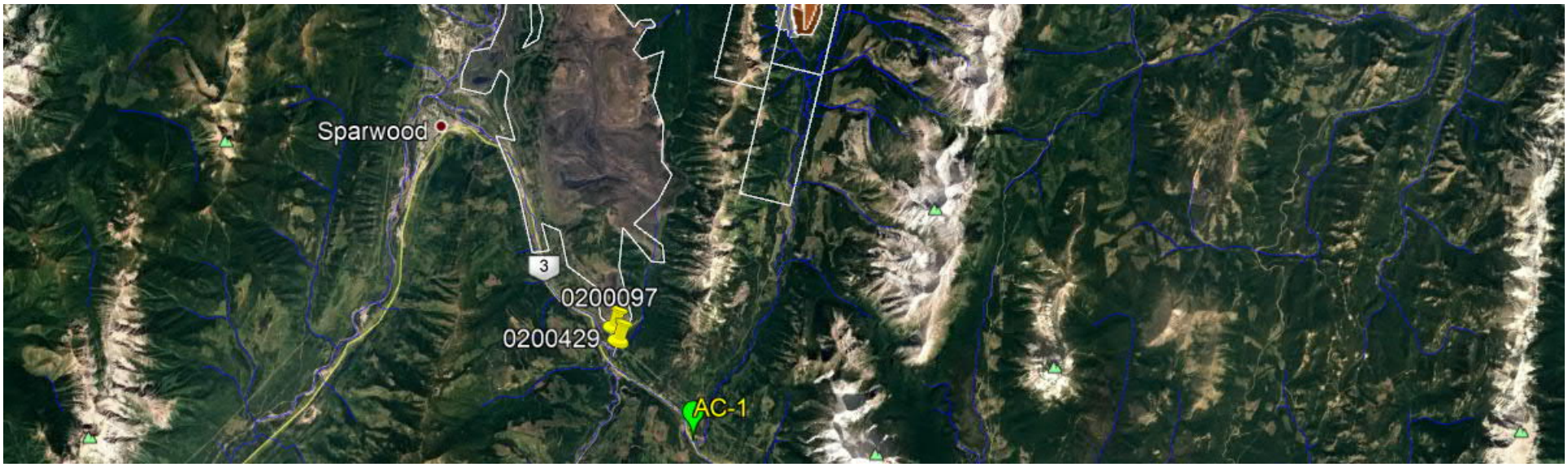
Appendix 11-I

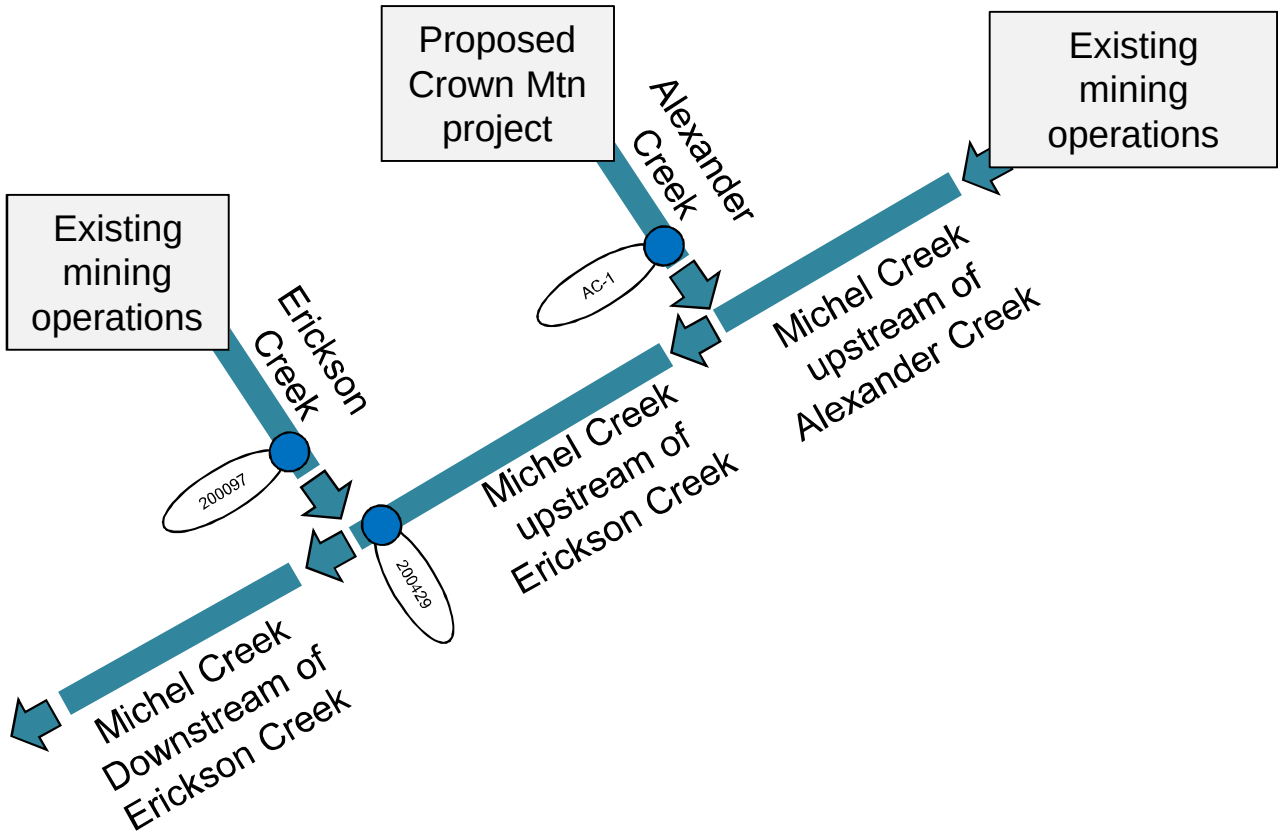
Mass Comparison of Nitrate, Selenium, and Sulphate Contributions in Michel Creek



