SUPPLEMENTARY INFORMATION

Table S1. Geochemical and isotopic measurements at the sampled locations within the proposed study in the HRSR watersheds. (Excel sheet submitted alongside).

Type of location	Sample Location	Sampling Date	Field parameters			Isotopes					Routine								
			pH	Electrical Conductivity at 25 °C µS/cm	Alkalinity HCO3-, mg/L	d2H	d18O	d13C	Radon-222		Dissolved Calcium	Dissolved Magnesium	Dissolved Sodium	Dissolved Potassium	Dissolved Chloride	Dissolved Sulfate (SO4)	Carbonate	Bicarbonate	Calculated Total Dissolved Solids
						vs VSMOW ‰	vs VSMOW ‰	vs VPDB ‰	Activity Bq/m3	Uncertainty Bq/m3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Spring Sampling Program																			
Alpine Sites																			
Surface water	Sheep River	24-Mar-23	8.19	398	130	-149.40	-19.74	-3.89	80	20	53.6	16.3	1.5	0.5	0.7	79.2	<6	151	226
Surface water	Highwood River	24-Mar-23	8.16	432	160	-148.90	-19.50	-7.42	1348	125	62.5	15.1	2.3	0.6	0.7	69	<6	196	246
Surface water	Sheep River	24-Apr-23	-	-	-	-151.40	-19.98	-3.78	54	18	-	-	-	-	-	-	-	-	-
Surface water	Highwood River	24-Apr-23	-	-	-	-149.30	-19.32	-7.60	1138	75	-	-	-	-	-	-	-	-	-
Surface water	Sheep River	20-Mar-24	8.17	378	-	-151.95	-19.84	-3.66	125	31	49.7	15.5	1.3	0.4	0.8	73.5	<6	149	214
Surface water	Highwood River	21-Mar-24	8.23	425	-	-150.32	-19.73	-7.07	1422	138	60.9	15.3	2.4	0.5	0.6	69.2	<6	201	248
Highwood and Sheep River Project- Provincial Monitoring Sites																			
Surface Water	Highwood River near the mouth	12-Apr-23	-	-	-	-146.8	-19.58	-8.93	414	45	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River D/S High River	12-Apr-23	-	-	-	-152.8	-20.25	-10.33	377	44	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River at Hwy 2	05-Apr-23	-	-	-	-147.7	-19.21	-8.82	365	44	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River near Diamond Valley	05-Apr-23	-	-	-	-145.4	-19.53	-6.42	-	-	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River near the mouth	04-May-23	-	-	-	-150.7	-19.95	-7.62	-	-	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River D/S High River	04-May-23	-	-	-	-152.5	-20.02	-7.85	-	-	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River at Hwy 2	04-May-23	-	-	-	-154.5	-20.19	-7.36	-	-	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River near Diamond Valley	04-May-23	-	-	-	-159.9	-20.84	-5.11	217	36	-	-	-	-	-	-	-	-	-
Surface Water	Highwood river near the mouth	11-Mar-24	-	-	-	-154.02	-20.18	-9.13	1117	481	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River D/S High River	11-Mar-24	-	-	-	-148.65	-19.52	-7.58	238	213	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River at hwy 2	11-Mar-24	-	-	-	-159.35	-20.71	-10.25	661	362	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River near Diamond Valley	11-Mar-24	-	-	-	-148.00	-19.60	-6.25	936	425	-	-	-	-	-	-	-	-	-
Precipitation																			
Precipitation	Sheep River Precipitation Station	20-Mar-24	-	-	-	-180.7	-23.5	-18.8	-	-	-	-	-	-	-	-	-	-	-
	Highwood River Precipitation Station	20-Mar-24	-	-	-	-167.3	-22.1	-18.7	-	-	-	-	-	-	-	-	-	-	-
	Okotoks Precipitation Station	21-Mar-24	-	-	-	-166.8	-21.6	-17.3	-	-	-	-	-	-	-	-	-	-	-
	High River Precipitation Station	21-Mar-24	-	-	-	-162.2	-21.6	-18.7	-	-	-	-	-	-	-	-	-	-	-
Springs in Little Bow																			
Surface Water	Bow River spring u/s	03-Apr-24	7.60	865	-	-148.69	-18.99	-15.12	954	64	23.8	2.0	80.6	4.8	124	5.2	<6	112	295
Surface Water	Bow River spring middle	03-Apr-24	7.68	666	-	-148.16	-19.29	-11.37	5971	145	88.4	21.1	19.9	2.2	24.6	53.6	<6	347	380
Surface Water	Bow River spring d/s	03-Apr-24	7.71	705	-	-149.63	-19.43	-12.68	1358	76	67.9	16.1	47.7	3.3	73.8	45.4	<6	278	391
Springs																			
Surface Water	Blue Rock Spring	03-Apr-24	7.71	783	-	-143.37	-18.49	-8.97	211	32	84.4	45.6	15.7	2.1	0.7	106	<6	431	467
Surface Water	Tongue Creek u/s	03-Apr-24	7.62	190	-	-165.35	-21.27	-14.56	6417	187	23.3	5.0	2.0	4.7	1.6	18	<6	100	104
Surface Water	Tongue Creek middle	03-Apr-24	8.03	448	-	-161.77	-20.59	-12.37	268	30	49.9	16.5	13.5	7.3	10.3	56.3	<6	202	253
Surface Water	Tongue Creek d/s	03-Apr-24	8.08	576	-	-159.91	-20.25	-10.66	225	34	50.6	21.3	34.0	9.3	11.1	75.4	<6	267	333

