2017-18	open	380	430	7
		winter	510	546	5
Total Dissolved Solids (mg/L)	1999-2009	open	211	245	48
		winter	257	290	32
	2017-18	open	220	254	7
		winter	290	300	5
Total Organic Carbon (mg/L)	1999-2009	open	2.2	4.3	23
		winter	1.3	1.8	16
	2017-18	open	1.3	1.7	7
		winter	1.1	1.4	5
Total Suspended Solids (mg/L)	1999-2009	open	11	80	71
		winter	4	9	48
	2017-18	open	16	83	7
		winter	12	64	5
Turbidity (NTU)	1999-2009	open	8.5	62.7	48
		winter	2.8	7.1	32
	2017-18	open	3.3	32.8	7
		winter	5.2	22.3	5
pH	1999-2009	open	8.30	8.46	48
		winter	8.00	8.23	37
	2017-18	open	8.35	8.38	7
		winter	8.11	8.25	5
<i>Escherichia coli</i> (cfu/100ml)	1999-2009	open	8	56	67
		winter	1	6	48
	2017-18	open	17	59	7
		winter	2	15	5

Table A14 Median and 90th percentile values for secondary indicators in the Bow River at Cluny.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
2,4-D (µg/L)	1999-2009	open	0.0065	0.0384	32
		winter	0.0025	0.0025	3
	2017-18	open	0.0088	0.0150	4
		winter			
Dicamba (µg/L)	1999-2009	open	0.0025	0.0100	32
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0025	4
		winter			
MCPA (µg/L)	1999-2009	open	0.0025	0.0097	32
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0099	4
		winter			
Mecoprop (µg/L)	1999-2009	open	0.0055	0.0209	32
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0099	4
		winter			
Total Mercury (ng/L)	1999-2009	open	0.30	2.53	17
		winter	0.30	0.37	5
	2017-18	open	1.67	4.32	7
		winter	3.07	5.36	5
Total Recoverable Selenium (µg/L)	1999-2009	open	0.70	0.93	10
		winter	0.79	0.82	4
	2017-18	open	0.60	0.64	7
		winter	0.70	0.86	5

Table A15 Median and 90th percentile values for primary indicators in the Bow River at Ronalane.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
Total Ammonia (mg/L)	1999-2009	open	0.020	0.081	70
		winter	0.130	0.292	49
	2017-18	open	0.008	0.056	7
		winter	0.084	0.136	5
Chloride (mg/L)	1999-2009	open	8.4	12.0	70
		winter	13.0	19.7	49
	2017-18	open	12.0	20.6	7
		winter	29.0	35.4	5
Nitrate (mg/L)	1999-2009	open	0.302	0.747	69
		winter	1.190	1.440	49
	2017-18	open	0.330	0.812	7
		winter	1.700	1.860	5
Total Nitrogen (mg/L)	1999-2009	open	0.68	1.26	70
		winter	1.58	1.91	49
	2017-18	open	0.78	1.28	7
		winter	2.20	2.32	5
Total Dissolved Phosphorus (mg/L)	2004-2009	open	0.005	0.010	35
		winter	0.005	0.017	24
	2017-18	open	0.002	0.009	7
		winter	0.006	0.009	5
Total Phosphorus (mg/L)	2004-2009	open	0.025	0.138	35
		winter	0.012	0.027	24
	2017-18	open	0.013	0.131	7
		winter	0.012	0.074	5
Sulphate (mg/L)	1999-2009	open	62.2	78.2	70
		winter	60.9	70.5	49
	2017-18	open	70.0	89.0	7
		winter	80.0	82.2	5
Sodium Adsorption Ratio	1999-2009	open	0.55	0.80	70
		winter	0.48	0.67	49
	2017-18	open	0.66	0.81	7
		winter	0.69	0.85	5

Specific Conductance (µS/cm)	1999-2009	open	386	431	70
		winter	448	499	49
	2017-18	open	420	514	7
		winter	540	558	5
Total Dissolved Solids (mg/L)	1999-2009	open	228	260	70
		winter	263	291	49
	2017-18	open	240	288	7
		winter	310	320	5
Total Organic Carbon (mg/L)	1999-2009	open	3.0	4.8	34
		winter	1.5	2.5	14
	2017-18	open	2.2	2.6	7
		winter	1.2	1.6	5
Total Suspended Solids (mg/L)	1999-2009	open	12	72	70
		winter	6	18	49
	2017-18	open	22	139	7
		winter	6	75	5
Turbidity (NTU)	1999-2009	open	10.4	73.3	70
		winter	3.8	17.4	49
	2017-18	open	9.5	45.0	7
		winter	3.3	32.0	5
pH	1999-2009	open	8.32	8.58	70
		winter	8.06	8.30	49
	2017-18	open	8.45	8.53	7
		winter	8.15	8.27	5
<i>Escherichia coli</i> (cfu/100ml)	1999-2009	open	14	77	69
		winter	1	6	49
	2017-18	open	5	36	7
		winter	5	12	5