Crown Mountain Mass Comparison

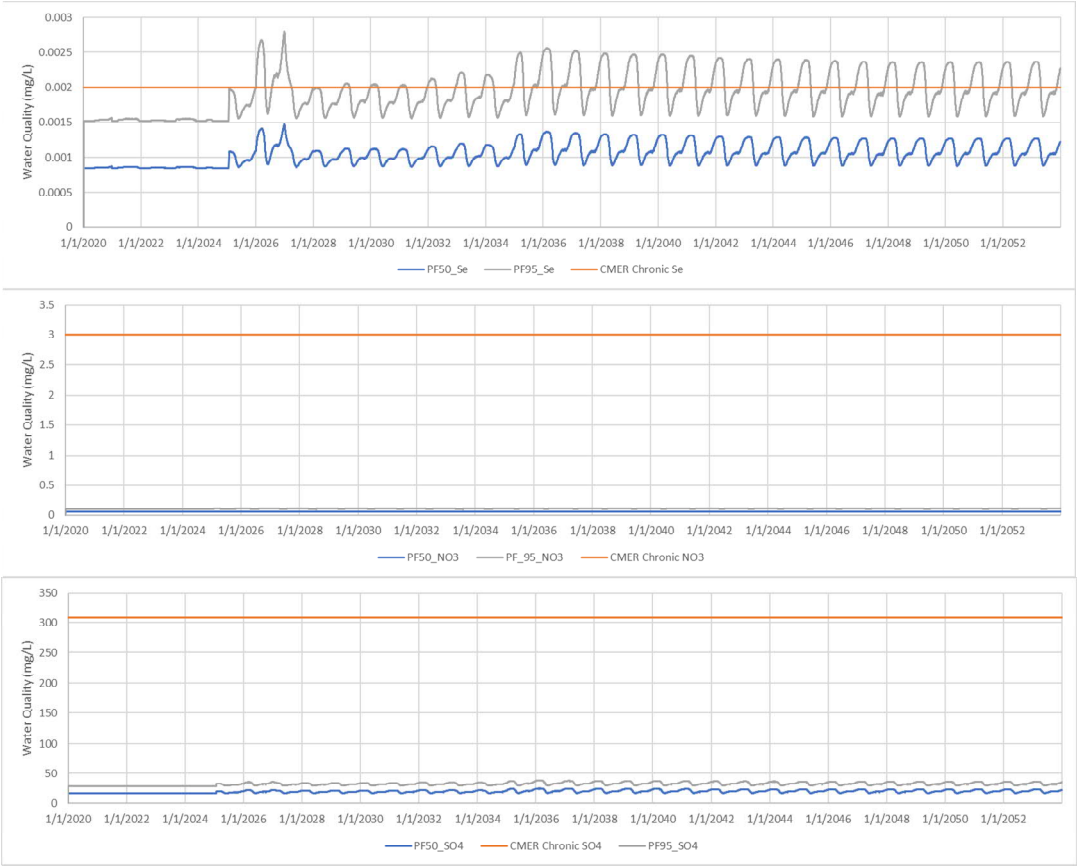
srk consulting

Stream Configuration



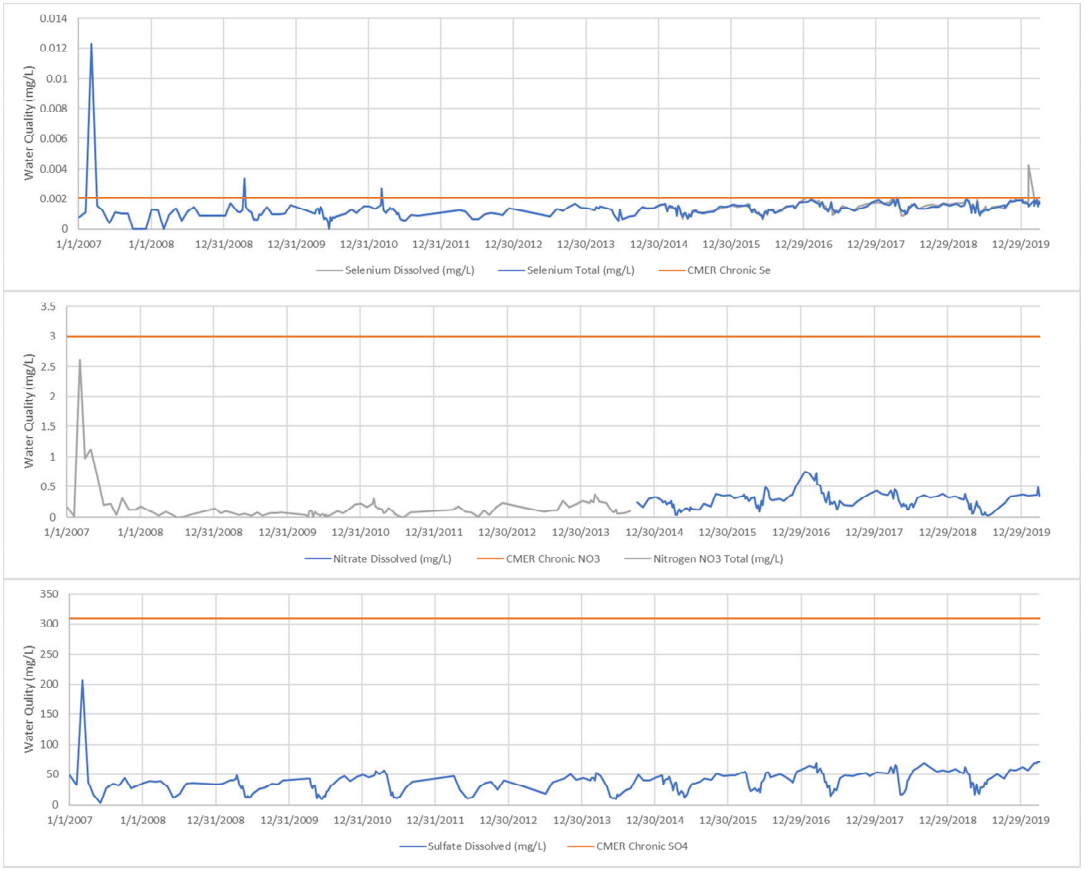
Alexander Creek Water Quality

- Water Quality extracted from Goldsim Predictive model
- Name: *Alexander Creek*
- ID: *AC_1*
- PF50: 50th Percentile layering succeeds
- PF95: 95th Percentile layering succeeds