Type of location	Sample Location	Sampling Date	Field parameters			Isotopes					Routine								
			pH	Electrical Conductivity at 25 °C µS/cm	Alkalinity HCO3-, mg/L	d2H	d18O	d13C	Radon-222		Dissolved Calcium	Dissolved Magnesium	Dissolved Sodium	Dissolved Potassium	Dissolved Chloride	Dissolved Sulfate (SO4)	Carbonate	Bicarbonate	Calculated Total Dissolved Solids
						vs VSMOW ‰	vs VSMOW ‰	vs VPDB ‰	Activity Bq/m3	Uncertainty Bq/m3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Okotoks																			
Surface Water	U1	26-Mar-24	8.23	479	-	-153.2	-19.8	-8.6	575	65	61.7	16.6	9.9	1.5	7.3	69.5	<6	234	281
Surface Water	U2	27-Mar-24	8.23	483	-	-153.4	-19.6	-8.3	1282	89	63.8	17.0	10.4	1.6	6.6	67.1	<6	226	278
Surface Water	D3	26-Mar-24	8.24	495	-	-153.3	-19.6	-8.5	1959	97	63.7	17.5	11.8	1.8	8.5	63.8	<6	242	286
Surface Water	D4	26-Mar-24	8.25	490	-	-152.9	-19.6	-8.6	671	67	64.3	17.5	11.9	1.7	8.5	61.8	<6	260	294
Groundwater	Production Well #1	26-Mar-24	7.84	583	-	-146.4	-19.0	-11.9	9421	1040	85.8	20.3	7.6	1.1	7.5	47.3	<6	334	334
Groundwater	Production Well #2	26-Mar-24	7.66	469	-	-146.7	-19.2	-7.5	5386	775	62.4	16.6	14.1	1.2	13.3	59.9	<6	227	279
Groundwater	Observation Well #6	08-Apr-24	7.87	482	-	-153.1	-19.8	-8.7	8043	951	63.5	16.2	8.1	1.0	5.4	66.1	<6	236	276
Groundwater	Production Well #12	26-Mar-24	7.65	705	-	-151.2	-19.6	-10.9	17591	1436	92.1	20.2	18.4	1.5	35.3	68.4	<6	326	396
Groundwater	Observation Well #96-2	08-Apr-24	7.87	496	-	-151.8	-19.7	-9.0	11134	1109	63.9	16.4	14.8	1.2	4.7	60.4	<6	255	287
Groundwater	Okotoks Borehole #3	08-Apr-24	7.80	622	-	-148.0	-19.1	-10.8	17993	1449	80.2	21.5	18.5	2.1	10.3	55.0	<6	341	356
Surface Water	U1	09-May	-	-	-	-155.8	-20.23	-6.88	68	20	-	-	-	-	-	-	-	-	-
Surface Water	D3	09-May	-	-	-	-154.6	-20.05	-7.16	49	16	-	-	-	-	-	-	-	-	-
Surface Water	D4	09-May	-	-	-	-154.5	-20.04	-7.14	49	12	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #1	09-May	-	-	-	-153.3	-19.69	-9.75	19133	445	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #1 dup	09-May	-	-	-	-	-	-	2519	148	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #2	09-May	-	-	-	-154.4	-19.96	-9.64	13240	381	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #2 dup	09-May	-	-	-	-	-	-	5998	217	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #12	09-May	-	-	-	-153.8	-19.9	-9.39	2224	153	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #12 dup	09-May	-	-	-	-	-	-	13571	340	-	-	-	-	-	-	-	-	-
Hgh River																			
Groundwater	Well 1	25-Mar-24	7.74	525	-	-155.0	-20.0	-9.8	9961	1175	64.3	17.2	19.6	1.3	21.9	59.9	<6	241	303
Groundwater	Well 3	25-Mar-24	7.83	610	-	-148.0	-19.4	-10.8	8990	1122	88.3	20.4	8.9	1.2	9.3	55.0	<6	337	349
Groundwater	High River Monitoring Well 1	21-Mar-24	7.84	733	-	-146.4	-19.0	-11.9	13103	1968	86.7	23.1	33.8	1.7	17.7	65.0	<6	398	424
Groundwater	High River Monitoring Well 2	04-Apr-24	8.27	184	-	-146.7	-19.2	-7.5	2276	614	12.5	10.5	4.4	1.4	2.1	7.9	<6	106	91
Groundwater	High River Monitoring Well 3	04-Apr-24	7.72	574	-	-146.8	-19.3	-10.0	14097	1527	79.3	21.2	12.2	1.4	10.9	51.4	<6	319	333
Foothills County																			
Groundwater	Ravencrest	01-Apr-24	8.24	1270	-	-147.0	-18.8	-11.6	11581	1390	37.2	17.9	207	1.5	175	40.8	<6	439	696
Groundwater	Square Butte Ranch W3	01-Apr-24	7.19	615	-	-141.1	-18.2	-13.7	14274	1696	72.6	27.5	14.6	1.4	25.8	18	<6	345	330
Groundwater	Diamond Valley Well #5	01-Apr-24	7.73	615	-	-150.1	-19.6	-8.9	5837	1006	89.0	21.6	9.5	1.0	5.4	117	<6	262	372
Groundwater	Green Haven	01-Apr-24	7.91	1150	-	-151.6	-19.3	-10.2	15880	1599	60.5	22.8	178	2.8	3.6	217	<6	516	739
Surface Water	Longview, Highwood River	01-Apr-24	7.95	453	-	-149.35	-19.61	-6.29	5521	170	62.8	14.9	5.4	0.6	1.1	68.8	<6	216	260

Type of location	Sample Location	Sampling Date	Field parameters			Isotopes					Routine									
			pH	Electrical Conductivity at 25 °C µS/cm	Alkalinity HCO3-, mg/L	d2H	d18O	d13C	Radon-222		Dissolved Calcium	Dissolved Magnesium	Dissolved Sodium	Dissolved Potassium	Dissolved Chloride	Dissolved Sulfate (SO4)	Carbonate	Bicarbonate	Calculated Total Dissolved Solids
Summer Sampling Program																				
Alpine Sites																				
Surface water	Sheep River	01-Jun-23	8.551	346.2	130	-159.30	-20.98	-4.97	101	29	-	-	-	-	-	-	-	-	-
Surface water	Highwood River	01-Jun-23	8.141	283.2	130	-154.39	-20.47	-6.73	196	39	-	-	-	-	-	-	-	-	-
Surface water	Sheep River	28-Jun-23	8.098	268.03	130	-154.00	-20.25	-4.39	15576	613	44.5	12.5	1.3	0.4	<0.4	47.5	<6	144	177
Surface water	Highwood River	28-Jun-23	8.283	298.94	170	-151.60	-19.96	-7.11	298	73	50.1	11.7	2.3	0.6	0.5	32.2	<6	178	185
Surface water	Sheep River	29-Aug-23	-	-	-	-151.30	-19.98	-4.84	39	10	-	-	-	-	-	-	-	-	-
Surface water	Highwood River	29-Aug-23	-	-	-	-149.80	-19.76	-7.79	407	34	-	-	-	-	-	-	-	-	-
Highwood and Sheep River Project- Provincial Monitoring Sites																				
Surface Water	Highwood River near the mouth	05-Jun-23	-	-	-	-152.2	-19.96	-6.53	43	12	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River D/S High River	05-Jun-23	-	-	-	-151.9	-19.91	-6.83	283	44	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River at Hwy 2	05-Jun-23	-	-	-	-154.1	-20.08	-6.94	-	-	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River near Diamond Valley	05-Jun-23	-	-	-	-150.7	-19.81	-5.17	56	16	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River near the mouth	06-Jul-23	-	-	-	-152.6	-20.01	-6.11	257	96	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River D/S High River	06-Jul-23	-	-	-	-151.4	-19.95	-6.66	135	33	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River at Hwy 2	06-Jul-23	-	-	-	-154.3	-20.29	-6.53	123	34	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River near Diamond Valley	06-Jul-23	-	-	-	-156.6	-20.68	-4.43	66	20	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River near the mouth	02-Aug-23	-	-	-	-145.84	-18.88	-6.41	634	66	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River D/S High River	02-Aug-23	-	-	-	-146.19	-19.09	-6.53	233	83	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River at Hwy 2	02-Aug-23	-	-	-	-148.27	-19.24	-7.57	69	24	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River near Diamond Valley	02-Aug-23	-	-	-	-149.35	-19.69	-5.05	58	15	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River near the mouth	07-Sep-23	-	-	-	-143.01	-18.51	-6.28	314	52	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River D/S High River	07-Sep-23	-	-	-	-142.77	-18.48	-6.05	525	68	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River at Hwy 2	07-Sep-23	-	-	-	-144.58	-18.94	-7.17	159	34	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River near Diamond Valley	07-Sep-23	-	-	-	-145.68	-19.31	-4.44	294	59	-	-	-	-	-	-	-	-	-
	Springs in Little Bow																			
Surface Water	Bow River spring u/s	27-Jun-23	7.739	316.64	170	-162.7	-19.57	-11.31	88	32	-	-	-	-	-	-	-	-	-
Surface Water	Bow River spring middle	27-Jun-23	7.893	544.34	300	-147.6	-19.25	-12.15	4471	184	-	-	-	-	-	-	-	-	-
Surface Water	Bow River spring d/s	27-Jun-23	8.061	600.54	300	-146.4	-18.91	-10.65	13743	304	-	-	-	-	-	-	-	-	-
Springs																				
Surface Water	Blue Rock Spring	29-Jun-23	7.616	623.42	260	-143.9	-18.55	-9.83	25796	766	86.9	46.9	16.4	2.3	0.7	104	<6	413	460
Surface Water	Tongue Creek	29-Jun-23	7.999	772.49	440	-121.6	-12.7	-9.99	123	41	-	-	-	-	-	-	-	-	-

