MILK RIVER WATERSHED

WATER MONITORING REPORT 2014

Prepared for: Milk River Watershed Council Canada

Prepared by: Palliser Environmental Services Ltd.

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Palliser Environmental Services Ltd.

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1.0 INTRODUCTION

The Milk River is the most southern major river system in Alberta. The headwaters of the Milk River originate in Montana and the river flows eastward through Alberta for about 288 km. The mainstem of the Milk River is prairie fed and is often referred to as the South Fork of the Milk River. Flows in the North Fork of the Milk River are augmented by water from the St. Mary River (i.e., the St. Mary River Diversion) as part of the Boundary Waters Treaty (1909).

The Milk River Watershed Council Canada has monitored the Milk River and some of its tributaries since 2006. This report is a compilation of data collected in 2014, with reference to water quality in 2013. Comparisons are made to Water Quality Objectives that were developed as part of the Milk River Integrated Watershed Management Plan (PESL 2015) as well as relevant provincial guidelines (ESRD 2013).

2.0 METHODS

Grab samples were collected approximately every two weeks (April-June) and monthly (July-October) from five sites: N Fork Milk River at 501, South Fork Milk River at 501, Upstream of the Town of Milk River (U/S Milk River), at HWY 880 Bridge and at the Pinhorn Ranch. Alberta Environment and Sustainable Resource Development also collected monthly samples at HWY 880 Bridge in 2014 and Environment Canada collected monthly samples at the Western and Eastern crossings (Figure 1) (this data is not included in this summary report). The MRWCC 2014 sampling dates were April 15, April 30, May 14, May 28, June 11, June 26, July 22, August 13, September 24 and October 28.

Select tributaries were also monitored in 2014; tributary monitoring occurred at three sites at Red Creek (i.e., Upstream, Middle and Downstream), at Verdigris Coulee and the three tributaries known as the "Eastern Tributaries" (i.e., Battle Creek, Middle Creek and Lodge Creek) that flow east to Saskatchewan and contribute flows to the Frenchman River (a tributary of the Milk River in Montana).

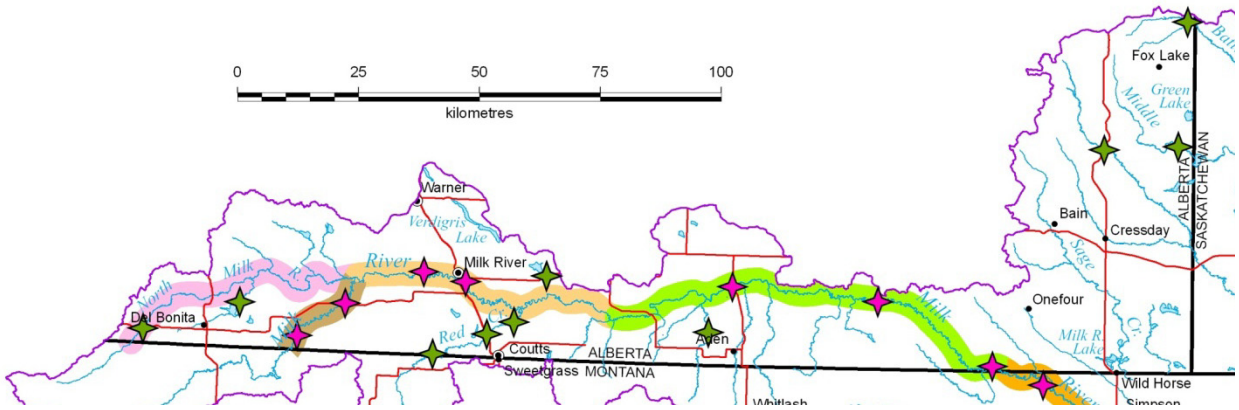

Figure 1. Map showing water monitoring locations sampled in the Milk River watershed, 2014.

Water samples were collected by staff from Cardston County, County of Warner, County of Forty Mile, Cypress County, the Milk River Watershed Council Canada, Alberta Environment and Sustainable Resource Development and Environment Canada. Samples were only collected when flows could be visually detected. Sample bottles were submersed to mid-depth by hand or using a sample pole (with

sample bottle attached) when the water was deep or fast-flowing. Each sample container was prepared using standard protocols (e.g., triple rinsing and preservation, where required). Sterile sample containers were provided by the analytical laboratory. The water samples were kept on ice in coolers and transported to ALS Laboratories in Calgary. ALS Laboratories Analytics is **CALA**[1] accredited for criteria and standards established by the Association under their Certificate of Laboratory Proficiency.

Samples were analysed using **APHA**[2] approved methods for general parameters (e.g., pH, specific conductivity) nutrients (total phosphorus (TP), total dissolved phosphorus (TDP), nitrate+nitrite nitrogen (NO3+NO2-N), total kjeldahl nitrogen (TKN) and total nitrogen [TN; calculated]), total suspended solids (TSS) and fecal coliform bacteria (FCB).

Water monitoring results were compared to local Milk River Water Quality Objectives (WQO) that were established for the four main river reaches (i.e., North Fork Milk River, Mainstem Milk River, Milk River Gravel Bed and Milk River Sand Bed) within the Milk River Integrated Watershed Management Plan (IWMP) (PESL 2015) and to applicable provincial surface water quality guidelines (ESRD 2014) (Table 1). The Milk River IWMP Implementation Strategy suggests that water quality data should be compared to the WQOs annually with a trend analysis completed every five years. The current 2014 data set is the second year of data collected since the WQOs were established.

Table 1. Summary of select Milk River water quality objectives for the four reaches in the watershed.

Parameter	Flow Period	Normal Range (25th to 75th Percentile)			Cautionary Range (75th to 90th Percentile)	Threshold (>90th Percentile)	Alberta Guidelines[a]
		Lower Limit	Median Target	Upper Limit			
Reach 1: North Fork							
Specific Conductivity (µS/cm)	Diversion	149	165	180	181 – 246	>246	≤1000 (Irrigation)
	Natural	418	445	485	486 – 512	>512	
pH (Value)	Diversion	8.09	8.12	8.19	<6.5 and >8.5	<6.5 and >8.5	>6.5 and <8.5
	Natural	8.38	8.39	8.40			
Total Suspended Solids (mg/L)	Diversion	9	16	28	29 – 59	>59	No Guideline
	Natural	1	5	22	23 – 55	>55	
Total Phosphorus (mg/L)	Diversion	0.010	0.014	0.021	0.022 – 0.037	>0.037	≤0.05 (Aquatic Life)
	Natural	0.007	0.012	0.025	0.026 – 0.100	>0.100	
Total Dissolved Phosphorus (mg/L)	Diversion	0.002	0.003	0.005	0.006 – 0.007	>0.007	No Guideline
	Natural	0.002	0.005	0.009	0.010 – 0.066	>0.066	
Total Nitrogen (mg/L)	Diversion	0.170	0.240	0.365	0.366 – 0.468	>0.468	≤1.0 (Aquatic Life)
	Natural	0.725	0.900	1.263	1.264 – 1.578	>1.578	
Nitrate+Nitrite Nitrogen (mg/L)	Diversion	0.023	0.057	0.100	0.100 – 0.114	>0.114	No Guideline
	Natural	0.307	0.387	0.510	0.511 – 0.729	>0.729	
Fecal Coliforms (cfu/100 mL)	Diversion	14	27	98	99 – 140	>140	≤100 (Irrigation)
	Natural	8	55	98	99 – 668	>668	
Reach 2: South Fork							
Specific Conductivity (µS/cm)	Apr-Oct	441	510	716	717 - 882	>882	≤1000 (Irrigation)
pH (Value)	Apr-Oct	8.32	8.44	8.50	<6.5 and >8.5	<6.5 and >8.5	>6.5 and <8.5
Total Suspended Solids (mg/L)	Apr-Oct	6	14	61	62 - 247	>247	No Guideline
Total Phosphorus (mg/L)	Apr-Oct	0.012	0.019	0.049	0.050 - 0.186	>0.186	≤0.05 (Aquatic Life)
Total Dissolved	Apr-Oct	0.004	0.006	0.008	0.009 - 0.015	>0.015	No Guideline

[1] **CALA** – Canadian Association for Laboratory Accreditation Inc.
[2] **APHA** – American Public Health Association

Parameter	Flow Period	Normal Range (25th to 75th Percentile)			Cautionary Range (75th to 90th Percentile)	Threshold (>90th Percentile)	Alberta Guidelines[a]
		Lower Limit	Median Target	Upper Limit			
Phosphorus (mg/L)							
Total Nitrogen (mg/L)	Apr-Oct	0.363	0.600	0.835	0.836 - 1.360	>1.360	≤1.0 (Aquatic Life)
Nitrate+Nitrite N (mg/L)	Apr-Oct	0.002	0.025	0.120	0.121 - 0.383	>0.383	No Guideline
Fecal Colifrom Bacteria (cfu/100 mLs)	Apr-Oct	15	77	223	224 - 619	>619	≤100 (Irrigation)
Reach 3: Gravel Bed (U/S Town of Milk River							
Specific Conductivity (µS/cm)	Diversion	169	210	250	251 – 398	>398	≤1000 (Irrigation)
	Natural	477	570	652	653 – 674	>674	
pH (Value)	Diversion	8.14	8.20	8.30	<6.5 and >8.5	<6.5 and >8.5	>6.5 and <8.5
	Natural	8.39	8.41	8.44			
Total Suspended Solids (mg/L)	Diversion	31	56	150	151 – 282	>282	No Guideline
	Natural	4	7	117	118 – 267	>267	
Total Phosphorus (mg/L)	Diversion	0.028	0.044	0.090	0.091 – 0.148	>0.148	≤0.05 (Aquatic Life)
	Natural	0.008	0.013	0.076	0.077 – 0.504	>0.504	
Total Dissolved Phosphorus (mg/L)	Diversion	0.002	0.003	0.006	0.007 – 0.010	>0.010	No Guideline
	Natural	0.003	0.005	0.015	0.016 – 0.173	>0.173	
Total Nitrogen (mg/L)	Diversion	0.220	0.325	0.453	0.453 – 0.667	>0.667	≤1.0 (Aquatic Life)
	Natural	0.313	0.680	1.134	1.135 – 1.637	>1.637	
Nitrate+Nitrite N (mg/L)	Diversion	0.020	0.043	0.086	0.087 – 0.141	>0.141	No Guideline
	Natural	0.036	0.096	0.324	0.325 – 0.479	>0.479	
Fecal Coliform Bacteria (cfu/100 mLs)	Diversion	31	68	133	134 – 272	>272	≤100 (Irrigation)
	Natural	10	49	207	208 – 522	>522	
Reach 4: Sand Bed							
Specific Conductivity (µS/cm)	Diversion	200	250	305	306 – 540	>540	≤1000 (Irrigation)
	Natural	684	727	770	771 – 936	>936	
pH (Value)	Diversion	8.20	8.24	8.30	<6.5 and >8.5	<6.5 and >8.5	>6.5 and <8.5
	Natural	8.41	8.46	8.50			
Total Suspended Solids (mg/L)	Diversion	64	131	234	235 – 384	>384	No Guideline
	Natural	4	13	75	76 – 228	>228	
Total Phosphorus (mg/L)	Diversion	0.059	0.088	0.135	0.136 – 0.220	>0.220	≤0.05 (Aquatic Life)
	Natural	0.008	0.013	0.030	0.031 – 0.086	>0.086	
Total Dissolved Phosphorus (mg/L)	Diversion	0.003	0.004	0.005	0.006 – 0.011	>0.011	No Guideline
	Natural	0.002	0.004	0.008	0.009 – 0.021	>0.021	
Total Nitrogen (mg/L)	Diversion	0.270	0.365	0.460	0.461 – 0.668	>0.668	≤1.0 (Aquatic Life)
	Natural	0.250	0.320	1.170	1.171 – 1.400	>1.400	
Nitrate+Nitrite N (mg/L)	Diversion	0.014	0.030	0.080	0.081 – 0.120	>0.120	No Guideline
	Natural	0.014	0.036	0.140	0.141 – 0.538	>0.538	
Fecal Coliform Bacteria (cfu/100 mLs)	Diversion	44	78	160	161 – 280	>280	≤100 (Irrigation)
	Natural	18	29	50	51 – 163	>163	

[a] Environmental Guidelines for Alberta Surface Waters (ESRD 2014).

3.0 RESULTS

3.1 PRECIPITATION

The 2014 water monitoring year was about the third wettest year recorded in recent history (2003 to 2014) with higher rainfall observed at most weather stations across the watershed (Figure 2). In 2014, 482 mm of precipitation was recorded at Cardston and 495 mm at Del Bonita in the western part of the watershed, compared to 429 mm at Masinasin and 332 mm at the Onefour weather station in the eastern part of the watershed.

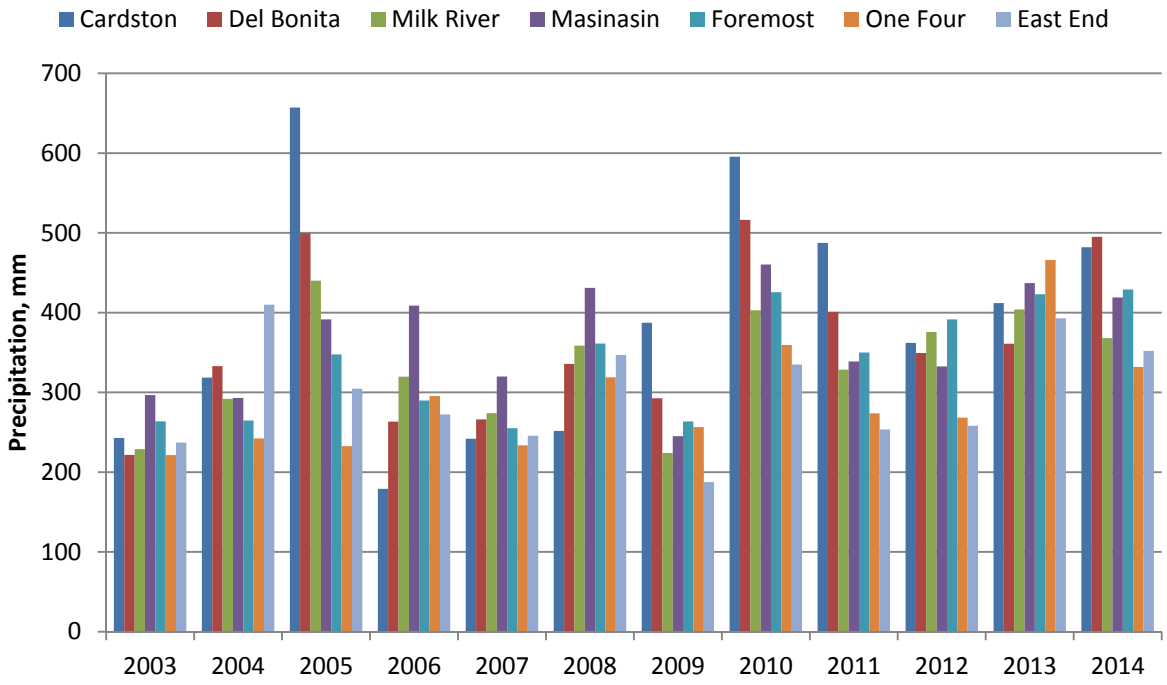

Figure 2. Summary of precipitation data at seven weather stations in the Milk River watershed for the period 2003 to 2014 (AgroClimatic Information Service 2014).