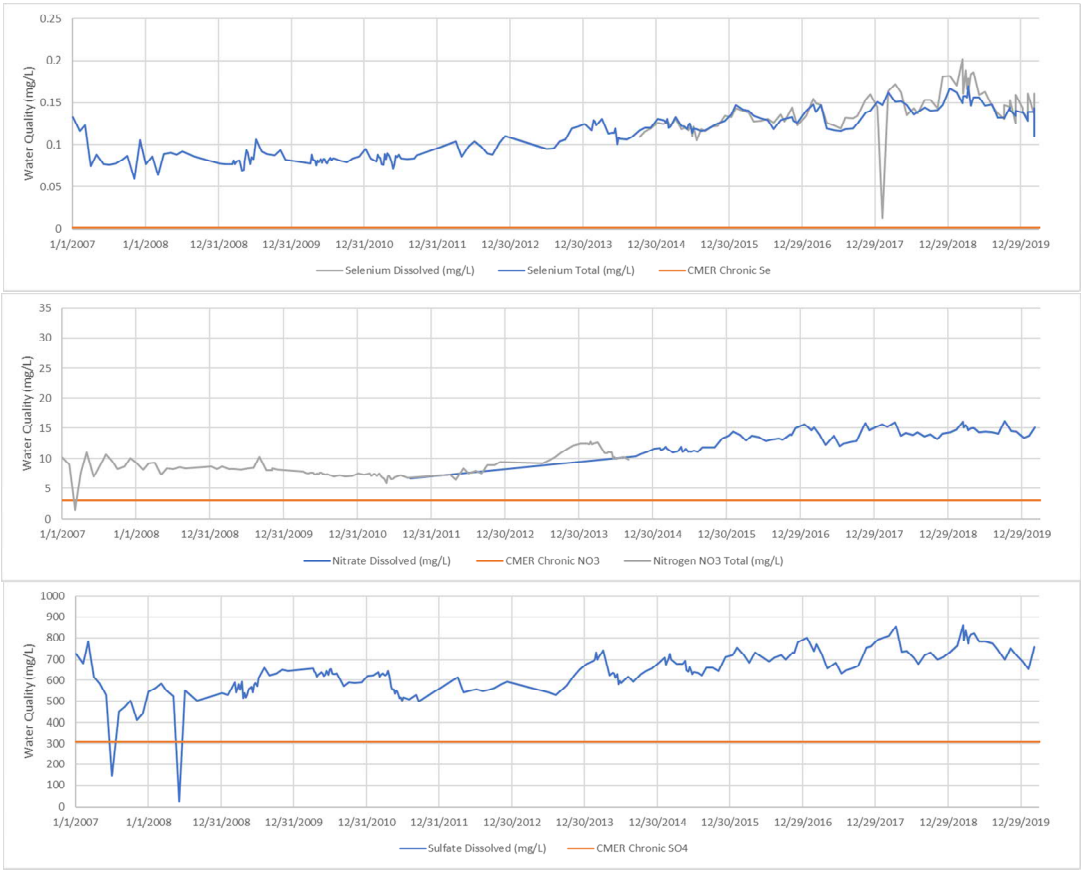
Michel Creek Water Quality

- Water Quality extracted from BCWaterTools.ca
- Name: *Michel Creek above Erickson Creek*
- ID: *0200203*
- Description: *Michel Creek immediately upstream of confluence with Erickson Creek*



Erickson Creek Water Quality

- Water Quality extracted from BCWaterTools.ca
- Name: *Evcc -Elkview (PE425) Erickson Creek at Mouth*
- ID: *0200097*
- Description: *Erickson Creek at confluence with Michel Creek*

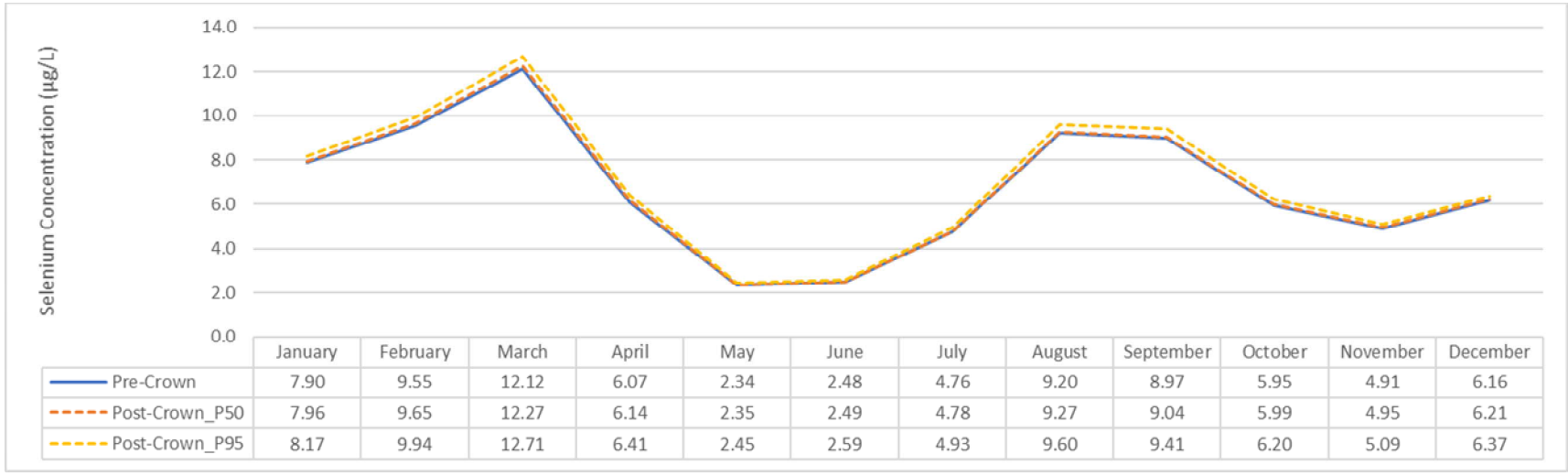


Methodology

1. From BC Water Tools or the Crown Mountain predictive model, obtain monthly average flowrate (Q) and water quality (WQ_{act}) for:
    a. Erickson Creek at the discharge to Michel Creek, and
    b. Alexander Creek at the discharge to Michel Creek.
    c. Michel Creek above Erickson Creek discharge
2. Determine actual mass flux (M_{act}) at each point $M_{act} = Q \times WQ_{act}$
3. Assume chemical mass from natural runoff based on reported flowrate and assumed background water quality (from predictive model) $M_{nat} = Q \times WQ_{nat}$
    i. Nitrate: .05 mg/L
    ii. Selenium: .000853 mg/L
    iii. Sulphate: 16.536 mg/L
4. Calculated mass added to Michel Creek at Alexander and Erickson Creek by mining operations $M_{add} = M_{act} - M_{nat}$
5. Calculated water quality of Michel Creek D/S of Erickson based on the calculated mass additions from above $WQ_{act} = {}^{M_{act}}/_{Q}$