Type of location	Sample Location	Sampling Date	Field parameters			Isotopes					Routine									
			pH	Electrical Conductivity at 25 °C µS/cm	Alkalinity HCO3-, mg/L	d2H	d18O	d13C	Radon-222		Dissolved Calcium	Dissolved Magnesium	Dissolved Sodium	Dissolved Potassium	Dissolved Chloride	Dissolved Sulfate (SO4)	Carbonate	Bicarbonate	Calculated Total Dissolved Solids
Okotoks																				
Surface Water	U1	28-Jun-23	8.34	324.32	160	-152.9	-19.95	-5.95	-	-	-	-	-	-	-	-	-	-	-	-
Surface Water	U2	28-Jun-23	8.35	342.16	80	-153.6	-19.97	-6.19	-	-	-	-	-	-	-	-	-	-	-	-
Surface Water	D3	28-Jun-23	8.332	336.32	160	-152.1	-19.84	-6.6	21061	582	-	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #1	05-Jul-23	7.79	416.29	250	-152.6	-19.86	-9.15	36586	950	-	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #2	05-Jul-23	7.83	403.22	190	-151.9	-19.55	-9.85	10085	318	-	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #4	05-Jul-23	7.71	462.68	260	-152.5	-19.87	-10.07	5217	173	-	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #6	05-Jul-23	7.48	659.89	320	-152.3	-19.68	-11.75	12804	527	-	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #12	05-Jul-23	7.55	555.46	250	-151.9	-19.78	-10.99	13209	389	-	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #8	07-Jul-23	7.67	375.34	190	-152.8	-19.92	-8.88	20696	459	-	-	-	-	-	-	-	-	-	-
Groundwater	Production Well #9	07-Jul-23	7.36	371.54	130	-152.1	-19.78	-8.98	7675	291	-	-	-	-	-	-	-	-	-	-
Groundwater	Observation Well #6	07-Jul-23	8	384.57	190	-152.9	-19.94	-8.9	4558	306	63.4	15.3	6.4	1.2	1.8	51.2	<6	215	245	
Groundwater	Observation Well #96-2	07-Jul-23	7.69	424.86	380	-152.3	-19.92	-9.59	6685	419	68.1	16.4	10.6	1.4	2.3	50.9	<6	245	270	
Groundwater	Okotoks Borehole #3	07-Jul-23	7.62	555.71	240	-148.3	-19.18	-11.97	56356	1109	83.5	22.4	19.4	2.1	13.5	56.8	<6	313	352	
Surface Water	Okotoks Infiltration Gallery	28-Jun-23	7.805	418.34	200	-152.6	-19.94	-9.06	9312	425	-	-	-	-	-	-	-	-	-	
High River																				
Groundwater	Well 1	27-Jun-23	7.87	431.8	250	-147.7	-19.32	-11.25	27995	489	-	-	-	-	-	-	-	-	-	
Groundwater	Well 3	27-Jun-23	8.068	446.64	260	-147.5	-19.44	-11.63	-	-	-	-	-	-	-	-	-	-	-	
Groundwater	High River Monitoring Well 1	27-Jun-23	7.683	615.64	360	-146.8	-19.11	-12.09	16932	346	-	-	-	-	-	-	-	-	-	
Groundwater	High River Monitoring Well 2	27-Jun-23	8.209	86.47	50	-146.6	-18.99	-11.4	281	43	-	-	-	-	-	-	-	-	-	
Groundwater	High River Monitoring Well 3	27-Jun-23	7.704	423.54	230	-146.2	-19.17	-10.41	3100	149	-	-	-	-	-	-	-	-	-	
Foothills County																				
Surface Water	Priddis Greens WTP	04-Jul-23	8.07	522.83	310	-136.5	-16.65	-11.38	4535	292	-	-	-	-	-	-	-	-	-	
Groundwater	Diamond Valley Well #7	06-Jul-23	7.65	437.15	200	-153.8	-20.17	-8.23	53101	1072	-	-	-	-	-	-	-	-	-	
Groundwater	Diamond Valley Well #5	06-Jul-23	7.72	457.45	200	-152.6	-19.94	-8.96	2791	206	-	-	-	-	-	-	-	-	-	
Groundwater	Square Butte Ranch W3	06-Jul-23	7.06	536.25	300	-141.2	-18.33	-13.79	9006	468	-	-	-	-	-	-	-	-	-	
Groundwater	Green Haven	06-Jul-23	7.9	947.92	350	-151.2	-19.21	-11.98	48171	1001	-	-	-	-	-	-	-	-	-	
Groundwater	Red Deer Lake School	06-Jul-23	7.5	1012.49	350	-144.7	-18.21	-15.53	No	No	-	-	-	-	-	-	-	-	-	
Groundwater	Blackie	06-Jul-23	8.07	1221.59	310	-159.4	-20.28	-16.33	112848	1758	-	-	-	-	-	-	-	-	-	
Groundwater	Ravencrest	06-Jul-23	7.93	1151.65	350	-145.3	-18.53	-13.4	24685	670	-	-	-	-	-	-	-	-	-	
Groundwater	Heritage Heights School	06-Jul-23	8.31	863.15	340	-154.9	-19.6	-19.2	No	No	-	-	-	-	-	-	-	-	-	
Groundwater	Cottonwood	06-Jul-23	8.88	622.27	240	-146.8	-18.34	-29.65	1836	194	-	-	-	-	-	-	-	-	-	
Surface Water	Longview, Highwood River	06-Jul-23	7.71	352.73	210	-151.4	-19.73	-6.98	2746	250	-	-	-	-	-	-	-	-	-	