More rain fell in June and in August at the upper end of the watershed, in the Cardston-Del Bonita area, compared to the middle and lower areas (Figure 3). Maximum rainfall was recorded on June 17th at Cardston (70.8 mm) and Del Bonita (69.6 mm). July was a relatively dry month across the watershed. In August, maximum rainfall was recorded on August 4th at Cardston (42.6 mm) and on August 2nd at Masinasin (28.0 mm). A wet period occurred in late August and early-September, with the eastern end of the watershed receiving the most rainfall, from Masinasin to Onefour. On August 22nd, 34 mm of rainfall was recorded at Onefour and this same area received a substantial amount of rainfall in September. The Town of Foremost received 31.6 mm of rain on September 3rd (Figure 3).

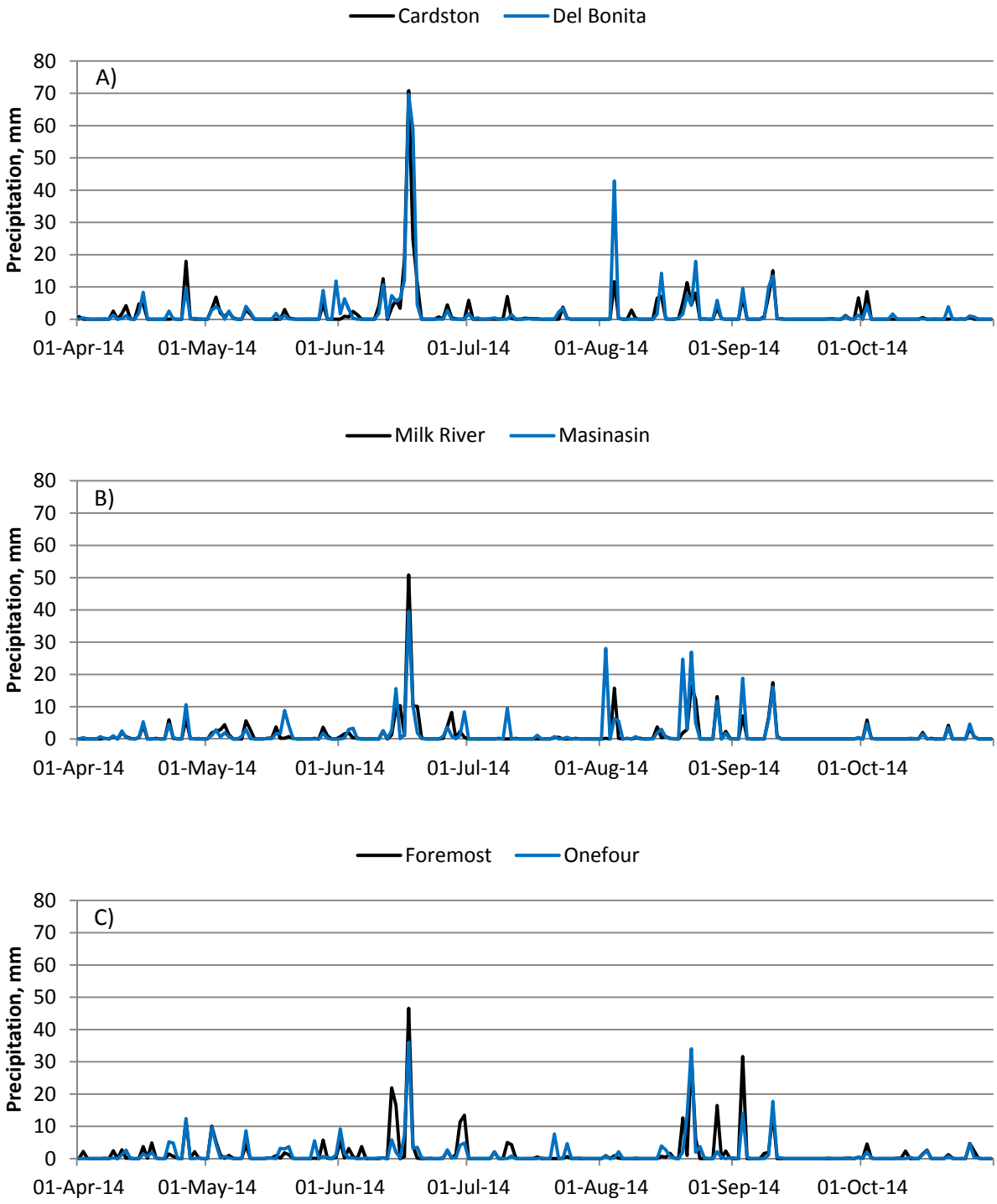

Figure 3. Precipitation during the 2014 monitoring period at A) the upper end of the Milk River watershed, B) the middle of the watershed and, C) the lower end of the watershed (AgroClimatic Information Service (ACIS) 2014).

3.2 RED CREEK

3.2.1 General Water Chemistry

General water chemistry parameters for Red Creek are presented in Table 2. In 2014, median water temperature was highest at the Middle site (16.2°C) compared to the Upstream (14.1°C) and Downstream (14.2°C) sites. The lowest water temperature was recorded at the Upstream site (2.9°C) on October 28th and the highest water temperature was recorded at the Middle site (23.6°C) on August 13th (Table 2).

Dissolved oxygen concentrations ranged from a low of 2.61 mg/L at the Upstream site to at high of 12.84 mg/L at the Downstream site in 2014 (Table 2). Median dissolved oxygen concentration was lowest at the Upstream site (5.95 mg/L) and highest at the Downstream site (9.38 mg/L). The acute daily minimum dissolved oxygen concentration for the protection of aquatic life is 5.0 mg/L and the chronic, 7-day average concentration is 6.5 mg/L (ESRD 2014).

Generally, dissolved oxygen concentrations were lower (poorer) in 2014 compared to 2013. At the Upstream site, 3 of 10 samples did not meet the acute daily minimum guideline and 6 of 10 samples did not meet the chronic guideline. Three of 9 samples did not meet the acute daily minimum concentration and 3 of 9 samples did not meet the chronic guideline (6.5 mg/L) at the Middle site. At the Downstream site, all samples met the acute guideline and 1 of 9 samples did not meet the chronic guideline (Table 3).

Table 2. Summary of general water quality parameters at Red Creek, 2013 and 2014.

Site	N	Water Temperature °C		Dissolved Oxygen mg/L		pH		Specific Conductivity µS/cm	
		Median	Range	Median	Range	Median	Range	Median	Range
2013									
Upstream	9	15.1	4.7-20.7	8.97	4.61-10.37	8.24	7.94-8.32	2550	2500-2700
Middle	10	16.3	6.6-22.2	7.61	4.14-11.60	8.29	8.01-8.79	2665	2220-2860
Downstream	10	15.7	6.5-22.9	9.33	7.84-10.91	8.29	8.04-8.40	2500	2230-2960
2014									
Upstream	10	14.1	2.9-20.7	5.95	2.61-10.7	8.22	8.11-8.42	2415	1880-2760
Middle	9	16.2	4.9-23.6	7.66	4.41-8.91	8.33	8.26-8.64	2590	2110-2880
Downstream	9	14.2	3.8-23.1	9.38	5.48-12.84	8.34	8.24-8.58	2620	2250-2830

Table 3. Summary of Red Creek water quality compliance with dissolved oxygen acute and chronic guidelines (ESRD 2014).

Year	Compliance: Dissolved Oxygen					
	Upstream		Middle		Downstream	
	Acute <5.0 mg/L	Chronic <6.5 mg/L	Acute <5.0 mg/L	Chronic <6.5 mg/L	Acute <5.0 mg/L	Chronic <6.5 mg/L
2013	89	67	90	70	100	100
2014	70	40	67	67	100	89

The pH guideline for the protection of aquatic life is >6.5 and <9.0 (ESRD 2014). All samples met the pH guideline in 2014.

Median specific conductivity ranged from 2415 µS/cm at the Upstream site to 2620 µS/cm at the Downstream site. All samples collected in 2014 were well above the irrigation guideline for general crops (>1000 µS/cm).

3.2.2 Nutrients

Phosphorus

Total phosphorus concentrations ranged from 0.015 mg/L at the Upstream site on October 28th to 0.457 mg/L at the Upstream site on June 26th (Table 4). Median total phosphorus concentration in 2014 was 0.073 mg/L at the Upstream site, 0.151 mg/L at the Middle site and 0.032 mg/L at the Downstream site (Table 4). Total phosphorus concentrations were generally higher in 2014 compared to 2013 (Figure 4).

The historic total phosphorus guideline for the protection of aquatic life is 0.05 mg/L (AENV 1999). Nine out of 10 samples collected at the Upstream site exceeded the historic total phosphorus guideline. Eight of 9 samples collected at the Middle site exceeded the total phosphorus guideline and 3 of 9 samples exceeded the guideline at the Downstream site.

Table 4. Summary of total and dissolved phosphorus concentrations at Red Creek, 2013 and 2014.

Site	N	Total Phosphorus, mg/L		Total Dissolved Phosphorus, mg/L	
		Median	Range	Median	Range
2013					
Upstream	9	0.022	0.015-0.035	0.007	0.003-0.014
Middle	10	0.081	0.038-0.163	0.030	0.010-0.047
Downstream	10	0.024	0.006-0.081	0.006	0.003-0.011
2014					
Upstream	10	0.073	0.015-0.457	0.030	0.006-0.426
Middle	9	0.151	0.031-0.178	0.048	0.019-0.139
Downstream	9	0.032	0.016-0.098	0.009	0.005-0.048

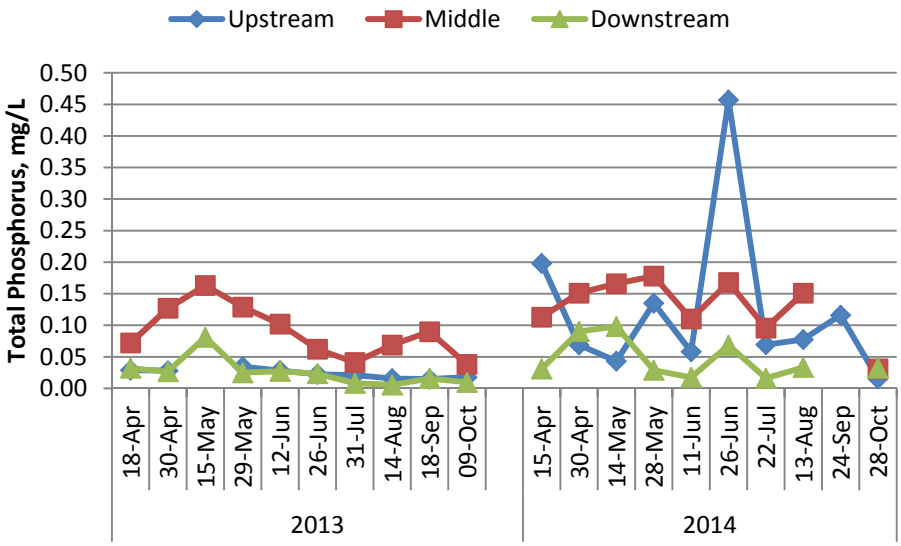

Figure 4. Total phosphorus concentrations at Red Creek, 2013 and 2014.

Total dissolved phosphorus ranged from 0.005 mg/L at the Downstream site (on May 28th and June 11th) to 0.426 mg/L at the Upstream site on June 26th (Table 4). The median total dissolved phosphorus concentration was lowest at the Downstream site (0.009 mg/L) compared to the highest median concentration at the Middle site (0.048 mg/L).

The percent total dissolved phosphorus contributing to total phosphorus tended to decrease in the downstream direction with 48% of the total phosphorus in the dissolved form at the Upstream site, 47% at the Middle site and 29% at the Downstream site. This was similar to 2013 at the Middle site (42% of TP present as dissolved) and the Downstream site (26% of TP as TDP).

The higher percentage of total dissolved phosphorus at the Upstream and Middle sites corresponds with lower dissolved oxygen concentrations observed at these two sites, particularly in 2014. Phosphate generally precipitates from surface water with iron or aluminum oxides and hydroxides when oxygen is present. Low dissolved oxygen concentrations in wetland sediments promote the release of phosphorus into solution (Mitsch and Gosselink 1993).

Nitrogen

Total nitrogen concentrations ranged from 0.487 mg/L on October 28th at the Middle site to 2.230 mg/L at the Upstream site, also on October 28th (Table 5). The median TN concentration was lowest at the Downstream site (1.230 mg/L) and highest at the Upstream site (1.638 mg/L). The majority of total nitrogen was composed of total kjeldahl nitrogen at the Middle and Downstream sites, while nitrate+nitrite nitrogen made up a larger proportion of the total nitrogen at the Upstream site (Table 5).

This decreasing trend in TN in the downstream direction is opposite to that in 2013 where TN increased in the downstream direction (Figure 5a). The higher nitrogen concentrations in 2014 can be attributed to the higher proportion of nitrate+nitrite nitrogen at the Upstream site in the early and late part of the season (Figure 5c).

Increases in groundwater contribution to flows at Red Creek in 2014 may have contributed to the higher nitrate+nitrite nitrogen concentrations at the Upstream site. The Upstream site is also characterized by a wetland environment where oxidation-reduction (redox) processes occur in the sediment. Organic N generally mineralizes to ammonium for use by plants and microorganism. Bacteria then oxidize ammonia to nitrate (Mitsch and Gosselink 1993).