Selenium Concentration

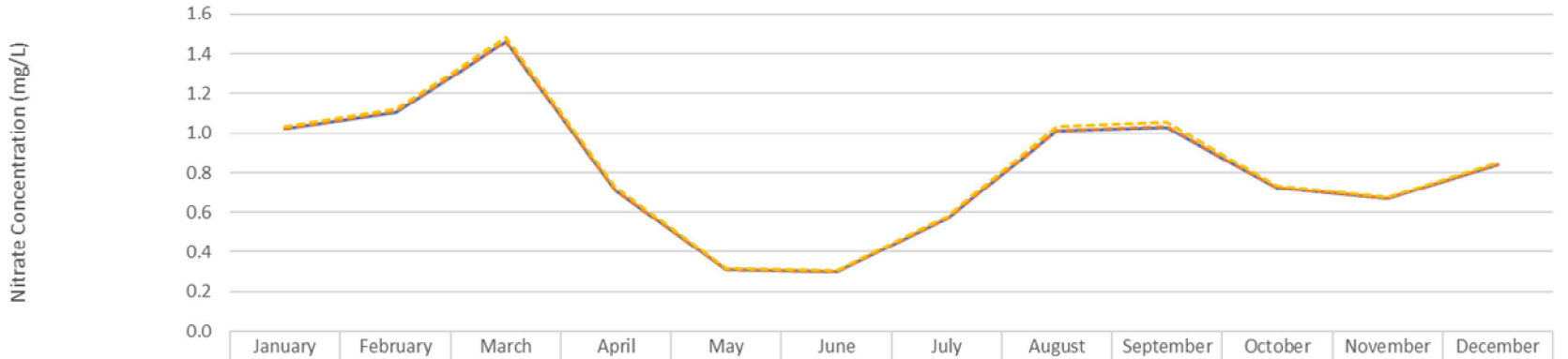
Estimate for Michel Creek D/S of confluence with Erickson Creek



	January	February	March	April	May	June	July	August	September	October	November	December
Pre-Crown	7.90	9.55	12.12	6.07	2.34	2.48	4.76	9.20	8.97	5.95	4.91	6.16
Post-Crown_P50	7.96	9.65	12.27	6.14	2.35	2.49	4.78	9.27	9.04	5.99	4.95	6.21
Post-Crown_P95	8.17	9.94	12.71	6.41	2.45	2.59	4.93	9.60	9.41	6.20	5.09	6.37

Nitrate Concentration

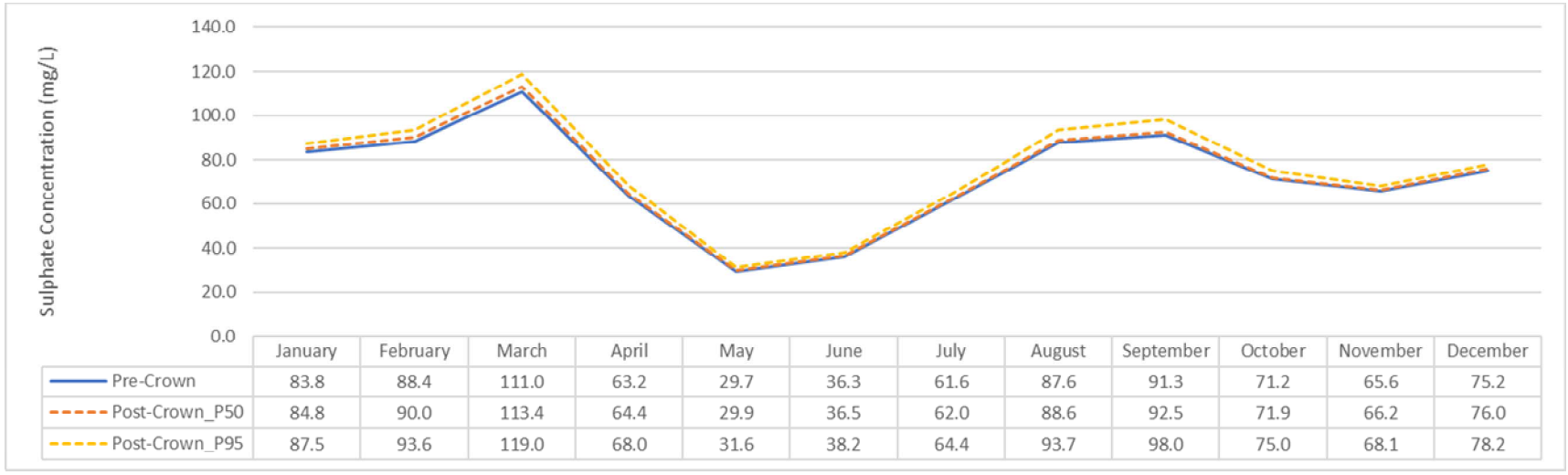
Estimate for Michel Creek D/S of confluence with Erickson Creek



	January	February	March	April	May	June	July	August	September	October	November	December
Pre-Crown	1.02	1.10	1.46	0.71	0.31	0.30	0.57	1.01	1.03	0.72	0.67	0.84
Post-Crown_P50	1.02	1.11	1.46	0.71	0.31	0.30	0.57	1.01	1.03	0.72	0.67	0.84
Post-Crown_P95	1.03	1.12	1.49	0.72	0.32	0.31	0.58	1.03	1.05	0.74	0.68	0.85