Type of location	Sample Location	Sampling Date	Field parameters			Isotopes					Routine									
			pH	Electrical Conductivity at 25 °C µS/cm	Alkalinity HCO3-, mg/L	d2H	d18O	d13C	Radon-222		Dissolved Calcium	Dissolved Magnesium	Dissolved Sodium	Dissolved Potassium	Dissolved Chloride	Dissolved Sulfate (SO4)	Carbonate	Bicarbonate	Calculated Total Dissolved Solids
Fall Sampling Program																				
Aline Sites																				
Surface water	Sheep River	14-Nov-23	8.266	369.21	130	-150.07	-19.58	-3.94	58	29	55.7	17	1.5	0.4	0.7	83.7	<6	156	236
Surface water	Highwood River	14-Nov-23	8.304	361.35	170	-149.04	-19.33	-7.42	830	138	61.2	15.2	2.4	0.5	0.5	60.4	<6	194	236
Highwood and Sheep River Project- Provincial Monitoring Sites																				
Surface Water	Highwood River near the mouth	05-Oct-23	-	-	-	-144.99	-18.98	-5.81	463	54	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River D/S High River	05-Oct-23	-	-	-	-145.27	-19.12	-5.85	593	79	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River at Hwy 2	05-Oct-23	-	-	-	-146.59	-19.07	-7.22	245	44	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River near Diamond Valley	05-Oct-23	-	-	-	-147.23	-19.52	-4.37	343	47	-	-	-	-	-	-	-	-	-
Surface Water	Highwood river near the mouth	02-Nov-23	-	-	-	-146.47	-19.24	-6.42	449	219	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River D/S High River	02-Nov-23	-	-	-	-145.92	-19.01	-6.34	183	134	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River at hwy 2	02-Nov-23	-	-	-	-146.96	-19.13	-7.47	300	175	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River near Diamond Valley	02-Nov-23				-147.42	-19.43	-4.54	50	75	-	-	-	-	-	-	-	-	-
Precipitation																				
Precipitation	Sheep River Precipitation Station	14-Nov-23	-	-	-	-154.3	-20.5	-13.0	-	-	-	-	-	-	-	-	-	-	-
	Highwood River Precipitation Station	14-Nov-23	-	-	-	-158.9	-21.5	-13.5	-	-	-	-	-	-	-	-	-	-	-
	Okotoks Precipitation Station	15-Nov-23	-	-	-	-148.8	-19.6	-13.1	-	-	-	-	-	-	-	-	-	-	-
	High River Precipitation Station	15-Nov-23	-	-	-	-129.4	-17.0	-25.0	-	-	-	-	-	-	-	-	-	-	-
Springs in Little Bow																				
Surface Water	Bow River spring u/s	22-Nov-23	7.73	647.66	160	-129.17	-16.68	-13.50	1776	77	51.4	4.9	54.2	8.8	93.3	3.4	<6	183	306
Surface Water	Bow River spring middle	22-Nov-23	7.709	583.46	260	-144.88	-18.76	-12.06	2835	96	94.6	21.8	16.6	2.1	14.8	57.3	<6	344	376
Surface Water	Bow River spring d/s	22-Nov-23	7.843	836.68	340	-143.79	-18.48	-12.42	1697	115	128	32.0	37.9	3.0	44.7	100	<6	422	553
Springs																				
Surface Water	Blue Rock Spring	14-Nov-23	7.588	652.03	340	-144.06	-18.45	-9.96	11281	235	85.9	46.0	16.2	2.2	0.7	103	<6	416	459
Surface Water	Tongue Creek Mid	15-Nov-23	8.248	740.78	400	-139.95	-17.47	-9.62	9787	251	77.4	43.1	41.5	3.4	15.8	31.4	<6	496	457
Okotoks																				
Surface Water	U1	29-Nov-23	8.478	440.69	190	-148.05	-19.32	-6.98	557	98	72.1	19.4	8.9	1.1	4.0	79.8	<6	232	300
Surface Water	D3	15-Nov-23	8.262	466.55	210	-148.55	-19.22	-6.99	1556	100	70.9	19.1	8.6	1.1	3.5	77.4	<6	230	294
Surface Water	D4	29-Nov-23	8.366	451.28	180	-148.27	-19.42	-7.40	1069	76	74.0	20.2	11.6	1.2	5.2	79.5	<6	245	312
Groundwater	Production Well #1	29-Nov-23	7.625	494.93	220	-148.4	-19.3	-9.8	573	40	72.4	18.7	14.4	1.5	11.1	71.6	<6	248	312
Groundwater	Production Well #2	29-Nov-23	7.553	487.49	250	-150.9	-19.3	-10.1	-	-	75.0	19.8	12.3	1.3	8.3	70.6	<6	263	317
Groundwater	Production Well #12	29-Nov-23	7.456	611.99	340	-148.9	-19.3	-12.3	21515	1617	96.5	21.2	17.9	1.8	13.8	62.9	<6	358	390
Groundwater	Observation Well #6	30-Nov-23	7.673	453.03	180	-149.1	-19.4	-9.3	6537	822	73.0	18.1	7.2	1.3	3.2	72.7	<6	240	294
Groundwater	Observation Well #96-2	30-Nov-23	7.49	621.32	230	-147.8	-19.3	-10.1	10938	1070	71.2	17.8	11.3	1.3	3.2	65.3	<6	248	292
Groundwater	Okotoks Borehole #3	30-Nov-23	7.623	555.34	270	-149.3	-19.2	-12.2	24210	1645	82.7	22.2	19.1	2.3	10.8	55.8	<6	334	358

Type of location	Sample Location	Sampling Date	Field parameters			Isotopes					Routine									
			pH	Electrical Conductivity at 25 °C µS/cm	Alkalinity HCO3-, mg/L	d2H	d18O	d13C	Radon-222		Dissolved Calcium	Dissolved Magnesium	Dissolved Sodium	Dissolved Potassium	Dissolved Chloride	Dissolved Sulfate (SO4)	Carbonate	Bicarbonate	Calculated Total Dissolved Solids
High River																				
Groundwater	Well 1	15-Nov-23	7.782	515.12	260	-148.8	-19.1	-10.8	-	-	87.1	21.0	8.8	1.3	8.0	51.5	<6	311	331
Groundwater	Well 3	15-Nov-23	7.717	531.26	300	-148.4	-19.1	-11.7	8044	950	94.8	21.8	8.0	1.3	3.3	48.4	<6	356	353
Groundwater	High River Monitoring Well 1	22-Nov-23	7.73	647.66	310	-147.6	-19.1	-12.6	14319	1347	79.3	21.6	48.8	1.9	20.9	60.0	<6	376	418
Groundwater	High River Monitoring Well 2	29-Nov-23	-	-	-	-147.7	-19.3	-5.6	-	-	25.4	12.3	4.6	2.0	2.0	14	<6	134	126
Groundwater	High River Monitoring Well 3	15-Nov-23	7.761	510.52	260	-148.3	-19.0	-10.9	9466	994	76.2	20.2	12.2	1.5	11.3	46.7	<6	290	311
Foothills County																				
Groundwater	Diamond Valley Well #5	29-Nov-23	7.873	463.59	190	-147.4	-19.3	-8.2	7407	211	74.6	17.9	6.3	0.9	1.6	97.3	<6	220	307
Groundwater	Square Butte Ranch W3	28-Nov-23	7.155	474.81	280	-141.4	-18.1	-14.8	21044	1929	73.7	28.4	15.6	1.4	26.6	19	<6	343	334
Groundwater	Green Haven	28-Nov-23	8.075	898.47	380	-149.3	-19.3	-11.6	36805	2465	41.5	14.9	183	2.3	5.1	188	<6	459	661
Groundwater	Ravencrest	28-Nov-23	8.249	1161.2	360	-144.6	-18.4	-12.1	13152	1422	41.2	19.7	209	1.8	159	42.4	<6	457	698
Surface Water	Longview, Highwood River	29-Nov-23	7.858	368.96	190	-148.4	-19.4	-6.3	2794	427	65.4	15.2	4.9	0.8	0.8	62.7	<6	206	251
Winter Sampling Program																				
Highwood and Sheep River Project- Provincial Monitoring Sites																				
Surface Water	Highwood river near the mouth	07-Dec-23	-	-	-	-148.61	-19.34	-6.17	834	300	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River D/S High River	07-Dec-23	-	-	-	-148.30	-19.25	-6.33	372	198	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River at hwy 2	07-Dec-23	-	-	-	-148.61	-19.46	-7.15	102	102	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River near Diamond Valley	07-Dec-23	-	-	-	-150.01	-19.44	-4.90	333	111	-	-	-	-	-	-	-	-	-
Surface Water	Highwood river near the mouth	09-Jan-24	-	-	-	-149.85	-19.59	-7.31	354	212	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River D/S High River	09-Jan-24	-	-	-	-148.98	-19.56	-7.34	255	184	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River at hwy 2	09-Jan-24	-	-	-	-149.03	-19.45	-8.75	1368	417	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River near Diamond Valley	09-Jan-24	-	-	-	-149.69	-19.72	-5.60	839	327	-	-	-	-	-	-	-	-	-
Surface Water	Highwood river near the mouth	07-Feb-24	-	-	-	-153.70	-19.96	-8.53	471	290	-	-	-	-	-	-	-	-	-
Surface Water	Highwood River D/S High River	07-Feb-24	-	-	-	-148.49	-19.48	-7.61	1097	434	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River at hwy 2	07-Feb-24	-	-	-	-150.43	-19.69	-8.80	298	236	-	-	-	-	-	-	-	-	-
Surface Water	Sheep River near Diamond Valley	07-Feb-24	-	-	-	-148.68	-19.66	-5.90	482	229	-	-	-	-	-	-	-	-	-

Table S2: Coordinates of the sampling locations currently sampled within the study and additional sites shared by the participating municipalities in the HRSR watersheds.