Table 5. Summary of nitrogen concentrations at Red Creek, 2013 and 2014.

Site	N	Nitrate+Nitrite Nitrogen mg/L		Total Kjeldahl Nitrogen mg/L		Total Nitrogen mg/L	
		Median	Range	Median	Range	Median	Range
2013							
Upstream	9	0.036	0.036-1.410	0.760	0.690-1.080	1.066	0.746-2.100
Middle	10	0.036	0.036-0.036	1.215	0.880-1.420	1.251	0.916-1.456
Downstream	10	0.644	0.258-1.520	0.655	0.380-2.480	1.244	0.898-3.780
2014							
Upstream	10	0.316	0.027-1.660	0.985	0.570-1.710	1.638	0.787-2.230
Middle	9	0.036	0.027-0.135	1.31	0.460-1.560	1.367	0.487-1.695
Downstream	9	0.135	0.027-0.839	0.79	0.530-1.590	1.230	0.717-1.725

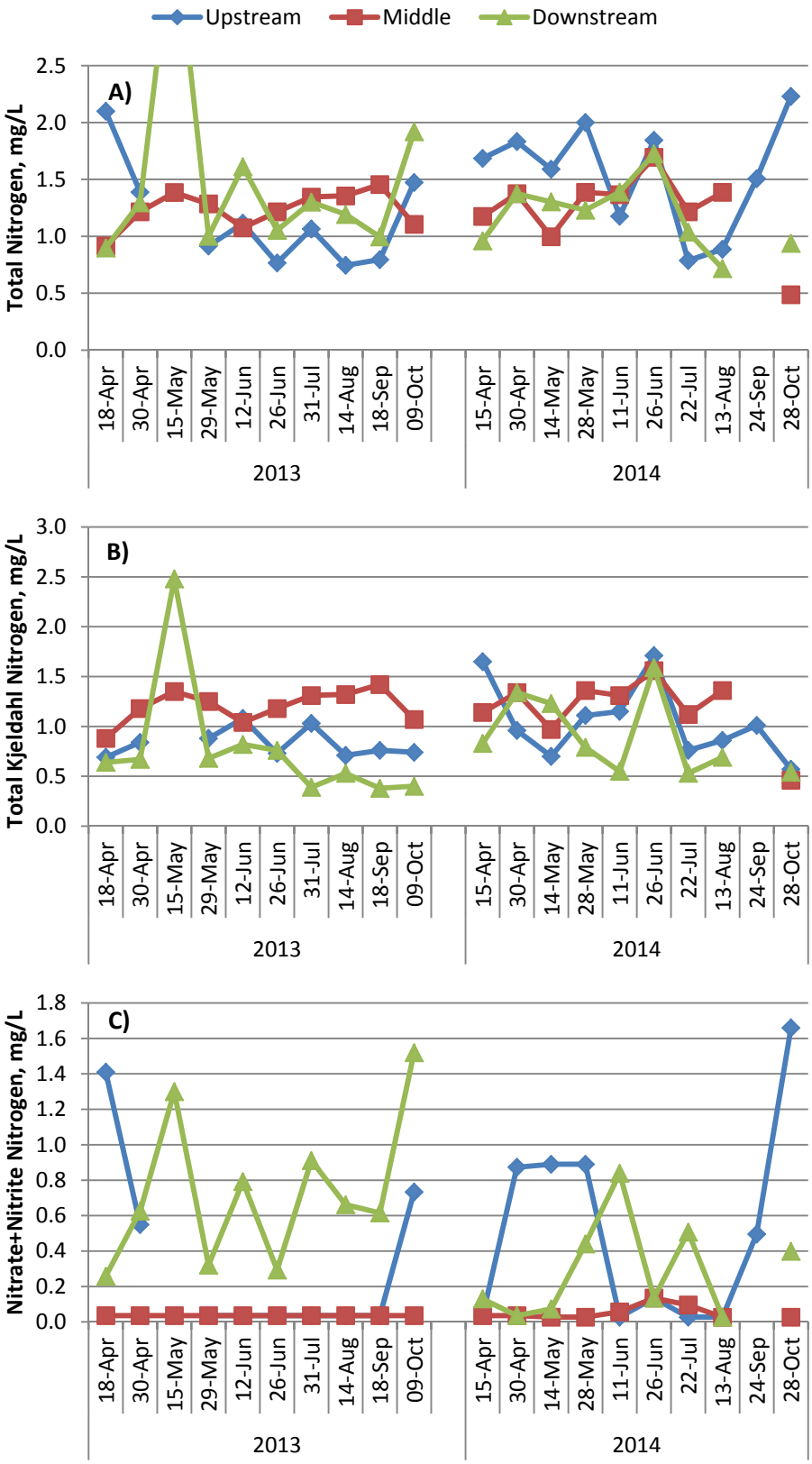

Figure 5. Nitrogen concentrations at Red Creek, 2013 and 2014. A) Total Nitrogen, B) Total Kjeldahl Nitrogen and C) Nitrate+Nitrite Nitrogen.

3.2.3 Total Suspended Solids

Total suspended solids concentrations ranged from 2 mg/L at the Upstream site on May 14th and September 24th to 40 mg/L at the Middle site on April 15th (Table 6; Figure 6). The median total suspended solids concentration was lowest at the Upstream site (6 mg/L) and highest at the Middle site (16 mg/L) (Table 6).

In 2013, TSS tended to increase in the downstream direction. This trend was not observed in 2014, when higher total suspended solids concentrations were observed at the Middle site.

Table 6. Summary of total suspended solids concentrations at Red Creek, 2013 and 2014.

Site	N	Total Suspended Solids mg/L	
		Median	Range
2013			
Upstream	9	2	2-13
Middle	10	5	2-21
Downstream	10	6	2-32
2014			
Upstream	10	6	2-26
Middle	9	16	4-40
Downstream	9	9	3-25

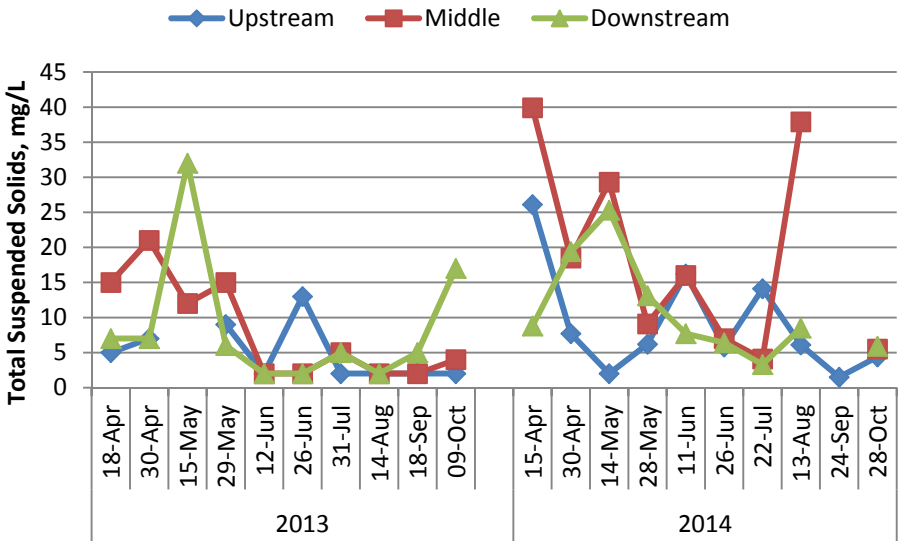

Figure 6. Total suspended solids concentrations at Red Creek, 2013 and 2014.

3.2.4 Fecal Coliform Bacteria

In 2014, fecal coliform bacteria counts ranged from 1 cfu/100 mL at all sites to 49000 cfu/100 mL at the Middle site on August 13th (Table 7; Figure 7). The median fecal coliform bacteria count was lowest at the Upstream site (46 cfu/100 mL) and was highest at the Middle site (400 cfu/100 mL).

Median fecal coliform bacteria counts were substantially higher in 2014 at the Middle and Downstream sites and somewhat higher at the Upstream site compared to 2013 counts (Table 7).

Table 7. Summary of fecal coliform bacteria counts at Red Creek, 2013 and 2014.

Site	N	Fecal Coliform Bacteria cfu/100 mL	
		Median	Range
2013			
Upstream	9	18	1-400
Middle	10	14	1-74
Downstream	10	44	1-17800
2014			
Upstream	10	46	1-900
Middle	9	400	1-49000
Downstream	9	300	1-4600

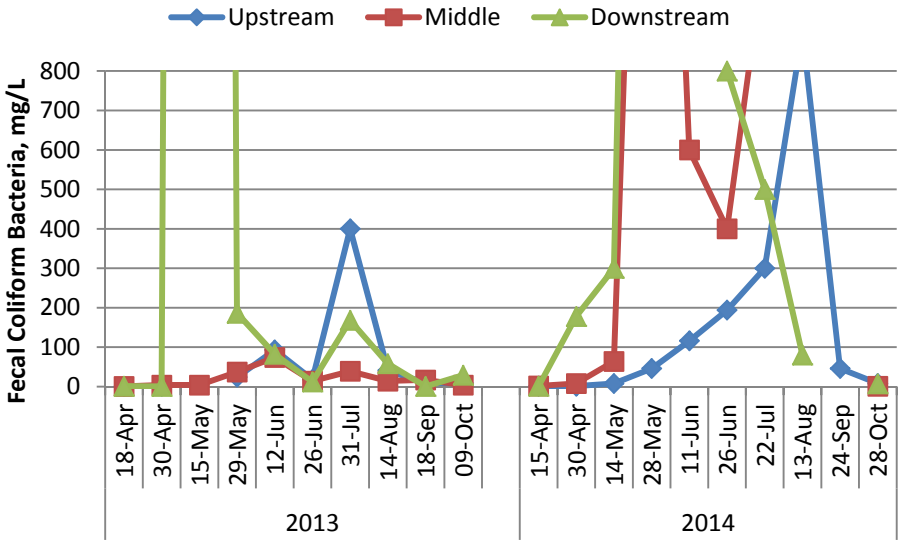

Figure 7. Fecal coliform bacteria counts at Red Creek, 2013 and 2014.

3.3 EASTERN TRIBUTARIES

3.3.1 General Water Chemistry

General water chemistry parameters are presented in Table 8. In 2014, median water temperature was warmest at Middle Creek (13.6°C) and Lodge Creek (13.2°C) compared to Battle Creek (10.6°C). The coolest water temperature was recorded at Middle Creek (-4.0°C) on April 16 and the warmest water temperature was recorded at Lodge Creek (20.8°C) on July 22.

Dissolved oxygen concentrations ranged from a low of 0.42 mg/L at Middle Creek to at high of 9.59 mg/L at Battle Creek (Table 8). Median dissolved oxygen concentration was lowest at Middle Creek (7.00 mg/L) and highest at Lodge Creek (8.38 mg/L). The acute daily minimum dissolved oxygen concentration for the protection of aquatic life is ≥5.0 mg/L and the chronic, 7-day average concentration is ≥6.5 mg/L (ESRD 2014). At Battle Creek, all samples met the acute daily minimum guideline and 1 of 10 samples did not meet the chronic guideline. At Middle Creek, 2 of 10 samples did not meet the acute daily minimum guideline (June 25 and August 13 samples) and 2 of 10 samples did not meet the chronic guideline. All samples met the acute and chronic guideline at Lodge Creek in 2014.

The pH guidelines for the protection of aquatic life is ≥6.5 and ≤9.0 (ESRD 2014). The pH was within guidelines for the protection of aquatic life at all sites in 2014.

In 2014, specific conductivity ranged from 338 to 410 µS/cm at Battle Creek, from 380 to 947 µS/cm at Middle Creek and from 780 to 1630 µS/cm at Lodge Creek (Table 8). Median conductivity was lowest at Battle Creek (369 µS/cm) and highest at Lodge Creek (1240 µS/cm).

The irrigation guideline is ≤700 µS/cm for sensitive crops such as strawberries and ≤1000 µS/cm for non-sensitive crops like cereals and forages (ESRD 2014). At Battle Creek, no samples exceeded irrigation guidelines, while at Middle Creek 3 of 10 samples exceeded the irrigation guideline for sensitive crops and all samples met the guideline for non-sensitive crops. At Lodge Creek, 9 of 10 samples exceeded the guideline for sensitive crops, and 6 of 10 samples exceeded the guideline for non-sensitive crops.

Table 8. Summary of general water quality parameters at the Eastern Tributaries, 2013 and 2014.

Creek	N	Water Temperature °C		Dissolved Oxygen mg/L		pH		Specific Conductivity µS/cm	
		Median	Range	Median	Range	Median	Range	Median	Range
2013									
Battle	10	10.6	0.7-17.4	7.67	6.34-9.93	8.25	8.19-8.38	380	313-397
Middle	10	15.0	5.2-21.0	6.99	2.59-9.27	8.20	7.97-8.29	681	516-740
Lodge	10	15.8	5.2-22.1	8.52	4.88-9.56	8.27	7.54-8.49	1006	468-1480
2014									
Battle	10	8.85	0.8-16.9	8.26	6.48-9.30	8.35	8.21-8.61	369	338-410
Middle	10	13.55	-4.0-19.8	7.00	0.42-9.25	8.28	8.22-8.57	687	380-947
Lodge	9	13.20	3.6-20.8	8.38	6.67-9.59	8.33	8.20-8.54	1240	780-1630

3.3.2 Nutrients

Phosphorus

In 2014, total phosphorus concentrations ranged from 0.012 to 0.041 mg/L at Battle Creek, from 0.055 to 0.293 mg/L at Middle Creek and from 0.013 to 0.106 mg/L at Lodge Creek (Table 9). Median total phosphorus concentration was highest at Middle Creek (0.116 mg/L) and lowest at Battle Creek (0.017 mg/L). The historic total phosphorus guideline for the protection of aquatic life is 0.05 mg/L (ESRD 2014). At Battle Creek, no samples exceeded the guideline for the protection of aquatic life, while all samples at Middle Creek and 6 of 10 samples at Lodge Creek exceeded the guideline (Figure 8).