Sulphate Concentration

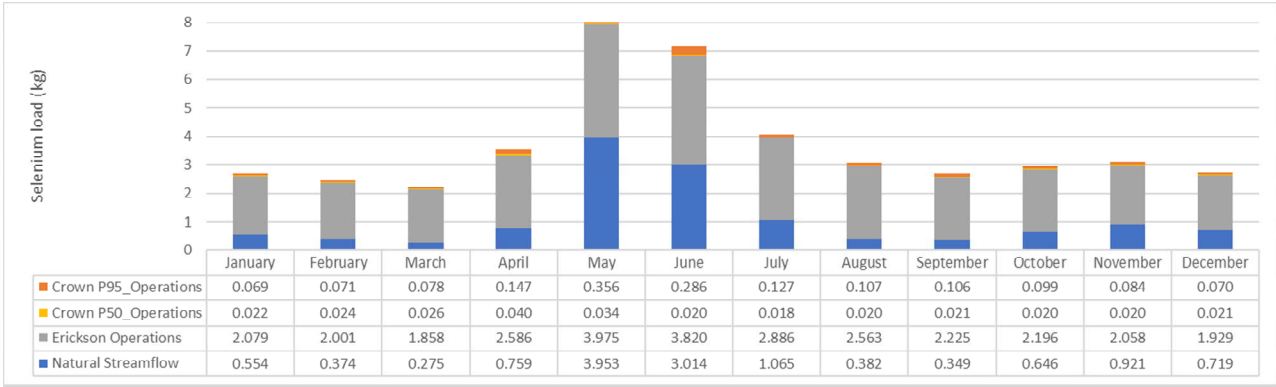
Estimate for Michel Creek D/S of confluence with Erickson Creek



	January	February	March	April	May	June	July	August	September	October	November	December
Pre-Crown	83.8	88.4	111.0	63.2	29.7	36.3	61.6	87.6	91.3	71.2	65.6	75.2
Post-Crown_P50	84.8	90.0	113.4	64.4	29.9	36.5	62.0	88.6	92.5	71.9	66.2	76.0
Post-Crown_P95	87.5	93.6	119.0	68.0	31.6	38.2	64.4	93.7	98.0	75.0	68.1	78.2

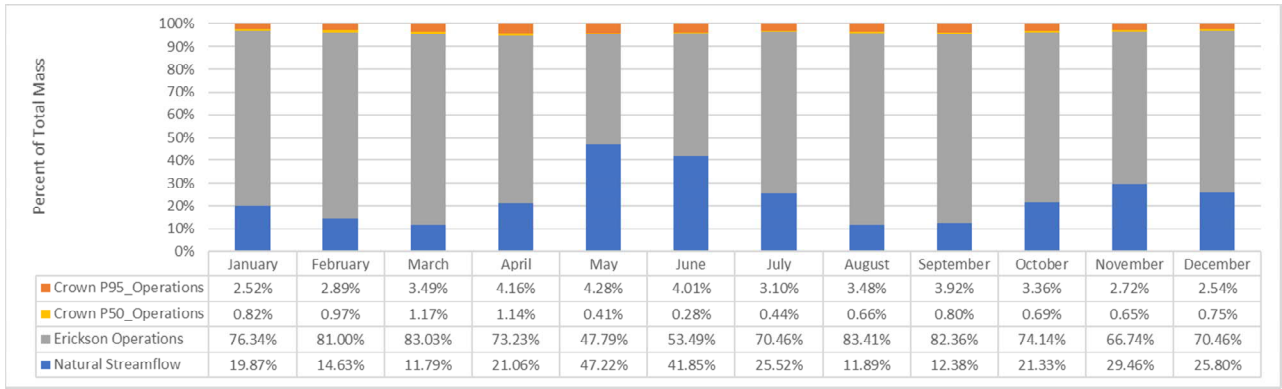
Selenium in Michel Creek

Mass Contribution



	January	February	March	April	May	June	July	August	September	October	November	December
Crown P95_Operations	0.069	0.071	0.078	0.147	0.356	0.286	0.127	0.107	0.106	0.099	0.084	0.070
Crown P50_Operations	0.022	0.024	0.026	0.040	0.034	0.020	0.018	0.020	0.021	0.020	0.020	0.021
Erickson Operations	2.079	2.001	1.858	2.586	3.975	3.820	2.886	2.563	2.225	2.196	2.058	1.929
Natural Streamflow	0.554	0.374	0.275	0.759	3.953	3.014	1.065	0.382	0.349	0.646	0.921	0.719

Percent Contribution

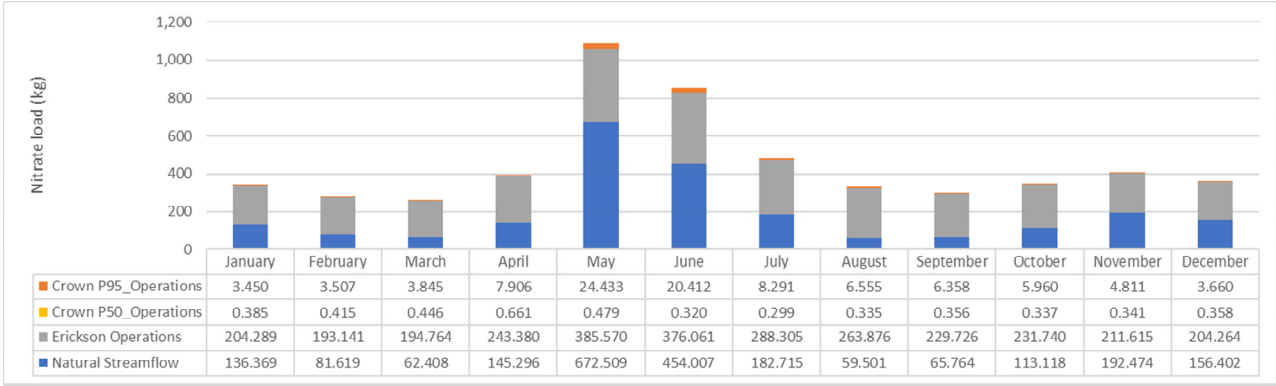


	January	February	March	April	May	June	July	August	September	October	November	December
Crown P95_Operations	2.52%	2.89%	3.49%	4.16%	4.28%	4.01%	3.10%	3.48%	3.92%	3.36%	2.72%	2.54%
Crown P50_Operations	0.82%	0.97%	1.17%	1.14%	0.41%	0.28%	0.44%	0.66%	0.80%	0.69%	0.65%	0.75%
Erickson Operations	76.34%	81.00%	83.03%	73.23%	47.79%	53.49%	70.46%	83.41%	82.36%	74.14%	66.74%	70.46%
Natural Streamflow	19.87%	14.63%	11.79%	21.06%	47.22%	41.85%	25.52%	11.89%	12.38%	21.33%	29.46%	25.80%