Town	Site ID	Type of Sampling Site	Latitude	Longitude
Alpine Sites	Sheep River	SW	50.60745556	-114.7277028
	Highwood River	SW	50.39095278	-114.58185
Provincial Monitoring Locations	Highwood River near Mouth	SW	50.78280556	-113.8230556
	Highwood River d/s High River	SW	50.6016502	-113.8583669
	Sheep River at Hwy 2	SW	50.70913889	-113.8891944
	Sheep River near Diamond Valley	SW	50.69713889	-114.2349167
Springs in Little Bow	Bow Spring Stream u/s	SW	50.577492	-113.866501
	Bow Spring Stream middle	SW	50.573905	-113.86572
	Bow Spring Stream d/s	SW	50.569781	-113.858925
Springs	Blue Rock Spring	SW	50.619725	-114.400444
	Tongue Creek	SW	50.596219	-114.302017
Okotoks	U1	SW	50.71620833	-114.0716889
	U2	SW	50.728133	-114.006004
	D3	SW	50.723144	-113.975472
	D4B	SW	50.715077	-113.947019
	D5	SW	50.703687	-113.904764
	Production Well #1	GW	50.72218886	-113.9763649
	Production Well #2	GW	50.72231702	-113.9749952
	Production Well #3	GW	50.72280693	-113.9746019
	Production Well #4	GW	50.72209587	-113.9738287
	Production Well #5	GW	50.72393212	-113.9753104
	Production Well #6	GW	50.7211008	-113.9756156
	Production Well #7	GW	50.7257466	-113.9993139
	Production Well #8	GW	50.72587718	-113.9995807
	Production Well #9	GW	50.7250403	-113.9970013
	Production Well #10	GW	50.72584146	-113.9982227
	Production Well #11	GW	50.72259221	-113.9744621
	Production Well #12	GW	50.72096101	-113.9740802
	Production Well #13	GW	50.72344669	-113.9777317
	Observation Well #6	GW	50.725571	-113.997184
	Observation Well #96-2	GW	50.724688	-113.995259
	Okotoks Borehole #3	GW	50.723039	-113.972581

Town	Site ID	Type of Sampling Site	Latitude	Longitude
High River	Well 1	GW	50.57817	-113.86978
	Well 3	GW	50.5767	-113.87039
	High River Monitoring Well 1	GW	50.573905	-113.86572
	High River Monitoring Well 2	GW	50.5795116	-113.8791111
	High River Monitoring Well 3	GW	50.5819855	-113.8685653
Foothills County	Priddis Greens WTP, Priddis Creek	SW	50.8980408	-114.4106276
	Fish Creek Ranch, Fish Creek	SW	50.87711428	-114.5319745
	Diamond Valley Well #7	GW	50.6696	-114.27295
	Diamond Valley Well #5	GW	50.668156	-114.275061
	Square Butte Ranch W3	GW	50.78935521	-114.5150166
	Green Haven	GW	50.72181171	-113.9322146
	Red Deer Lake School	GW	50.88702225	-114.1651381
	Blackie	GW	50.60637825	-113.6247541
	Ravencrest	GW	50.70666625	-113.8800911
	Heritage Heights School	GW	50.80591591	-113.9375639
	Cottonwood	GW	50.84922778	-113.8711634
	Longview, Highwood River	SW	50.52471734	-114.2356693

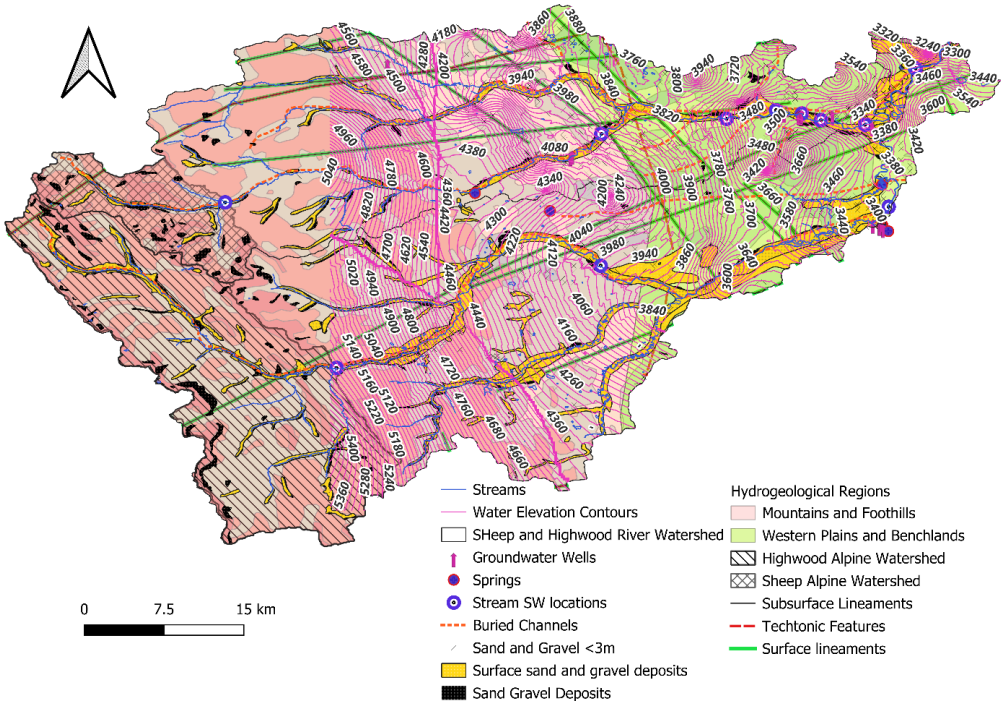


Figure S1. Groundwater elevation contours (feet above sea level) based on well data.

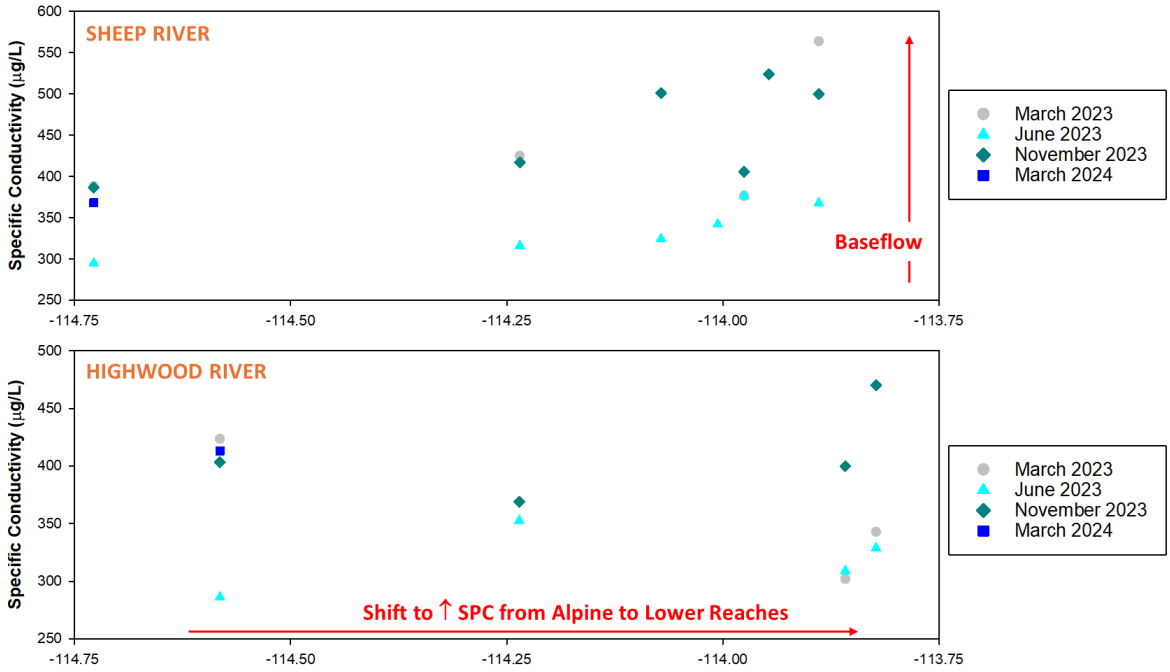


Figure S2. West to east synoptic Specific Conductivity (SPC) trends along Sheep and Highwood River surface waters from alpine headwaters to low latitude eastern reaches over a hydrological sampling year.