Middle Creek had substantially higher median and maximum TP and TDP concentrations in 2014 compared to 2013. In comparison, TP and TDP were similar in 2013 and 2014 at Battle Creek and Lodge Creek, except at Lodge Creek where the maximum concentration was substantially lower in 2014 (0.106 mg/L) compared to 2013 (0.601 mg/L).

Table 9. Total and total dissolved phosphorus concentrations at the Eastern Tributaries, 2013 and 2014.

Creek	N	Total Phosphorus (mg/L)		Total Dissolved Phosphorus (mg/L)	
		Median	Range	Median	Range
2013					
Battle	10	0.022	0.009-0.045	0.008	0.003-0.015
Middle	10	0.075	0.030-0.163	0.055	0.017-0.133
Lodge	10	0.047	0.020-0.601	0.033	0.003-0.080
2014					
Battle	10	0.017	0.012-0.041	0.009	0.006-0.012
Middle	10	0.116	0.055-0.293	0.079	0.021-0.272
Lodge	9	0.060	0.013-0.106	0.025	0.003-0.068

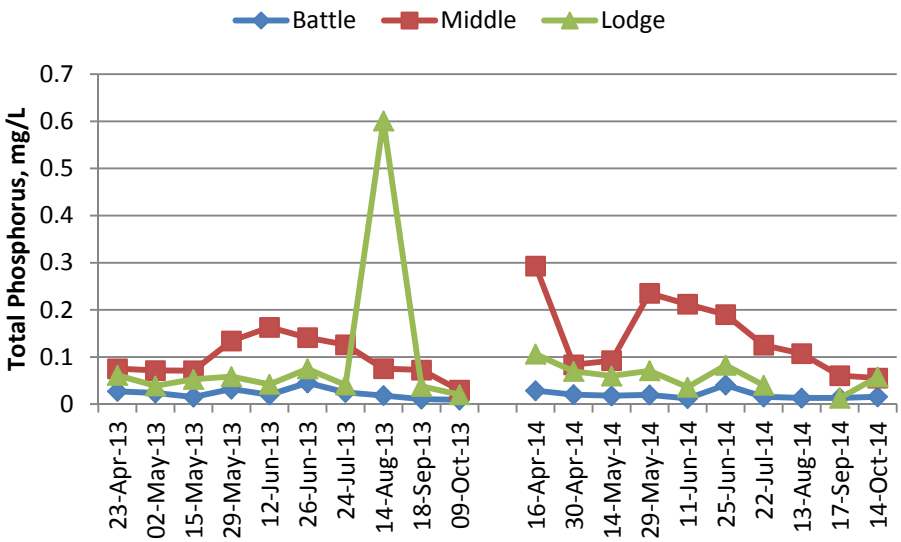

Figure 8. Total phosphorus concentrations at the Eastern Tributaries, 2013 and 2014.

Nitrogen

In 2014, total nitrogen concentrations ranged from 0.127 mg/L at Battle Creek on multiple dates in 2014 to 1.165 mg/L at Middle Creek on April 16 (Table 10). The median TN concentration was lowest at Battle Creek (0.127 mg/L) and highest at Middle Creek (0.722 mg/L). The majority of total nitrogen was composed of total kjeldahl nitrogen at all of the Eastern Tributaries, while nitrate+nitrite nitrogen made up only 0.036 mg/L of the total nitrogen concentration, or less than the detection limit of the analytical equipment (Table 10).

Table 10. Summary of nitrogen concentrations at the Eastern Tributaries, 2013 and 2014.

Creek	N	Nitrate+Nitrite Nitrogen mg/L		Total Kjeldahl Nitrogen mg/L		Total Nitrogen mg/L	
		Median	Range	Median	Range	Median	Range
2013							
Battle	10	0.036	0.036-0.036	0.100	0.100-0.100	0.136	0.136-0.136
Middle	10	0.036	0.036-0.036	0.555	0.440-0.750	0.591	0.476-0.789
Lodge	10	0.036	0.036-0.036	0.500	0.440-1.840	0.536	0.476-1.876
2014							
Battle	10	0.027	0.027-0.077	0.100	0.100-0.230	0.127	0.127-0.266
Middle	10	0.027	0.027-0.175	0.695	0.310-0.990	0.722	0.337-1.165
Lodge	9	0.027	0.027-0.175	0.650	0.370-1.020	0.677	0.397-1.047

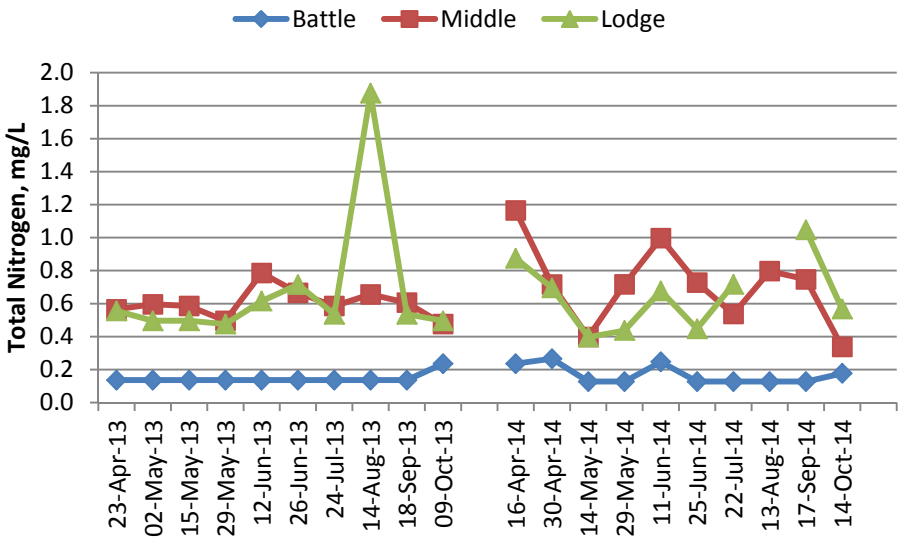

Figure 9. Total nitrogen concentrations at the Eastern Tributaries, 2013 and 2014.

3.3.3 Total Suspended Solids

In 2014, total suspended solids concentrations ranged from 2 mg/L at all sites on multiple sample dates to 19 mg/L at Battle Creek on June 25 (Table 11; Figure 10). The median total suspended solids concentration was lowest at Middle Creek (4 mg/L) and highest at Lodge Creek (8 mg/L). Compared to 2013, median and maximum total suspended solids concentrations were higher in 2014 with the exception of Lodge Creek where the maximum concentration was about half that observed in 2013.

Table 11. Summary of total suspended solids concentrations at the Eastern Tributaries, 2013 and 2014.

Creek	N	Total Suspended Solids mg/L	
		Median	Range
2013			
Battle	10	5	2-13
Middle	10	2	2-2
Lodge	10	3	2-30
2014			
Battle	10	6	2-19
Middle	10	4	2-17
Lodge	9	8	2-16

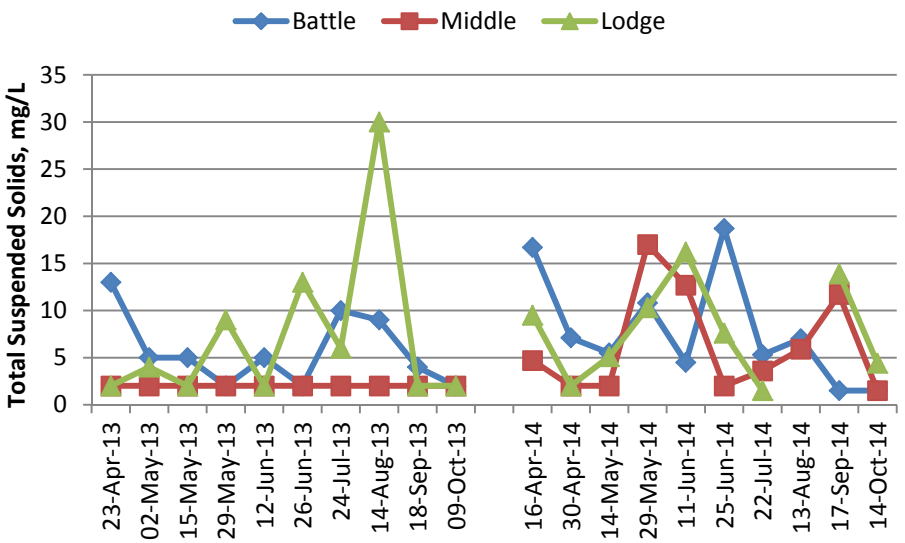

Figure 10. Total suspended solids concentrations at the Eastern Tributaries, 2013 and 2014.

3.3.4 Fecal Coliform Bacteria

In 2014, fecal coliform bacteria counts ranged from 1 cfu/100 mL at all sites to 500 cfu/100 mL at Battle Creek on July 22 (Table 12; Figure 10). The median fecal coliform bacteria count was lowest at Lodge Creek (9 cfu/100 mL) and Battle Creek (10 cfu/100 mL) and highest at Middle Creek (36 cfu/100 mL). Compared to 2013, the median fecal coliform bacteria count was somewhat greater at Middle Creek in 2014, while the counts at Battle and Lodge creeks were somewhat lower.

Table 12. Summary of fecal coliform bacteria counts at the Eastern Tributaries, 2013 and 2014.

Creek	N	Fecal Coliform Bacteria cfu/100 mL	
		Median	Range
2013			
Battle	10	22	0.5-191
Middle	10	21	0.5-264
Lodge	10	21	0.5-200
2014			
Battle	10	10	1-500
Middle	10	36	1-214
Lodge	9	9	1-300

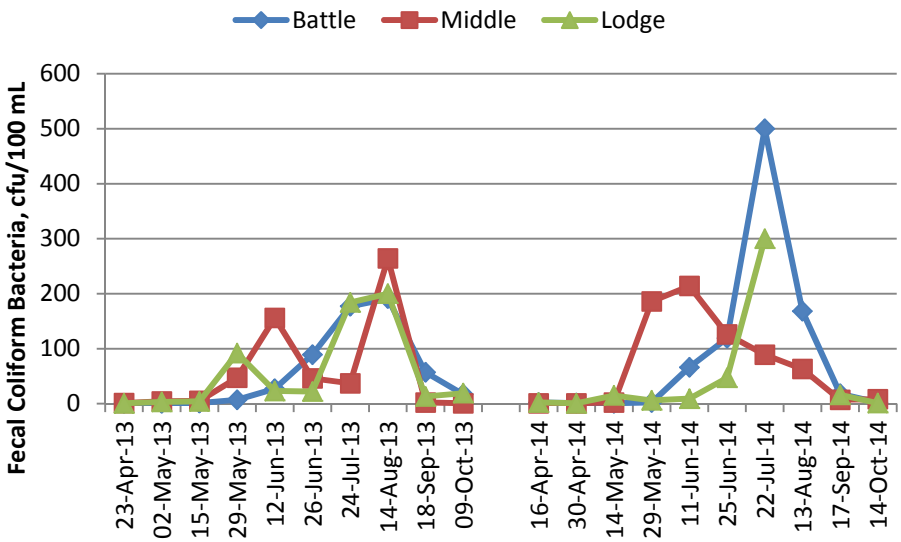

Figure 11. Fecal coliform bacteria counts at the Eastern Tributaries, 2013 and 2014.

3.4 NORTH FORK AND MAINSTEM MILK RIVER

3.4.1 St. Mary/Milk River Diversion Operation

The St. Mary/Milk River Diversion was turned on May 13, 2014 and increased to about 11.3 m^3/s (400 cfs) by May 20, 2014. The start date was later in 2014 compared to the previous eight years, except in 2011, when flows were initiated in July due to flooding. The ramping down of flows began on September 3, 2014 with daily reductions of about 2.1 m^3/s (75 cfs). The diversion was completely shut down by September 10, 2014. Table 13 shows the start-up and shut-down dates of the St. Mary/Milk River Diversion since 2006.

Table 13. St. Mary/Milk River Diversion start-up and shut-down dates for the 2006 through 2013 monitoring period (USBR 2012).

Year	Start Date	End Date
2006	March 05	September 24
2007	March 07	September 03
2008	March 17	September 12
2009	March 16	September 24
2010	March 21	September 03
2011	July 24	October 06
2012[a]	April 9	September 15
2013[b]	March 11	September 24
2014[c]	May 13	September 10

[a]Start-up was April 9th and flows were ramped up until April 14th; shut-down started on September 11th and was ramped down to zero on September 15th.
[b]Note that the start date was March 11 with 1.4 m^3/s (50 cfs) of water, but flows were not substantial until about March 25 when flows reached about 11.3 m^3/s (400 cfs).
[c]Note that flow ramping began on May 13 increasing to 11.3 m^3/s (400 cfs) by May 20. Flow ramping began again on September 3 with daily reductions of about 2.1 m^3/s (75 cfs) with complete shut-down by September 10.

3.4.2 Streamflow

Streamflows at the Milk River at Western Crossing station were higher in June 2014 compared to the same month in the previous two years. At the Milk River at Western Crossing Station, maximum streamflow was recorded on June 19 (83.9 m^3/s) (Figure 12).

Streamflows were higher in June 2014 compared to the same month in the previous two years. Maximum streamflow reached 123 m^3/s at the Milk River at Milk River Station on June 19 and 120 m^3/s was recorded at the Milk River at Eastern Crossing station on June 21 (Figure 12).