Contribution based off of total mass for 95th percentile water balance results, add *Crown P50_Operations* & *Crown P95 _Operations* contributions for total 95th percentile contribution from Crown Operations

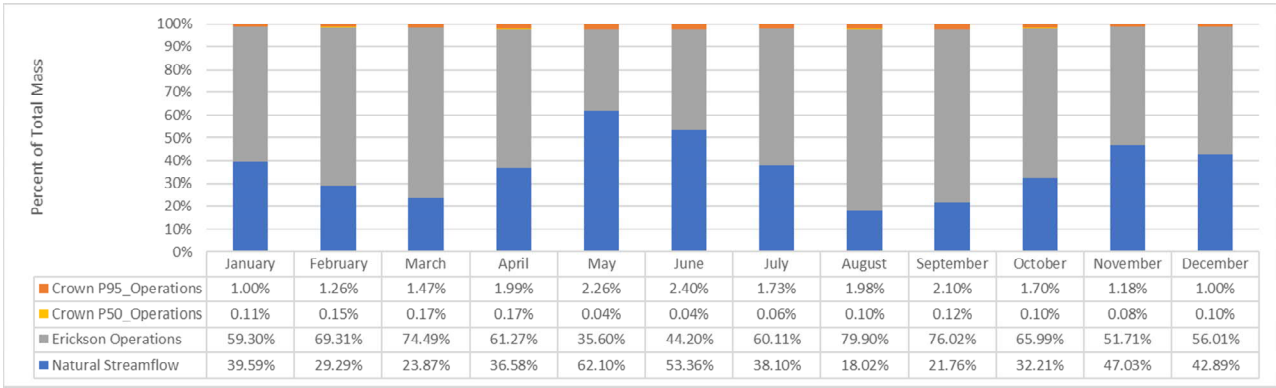
Nitrate in Michel Creek

Mass Contribution



	January	February	March	April	May	June	July	August	September	October	November	December
Crown P95_Operations	3.450	3.507	3.845	7.906	24.433	20.412	8.291	6.555	6.358	5.960	4.811	3.660
Crown P50_Operations	0.385	0.415	0.446	0.661	0.479	0.320	0.299	0.335	0.356	0.337	0.341	0.358
Erickson Operations	204.289	193.141	194.764	243.380	385.570	376.061	288.305	263.876	229.726	231.740	211.615	204.264
Natural Streamflow	136.369	81.619	62.408	145.296	672.509	454.007	182.715	59.501	65.764	113.118	192.474	156.402

Percent Contribution

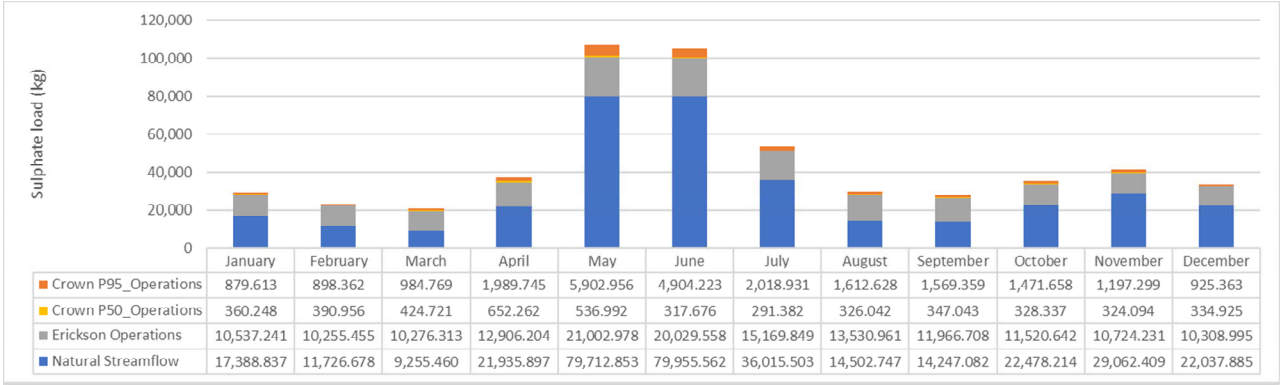


	January	February	March	April	May	June	July	August	September	October	November	December
Crown P95_Operations	1.00%	1.26%	1.47%	1.99%	2.26%	2.40%	1.73%	1.98%	2.10%	1.70%	1.18%	1.00%
Crown P50_Operations	0.11%	0.15%	0.17%	0.17%	0.04%	0.04%	0.06%	0.10%	0.12%	0.10%	0.08%	0.10%
Erickson Operations	59.30%	69.31%	74.49%	61.27%	35.60%	44.20%	60.11%	79.90%	76.02%	65.99%	51.71%	56.01%
Natural Streamflow	39.59%	29.29%	23.87%	36.58%	62.10%	53.36%	38.10%	18.02%	21.76%	32.21%	47.03%	42.89%

Contribution based off of total mass for 95th percentile water balance results, add *Crown P50_Operations* & *Crown P95 _Operations* contributions for total 95th percentile contribution from Crown Operations