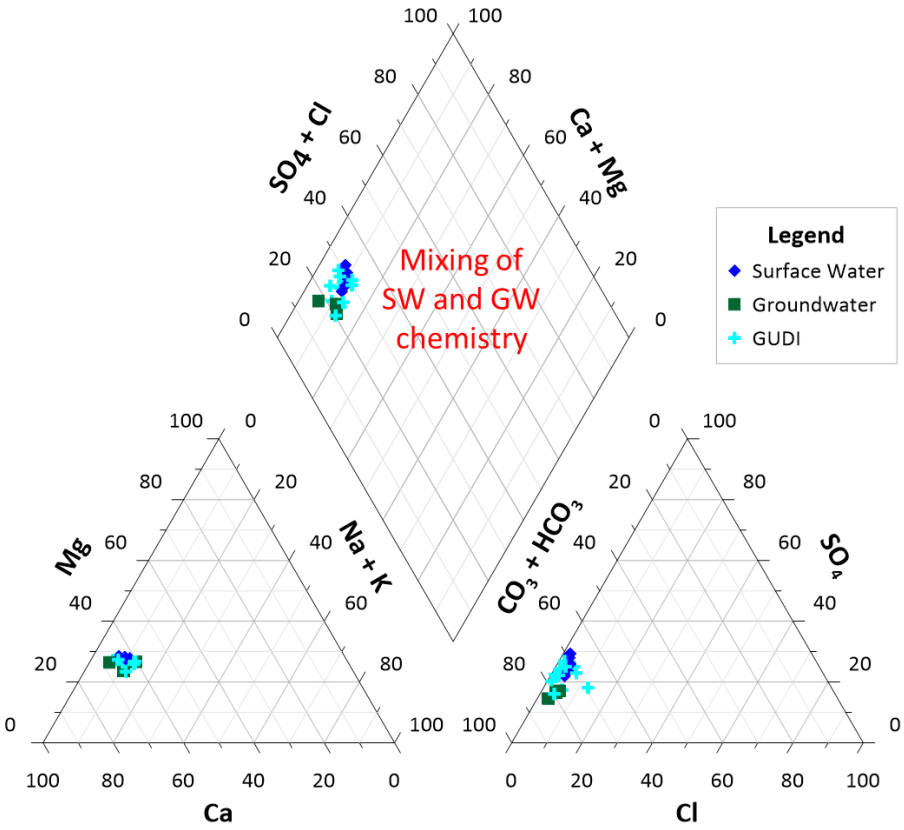


Figure S3. Piper Plot showing the range of major ions in the Okotoks surface water and groundwater sampling stations over the sampled hydrological time period from March 2023-April 2024. The figure shows the influence of surface water input in the GUDI (groundwater under direct influence of surface water) wells.

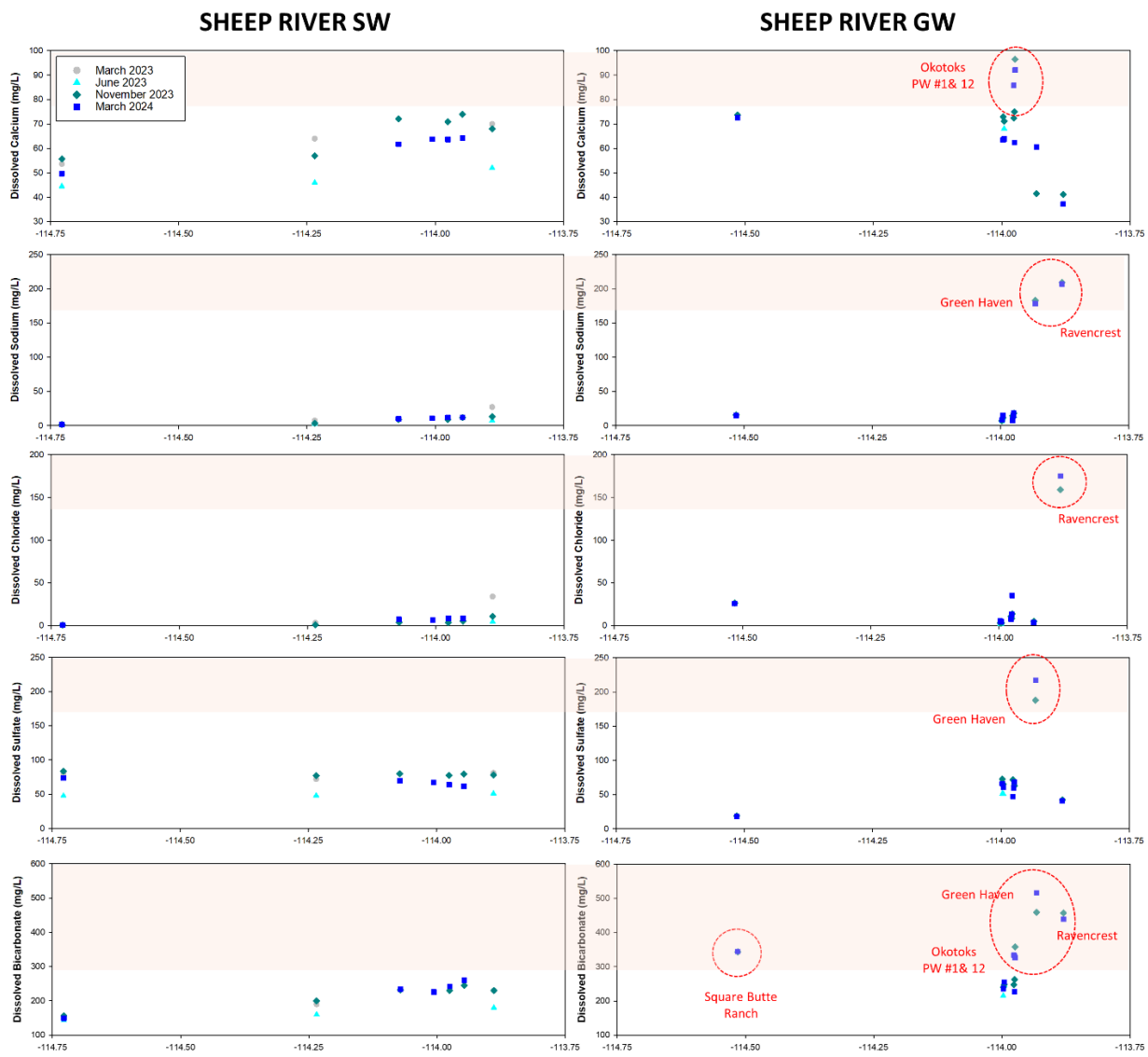


Figure S4. West to east synoptic trends for major ions (Calcium, Sodium, Chloride, Sulfate, and Bicarbonate) along Sheep River groundwater and surface waters from alpine headwaters to low latitude eastern reaches over a hydrological sampling year.