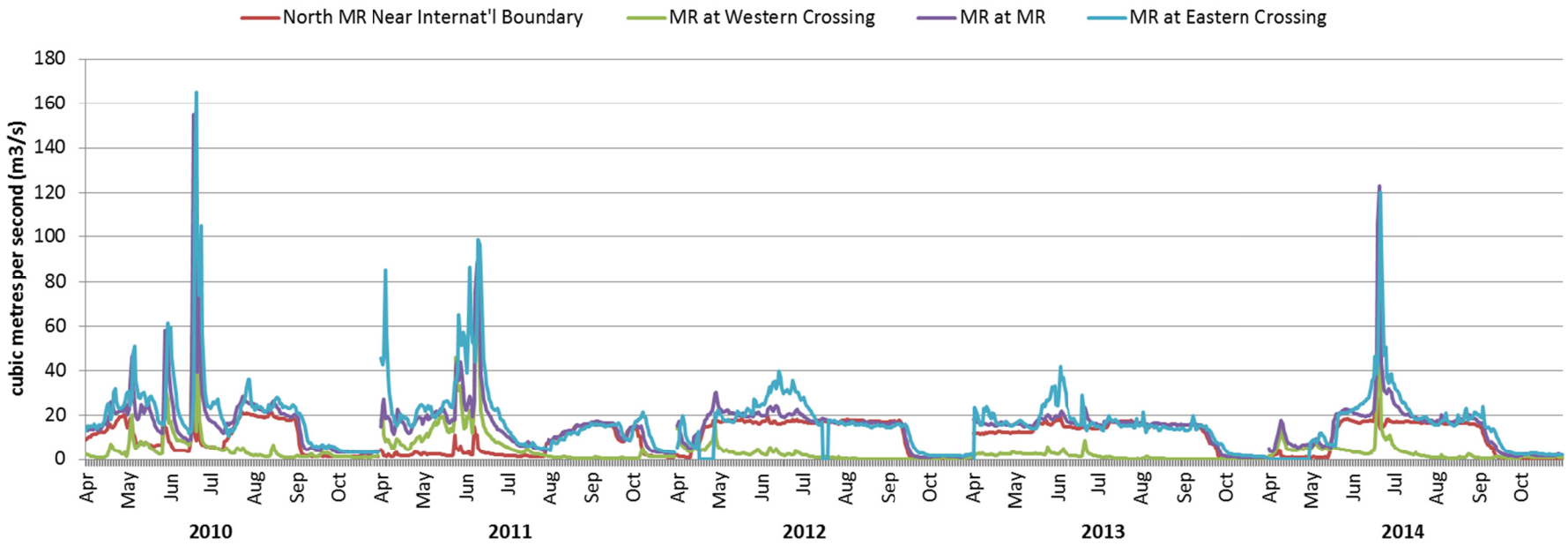

Figure 12. Streamflow at multiple gauging stations on the Milk River, 2010-2014.

3.4.3 General Water Chemistry

Note that while 2013 water chemistry results are presented in the data tables for comparison, they are generally not discussed in the result summaries.

General water chemistry parameters are presented in Table 14. In 2014, median water temperature ranged from 12.1°C at the N. Milk River at 501 site to 17.0°C at the Milk River at HWY 880 site. The lowest water temperature was recorded at the Pinhorn site (0.1°C) on October 28 and the highest water temperature was recorded at the Milk River u/s Milk River site (21.5°C) on August 13.

Dissolved oxygen concentrations ranged from a low of 6.23 mg/L at the Pinhorn site to a high of 10.84 mg/L also at the Pinhorn site (Table 14). Median dissolved oxygen concentration was lowest at the Milk River at 501 site (7.14 mg/L) and highest at the N. Milk River at 501 site (7.70 mg/L). The acute daily minimum dissolved oxygen concentration for the protection of aquatic life is 5.0 mg/L and the chronic, 7-day average concentration is 6.5 mg/L (AENV 1999). At the Milk River, all samples at all sites met the acute daily minimum guideline and only 2 of 10 samples at the Pinhorn site and 1 of 10 samples at the HWY 880 site did not meet the chronic guideline. The non-compliant observations were measured on June 26 at both sites, and again on August 13 at the Pinhorn site.

The pH guidelines for the protection of aquatic life is $\geq$6.5 and $\leq$9.0 (ESRD 2013). The pH was within guidelines for the protection of aquatic life at all sites in 2014.

Conductivity was lowest at the N. Milk River at 501 site (139 µS/cm) on August 13 and highest at the Pinhorn site (785 µS/cm) on October 28. Median specific conductivity ranged from a low of 149 µS/cm at the N. Milk River at 501 site to a high of 696 µS/cm at the Milk River at the Pinhorn site (Table 15). The irrigation guideline is $\leq$700 µS/cm for sensitive crops such as strawberries and $\leq$1000 µS/cm for non-sensitive crops like cereals and forages (AENV 1999). At the Milk River, all samples met the irrigation guidelines for non-sensitive crops. One of 7 samples exceeded the guideline for sensitive crops at the Hwy 880 site on October 28 and, 1 of 9 samples exceeded the guideline for sensitive crops at the Pinhorn site.

All sites met the WQO-50 and WQO-90 objectives in 2014 (Table 15).

Table 14. Summary of general water quality parameters at the Milk River, 2013 and 2014.

Site	N	Water Temperature °C				Dissolved Oxygen mg/L				pH			
		2013		2014		2013		2014		2013		2014	
		Median	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range
Milk River at Western Crossing	7	17.9	6.8-22.4			9.78	9.08-11.40			8.80	8.60-9.00		
N. Fork at 501	10	12.1	3.2-18.5	12.1	4.3-18.2	7.57	6.79-9.58	7.70	7.03-9.29	8.21	7.84-8.37	8.43	8.17-8.51
Milk River at 501	10	12.9	4.8-18.8	14.4	5.2-19.0	7.37	6.94-9.47	7.14	6.72-8.56	8.44	8.36-8.65	8.49	8.32-8.57
U/S Milk River	10	14.5	6.4-20.5	14.4	2.0-21.5	7.37	6.84-9.36	7.69	6.51-9.87	8.38	8.21-8.58	8.40	8.28-8.60
AT HWY 880	7	17.2	5.2-21.9	17.0	0.8-20.5	8.70	7.87-12.50	7.44	6.37-10.82	8.22	8.02-8.32	8.36	8.28-8.61
Pinhorn	10	15.4	4.3-21.2	15.6	0.1-20.7	7.18	6.36-9.76	7.49	6.23-10.84	8.34	8.19-8.49	8.36	8.30-8.63
Milk River at Eastern Crossing	7[a]	20.1	9.3-23.4			8.73	8.05-10.95			8.20	8.20-8.60		

[a]Note that N=5 for pH.

Table 15. Summary of specific conductivity at the Milk River, 2013 and 2014.

Site	Flow Period	Water Quality Objective		2013				2014			
		WQO-50	WQO-90	N	50th	90th	Range	N	50th	90th	Range
N. Fork at 501	Diversion	165	246	9	152	163	132-164	4	149	165	139-172
	Natural	445	512	1	399	-	-	5	454	473	427-474
MR @ Western Crossing	April-Oct	510	882	7	509	585	420-614				
MR at 501	April-Oct			10	473	592	434-799	10	489	579	354-588
U/S Milk River	Diversion	210	398	9	218	247	161-265	5	208	317	170-383
	Natural	570	674	1	522	-	-	5	492	580	458-606
AT HWY 880	Diversion	250	540	6	***308***	321	206-322	5	245	382	210-460
	Natural	727	936	1	782	-	-	5	654	735	477-759
Pinhorn	Diversion	250	540	9	***311***	326	200-348	5	261	404	223-481
	Natural	727	936	1	691	-	-	5	696	759	482-785
MR @ Eastern Crossing	Diversion	250	540	4	266	348	201-366				
	Natural	727	936	1	723	-	-				

3.4.4 Nutrients

Phosphorus

Similar to previous years, total phosphorus in the Milk River tended to increase in the downstream direction. During the diversion period, total phosphorus concentrations ranged from 0.008 to 0.033 mg/L at the North Fork at 501 site, 0.039 to 0.255 mg/L at the U/S Milk River site and from 0.133 to 0.446 mg/L at the Pinhorn site (Table 16). During the natural flow period, total phosphorus ranged from 0.003 to 0.027 mg/L at the North Fork at 501 site, from 0.009 to 0.202 mg/L at the U/S Milk River site and from 0.009 to 0.271 mg/L at the Pinhorn site.

Median total phosphorus concentrations were consistent with the historical WQO-50 concentrations during the diversion period at the upstream sites (North Fork at 501, Milk River at 501 and at Hwy 880 sites). The WQO-50 was exceeded by more than 20% at the Pinhorn site during the same period. During the natural flow period, the WQO-50 was exceeded at the downstream sites (U/S Milk River, at HWY 880 and Pinhorn sites).

The WQO-90 was exceeded by more than 20% during the diversion period at all downstream sites (from U/S Milk River to the Pinhorn) (Table 16). During the natural flow period, only the HWY 880 and Pinhorn sites exceeded the WQO-90 by more than 20%. At the Pinhorn site, total phosphorus concentrations were nearly double the WQO-90 during the diversion period and two and a half times greater during the natural flow period.

Table 16. Summary of total phosphorus concentrations at the Milk River, 2013 and 2014.

Site	Flow Period	Water Quality Objectives		2013				2014			
		WQO-50	WQO-90	N	50th	90th	Range	N	50th	90th	Range
N. Fork at 501	Diversion	0.014	0.037	9	0.010	0.029	0.003-0.059	5	0.013	0.029	0.008-0.033
	Natural	0.012	0.100	1	0.003	-	-	5	0.013	0.022	0.003-0.027
Milk River @ Western Crossing	April-Oct	0.019	0.186	6	***0.040***	0.043	0.023-0.044				
Milk River at 501	April-Oct			10	0.021	0.044	0.012-0.047	10	0.021	0.089	0.008-0.098
U/S Milk River	Diversion	0.044	0.148	9	0.035	0.061	0.012-0.083	5	***0.050***	***0.232***	0.039-0.255
	Natural	0.013	0.504	1	0.007	-	-	5	***0.029***	0.134	0.009-0.202
AT HWY 880	Diversion	0.088	0.220	6	***0.099***	***0.260***	0.033-0.410	5	0.089	***0.311***	0.076-0.325
	Natural	0.013	0.086	1	0.005	-	-	4	***0.029***	***0.202***	0.007-0.270
Pinhorn	Diversion	0.088	0.220	9	***0.120***	***0.246***	0.061-0.352	5	***0.190***	***0.436***	0.133-0.446
	Natural	0.013	0.086	1	0.006	-	-	4	***0.048***	***0.210***	0.009-0.271
Milk River @ Eastern Crossing	Diversion	0.088	0.220	5	***0.112***	***0.237***	0.050-0.272				
	Natural	0.013	0.086	1	0.014	-	-				

If the median is within 10% of WQO the value is considered to meet the WQO – Green
If the median is within 20% above WQO value was considered within normal range - Yellow
If the median is greater than 20% above the WQO, the value exceeds the WQO - Red

During the diversion period, total dissolved phosphorus concentration was 0.003 mg/L at the North Fork at 501 site, ranged from 0.003 to 0.039 mg/L at the U/S Milk River site and from 0.003 to 0.033 mg/L at the Pinhorn site (Table 17). During the natural flow period, total dissolved phosphorus ranged from 0.003 to 0.007 mg/L at the North Fork at 501 site, from 0.003 to 0.030 mg/L at the U/S Milk River site and from 0.003 to 0.007 mg/L at the Pinhorn site.

Median total dissolved phosphorus concentrations were consistent with the historical WQO-50 concentrations during the diversion period at the upstream sites (North Fork at 501, Milk River at 501 and U/S Milk River sites). The WQO-50 was exceeded by more than 20% at the Pinhorn site during the same period. During the natural flow period, the WQO-50 was exceeded only at the U/S Milk River site.

The WQO-90 was exceeded by more than 20% only during the diversion period at all downstream sites (from U/S Milk River to the Pinhorn) (Table 17). The WQO-90 was not exceeded at any sites during the natural flow period.

Table 17. Summary of total dissolved phosphorus concentrations at the Milk River, 2013 and 2014.

Site	Flow Period	Water Quality Objective		2013				2014			
		WQO-50	WQO-90	N	50th	90th	Range	N	50th	90th	Range
N. Fork at 501	Diversion	0.003	0.007	9	0.003	0.008	0.003-0.010	4	0.003	0.003	0.003-0.003
	Natural	0.005	0.066	1	0.003	-	-	5	0.006	0.007	0.003-0.007
Milk River @ Western Crossing	Apr-Oct	0.006	0.015	6	0.007	0.008	0.006-0.008				
Milk River at 501	Apr-Oct			10	0.003	0.009	0.003-0.010	10	0.004	0.008	0.003-0.022
U/S Milk River	Diversion	0.003	0.010	9	0.003	0.008	0.003-0.010	5	0.003	0.024	0.003-0.039
	Natural	0.005	0.173	1	0.003	-	-	5	0.007	0.021	0.003-0.030
AT HWY 880	Diversion	0.004	0.011	6	0.003	0.008	0.002-0.010	5	0.006	0.028	0.003-0.043
	Natural	0.004	0.021	1	***0.013***	-	-	4	0.005	0.007	0.003-0.008
Pinhorn	Diversion	0.004	0.011	9	0.003	0.009	0.003-0.010	5	0.006	0.022	0.003-0.033
	Natural	0.004	0.021	1	0.003	-	-	4	0.004	0.007	0.003-0.007
Milk River @ Eastern Crossing	Diversion	0.004	0.011	5	***0.005***	0.008	0.003-0.010				
	Natural	0.004	0.021	1	0.004	-	-				

If the median is within 10% of WQO the value is considered to meet the WQO – Green
If the median is within 20% above WQO value was considered within normal range - Yellow
If the median is greater than 20% above the WQO, the value exceeds the WQO – Red

Total Nitrogen

During the diversion period, total nitrogen concentrations ranged from 0.100 to 0.320 mg/L at the North Fork at 501 site, 0.127 to 0.717 mg/L at the U/S Milk River site and from 0.297 to 1.101 mg/L at the Pinhorn site (Table 18). During the natural flow period, total nitrogen ranged from 0.202 to 0.576 mg/L at the North Fork at 501 site, from 0.297 to 1.070 mg/L at the U/S Milk River site and from 0.036 to 1.222 mg/L at the Pinhorn site.

Median total nitrogen concentrations were consistent with the historical WQO-50 concentrations during the diversion period at all sites except at Pinhorn where the median value was greater than 20% of the

objective. During the natural flow period, At HWY 880 was the only site to exceed the WQO-50 by more than 20%.

The WQO-90 for total nitrogen was exceeded by more than 20% during the diversion period at the sites At HWY 880 and Pinhorn (Table 18). All sites met the WQO-90 for total nitrogen during the natural flow period.

Table 18. Summary of total nitrogen concentrations at Milk River, 2013 and 2014.