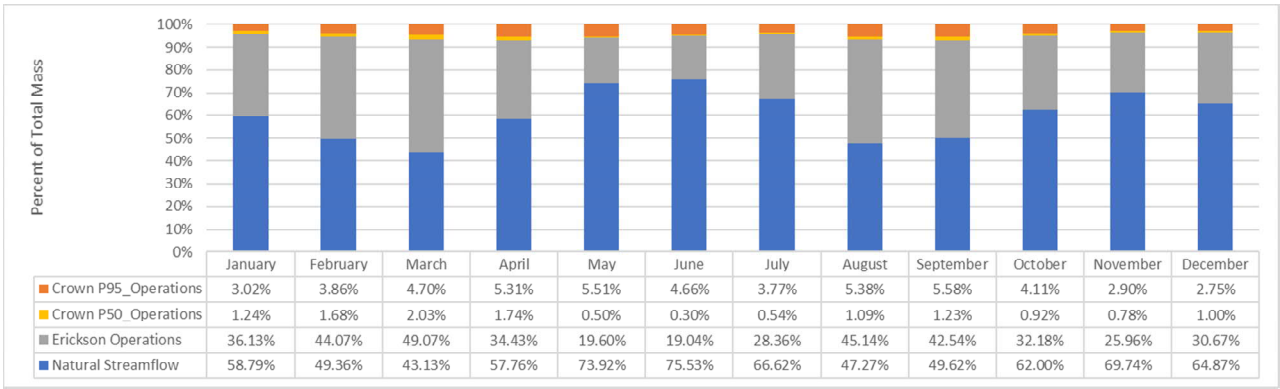
Sulphate in Michel Creek

Mass Contribution



	January	February	March	April	May	June	July	August	September	October	November	December
Crown P95_Operations	879.613	898.362	984.769	1,989.745	5,902.956	4,904.223	2,018.931	1,612.628	1,569.359	1,471.658	1,197.299	925.363
Crown P50_Operations	360.248	390.956	424.721	652.262	536.992	317.676	291.382	326.042	347.043	328.337	324.094	334.925
Erickson Operations	10,537.241	10,255.455	10,276.313	12,906.204	21,002.978	20,029.558	15,169.849	13,530.961	11,966.708	11,520.642	10,724.231	10,308.995
Natural Streamflow	17,388.837	11,726.678	9,255.460	21,935.897	79,712.853	79,955.562	36,015.503	14,502.747	14,247.082	22,478.214	29,062.409	22,037.885

Percent Contribution

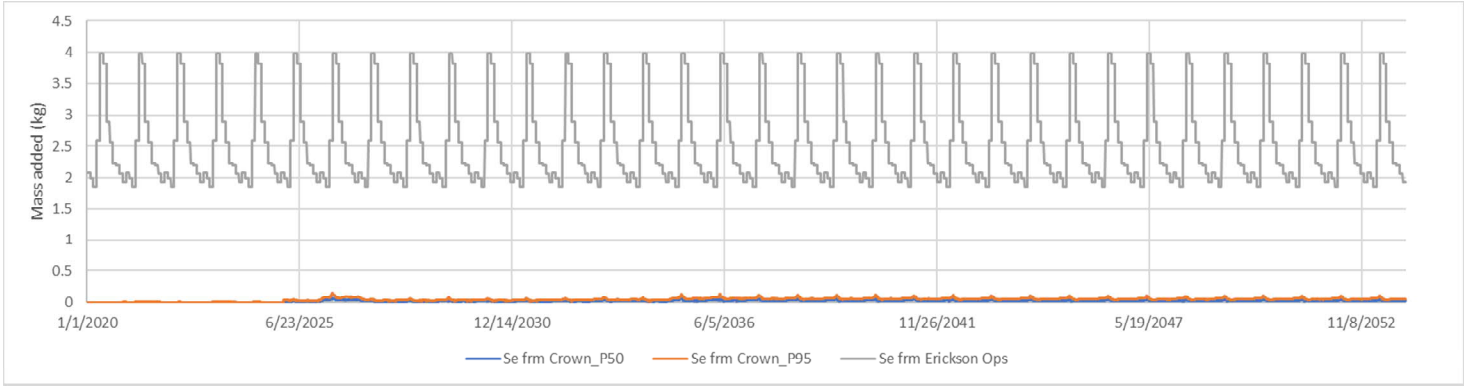


	January	February	March	April	May	June	July	August	September	October	November	December
Crown P95_Operations	3.02%	3.86%	4.70%	5.31%	5.51%	4.66%	3.77%	5.38%	5.58%	4.11%	2.90%	2.75%
Crown P50_Operations	1.24%	1.68%	2.03%	1.74%	0.50%	0.30%	0.54%	1.09%	1.23%	0.92%	0.78%	1.00%
Erickson Operations	36.13%	44.07%	49.07%	34.43%	19.60%	19.04%	28.36%	45.14%	42.54%	32.18%	25.96%	30.67%
Natural Streamflow	58.79%	49.36%	43.13%	57.76%	73.92%	75.53%	66.62%	47.27%	49.62%	62.00%	69.74%	64.87%

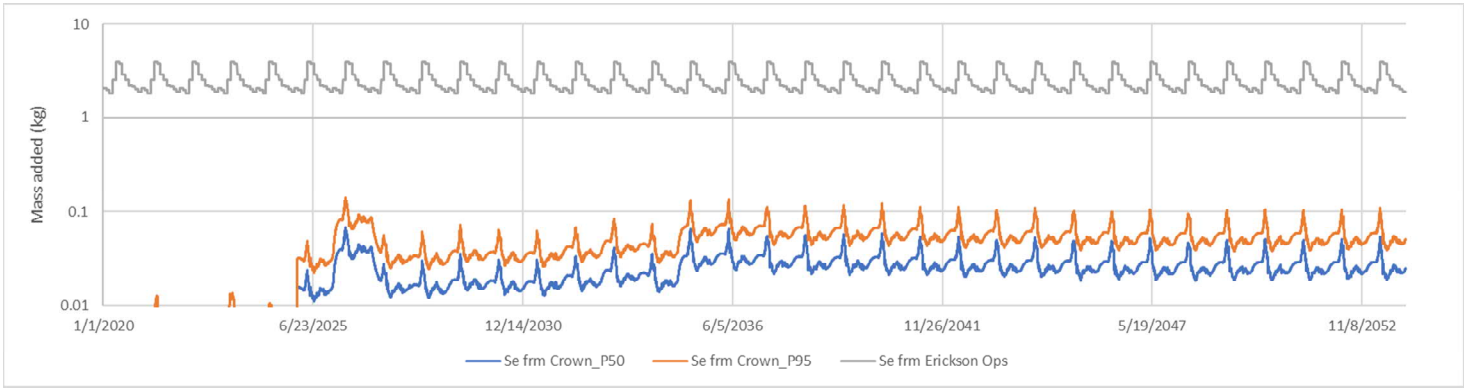
Contribution based off of total mass for 95th percentile water balance results, add *Crown P50_Operations* & *Crown P95 _Operations* contributions for total 95th percentile contribution from Crown Operations