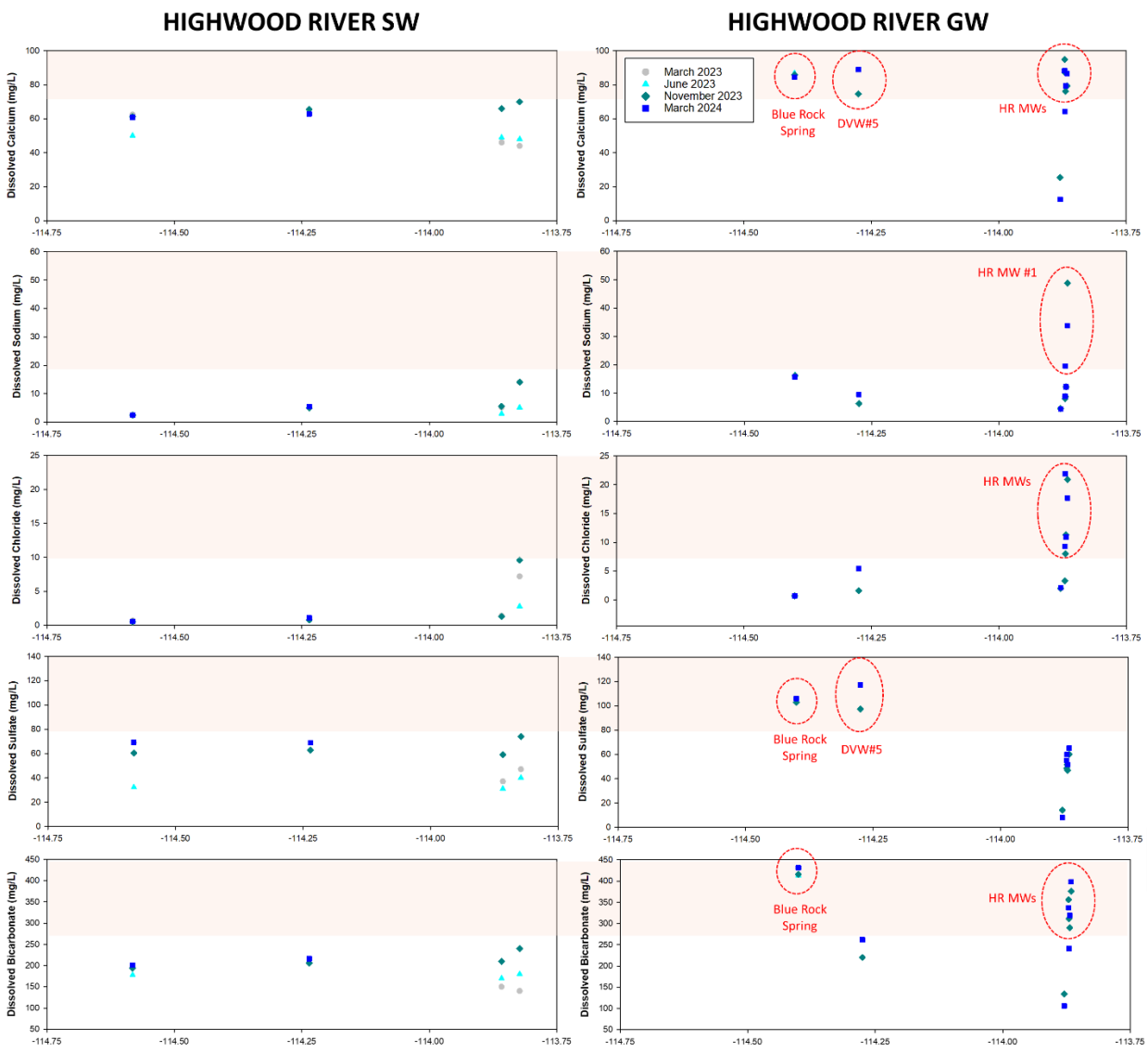


Figure S5. West to east synoptic trends for major ions (Calcium, Sodium, Chloride, Sulfate, and Bicarbonate) along the Highwood River groundwater and surface waters from alpine headwaters to low latitude eastern reaches over a hydrological sampling year.

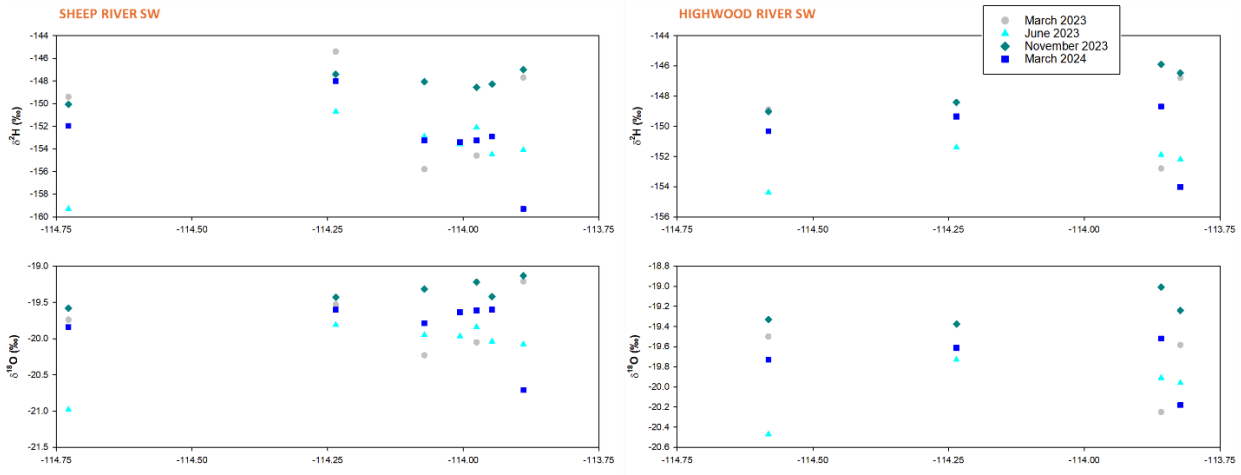


Figure S6. Sheep and Highwood River $\delta^{2}H$ and $\delta^{18}O$ isotopic signatures along a longitudinal gradient from Western to Eastern portions of the watershed outlined for both groundwater and surface water sampling stations.

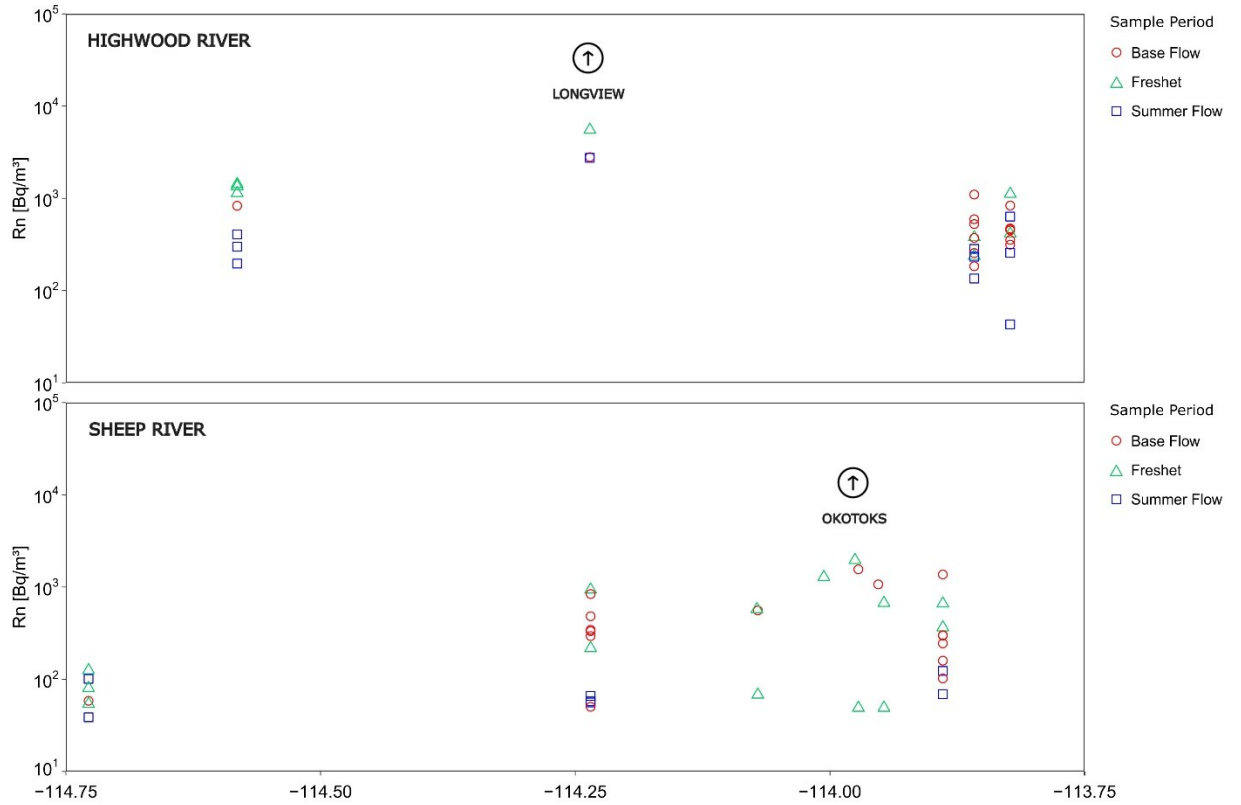


Figure S7. West to east synoptic Radon concentration trends along the Highwood (top) and Sheep River (bottom) surface waters from alpine headwaters to low latitude eastern reaches over a hydrological sampling year. The upward arrow indicates locations where significant increases in Radon concentration were observed.