Site	Flow Period	Water Quality Objective		2013				2014			
		WQO-50	WQO-90	N	50th	90th	Range	N	50th	90th	Range
N. Fork at 501	Diversion	0.240	0.468	9	0.136	0.290	0.136-0.334	5	0.176	0.274	0.100-0.320
	Natural	0.900	1.578	1	0.488	-	-	5	0.289	0.516	0.202-0.576
Milk River @ Western Crossing	April-October	0.600	1.360	6	0.480	0.737	0.343-0.751				
Milk River at 501	April-October			10	0.411	0.578	0.316-0.871	10	0.347	0.552	0.277-0.596
U/S Milk River	Diversion	0.325	0.667	9	0.296	0.434	0.136-0.506	5	0.307	0.624	0.127-0.717
	Natural	0.680	1.637	1	0.326	-	-	5	0.486	1.036	0.297-1.070
AT HWY 880	Diversion	0.365	0.668	6	0.330	0.435	0.160-0.470	5	0.367	***0.859***	0.277-0.880
	Natural	0.320	1.400	1	0.210	-	-	5	***0.486***	0.966	0.036-1.106
Pinhorn	Diversion	0.365	0.668	9	***0.446***	0.682	0.136-0.806	5	***0.487***	***1.043***	0.297-1.101
	Natural	0.320	1.400	1	0.136	-	-	5	0.227	0.931	0.036-1.222
Milk River @ Eastern Crossing	Diversion	0.365	0.668	5	***0.657***	***0.900***	0.383-0.916				
	Natural	0.320	1.400	1	0.191	-	-				

If the median is within 10% of WQO the value is considered to meet the WQO – Green
If the median is within 20% above WQO value was considered within normal range - Yellow
If the median is greater than 20% above the WQO, the value exceeds the WQO – Red

3.4.5 Total Suspended Solids

During the diversion period, total suspended solids concentrations ranged from 7.9 to 34.6 mg/L at the North Fork at 501 site, 47.7 to 267 mg/L at the U/S Milk River site and from 137.0 to 540 mg/L at the Pinhorn site (Table 19). During the natural flow period, total suspended solids ranged from 1.5 to 9.3 mg/L at the North Fork at 501 site, from 1.5 to 132 mg/L at the U/S Milk River site and from 3.8 to 251 mg/L at the Pinhorn site.

Median total suspended solids concentrations were consistent with the historical WQO-50 concentrations during the diversion period at the upstream sites (North Fork at 501 and Milk River at 501 sites). The WQO-50 was exceeded by more than 20% at the U/S Milk River and Pinhorn sites during the same period. During the natural flow period, the WQO-50 was exceeded at the downstream sites (U/S Milk River, at HWY 880 and Pinhorn sites).

The WQO-90 for total suspended solids was met at all sites during both the diversion and natural flow periods, except at the Pinhorn site where the it was exceeded by more than 20% during the diversion period (Table 19).

Table 19. Summary of total suspended solids concentrations at Milk River, 2013 and 2014.

Site	Flow Period	Water Quality Objectives		2013				2014			
		WQO-50	WQO-90	N	50th	90th	Range	N	50th	90th	Range
N. Fork at 501	Diversion	16	59	9	9	39	2-45	4	15	30	7.9-34.6
	Natural	5	55	1	2	-	-	5	2	6.4	1.5-9.3
Milk River @ Western Crossing	April-October	14	247	6	***21***	44	11-62				
Milk River at 501	April-October			10	10	-	2-39	10	14.7	98.6	1.5-112
U/S Milk River	Diversion	56	282	9	40	66	22-90	5	***78***	239	47.7-267
	Natural	7	267	1	2	-	-	5	***17.6***	88.0	1.5-132
AT HWY 880	Diversion	131	384	6	130	290	42-410	5	151	386.8	87.6-388
	Natural	13	228	1	2	-	-	4	***20.8***	226.2	1.5-306
Pinhorn	Diversion	131	384	9	***163***	298	30-463	5	***213***	***488***	137-540
	Natural	13	228	1	2	-	-	4	***36.8***	195.4	3.8-251
Milk River @ Eastern Crossing	Diversion	131	384	5	***231***	355	124-423				
	Natural	13	228	1	8	-	-				

If the median is within 10% of WQO the value is considered to meet the WQO – Green
If the median is within 20% above WQO value was considered within normal range - Yellow
If the median is greater than 20% above the WQO, the value exceeds the WQO – Red

3.4.6 Fecal Coliform Bacteria

During the diversion period, fecal coliform bacteria counts ranged from 56 to 226 cfu/100 mL at the North Fork at 501 site, 89 to 360 cfu/100 mL at the U/S Milk River site and from 48 to 229 cfu/100 mL at the Pinhorn site (Table 20). During the natural flow period, fecal coliform bacteria counts ranged from 5 to 53 cfu/100 mL at the North Fork at 501 site, from 2 to 142 cfu/100 mL at the U/S Milk River site and from 2 to 38 cfu/100 mL at the Pinhorn site.

Median fecal coliform bacteria counts exceeded the historical WQO-50 counts by more than 20% at all the sites during the diversion period (Table 20). During the natural flow period, the WQO-50 was exceeded by more than 20% at the Milk Rivr at 501 site.

The WQO-90 for fecal coliform bacteriawas exceeded by more than 20% during the diversion period at North Fork at 501 and Milk River at 501 (Table 20). During the natural flow period, all sites met the WQO-90.

Table 20. Summary of fecal coliform bacteria counts at Milk River, 2013 and 2014.

Site	Flow Period	Water Quality Objectives		2013				2014			
		WQO-50	WQO-90	N	50th	90th	Range	N	50th	90th	Range
N. Fork at 501	Diversion	27	140	9	64	320	8-400	5	138	201.2	56-226
	Natural	55	668	1	28	-	-	5	11	46	5-53
Milk River @ Western Crossing	April-October	77	619	7	***100***	***2029***	2-3516				
Milk River at 501	April-October			10	53	410	1-500	10	104	2030	4-3200

Site	Flow Period	Water Quality Objectives		2013				2014			
		WQO-50	WQO-90	N	50th	90th	Range	N	50th	90th	Range
U/S Milk River	Diversion	68	272	9	32	71	1-102	5	158	288.8	89-360
	Natural	49	522	1	2	-	-	5	5	91.2	2-142
AT HWY 880	Diversion	78	280	6	40	***1118***	1-2100	5	142	206	70-210
	Natural	29	163	1	18	-	-	4	5.5	42	1-57
Pinhorn	Diversion	78	280	9	48	206	17-300	5	128	189.4	48-229
	Natural	29	163	1	7	-	-	4	13	32.6	2-38
Milk River @ Eastern Crossing	Diversion	78	280	6	56	132	6-200				
	Natural	29	163	1	3	-					

If the median is within 10% of WQO the value is considered to meet the WQO – Green
If the median is within 20% above WQO value was considered within normal range - Yellow
If the median is greater than 20% above the WQO, the value exceeds the WQO – Red

4.0 SUMMARY AND RECOMMENDATIONS

4.1 Summary

Eastern Tributaries

- Median specific conductivity values at Lodge Creek appear to be increasing, while values tend to be stable at Battle and Middle creeks.
- Median total phosphorus at Battle Creek shows a minor decreasing trend, while a moderate increasing trend is observed at Middle Creek. Median total phosphorus concentrations are generally stable at Lodge Creek. It should be noted that Lodge Creek was dry in August, September and October 2012.
- Median total nitrogen is increasing at Lodge Creek and is attributed to an increase in total kjeldahl nitrogen, the organic form of total nitrogen.
- Lodge Creek had low fecal coliform bacteria counts, while the upper range of fecal coliform bacteria increased at Middle Creek in 2014

Red Creek

- Total phosphorus was generally higher in 2014 compared to previous years
- Total nitrogen was substantially higher in 2014 at the Upstream site compared to previous two years and an increasing trend was observed at the Middle site. The increase in total nitrogen at the Upstream site is related to increased concentrations of nitrate-nitrogen, particularly in April and May. An increasing trend in total kjeldahl nitrogen concentrations is observed at all sites since 2012.
- Fecal coliform bacteria are more similar in 2012 and 2014 compared to 2013. Median fecal coliform bacteria counts are generally less than 100 cfu/100 mL at the Upstream and Middle sites; at the Downstream site, counts are nearly double at 200 cfu/100 mL (2012 and 2014).

Milk River

- Water quality in the Milk River mainstem is highly influenced by the St. Mary River Diversion that augments natural flow in the river during the summer months. In 2014, the St. Mary Diversion began May 10 and ended September 10. The start- up date was somewhat later compared to 2012 (April) and 2013 (March).

- A later start-up generally results in a higher median for parameters that are typically diluted by the St. Mary River water (i.e., conductivity, nitrogen) and a lower median for parameters that typically increase with the increase in flows (i.e, total phosphorus and total suspended solids).
- Median specific conductivity values, total nitrogen concentrations and fecal coliform bacteria counts were higher at the site U/S of Milk River in 2014 compared to the previous years; however median values were similar at the most downstream sites (i.e., Hwy 880 and Pinhorn).
- Median total suspended solids concentrations were lower in 2014 compared to previous years at the site U/S of Milk River, HWY 880 and Pinhorn, while median total phosphorus concentrations were similar at all sites to the previous two years.

4.2 Recommendations

Red Creek

- Historically, there have been landowner concerns regarding water quality at Red Creek. The main concerns are related to potential pesticide use and their impact on amphibians, as well as heavy metals (e.g., Mercury, Cadmium, and Lead) and their potential impact on livestock health. Landowners have noted that they have not observed the same abundance of leopard frogs, in particular, at the creek.

  To support the Red Creek Watershed Group, a scoping study could be undertaken to better understand pesticides and heavy metals at Red Creek. Further, a better understanding of land use, occurrence of streambank erosion and riparian health could help to better interpret water quality results. There may be potential for fecal coliform source tracking to better understand the source of fecal coliform bacteria at Red Creek. Further discussions could be held with landowners who may observe changes in activity or land management in the area (e.g., livestock, wildlife).

Milk River

- The existing Milk River (mainstem) sites should be maintained.
- The site downstream of the Milk River treatment lagoons should be re-initiated.
- The MRWCC should continue to collect water quality data at HWY 880 for consistency with the overall Milk River water quality data base. AEP could consider increasing their monitoring frequency at HWY 880 to coincide with MRWCC sampling dates.

5.0 REFERENCES

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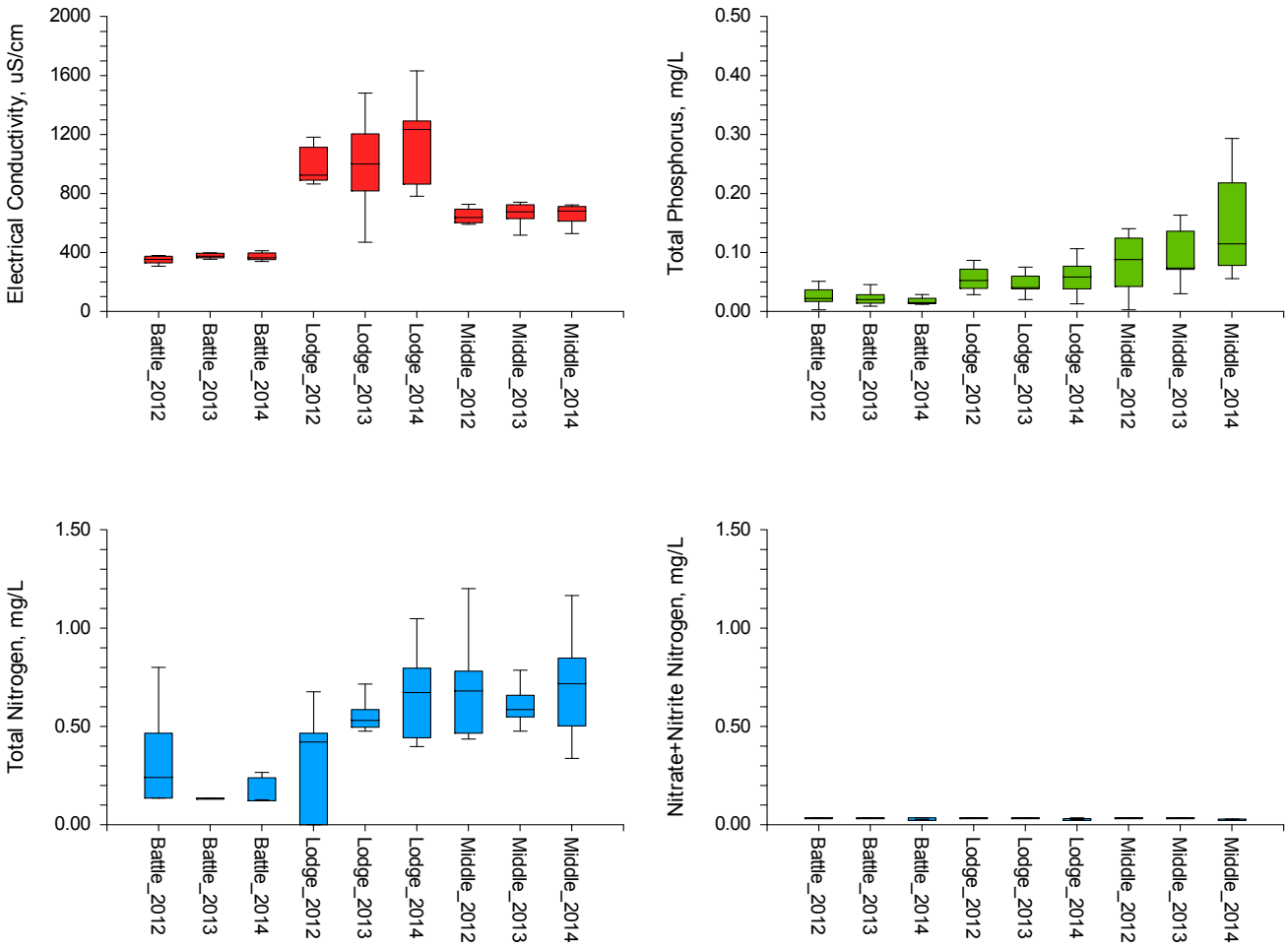
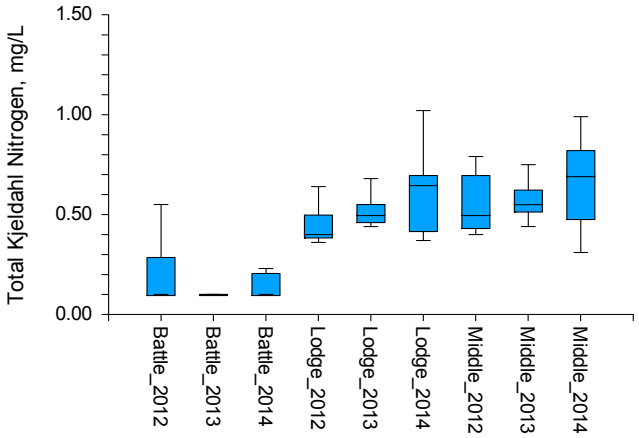
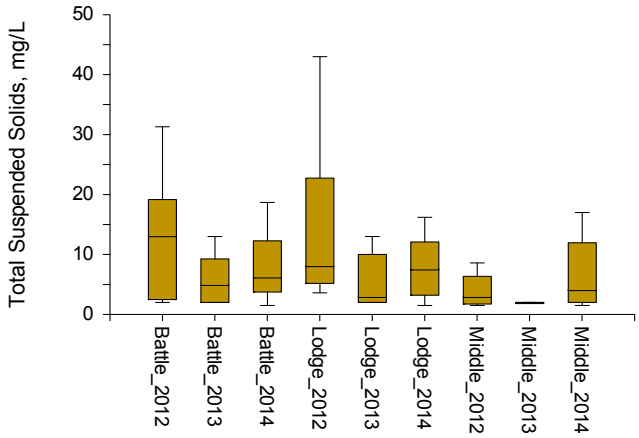
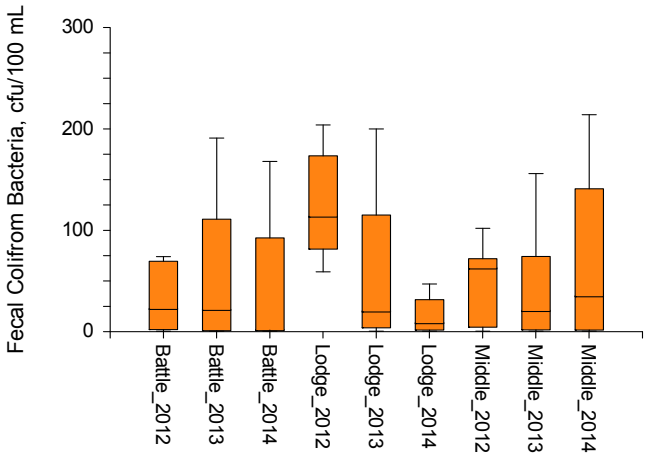
APPENDIX A. Trends in water quality for select parameters at the Eastern Tributaries, Red Creek and the Milk River Mainstem sites. Trends are represented by box and whisker plots. The middle line within each box represents the median or 50th percentile, the lower line of the box represents the 25th percentile and the upper line the 75th percentile.