Table A16 Median and 90th percentile values for secondary indicators in the Bow River at Ronalane.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
2,4-D (µg/L)	1999-2009	open	0.0325	0.1443	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0145	0.0457	4
		winter			
Dicamba (µg/L)	1999-2009	open	0.0095	0.0354	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0092	4
		winter			
MCPA (µg/L)	1999-2009	open	0.0025	0.0629	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0141	4
		winter			
Mecoprop (µg/L)	1999-2009	open	0.0055	0.0160	44
		winter	0.0025	0.0025	3
	2017-18	open	0.0025	0.0204	4
		winter			
Total Mercury (ng/L)	1999-2009	open	0.90	4.24	18
		winter	0.30	0.51	6
	2017-18	open	1.62	6.44	7
		winter	0.86	4.04	5
Total Recoverable Selenium (µg/L)	1999-2009	open	0.69	0.94	14
		winter	0.83	1.00	5
	2017-18	open	0.70	0.87	7
		winter	0.90	1.08	5

Table A17 Median and 90th percentile values for primary indicators in the Milk River at SH 880.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
Total Ammonia (mg/L)	2003-2009	open	0.025	0.070	81
		winter	0.040	0.130	31
	2017-18	open	0.008	0.021	7
		winter	0.029	0.036	5
Chloride (mg/L)	2003-2009	open	1.3	6.2	81
		winter	8.0	14.3	31
	2017-18	open	1.4	5.3	7
		winter	9.6	13.0	5
Nitrate (mg/L)	2003-2009	open	0.031	0.123	81
		winter	0.382	0.807	31
	2017-18	open	0.012	0.021	7
		winter	0.350	0.574	5
Total Nitrogen (mg/L)	2003-2009	open	0.32	0.59	78
		winter	0.82	1.22	31
	2017-18	open	0.21	0.54	7
		winter	0.63	1.03	5
Total Dissolved Phosphorus (mg/L)	2003-2009	open	0.003	0.006	81
		winter	0.003	0.010	31
	2017-18	open [†]	0.002	0.005	7
		winter	0.006	0.012	5
Total Phosphorus (mg/L)	2003-2009	open	0.079	0.193	81
		winter	0.007	0.039	31
	2017-18	open	0.047	0.194	7
		winter	0.008	0.024	5
Sulphate (mg/L)	2003-2009	open	22.3	170.0	81
		winter	197.0	316.0	31
	2017-18	open	23.0	122.8	7
		winter	200.0	292.0	5
Sodium Adsorption Ratio	2003-2009	open	0.43	2.26	81
		winter	2.54	3.80	31
	2017-18	open	0.45	1.79	7
		winter	2.66	3.38	5

Specific Conductance (µS/cm)	2003-2009	open	248	733	81
		winter	916	1380	31
	2017-18	open	250	680	7
		winter	1100	1340	5
Total Dissolved Solids (mg/L)	2003-2009	open	140	488	81
		winter	606	900	31
	2017-18	open	140	400	7
		winter	640	834	5
Total Organic Carbon (mg/L)	2003-2009	open	2.1	4.2	39
		winter	3.7	4.8	26
	2017-18	open	1.1	3.4	7
		winter	2.4	5.0	5
Total Suspended Solids (mg/L)	2003-2009	open	107	304	81
		winter	3	12	31
	2017-18	open	69	304	7
		winter	1	1	5
Turbidity (NTU)	2003-2009	open	60.0	170.0	81
		winter	3.7	17.5	31
	2017-18	open	25.0	56.0	7
		winter	1.8	4.1	5
pH	2003-2009	open	8.23	8.43	81
		winter	8.30	8.41	31
	2017-18	open	8.24	8.52	7
		winter	8.26	8.37	5
<i>Escherichia coli</i> (cfu/100ml)	2003-2009	open	57	230	79
		winter	1	9	30
	2017-18	open	72	211	7
		winter	2	9	5

† A suspect total dissolved phosphorus value from the open water season was removed prior to analysis. Please refer to Appendix B for details.

Table A18 Median and 90th percentile values for secondary indicators in the Milk River at SH 880.