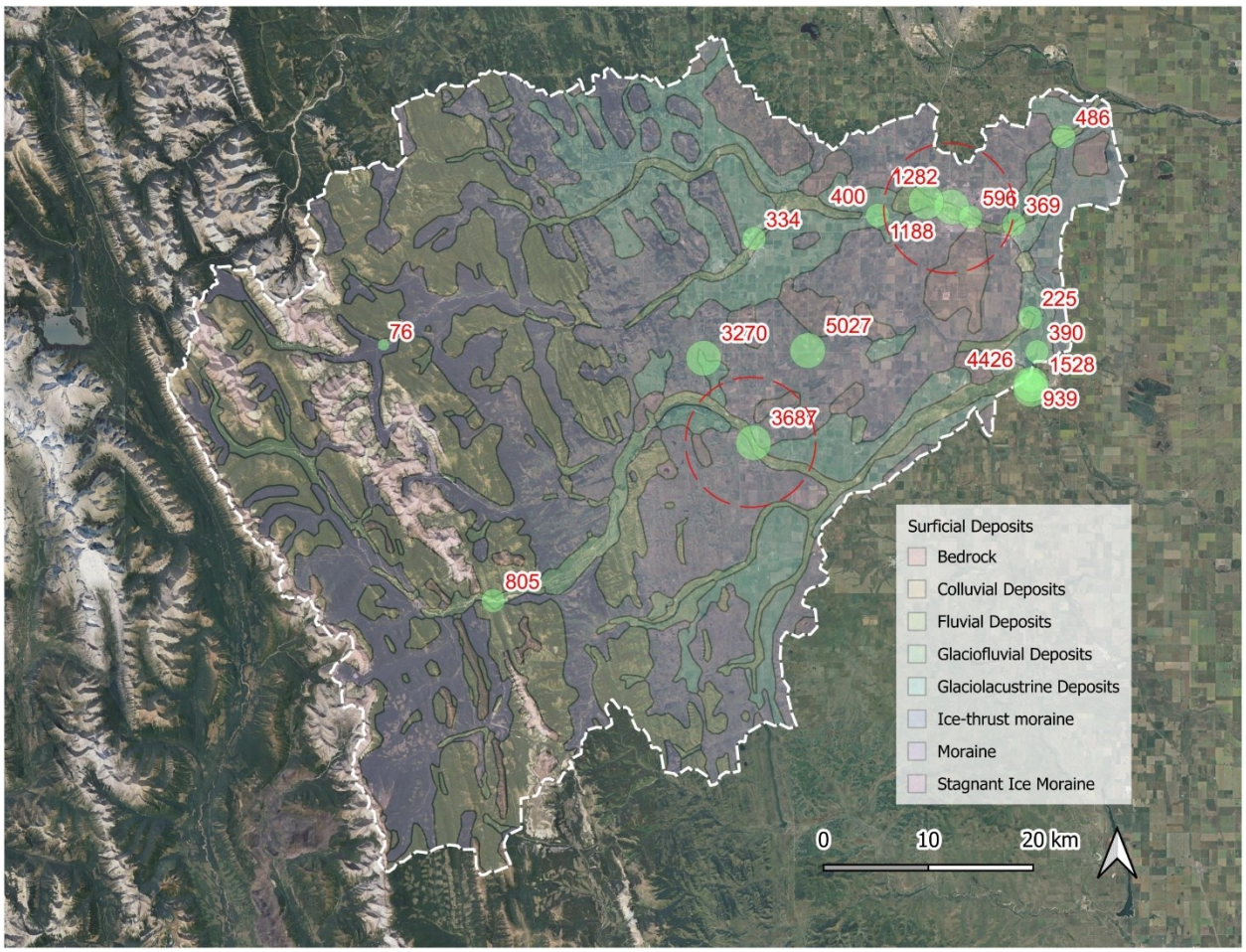


Figure S8. Average Radon concentration (Bq/m^3) measured in samples collected from surface water in rivers and streams plotted on the surficial deposits map. The red dashed circles indicate areas where significant groundwater and surface water interactions are potentially occurring.

Additional geochemical analysis details are outlined below:

The geochemical analysis included the characterization of major and minor ions. Isotope samples collected during winter, spring freshet, summer and fall seasons over one hydrologic year included the following tracers:

i) **Deuterium (δ^2H) and Oxygen ($\delta^{18}O$) stable isotopes** were analyzed for hydrograph separation and source component partitioning (rainfall, groundwater, surface water and snowmelt; [15]. Isotopes of water were analyzed by isotope ratio mass spectrometry using Thermo Scientific Delta V Advantage. Oxygen was prepared using a Gasbench II by equilibrating water and CO_2 and then introducing CO_2 into the dual inlet using an autosampler [38]. Hydrogen was analyzed by auto-injecting water into a chromium reactor heated to 875°C in the HDevice to produce H_2, which was streamed to the dual inlet for analysis [39]. Results are reported in "δ" notation in permil (‰) relative to Vienna Standard Mean Ocean Water (V-SMOW) and normalized to the SMOW-SLAP scale where SLAP is Standard Light Arctic Precipitation [40]. Analytical uncertainty is estimated to be better than ±0.2 ‰ for $\delta^{18}O_{H2O}$ and ±1 ‰ for δ^2H_{H2O}.

ii) **Carbon isotopes ($\delta^{13}C$) in dissolved inorganic carbon** were analyzed to differentiate between water recharged in the soil or in deeper aquifer systems. $^{13}C/^{12}C$ in dissolved inorganic carbon, $\delta^{13}C$-DIC was analyzed using an established method on a Delta V Advantage mass spectrometer, and a GasBench II peripheral. In brief, water samples were added to a helium-flushed vial and then acidified. CO_2 released by the acid was allowed to equilibrate between the headspace and solution. A CTC Analytics autosampler was then used to sample the headspace and interface to the GasBench II, where multiple injections of the sample carbon (as CO_2) were measured versus pure CO_2 monitoring gas. In-house standards, established by runs with NBS18, NBS19 and LSVEC, were run routinely as samples to allow the results to be reported vs Vienna Pee Dee Belemnite (VPDB). Results are accurate to ± 0.3‰.

iii) **Radon (222Rn) isotope concentration** in rivers and groundwater samples was used to identify and quantify the amount and timing of groundwater inflows to the rivers [22] and to facilitate mapping of groundwater-surface water interactions. Radon-222 was measured using Durridge RAD-7 units. The Durridge RAD-7 units were combined with other specialized attachments (Rad H2O and Big Bottle System), which agitate the radon gas out of water samples, allowing for the quantification of dissolved radon gas concentrations in water. The measurement accuracy is within ±5% and is corrected for relative humidity ranging from 0% - 100%.