EASTERN TRIBUTARIES

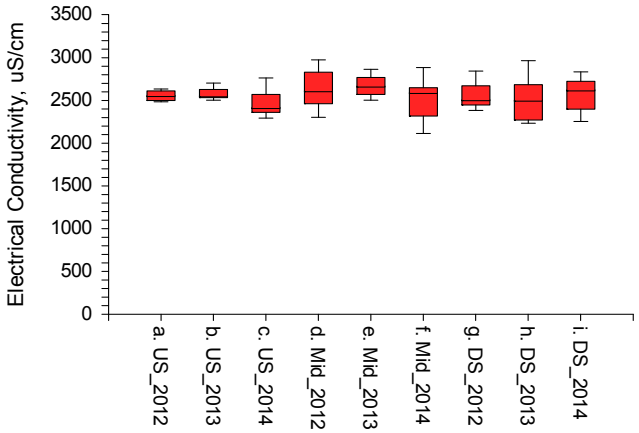


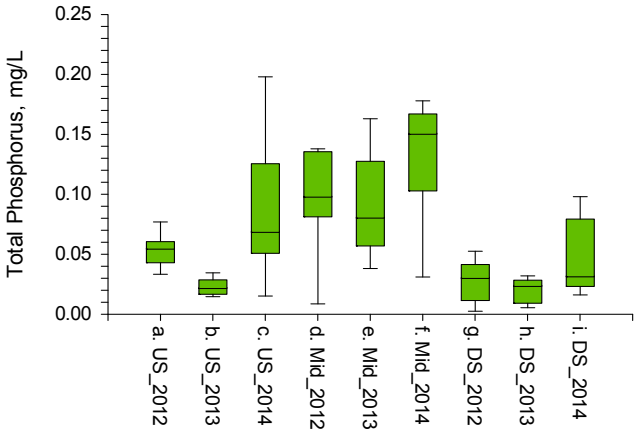

Total Kjeldahl Nitrogen, mg/L
1.50
1.00
0.50
0.00
Battle_2012
Battle_2013
Battle_2014
Lodge_2012
Lodge_2013
Lodge_2014
Middle_2012
Middle_2013
Middle_2014

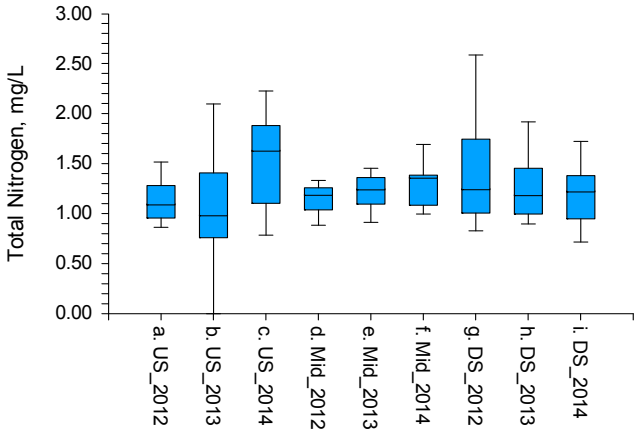

Total Suspended Solids, mg/L
50
40
30
20
10
0
Battle_2012
Battle_2013
Battle_2014
Lodge_2012
Lodge_2013
Lodge_2014
Middle_2012
Middle_2013
Middle_2014

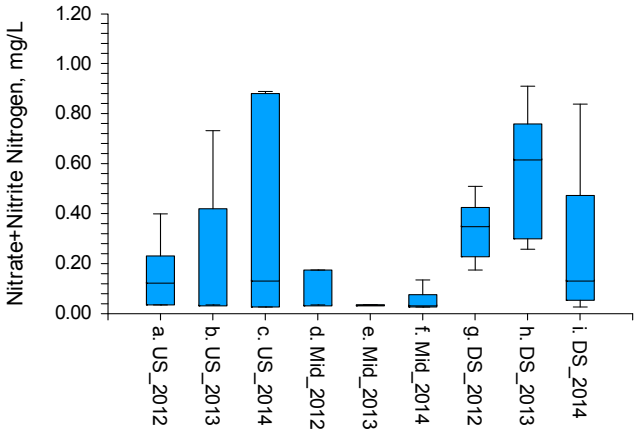

Fecal Colifrom Bacteria, cfu/100 mL
300
200
100
0
Battle_2012
Battle_2013
Battle_2014
Lodge_2012
Lodge_2013
Lodge_2014
Middle_2012
Middle_2013
Middle_2014

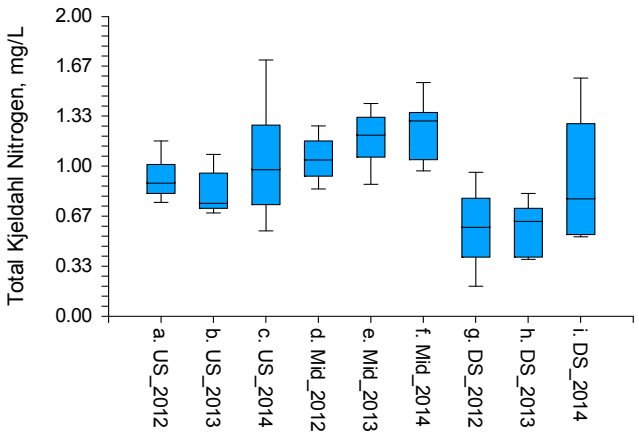
RED CREEK

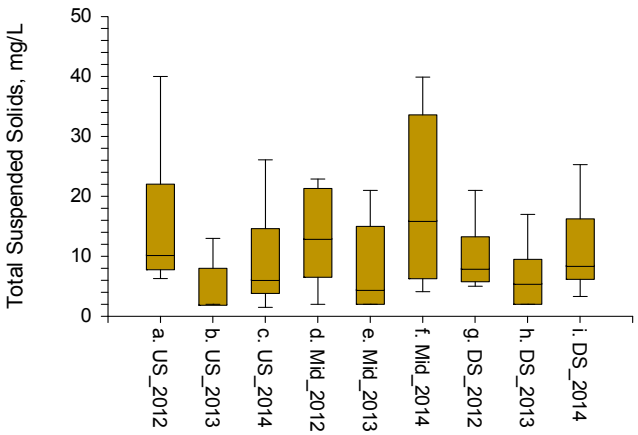

Electrical Conductivity, uS/cm
3500
3000
2500
2000
1500
1000
500
0
a. US_2012
b. US_2013
c. US_2014
d. Mid_2012
e. Mid_2013
f. Mid_2014
g. DS_2012
h. DS_2013
i. DS_2014

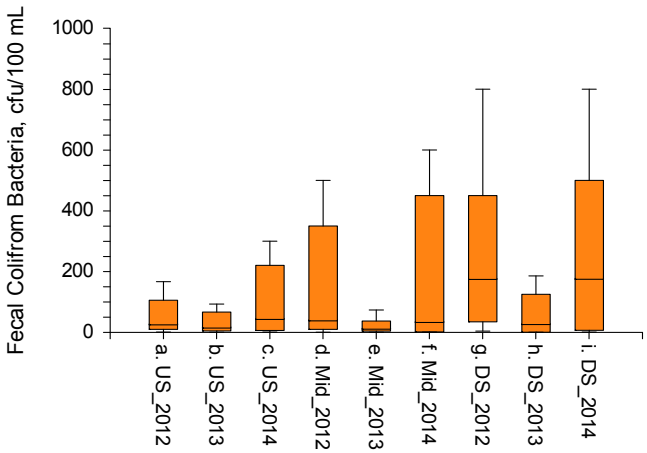

Total Phosphorus, mg/L
0.25
0.20
0.15
0.10
0.05
0.00
a. US_2012
b. US_2013
c. US_2014
d. Mid_2012
e. Mid_2013
f. Mid_2014
g. DS_2012
h. DS_2013
i. DS_2014


Total Nitrogen, mg/L
3.00
2.50
2.00
1.50
1.00
0.50
0.00
a. US_2012
b. US_2013
c. US_2014
d. Mid_2012
e. Mid_2013
f. Mid_2014
g. DS_2012
h. DS_2013
i. DS_2014


Nitrate+Nitrite Nitrogen, mg/L
1.20
1.00
0.80
0.60
0.40
0.20
0.00
a. US_2012
b. US_2013
c. US_2014
d. Mid_2012
e. Mid_2013
f. Mid_2014
g. DS_2012
h. DS_2013
i. DS_2014

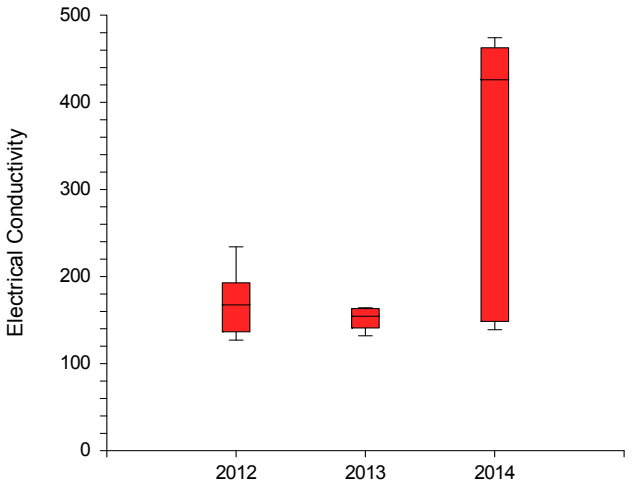

Total Kjeldahl Nitrogen, mg/L
2.00
1.67
1.33
1.00
0.67
0.33
0.00
a. US_2012
b. US_2013
c. US_2014
d. Mid_2012
e. Mid_2013
f. Mid_2014
g. DS_2012
h. DS_2013
i. DS_2014

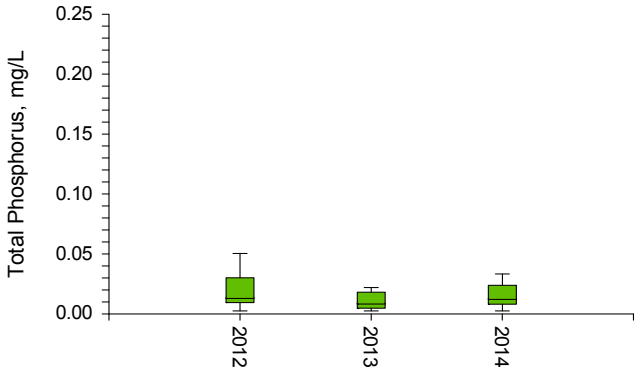

Total Suspended Solids, mg/L
50
40
30
20
10
0
a. US_2012
b. US_2013
c. US_2014
d. Mid_2012
e. Mid_2013
f. Mid_2014
g. DS_2012
h. DS_2013
i. DS_2014

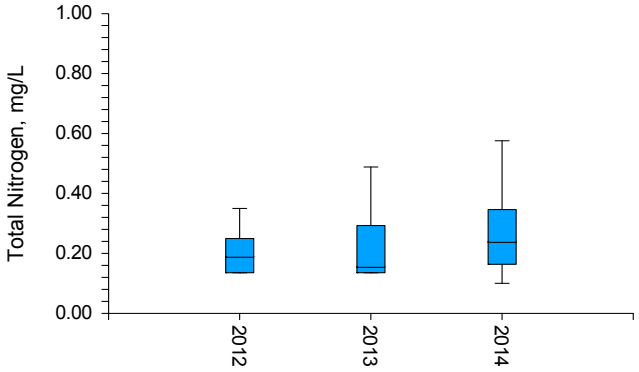

Fecal Colifrom Bacteria, cfu/100 mL
1000
800
600
400
200
0
a. US_2012
b. US_2013
c. US_2014
d. Mid_2012
e. Mid_2013
f. Mid_2014
g. DS_2012
h. DS_2013
i. DS_2014