Selenium Mass added to Michel Creek

Linear Scale

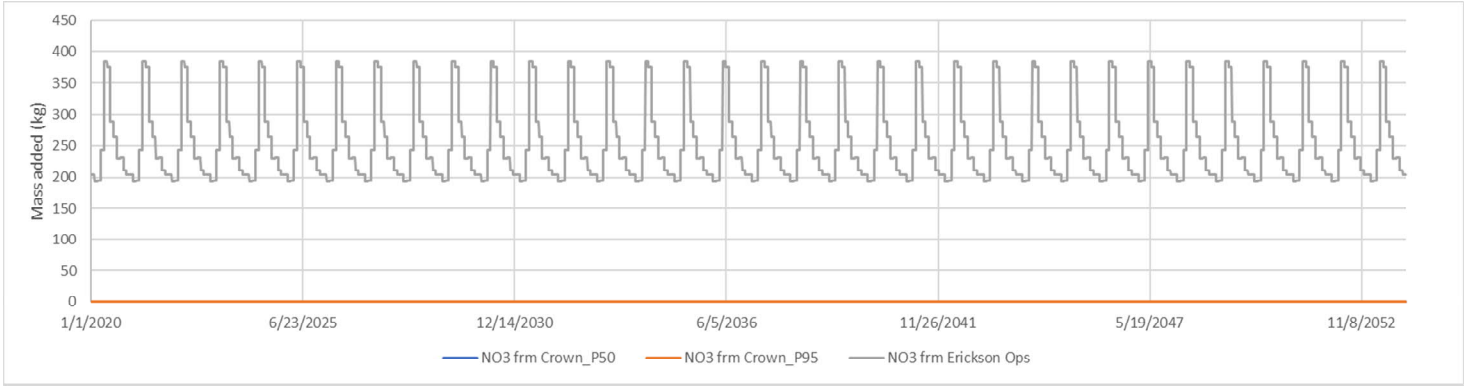


Log Scale

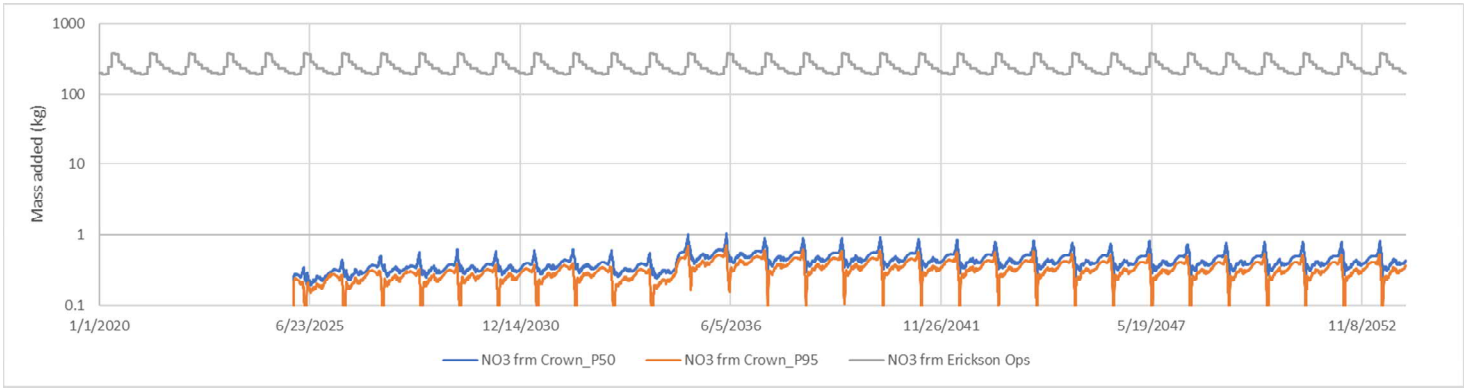


Nitrate Mass added to Michel Creek

Linear Scale

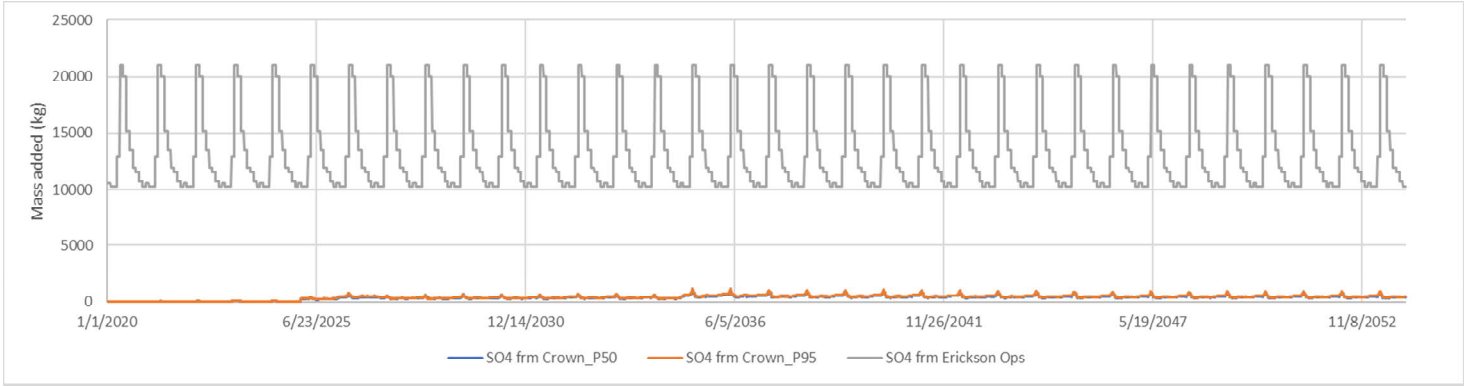


Log Scale



Sulphate Mass added to Michel Creek

Linear Scale



Log Scale