INDICATOR	TIME PERIOD	SEASON	MEDIAN	90 TH PERCENTILE	<i>n</i>
2,4-D (µg/L)	2003-2009	open	0.0025	0.0114	24
		winter			0
	2017-18	open	0.0025	0.0134	4
		winter			
Dicamba (µg/L)	2003-2009	open	0.0025	0.0025	24
		winter			0
	2017-18	open	0.0025	0.0025	4
		winter			
MCPA (µg/L)	2003-2009	open	0.0025	0.0030	24
		winter			0
	2017-18	open	0.0025	0.0092	4
		winter			
Mecoprop (µg/L)	2003-2009	open	0.0025	0.0025	24
		winter			0
	2017-18	open	0.0025	0.0025	4
		winter			
Total Mercury (ng/L)	2003-2009	open	2.15	9.50	18
		winter	0.30	0.70	6
	2017-18	open	3.63	7.89	7
		winter	3.64	9.61	5
Total Recoverable Selenium (µg/L)	2003-2009	open	0.35	0.89	14
		winter	1.20	1.51	5
	2017-18	open	0.30	0.68	7
		winter	1.10	1.58	5

Appendix B

Removal of Suspect Total Dissolved Phosphorus Value at Milk River at SH 880

During the data validation process, a data point at Milk River at SH 880 was identified and flagged in the database as suspect. The specific data point was total dissolved phosphorus (TDP) collected on July 12 (open water season). The sample was flagged as suspect for the following reasons:

1. The TDP concentration (0.53 mg/L) exceeded the total phosphorus (TP) concentration (0.044 mg/L) by an order of magnitude and the difference between TDP and TP was outside laboratory uncertainty. As TDP is a component of TP, TDP should not exceed TP.
2. The TDP value measured here is rare in the long-term data set (Figure B1). While similarly high concentrations have occurred in the historical record, the values were always accompanied by high TP.
3. The error in the ratio of TDP to TP (i.e., TDP:TP > 1) was not likely due to an error in the TP measurement. TP in the Milk River is typically related to TSS (Figure B2) and the specific data point on July 12 for TP falls within the expected range based on the concurrent TSS concentration.

Owing to the suspect nature of this TDP data point, it was removed from the analyses. The removal of the suspect TDP data point resulted in a change in the open water season for the 90th percentile concentration at this site, but no change in the median concentration (Table B1). The inclusion of the suspect data point resulted in a 90th percentile concentration (0.215 mg/L) greater than the peak trigger value (0.006 mg/L), which results in running additional statistical tests to determine the significance of the current year peak concentration being greater than the peak trigger value. To be conservative, the analysis of TDP data at Milk River at SH 880 for significance was ran both with and without the suspect data point. There was no significant exceedance of the peak trigger in either case. The removal of the suspect value only altered the 90th percentile concentration as presented in Table B1 below.

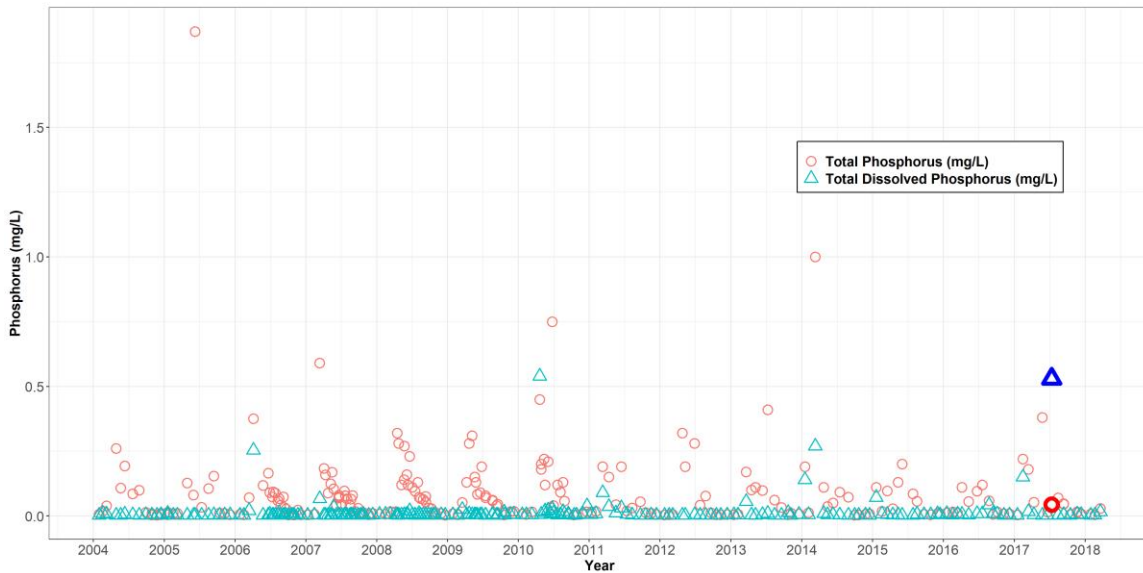


Figure B1 Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations over time, as indicated by shape. The bold markers indicate the suspect samples.