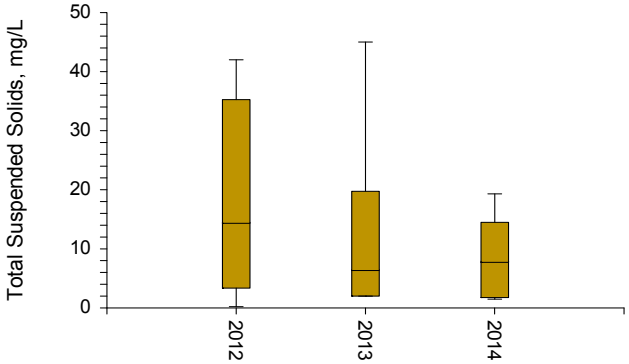
MILK RIVER MAINSTEM

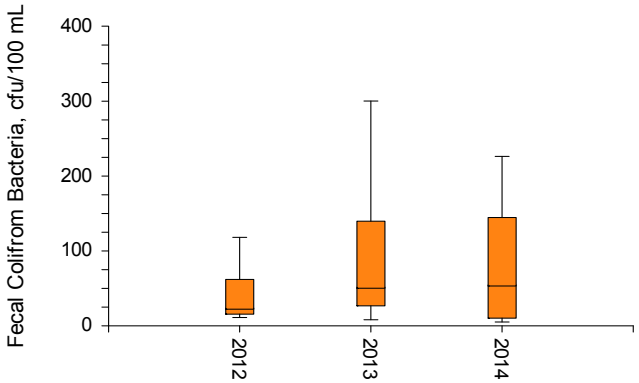
NORTH FORK MILK RIVER



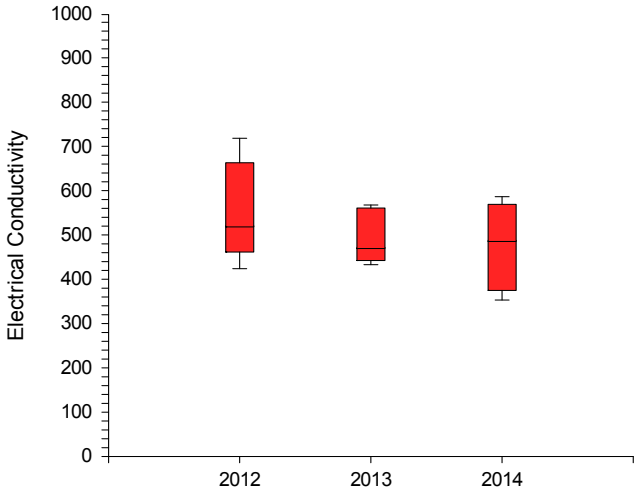


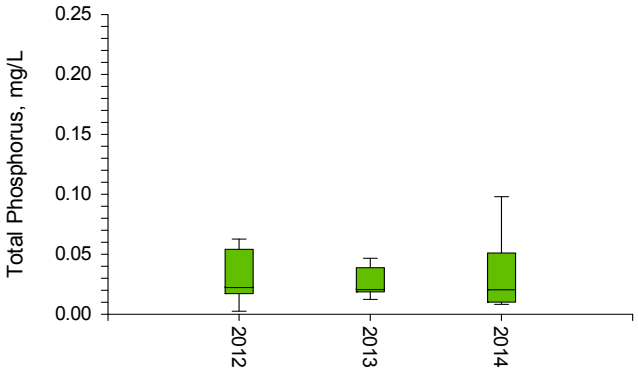


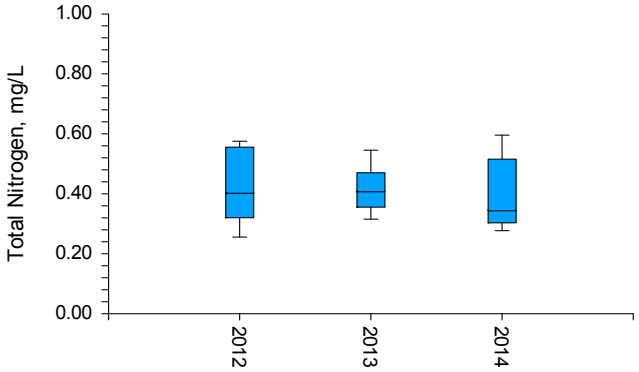


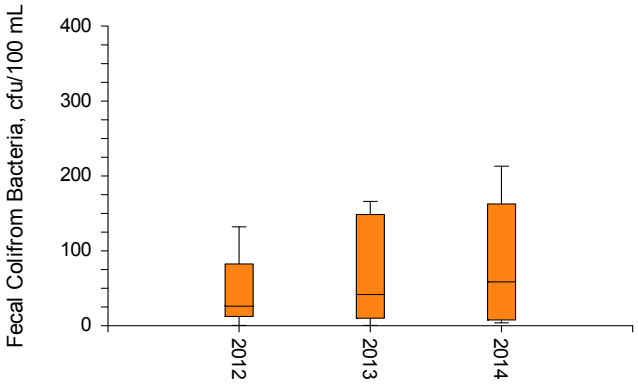


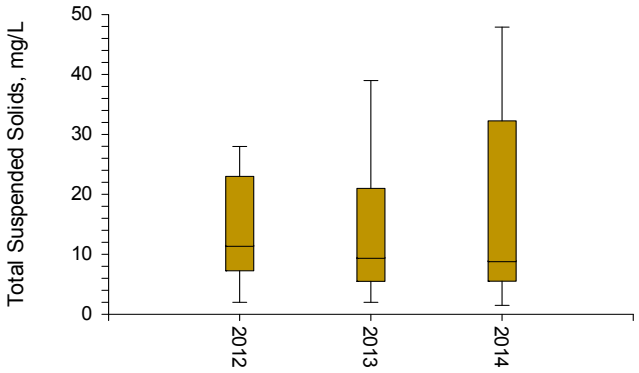
MILK RIVER (SOUTH FORK)



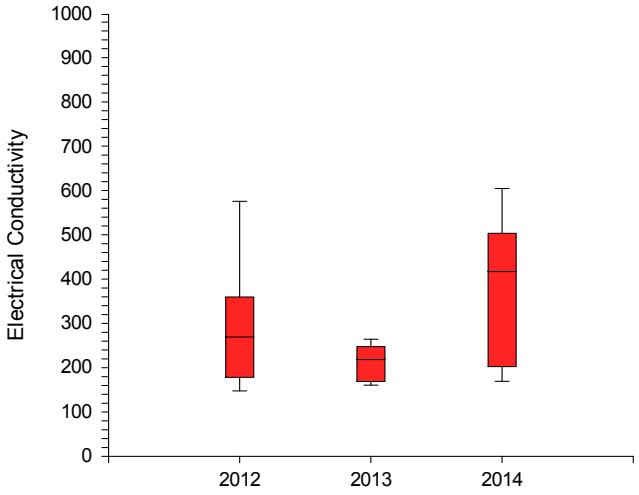


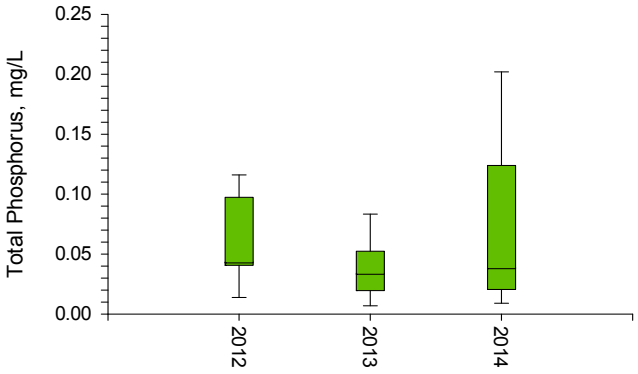


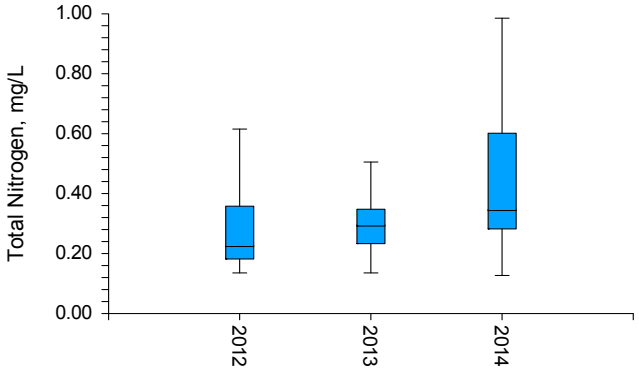


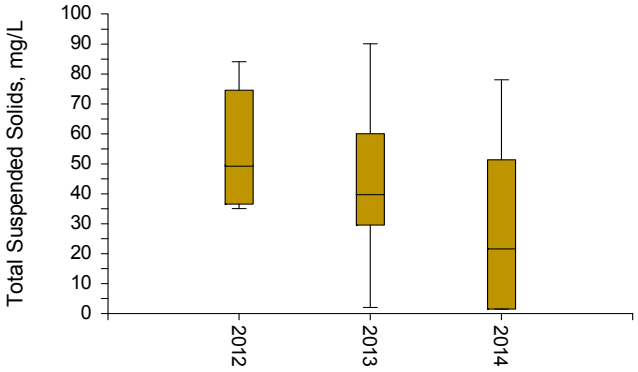


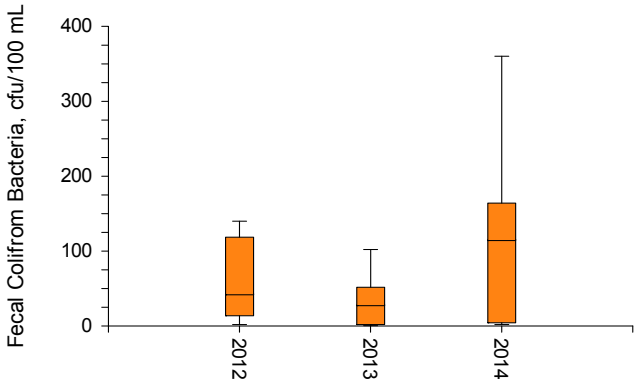
MILK RIVER UPSTREAM OF THE TOWN OF MILK RIVER



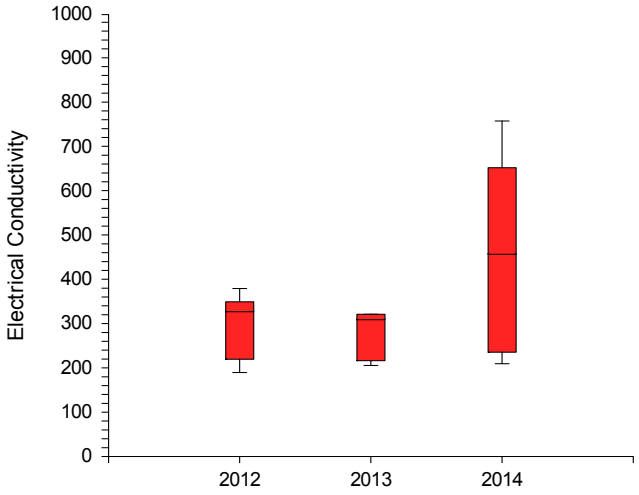


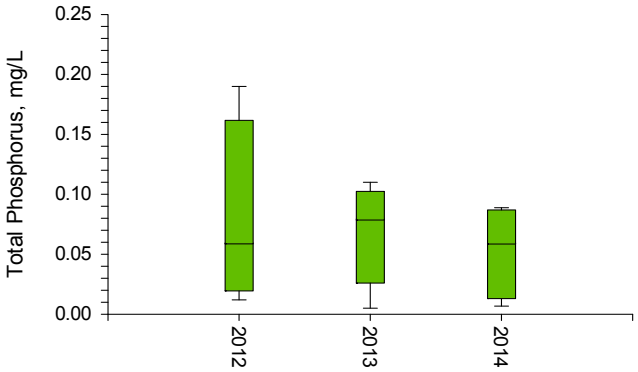


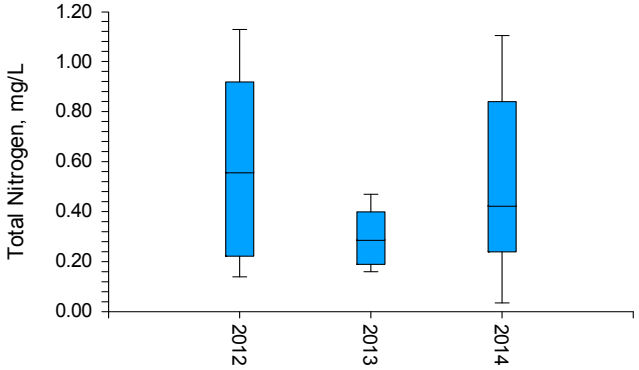


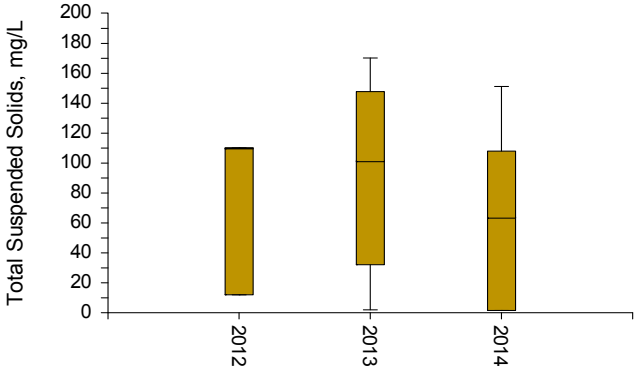


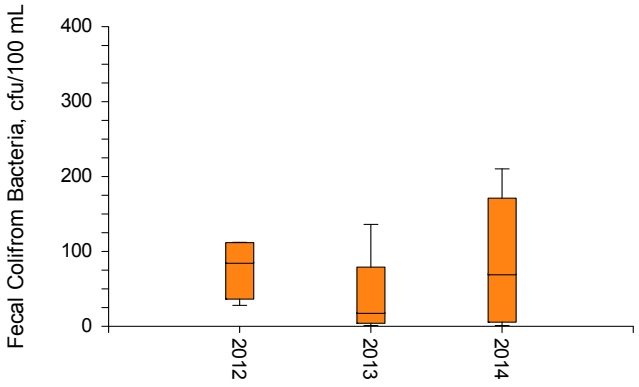
MILK RIVER AT HWY 880











MILK RIVER AT PINHORN