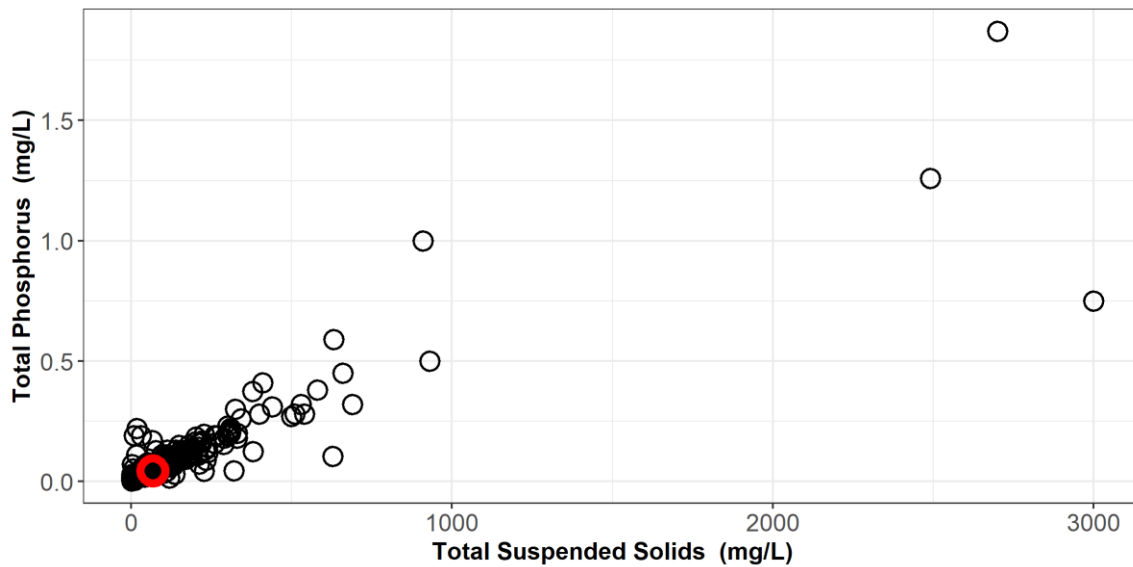


Figure B2 Total phosphorus (TP) concentrations as a function of total suspended solids (TSS) concentrations. The red circle indicates the suspect TP value with its associated TSS value.

Table B1 median and 90th percentile values for total dissolved phosphorus (TDP) at Milk River at SH 880 during the open water season, for the historical dataset as well as with and without the suspect TDP value.

Total Dissolved Phosphorus (mg/L) – Open Water Season		
Historical (1999-2009)	Median	0.003
	90 th percentile	0.006
Without suspect value	Median	0.002
	90 th percentile	0.005
With suspect value	Median	0.002
	90 th percentile	0.215

References

- Alberta Environment & Sustainable Resource Development (AESRD). 2014a. Environmental Quality Guidelines for Alberta Surface waters, July 14, 2014. Water Policy Branch, Policy Division. Edmonton. 48 pp. ISBN: 978-1-4601-1523-7 (Print); 978-1-4601-1524-4 (PDF). Available at: <https://open.alberta.ca/publications/9781460115244>.
- Alberta Environment & Sustainable Resource Development (AESRD). 2014b. South Saskatchewan Regional Plan, 2014-2024. Edmonton. 200 pp. ISBN: 978-1-4601-1862-7 (Print); 978-1-4601-1863-4 (PDF). Available at: <https://open.alberta.ca/publications/9781460118634>.
- Alberta Environment & Sustainable Resource Development (AESRD). 2014c. South Saskatchewan Region, Surface Water Quality Management Framework, For the Mainstem Bow, Milk, Oldman and South Saskatchewan Rivers (Alberta). Edmonton. 68 pp. ISBN: 978-1-4601-1860-3 (Print); 978-1-4601-1861-0 (PDF). Available at: <https://open.alberta.ca/publications/9781460118603#summary>.
- Government of Alberta (GoA). 2008. Land-use Framework. Edmonton. 54 pp. ISBN: 978-7785-7713-3 (Print); 978-0-7785-7714-0 (PDF). Available at <https://www.landuse.alberta.ca/PlanforAlberta/LanduseFramework/Pages/default.aspx>.
- Government of Alberta (GoA). 2009. Alberta Land Stewardship Act, Statutes of Alberta, 2009, Chapter A-26.8. 53 pp. Available at <https://www.landuse.alberta.ca/Governance/ALSA/Pages/default.aspx>.
- HDR Corporation. 2011. South Saskatchewan Regional Plan Surface Water Quality Management Framework: Statistical Methods Final Report. Prepared for Alberta Environment. 121 pp. ISBN: 978-1-4601-2539-7 (PDF). Available at: <https://open.alberta.ca/publications/9781460125397>.
- Smith, E. P., K. Ye, C. Hughes and L. Shabman. 2001. Statistical Assessment of Violations of Water Quality Standards under Section 303(d) of the Clean Water Act. Environ. Sci. Technol. 35: 606-612.